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		GOVERNMENT POLYTECHNIC 28/04/2020 SAMBALPUR (RENGALI), ODISHA		
		Lecture notes on Basic Electrical Engg.		
		1st year Electrical Engg.		

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① Fundamentals

1.1 Electric currents :-

The electric current is defined as the rate of flow of electric charge or electrons w.r.to time.

$$\text{current} = \frac{\text{charge flowing across any cross-section}}{\text{Time taken for crossing the section.}}$$

The current is the rate of flow of charges with respect to time (t)

$$\text{so } I = \frac{dq}{dt} \quad \begin{matrix}(\text{Charges}) \\ (\text{seconds})\end{matrix} \quad (\text{ampere})$$

$$\boxed{i = \frac{q}{t}}$$

i = electric current (amp)
q = charges (coulombs)
t = time (seconds)

Voltage voltage b/w two points is defined as the energy required to move one coulomb of charge from one point to another, and it is denoted by 'v'.

→ It is expressed in terms energy (w) per unit charge 'q'

$$V = \frac{W}{q}$$

$$W = Vq$$

$1e^- = 1.6 \times 10^{-19}$ coulomb

1 coulomb $= 0.625 \times 10^{19}\ e^-$

1 coulomb $= \frac{1}{1.6 \times 10^{-19}}\ e^-$

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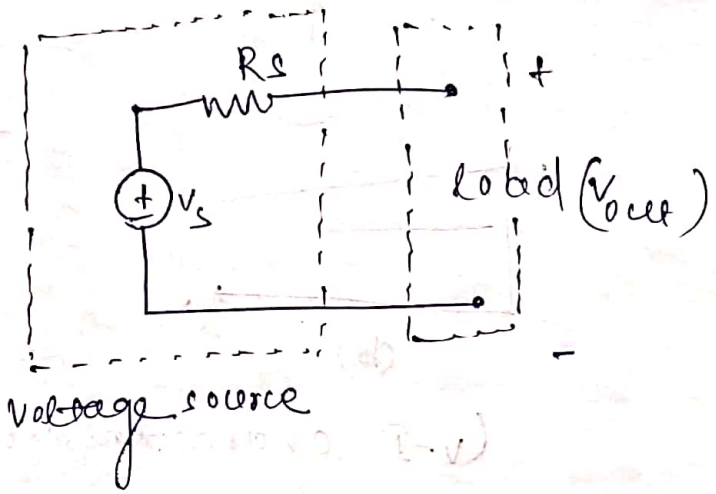
1.2 Source and load



Source :→ An electrical source is an electrical device of a circuit that delivers a net amount of energy to the outside / to it's terminals / load.

types of source :→

2 types of source

① voltage source → Battery, generator

② current source → semiconductor device like transistor, photo electric cell.

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Load (passive element)

An electrical load is an electrical components of a circuit that consumes electric power or electrical energy.

→ lamp, TV, Heater

1.3 State ohm's law and concept of resistance

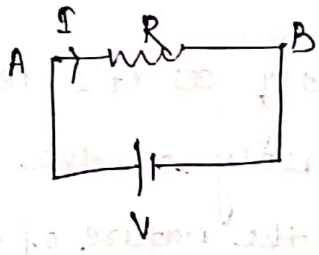
Ohm's Law

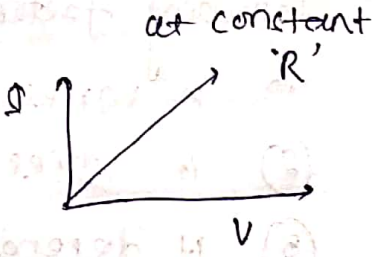
Ohm's law state that the current flowing in a conductor is directly proportional to the potential difference between two ends of a conductor at constant temperature.

$I \propto V$

$\Rightarrow I = \frac{V}{R}$

$\Rightarrow \boxed{V = IR}$





V = potential diff. b/w two terminal of a conductor

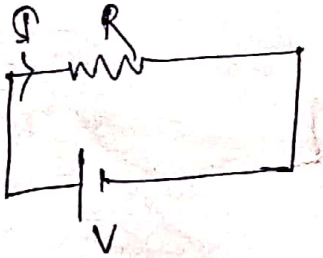
I = current

R = Resistance of conductor

unit of Resistance

The unit of Resistance is ohm (Ω)

or A conductor is said to have a resistance of one ohm if it permits one ampere current to flow through it when one volt is impressed across it's terminals.



$R = \frac{V}{I}$

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Resistance (R)

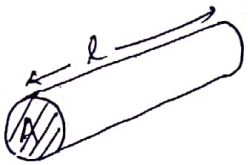
It is defined as the property of a material due to which it opposes the flow of current through it. It is denoted by 'R'

unit = Ω (ohm)

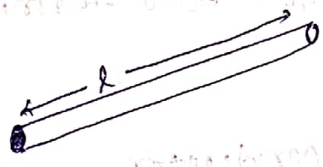
Law of Resistance

The resistance 'R' offered by a conductor depends on the following factors

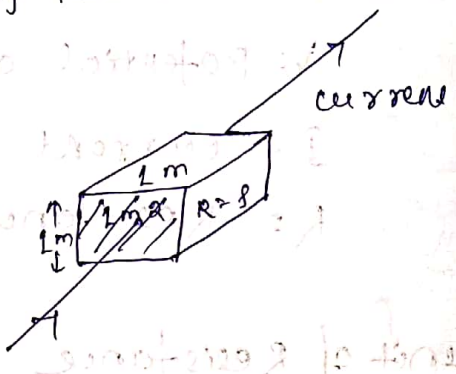
1. It varies directly as it's length (L)
2. It varies inversely as the cross-section 'A' of the conductor
3. It depends on the nature of the material
4. It also depends on the temperature of the conductor.



small
large A
low R



large l
small A
greater R



$$R \propto \frac{L}{A}$$

$$\Rightarrow \boxed{R = \rho \frac{L}{A}}$$

ρ = specific Resistance / Resistivity

when $L = 1\ m$, $A = 1\ m^2$ then $\boxed{R = \rho}$

$$\rho = \frac{RA}{l} = \frac{\text{ohm} \cdot m^2}{m} = \text{ohm} \cdot m$$

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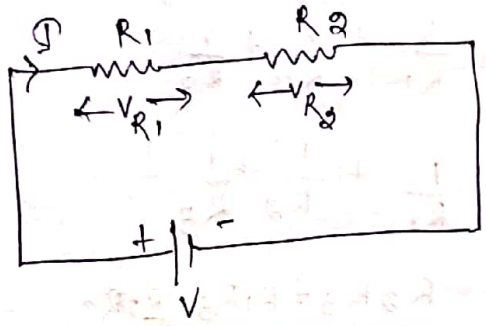
1.4 Relation of V, I & R in series circuit



$V = V_{R_1} + V_{R_2}$

V_{R_1}, V_{R_2} = voltage drop against individual resistance.

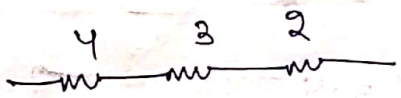
(series connection of pure resistance in DC circuit)

$IR_{eq} = IR_1 + IR_2$

$\Rightarrow \boxed{R_{eq} = R_1 + R_2}$

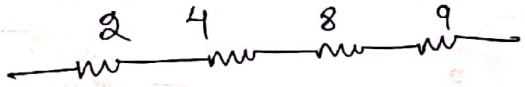
In series circuit, current 'I' is same in each branch and total resistance $R_{eq} = R_1 + R_2$. and also voltage is divided in each branch.

Q.1



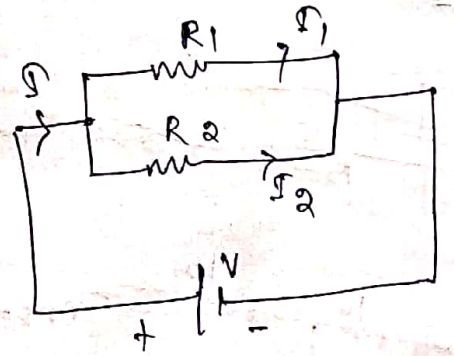
$R_{eq} = 4 + 3 + 2 = 9\Omega$

Q. 2



$R_{eq} = 2 + 4 + 8 + 9 = 23\Omega$

1.5 Relation of V, I & R in Parallel circuit



$I = I_1 + I_2$

$\Rightarrow \frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2}$

$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R_{eq}} = \frac{R_1 + R_2}{R_1 R_2}$

$\Rightarrow \boxed{R_{eq} = \frac{R_1 R_2}{R_1 + R_2}}$

In parallel circuit, voltage is same, current is divided in each branch and $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

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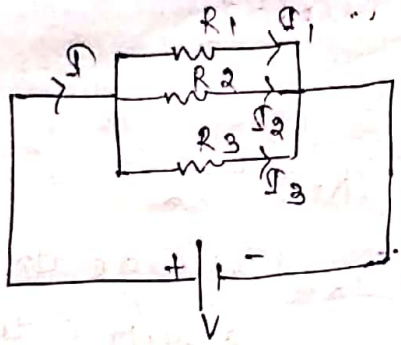


$$I = I_1 + I_2 + I_3$$

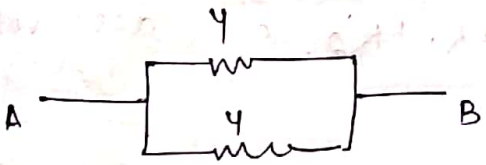
$$\Rightarrow \frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{R_2R_3 + R_1R_3 + R_1R_2}{R_1R_2R_3}$$

$$\Rightarrow \boxed{R_{eq} = \frac{R_1R_2R_3}{R_1R_2 + R_2R_3 + R_3R_1}}$$

Q.1



Q.2

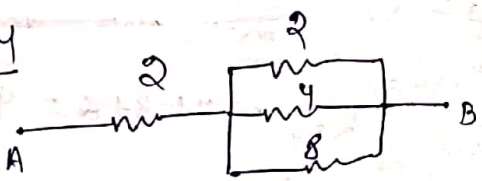


6

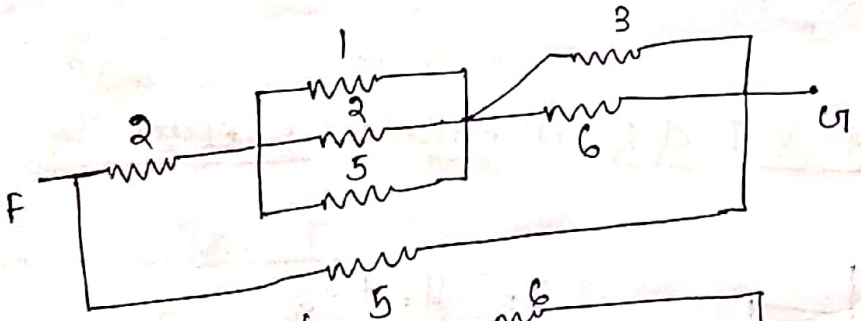
Q.3



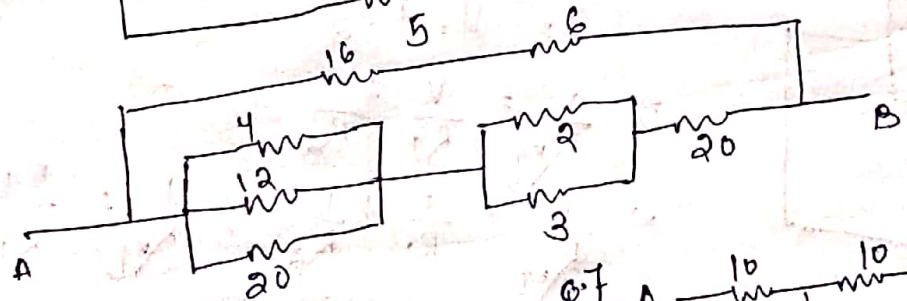
Q.4



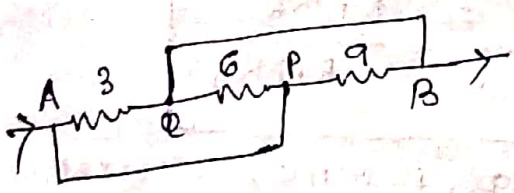
Q.4



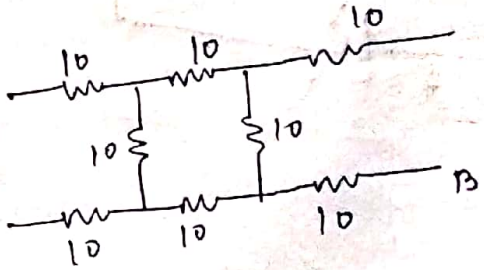
Q.5



Q.6



Q.7



Ans = 30 Ω

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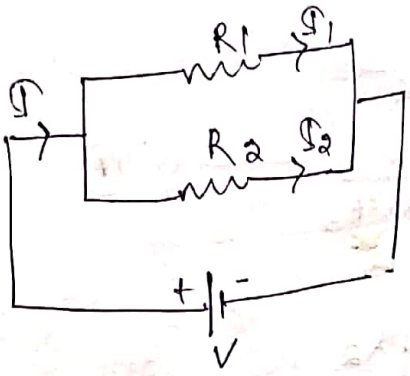
1.6 Division of current in parallel circuit



$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

$$I = \frac{V}{R_{eq}}$$

$$\Rightarrow \boxed{V = I \cdot R_{eq}} \rightarrow \text{eq}^n (1)$$

$$I_1 = \frac{V}{R_1}$$

$$\Rightarrow I_1 = \frac{I \cdot R_{eq}}{R_1}$$

$$\Rightarrow I_1 = \frac{I}{R_1}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$$

$$\Rightarrow \boxed{I_1 = I\left(\frac{R_2}{R_1 + R_2}\right)}$$

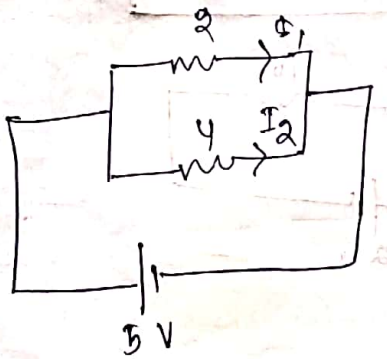
$$I_2 = \frac{V}{R_2}$$

$$\Rightarrow I_2 = \frac{I \cdot R_{eq}}{R_2}$$

$$\Rightarrow I_2 = \frac{I}{R_2}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$$

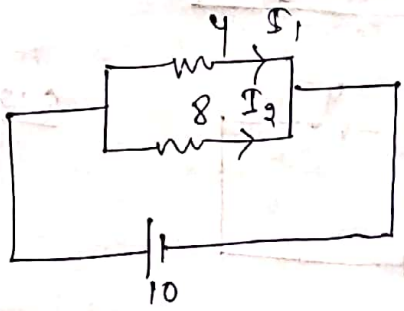
$$\Rightarrow \boxed{I_2 = I\left(\frac{R_1}{R_1 + R_2}\right)}$$

Q.1



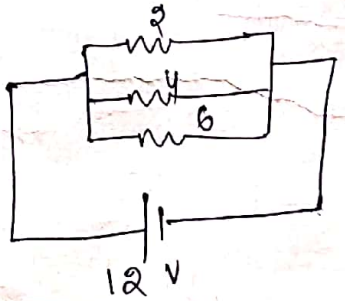
Find I, I_1 & I_2

Q.2



Find I, I_1 & I_2

Q.3



Find I, I_1, I_2 & I_3

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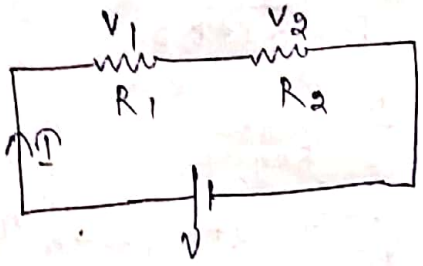
Division of voltage in series circuit



$R_{eq} = R_1 + R_2$

$I = \frac{V}{R_{eq}} = \frac{V}{R_1+R_2} \longrightarrow$ eqn (1)

$V_1 = I \cdot R_1$

$\Rightarrow I = \frac{V_1}{R_1} \longrightarrow$ eqn (2)

$V_2 = I \cdot R_2$

$\Rightarrow I = \frac{V_2}{R_2} \longrightarrow$ eqn (3)

from eqn (1) & (2), we get

$$\frac{V}{R_1+R_2} = \frac{V_1}{R_1}$$

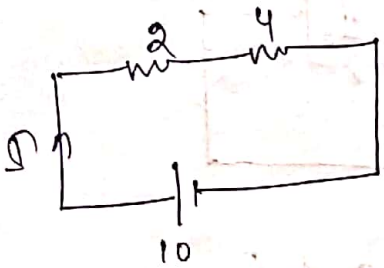
$$\Rightarrow \boxed{V_1 = V\left(\frac{R_1}{R_1+R_2}\right)}$$

from eqn (1) & (3), we get

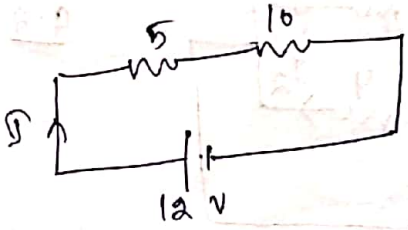
$$\frac{V}{R_1+R_2} = \frac{V_2}{R_2}$$

$$\Rightarrow \boxed{V_2 = V\left(\frac{R_2}{R_1+R_2}\right)}$$

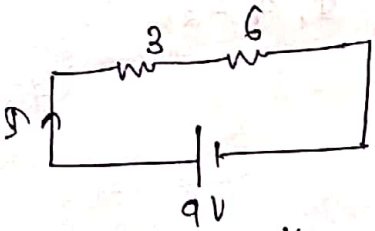
Q.1



Q.2



Q.3



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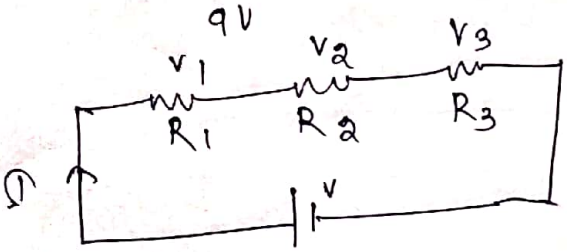

I,

$$V_1 = V\left(\frac{R_1}{R_1+R_2+R_3}\right)$$

$$V_2 = V\left(\frac{R_2}{R_1+R_2+R_3}\right)$$

$$V_3 = V\left(\frac{R_3}{R_1+R_2+R_3}\right)$$

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1.7 Effect of Power in series and parallel circuit

Power :→ The rate at which work is done in an electric circuit is called electric power.

$$\text{electric power} = \frac{\text{work done in an electric circuit}}{\text{time}}$$

* when 'voltage' 'v' is applied to a circuit, it causes current to flow through it, clearly work is being done by moving the electrons in the circuit.
* This work done is moving the electrons in a unit time is called the electric power.

V = P.D across 'AB' in volt

I = current in Amp

R = Resistance of AB in ohms

t = time in seconds for which current flows.

$$i = \frac{q}{t}$$

$$V = \frac{\text{work}}{q}$$

$$\Rightarrow V = \frac{W}{q} \Rightarrow \boxed{W = Vq = VIt}$$

or $\quad \text{power } (P) = \frac{w}{t} = \frac{vit}{t} = vi$ Joule/second or watt

or $\quad (P) = vi = i \cdot R \cdot i = i^2 R$

or $\quad (P) = vi = v \cdot \frac{v}{R} = \frac{v^2}{R}$

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Energy :→

Energy is defined as the ability of doing work. In electricity, the total workdone in an electric circuit is called electrical energy.

Electrical energy = Electrical power × t

$$= P \times t$$

$$E = Vit = I^2Rt = \frac{V^2}{R}t$$

So electrical energy is measured in kWh.

1.8 Kirchhoff's law

particularly useful

(i) In determining the equivalent resistance of a complicated network of conductor.

(ii) For calculating the current flowing in the various conductor.

It has 2 Laws

(1) Kirchhoff's current law (KCL)

"In any electrical network, the algebraic sum of the current meeting at a point or junction is zero."

or

The sum of incoming current is equal to the sum of outgoing current at a point or junction.

incoming current = out going current

(+ve sign) (-ve sign)

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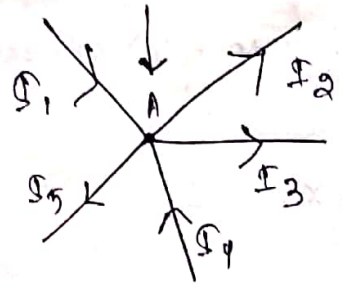
node / junction



(Fig-1)

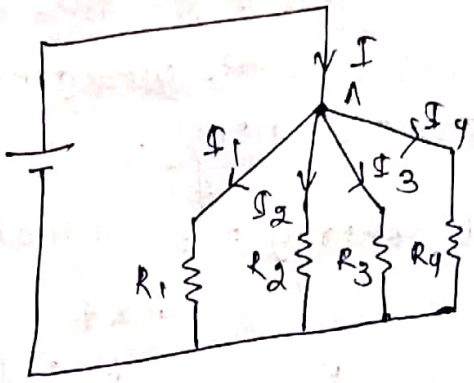


Fig-2)

For Fig-1

$I_1 + (-I_2) + (-I_3) + I_4 + (-I_5) = 0$

$\Rightarrow I_1 - I_2 - I_3 + I_4 - I_5 = 0$

$\Rightarrow \boxed{I_1 + I_4 = I_2 + I_3 + I_5}$

$I + (-I_1) + (-I_2) + (-I_3) + (-I_4) = 0$

$\Rightarrow I - I_1 - I_2 - I_3 - I_4 = 0$

$\Rightarrow \boxed{I = I_1 + I_2 + I_3 + I_4}$

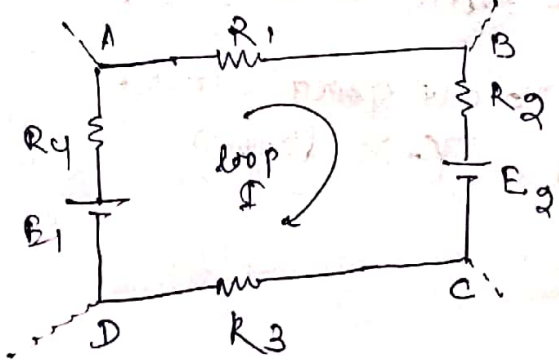
$\boxed{\sum I = 0}$

(2) Kirchhoff's voltage law (KVL)

* The algebraic sum of the product of current and resistance in each of the conductors in any closed path in a network plus the algebraic sum of the emfs in that path is zero.

(or)

* The algebraic sum of the product of I & R in each conductor plus the algebraic sum of the emf in a closed path is zero.



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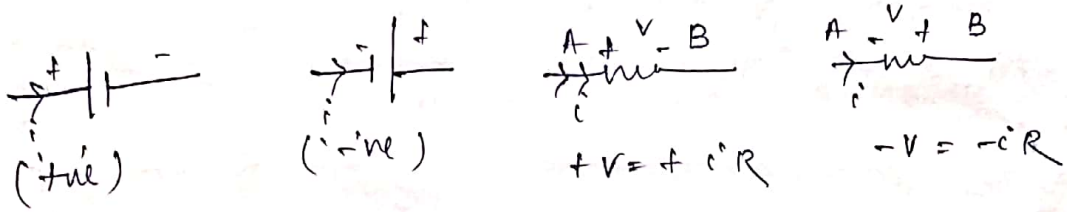
$$\mathcal{I}R_1 + \mathcal{I}R_2 + E_2 - \mathcal{I}R_3 - E_1 + \mathcal{I}R_4 = 0$$

$$\Rightarrow \boxed{\mathcal{I}R_1 + \mathcal{I}R_2 + \mathcal{I}R_3 + \mathcal{I}R_4 = E_1 - E_2}$$

imp

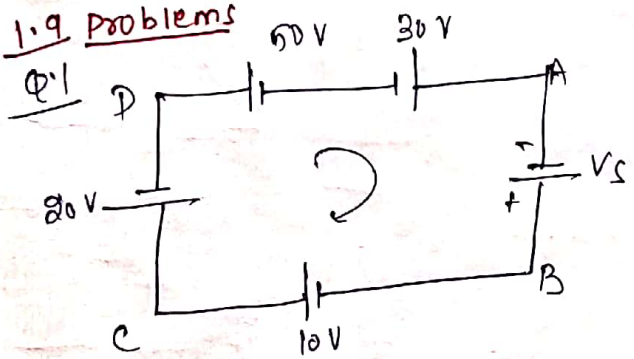
It is important to note that the sign of the battery emf is independent of the direction of the current through that branch.



* it is clear that the sign of voltage drop across a resistor depends on the direction of current through that resistor but is independent of the polarity of any other source of emf in the ckt under consideration.

1.9 Problems

Q:1



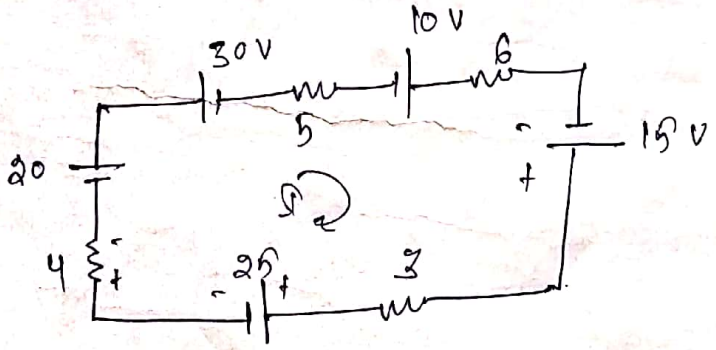
$$-V_S - 10 + 20 + 50 - 30 = 0$$

$$\Rightarrow -V_S - 40 + 70 = 0$$

$$\Rightarrow -V_S + 30 = 0$$

$$\Rightarrow \boxed{V_S = 30 \text{ volt}}$$

Q:2



Find 'I'

$$-15 + 3\mathcal{I} + 25 + 4\mathcal{I} - 20 + 30 + 5\mathcal{I} - 10 + 6\mathcal{I} = 0$$

$$\Rightarrow 18\mathcal{I} - 45 + 55 = 0$$

$$\Rightarrow 18\mathcal{I} + 10 = 0$$

$$\Rightarrow \mathcal{I} = \frac{-10}{18} = -0.55 \text{ Amp}$$

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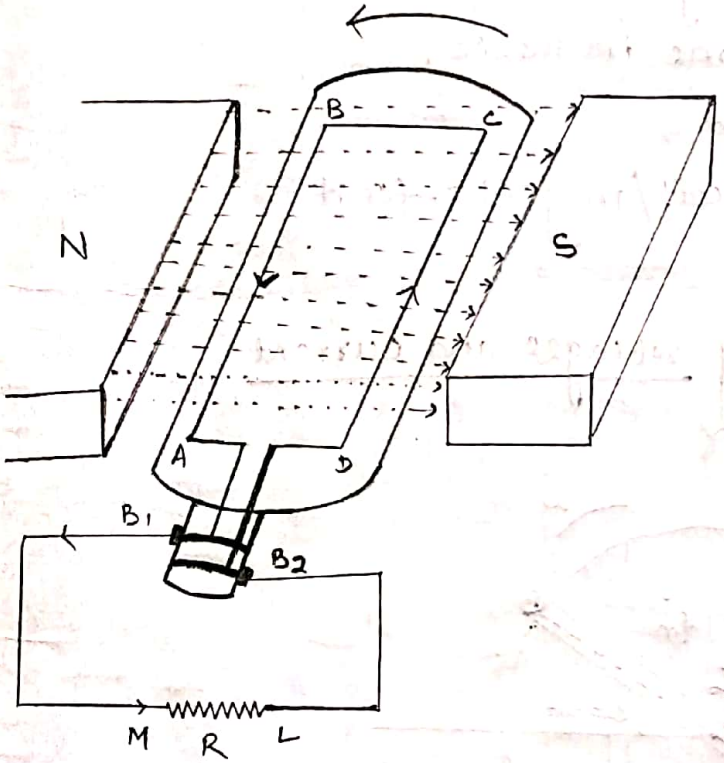
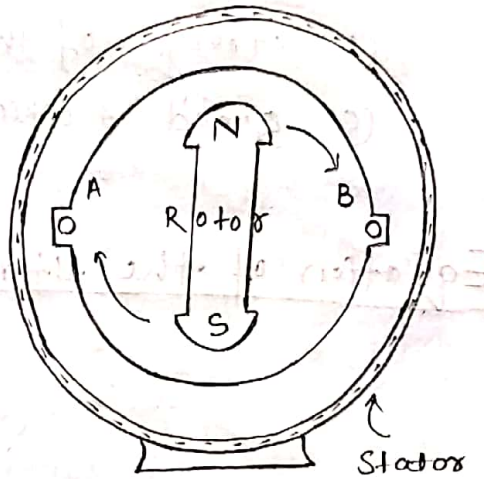
Chapter-2 A.C Theory

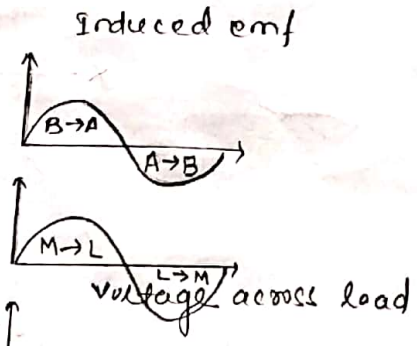
2.1 Generation of alternating emf

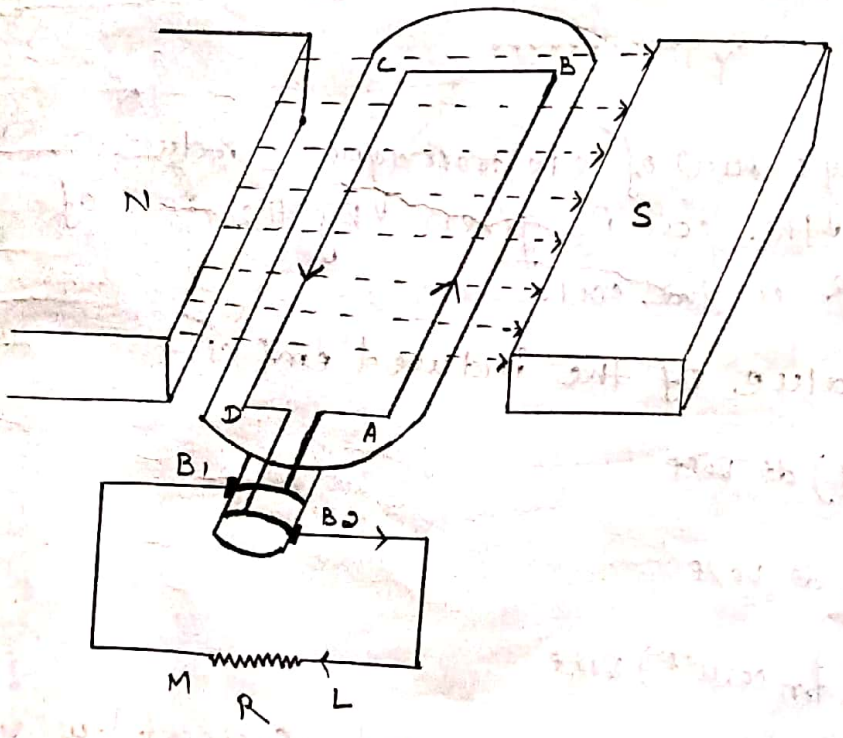
(Generation of alternating voltage and current)

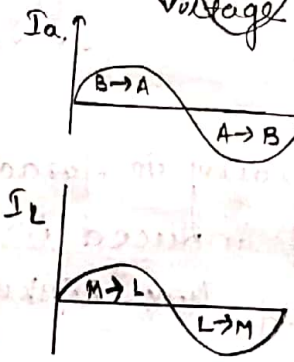


(Fig-1)









(Fig-2)

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Alternating voltage may be generated by rotating a coil in a magnetic field or by rotating a magnetic field with in a stationary coil.

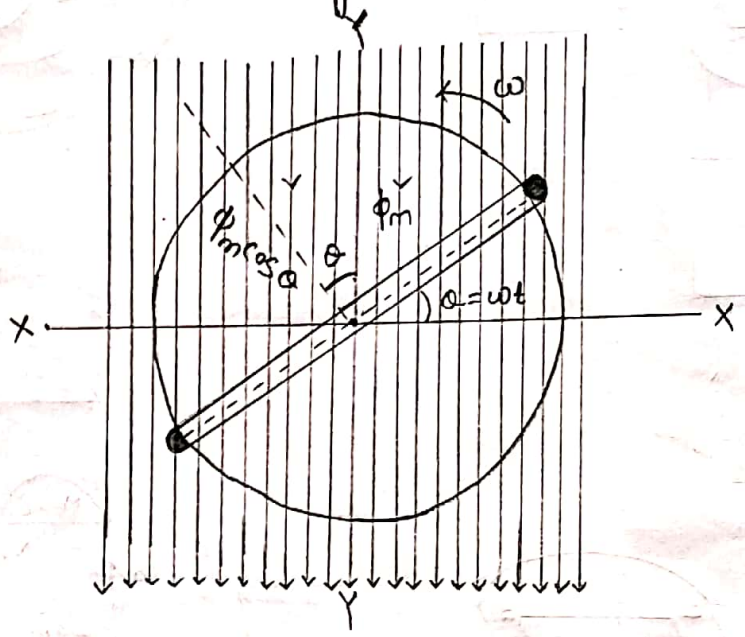
The value of the voltage generated depends upon

(a) The number of turns in the coil

(b) strength of the field

(c) Speed at which the coil / magnetic field

Equation of the Alternating voltages and current



According to faraday's law of electromagnetic induction, the emf induced in the coil is given by the rate of change of flux-linkage in the coil.

Instantaneous value of the induced emf is

$$e = -\frac{d}{dt}(N\phi) \text{ volt}$$

$$\Rightarrow e = -N\frac{d\phi}{dt} \text{ volt}$$

$$\Rightarrow e = -N\frac{d}{dt}(\phi_m \cos\omega t) \text{ volt}$$

$$\Rightarrow e = -N\phi_m \frac{d}{dt}(\cos\omega t) \text{ volt} = -N\phi_m(-\sin\omega t)\cdot\omega \text{ volt}$$

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$\Rightarrow e = N\phi_m \omega \sin\omega t$ volt

$\Rightarrow \boxed{e = N\phi_m \omega \sin\theta}$ volt

when $\alpha = 90°$, $\sin\alpha = 1$

'e' has maximum value say E_m

so $E_m = N\phi_m \omega . 1$

$\Rightarrow \boxed{E_m = N\phi_m \omega}$

$\Rightarrow \boxed{E_m = \omega N B_m A = 2\pi f N B_m A}$

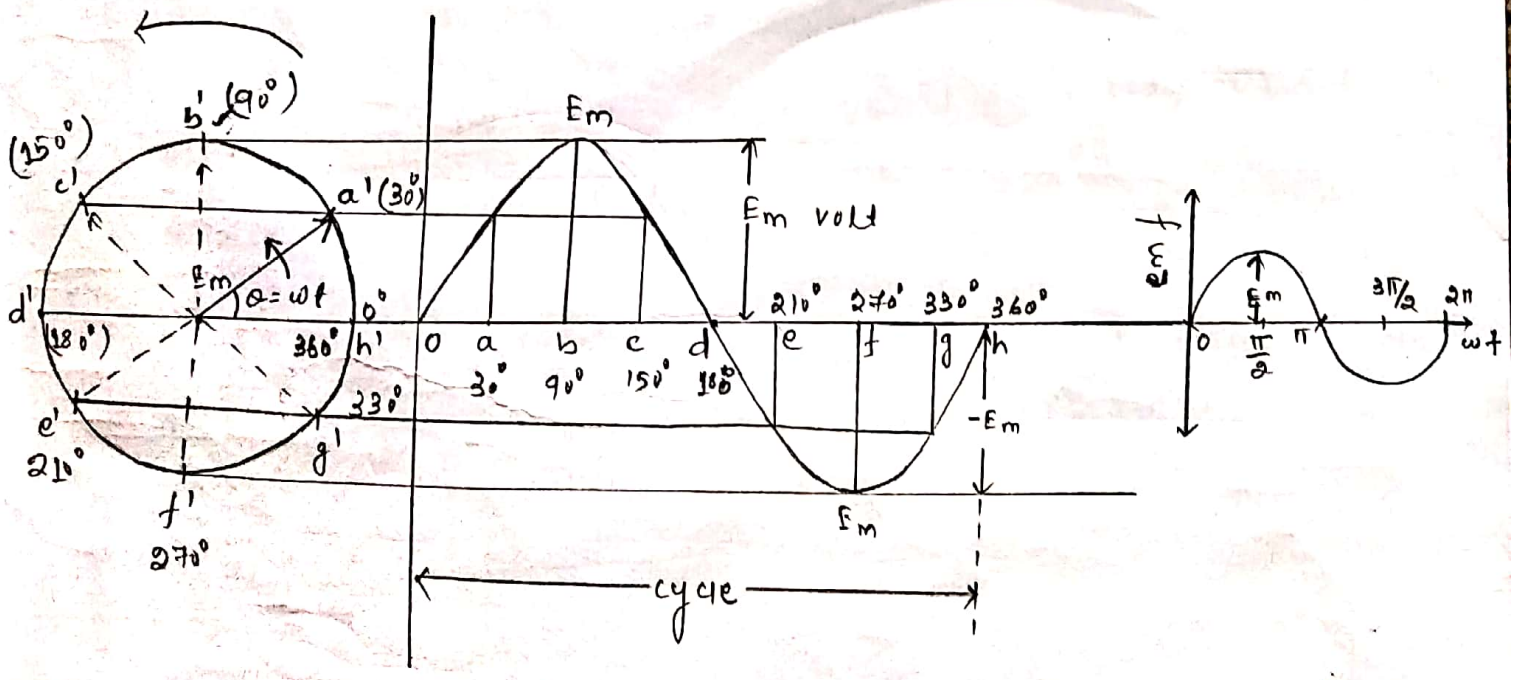
so $\boxed{e = E_m \sin\theta}$ $\boxed{e = E_m \sin\omega t}$ $\boxed{e = E_m \sin 2\pi f t}$

$\boxed{i = I_m \sin\theta}$ $\boxed{i = I_m \sin\omega t}$ $\boxed{i = I_m \sin 2\pi f t}$

ω = angular velocity

$\omega = 2\pi f$ radian/second

$\omega t = \theta$



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2.2 Difference between D.C & A.C

Basic	Alternating current (A.C)	Direct current (D.C)
① Defination	→ The direction of current reverse periodically	→ The direction of the current remain same
② frequency	→ 50 HZ or 60 HZ	→ zero
③ power factor	→ Lies between '0' & '1'	→ always 1
④ Types of loads	→ Their loads are resistive, inductive & capacitive	→ Their load is usually resistive in nature
⑤ source	→ Alternator	→ Generator, battery, solar cell
⑥ passive parameter	→ impedance	→ Resistance

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2.3 **cycle**:→ one complete set of positive and negative values of alternating quantity is known as cycle.



frequency (f):→ The no. of cycle/second is called the frequency of the alternating quantity.
It's unit is hertz (Hz)

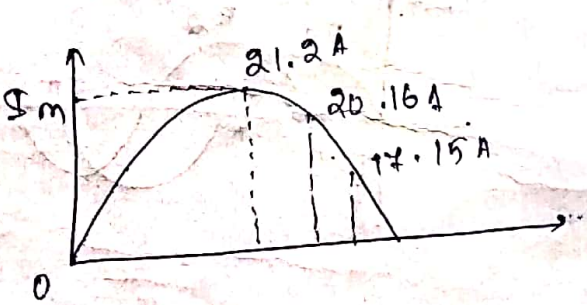
Time period (T):→ The time taken by an alternating quantity to complete one cycle is called it's time period.

Example $f = 50$ Hz

$$T = \frac{1}{f} = \frac{1}{50} = 0.02 \text{ sec.}$$

Amplitude:→ The maximum value, positive or negative of an alternating quantity is known as it's amplitude

Instantaneous value:→ The value of voltage or current obtained at any instant of time is called instantaneous values.



$e = E_m \sin\omega t$ $\quad i = I_m \sin\omega t$

$e = e_m \sin\theta$ $\quad i = I_m \sin\theta$

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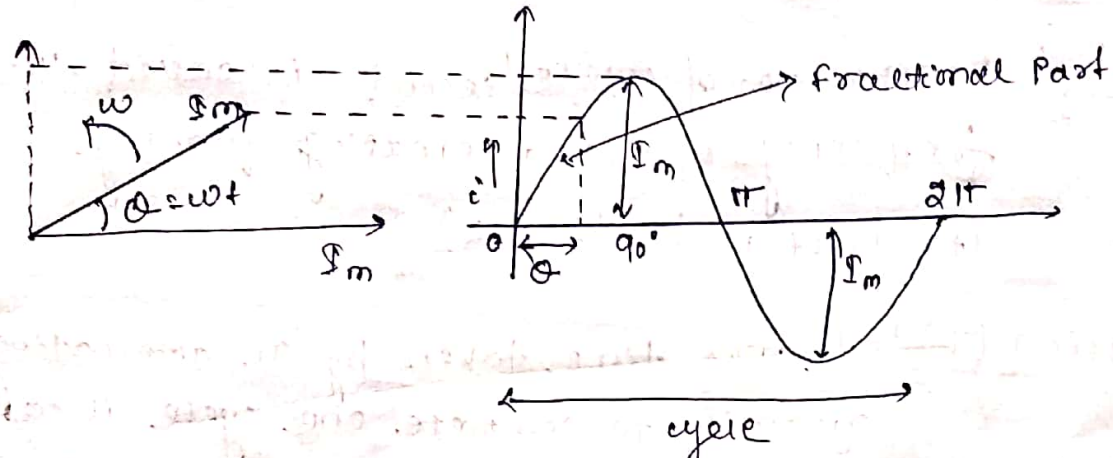
Phase angle (α)

The phase angle of an alternating quantity is defined as the fractional part of a cycle through which the quantity moves forward from a selected origin.



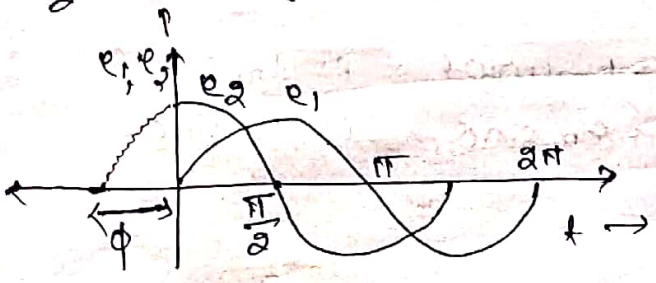
(The phase of the rotating coil at the instant is 'ωt' which is called it's phase angle α)

Phase difference (ϕ)

The phase difference between the two electrical quantities is defined as the angular phase difference between the maximum possible values of the two alternating quantities having the same frequency.

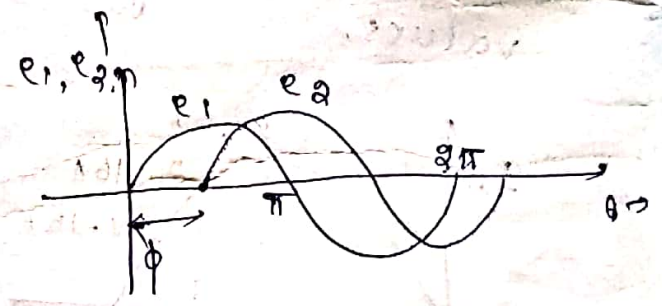
$e_1 = E_m \sin \omega t$

$e_2 = E_m \sin(\omega t + \phi)$



$e_1 = E_m \sin \omega t$

$e_2 = E_m \sin(\omega t - \phi)$



ϕ = phase difference

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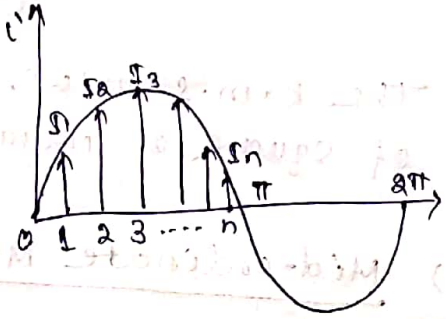
2.4

Average value

→ The average of all the instantaneous values of an alternating voltage or current over one complete cycle is called average value

(i) Mid-ordinate Method

$$I_{av} = \frac{I_1 + I_2 + I_3 + \cdots + I_n}{n}$$



→ The average value over a complete cycle is zero (sinusoidal & non-sinusoidal)

→ Hence the average value is obtained by adding or integrating the instantaneous values of voltage or current over one half-cycle only.

→ But in the case of an unsymmetrical alternating current (i.e half-wave rectified current) the average value must always be taken over the whole cycle.

(ii) Analytical Method

$$I_{av} = \int_0^{\pi} \frac{i\,d\alpha}{(\pi - 0)} = \int_0^{\pi} \frac{I_m \sin\alpha\, d\alpha}{\pi} = \frac{I_m}{\pi} \int_0^{\pi} \sin\alpha\, d\alpha$$

$$= \frac{I_m}{\pi} \left[-\cos\alpha\right]_0^{\pi} = \frac{I_m}{\pi} - [\cos\pi - \cos 0]$$

$$= \frac{I_m}{\pi} - (-1-1) = \frac{2I_m}{\pi} = \frac{I_m}{(\pi/2)} = 0.637 I_m$$

Rms value (Root-mean-square value)

The Rms value of an alternating current is given by that steady (D.C) current which when flowing through a given circuit for a given time produces the same heat as produced by the alternating current when flowing through the same circuit for the same time.

(OR)

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The steady current which, when flows through a resistor of known resistance for a given period of time than as a result, the same quantity of heat is produced by the alternating current when flow through the same resistor for the same period of time is called R.m.s or effective value of the alternating current.

(OR)

The R.m.s value is defined as the square root of means of square of instantaneous values over one cycle.

(i) Mid-ordinate Method

$$I_{rms} = I_{eff} = \sqrt{\left(\frac{I_1^2 + I_2^2 + I_3^2 + \cdots\cdots + I_n^2}{n}\right)}$$

$$I_{eff} = \sqrt{\text{mean of square of instantaneous values}}$$

$$V_{rms} = V_{eff} = \sqrt{\left(\frac{V_1^2 + V_2^2 + V_3^2 + \cdots\cdots + V_n^2}{n}\right)}$$

(ii) Analytical Method

$$I_{rms} = \sqrt{\int_0^{2\pi} \frac{i^2 d\theta}{(2\pi - 0)}}$$

$$= \sqrt{\int_0^{2\pi} \frac{I_m^2 \sin^2\theta \, d\theta}{2\pi}}$$

$$= \sqrt{\frac{I_m^2}{2\pi} \int_0^{2\pi} \left(\frac{1 - \cos 2\theta}{2}\right) d\theta}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \int_0^{2\pi} (1 - \cos 2\theta) \, d\theta}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \left[\theta - \frac{\sin 2\theta}{2}\right]_0^{2\pi}}$$

$$\Rightarrow I_{rms} = \sqrt{\frac{I_m^2}{4\pi} \left\{\left[\theta - I_0^{2\pi} - 0\right]\right.}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \left[\theta\right]_0^{2\pi}}$$

$$= \sqrt{\frac{I_m^2}{4\pi} (2\pi - 0)}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \cdot 2\pi}$$

$$\Rightarrow I_{rms} = \sqrt{\frac{I_m^2}{2}}$$

$$\Rightarrow \boxed{I_{rms} = \frac{I_m}{\sqrt{2}}}$$

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Amplitude factor (crest or peak factor)

It is defined as the ratio between maximum value and R.m.s value.

$$K_a = \frac{\text{maximum value}}{\text{R.m.s value}} = \frac{I_m}{I_m/\sqrt{2}} = \sqrt{2} = 1.414$$

(OR)

(It is defined as the ratio of maximum value to R.m.s value)

Form factor

The ratio of R.m.s value to average value is known as form factor.

$$\text{Form factor } (K_f) = \frac{\text{R.m.s value}}{\text{Average value}} = \frac{\frac{I_m}{\sqrt{2}}}{\frac{2I_m}{\pi}} = \frac{0.707 I_m}{0.637 I_m} = 1.11$$

Q.1 A sine wave is represented by the equation $e = 144 \sin(314t - \frac{\pi}{3})$ calculate the average value, r.m.s value and frequency.

(1) $V_{av} = \frac{2V_m}{\pi} = \frac{2 \times 144}{\pi} = 91.71$ volt

(2) $V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{144}{\sqrt{2}} = 101.82$ volt.

(3) $\omega = 2\pi f$

$f = \frac{\omega}{2\pi} = \frac{314}{2\pi} = 50$ Hz

Q.2 An alternating current, frequency 60 Hz has a maximum value of 120 Amp. write down the equation for its instantaneous value.

Find (a) The instantaneous value after $1/360$ second.

(b) The time taken to reach 96 Amp for the first time.

$I = I_m \sin \omega t$

$= 120 \sin(2\pi f t)$

$= 120 \sin(2\pi \cdot 60 \cdot t)$

$= 120 \sin(120\pi t)$

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(a) $i = 120 \sin(120\pi t)$

$= 120 \sin\left(120 \times 180 \times \frac{1}{360}\right)$

$= 120 \sin 60^\circ$

$= 103.9$ Amp

(b) $q_6 = 120 \sin \omega t$

$\Rightarrow q_6 = 120 \sin(2\pi f t)$

$\Rightarrow q_6 = 120 \sin(2 \times 180 \times 60 \times t)$

$\Rightarrow q_6 = 120 \sin(21600t)$

$\Rightarrow \sin(21600t) = \frac{q_6}{120} = 0.8$

$\Rightarrow 21600t = \sin^{-1}(0.8) = 53.13$

$\Rightarrow t = \frac{53.13}{21600}$

$\Rightarrow t = 2.45 \times 10^{-3}$ sec.

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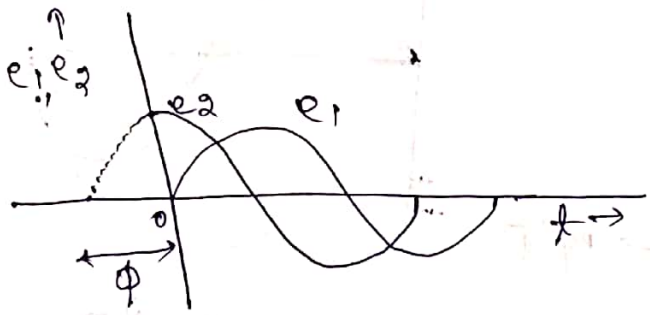
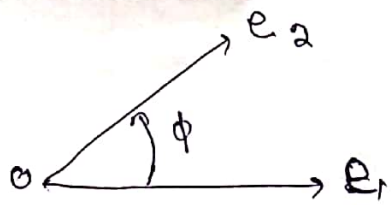
25 ~~Acus through~~

Represent AC values in phasor diagrams

$e_1 = E_m \sin\omega t$

$e_2 = E_m \sin(\omega t + \phi)$

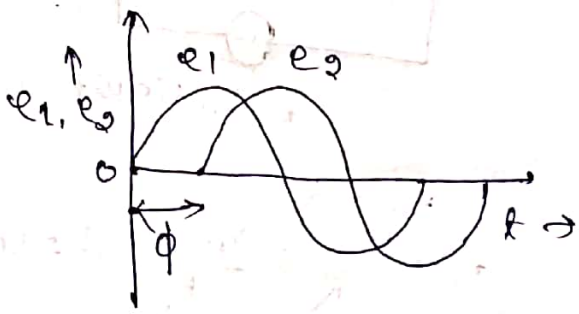


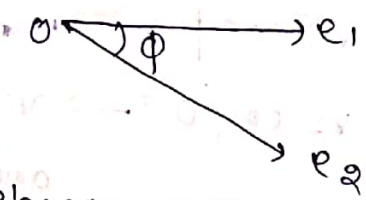


Phasor presentation

$e_1 = E_m \sin\omega t$

$e_2 = E_m \sin(\omega t - \phi)$



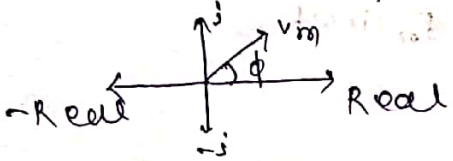


Phasor representation

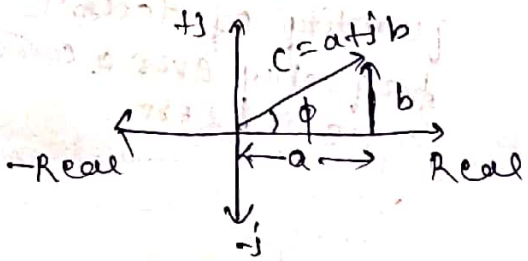
Phasor Representation

There are 3 way of phasor representation in mathematical form.

① polar form :→ suppose we have a phasor which has an amplitude of V_m and makes an angle with the horizontal axis. so in the polar form, we can represent it as V_m.



② Rectangular form :→ In this form we can represent any phasor as complex number like a+jb.



$c = \sqrt{a^2 + b^2}$

$\phi = \tan^{-1}\left(\frac{b}{a}\right)$

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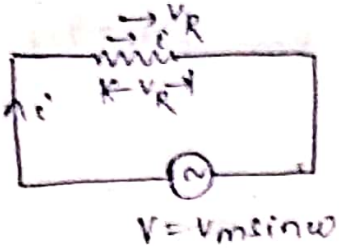
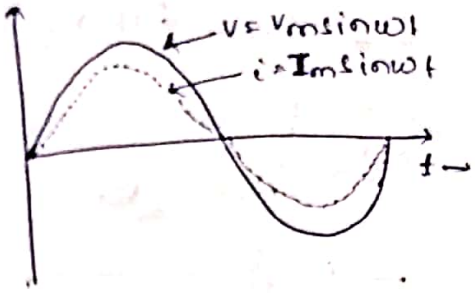
2.6 AC through pure resistance, inductance & capacitance

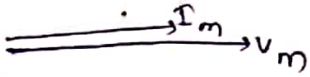
AC through pure resistance :→





$V = i \cdot R$

$\Rightarrow i = \frac{V}{R} = \frac{V_m \sin\omega t}{R} = i_m \sin\omega t \rightarrow$ eqn (1)



$P = VI\cos\phi$

$\Rightarrow P = VI\cos(0) \rightarrow$ angle b/w voltage and current

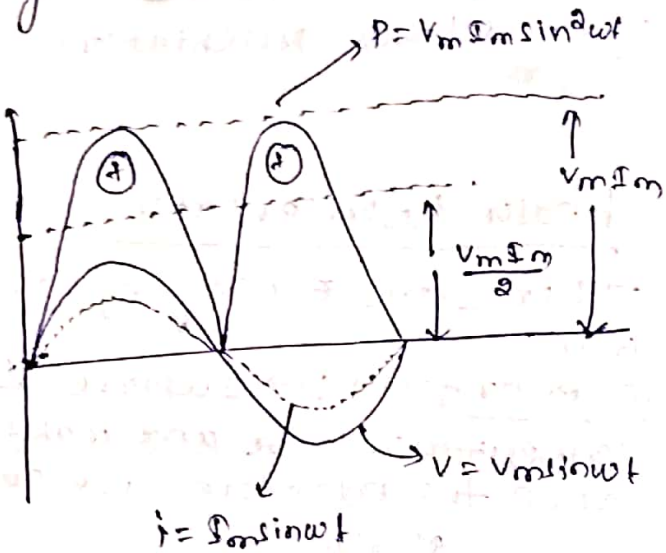
$\Rightarrow P = V.I$

(OR)

$P = V \cdot I$

$\Rightarrow P = V_m \sin\omega t \times \frac{V_m \sin\omega t}{R}$

$\Rightarrow P = \frac{V_m^2}{R} \sin^2\omega t$



$\Rightarrow P = \frac{V_m^2}{R}\left(\frac{1-\cos 2\omega t}{2}\right)$

$\Rightarrow P = \frac{V_m^2}{2R} - \frac{V_m^2}{2R}(\cos 2\omega t)$ → The average of a sinusoidal quantity of double frequency over a complete cycle is zero.

$\Rightarrow P = \frac{V_m^2}{2R} = \frac{V_m}{2} \cdot \frac{V_m}{R} = \frac{V_m}{2} \cdot I_m$

$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} = V_{rms} \cdot I_{rms}$

$\Rightarrow P = \frac{V_m I_m}{\sqrt{2} \cdot \sqrt{2}}$

$\Rightarrow \boxed{P = V_{rms} \cdot I_{rms}}$

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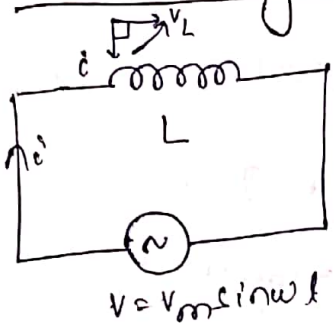
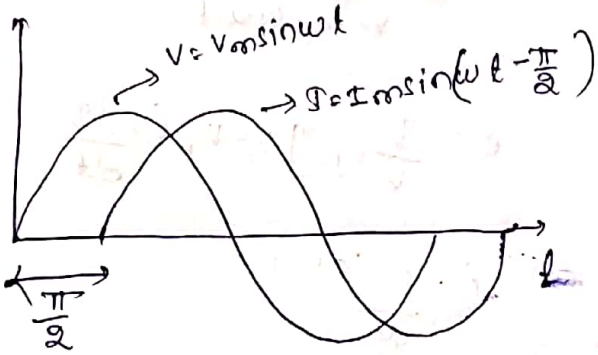
AC through pure inductor :-





$$V = L \frac{di}{dt}$$

$$\Rightarrow di = \frac{V}{L} dt$$

$$\Rightarrow di = \frac{V_m \sin\omega t}{L} dt$$

$$\Rightarrow \int di = \int \frac{V_m}{L} \sin\omega t \, dt$$

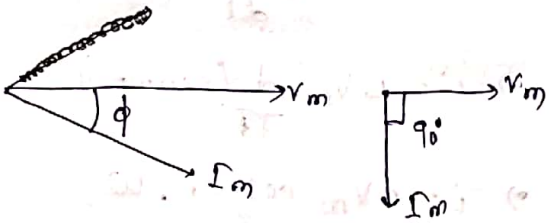
$$\Rightarrow i = \frac{V_m}{L} \int \sin\omega t \, dt$$

$$\Rightarrow i = \frac{V_m}{L} \left[\frac{-\cos\omega t}{\omega}\right] = \frac{V_m}{\omega L} [-\cos\omega t]$$

$$\Rightarrow i = \frac{V_m}{\omega L} \left\{\sin\left(\omega t - \frac{\pi}{2}\right)\right\}$$

$$\Rightarrow i = I_m \left\{\sin\left(\omega t - \frac{\pi}{2}\right)\right\}$$

$$\Rightarrow \boxed{i = I_m \sin\left(\omega t - \frac{\pi}{2}\right)}$$

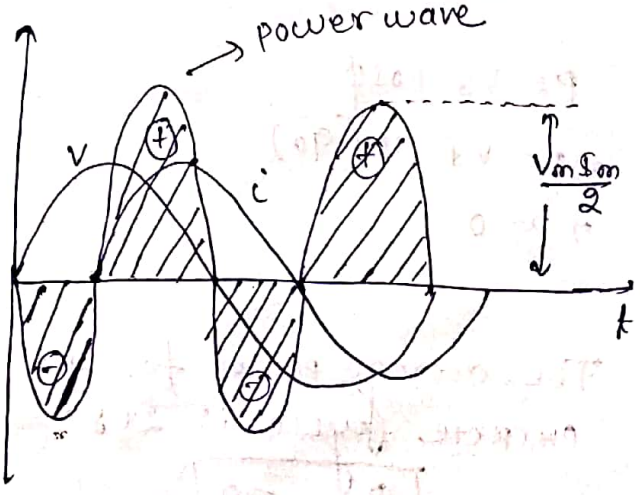


$$\boxed{I_m = \frac{V_m}{\omega L} = \frac{V_m}{X_L}}$$

$$P = VI \cos\phi$$

$$\Rightarrow P = VI \cdot \cos(90)$$

$$\Rightarrow P = 0$$



The average power for a complete cycle is zero.

$$\boxed{P_{(avg)} = 0}$$

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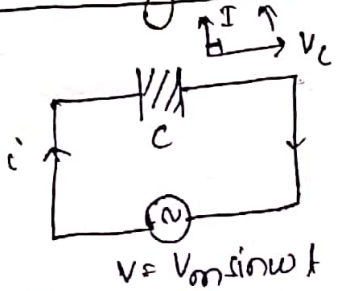
AC through pure capacitor :→



$C = \frac{q}{V}$, $q = CV$, $i = \frac{dq}{dt}$

$\Rightarrow i = \frac{d(CV)}{dt}$

$\Rightarrow i = C\frac{d(V_m \sin\omega t)}{dt}$

$\Rightarrow i = CV_m \frac{d}{dt}(\sin\omega t)$

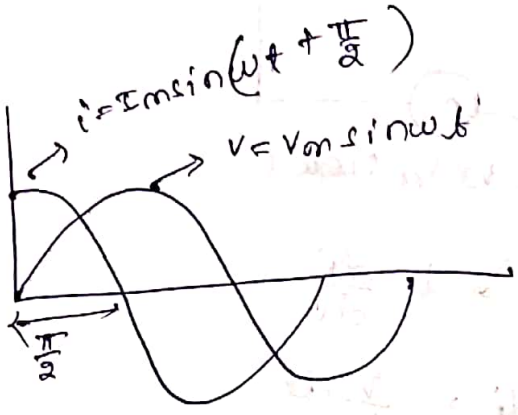
$\Rightarrow i = CV_m \cos\omega t \cdot \omega$

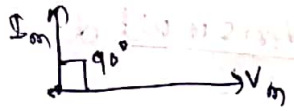
$\Rightarrow i = \omega C V_m \cos\omega t$

$\Rightarrow i = \omega C V_m \sin(\omega t + 90^\circ)$

$\Rightarrow \boxed{i = \omega C V_m \sin\left(\omega t + \frac{\pi}{2}\right)}$

$\Rightarrow \boxed{i = I_m \sin\left(\omega t + \frac{\pi}{2}\right)}$



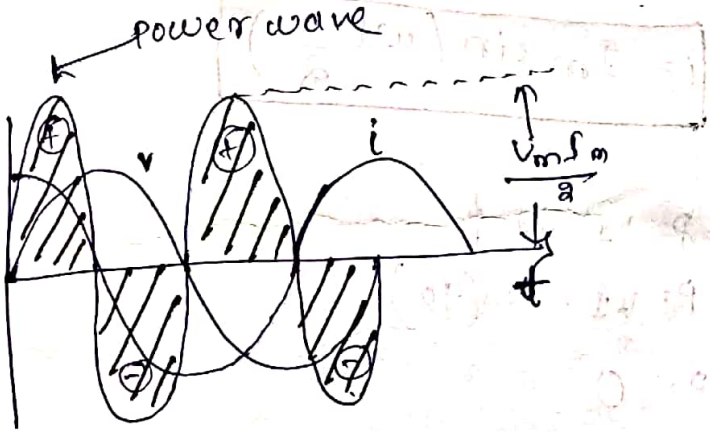


$$\boxed{I = \frac{V_m}{(1/\omega C)} = \frac{V_m}{X_C}}$$

$P = VI\cos\phi$

$\Rightarrow P = VI\cos(90)$

$\Rightarrow P = 0$



The average power for a complete cycle is zero

$$\boxed{P_{avg} = 0}$$

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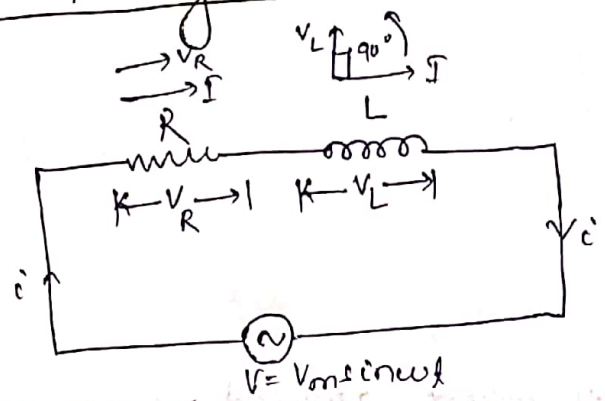
2.7 AC through RL, RC, RLC series circuits

AC through series RL circuit



→ consider a series R-L ckt where applied voltage and current are V & I respectively.

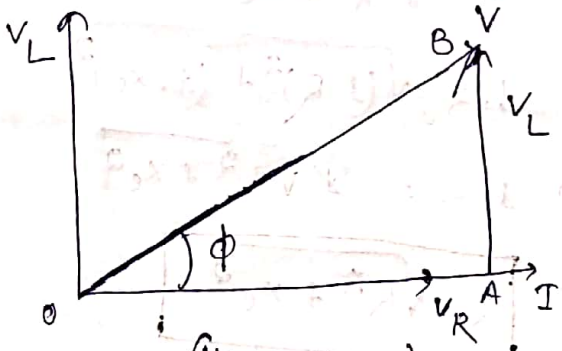
→ voltage 'V_R' across resistor is inphase with current and voltage 'V_L' across inductor leads the current by 90°.

$$V = \sqrt{(V_R)^2 + (V_L)^2}$$

$$\Rightarrow IZ = \sqrt{(I \cdot R)^2 + (I \cdot X_L)^2}$$

$$\Rightarrow Z = \sqrt{(R^2 + X_L^2)}$$

$$\Rightarrow \boxed{Z = \sqrt{R^2 + X_L^2}}$$



(Voltage triangle)

$$\tan\phi = \frac{P}{b} = \frac{b}{b} = \frac{V_L}{V_R}$$

$$\Rightarrow \tan\phi = \frac{I X_L}{I R}$$

$$\Rightarrow \boxed{\phi = \tan^{-1}\left(\frac{X_L}{R}\right)}$$

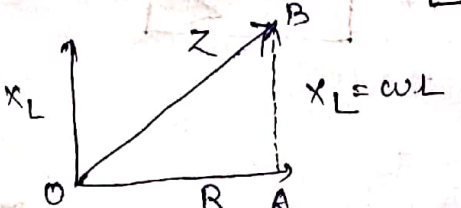
$$\boxed{I = \frac{V}{Z}}$$

$$\boxed{P = VI\cos\phi}$$

$$\cos\phi = \frac{b}{h} = \frac{V_R}{V}$$

$$\Rightarrow \cos\phi = \frac{I \cdot R}{I \cdot Z} = \frac{R}{Z}$$

$$\Rightarrow \boxed{\cos\phi = \frac{R}{Z}}$$



(Impedance triangle)

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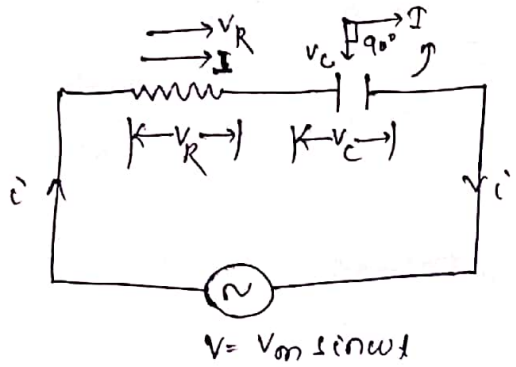
AC through series RC circuit



→ consider a series RC circuit, where applied voltage and current are 'V' & 'I' respectively.

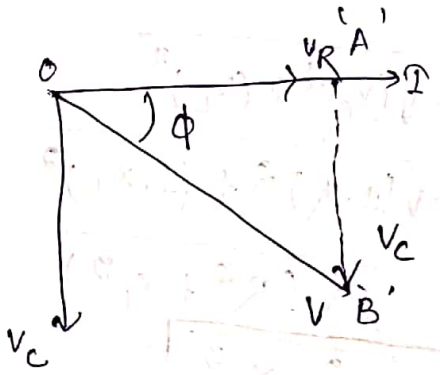
→ The voltage 'v_R' across resistor is in-phase with current and voltage 'v_C' across capacitor lags the current by 90°.

$$V = \sqrt{V_R^2 + V_C^2}$$

$$\Rightarrow I.Z = \sqrt{(IR)^2 + (I.X_C)^2}$$

$$\Rightarrow I.Z = I\sqrt{R^2 + X_C^2}$$

$$\Rightarrow \boxed{Z = \sqrt{R^2 + X_C^2}}$$



(Voltage triangle)

$$\tan\phi = \frac{P}{b} = \frac{V_C}{V_R}$$

$$\Rightarrow \tan\phi = \frac{I.X_C}{I.R}$$

$$\Rightarrow \tan\phi = \frac{X_C}{R}$$

$$\Rightarrow \boxed{\phi = \tan^{-1}\left(\frac{X_C}{R}\right)}$$

$$\boxed{I = \frac{V}{Z}}$$

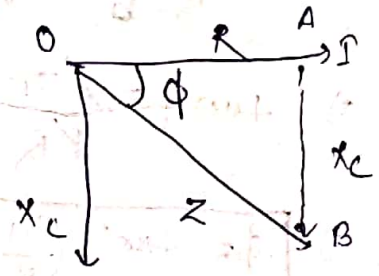
$$\boxed{P = VI\cos\phi}$$

$$\cos\phi = \frac{P}{h} = \frac{V_R}{V}$$

$$\Rightarrow \cos\phi = \frac{I.R}{I.Z}$$

$$\Rightarrow \boxed{\cos\phi = \frac{R}{Z}}$$

$$\Rightarrow$$



(Impedance triangle)

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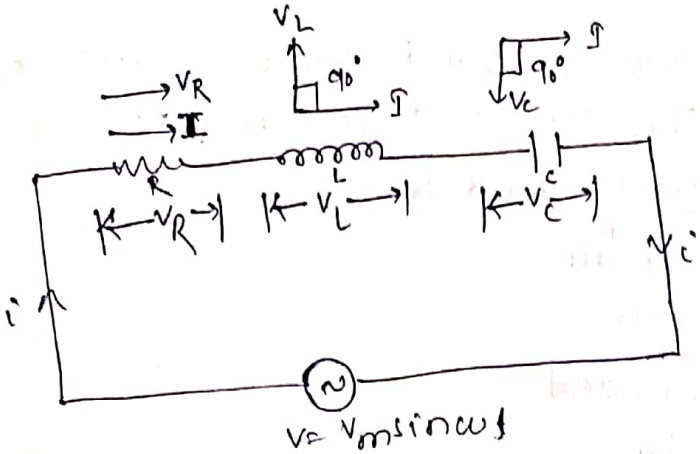
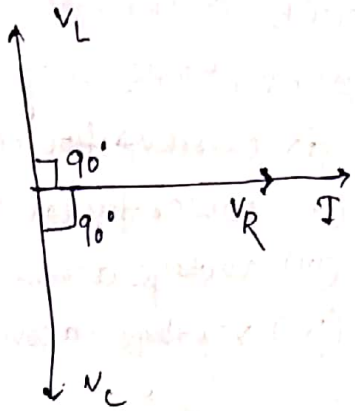
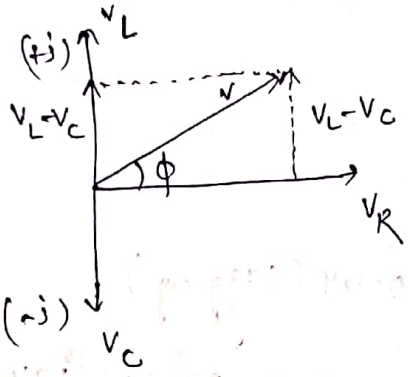
AC through series R-L-C circuit

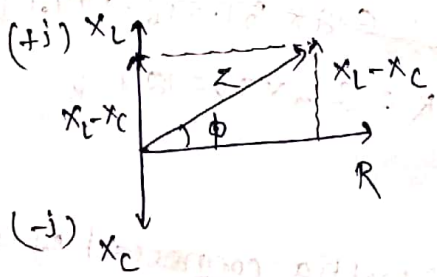




(i) $V_L > V_C$

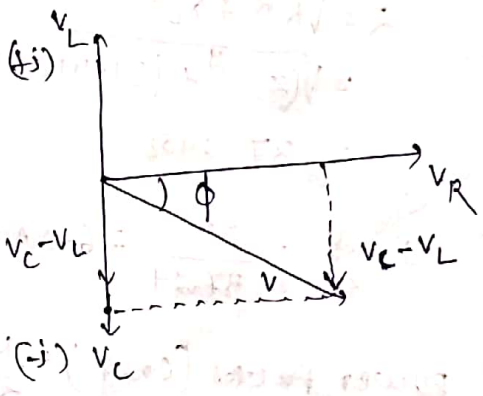
$X_L > X_C$

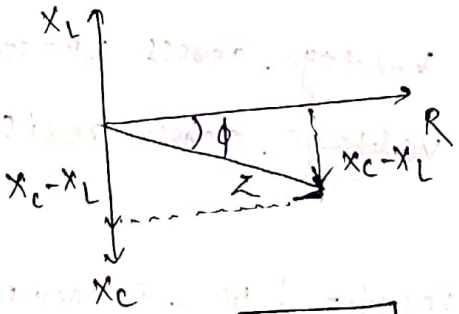




(ii) $V_C > V_L$

$X_C > X_L$





$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$\Rightarrow I \cdot Z = I\sqrt{R^2 + (X_L - X_C)^2}$$

$$\Rightarrow \boxed{Z = \sqrt{R^2 + (X_L - X_C)^2}}$$

$$\boxed{I = \frac{V}{Z}}$$

$$\boxed{P = VI\cos\phi}$$

$$\boxed{\cos\phi = \frac{R}{Z}}$$

$$\tan\phi = \frac{P}{b} = \frac{V_L - V_C}{V_R}$$

$$= \frac{I(X_L - X_C)}{I \cdot R}$$

$$\Rightarrow \tan\phi = \frac{X_L - X_C}{R}$$

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2.8 Simple Problems on RL, RC & RLC series circuit

Q.1 In a circuit an inductor of 0.1 H is connected in series with a resistor of 20Ω. The circuit is connected across a 230V, 50Hz single phase supply. Find the
(i) current flowing in the circuit
(ii) Power factor of the circuit
(iii) voltage across the reactor, and
(iv) voltage across the resistor.

given
$L = 0.1H$
$X_L = 2\pi f L = 2 \times 3.14 \times 50 \times 0.1 = 31.416\Omega$
(inductive reactance)

$$Z = \sqrt{R^2 + X_L^2}$$
$$= \sqrt{(20)^2 + (31.416)^2}$$
$$= 37.24\Omega$$

(i) $I = \frac{V}{Z} = \frac{230}{37.24} = 6.2$ Amp

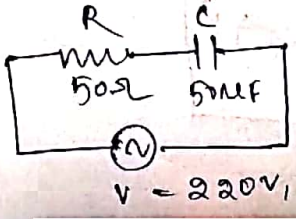
(ii) power factor $(\cos\phi) = \frac{R}{Z} = \frac{20}{37.24} = 0.54$ (lagging)

(iii) Voltage across Reactor $(V_L) = I X_L = 6.2 \times 31.416 = 194.8$ V

(iv) Voltage across resistor $(V_R) = I \cdot R = 6.2 \times 20 = 124$ V

Q.2 A resistor of 50Ω is connected in series with a connected of 50 to a supply at 220V, 50Hz. Find (i) capacitive reactance (ii) Impedance (iii) current (iv) power factor of the circuit. (v) phase angle (vi) voltage across resistor (vii) voltage across capacitor and (viii) power consumed.

given $R = 50\Omega$
$C = 50\mu F$



V = 220V, 50Hz

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(i) capacitive reactance $X_C = \frac{1}{2\pi fC} = \frac{1}{2 \times 3.14 \times 50 \times 50 \times 10^{-6}} = 63.66\,\Omega$

(ii) impedance $Z = \sqrt{R^2 + X_C^2}$

$= \sqrt{(50)^2 + (63.66)^2} = 80.95\,\Omega$

(iii) circuit current $I = \frac{V}{Z} = \frac{220\,V}{80.95} = 2.7$ Amp.

(iv) power factor, $\cos\phi = \frac{R}{Z} = \frac{50}{80.95} = 0.617$ (leading)

(v) phase angle $(\phi) = \cos^{-1}\left(\frac{R}{Z}\right) = \cos^{-1}(0.617) = 51.9^\circ$ (leading)

(vi) voltage across resistor $(V_R) = I.R = 2.7 \times 50 = 135\,V$

(vii) voltage across capacitor $(V_C) = I.X_C = 2.7 \times 63.66 = 172$ volt

(viii) power consumed $(P) = VI\cos\phi = 220 \times 2.7 \times 0.617 = 366.5$ watt

Q.3

A coil of resistance 'R' and inductance 'L' is connected across 100V, 50 Hz supply. The current through the coil is found to be 2 Amp and the power dissipated is 100 watt. Find R and L.

Impedance, $Z = \frac{V}{I} = \frac{100}{2} = 50\,\Omega$

power dissipated, $I^2R = (2)^2.R = 100$ watt

$\Rightarrow 4R = 100$

$\Rightarrow R = \frac{100}{4} = 25\,\Omega$

$\Rightarrow Z = \sqrt{R^2 + (X_L)^2}$

$\Rightarrow (50)^2 = (25)^2 + X_L^2$

$\Rightarrow X_L = \sqrt{(50)^2 - (25)^2} = 43.3\,\Omega$

$X_L = 2\pi fL$

$\Rightarrow L = \frac{X_L}{2\pi f} = \frac{43.3}{2 \times 3.14 \times 50} = 0.1378\,H$

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Q.4 A resistance of 12Ω, an inductance of 0.15H and a capacitance of 100μF are connected in series across 200V, 50Hz supply. Calculate (a) current (b) power factor of the circuit (c) voltage drops across resistance, inductance and capacitance (d) draw the complete phasor diagram of the circuit.

given

$R = 12\Omega, \quad L = 0.15\,H \quad C = 100\,\mu F$

inductive reactance $X_L = 2\pi f L$

$= 2 \times 3.14 \times 50 \times 0.15 = 47.12\,\Omega$

capacitive reactance $X_C = \frac{1}{2\pi f C}$

$= \frac{1}{2 \times 3.14 \times 50 \times 100 \times 10^{-6}}$

$= 31.83\Omega$

Total impedance $(Z) = \sqrt{R^2 + (X_L - X_C)^2}$

$= \sqrt{(12)^2 + (47.12 - 31.83)^2}$

$= 19.44\,\Omega$

(a) current $(I) = \frac{V}{Z} = \frac{200}{19.44} = 10.3$ Amp

(b) power factor $(\cos\phi) = \frac{R}{Z} = \frac{12}{19.44} = 0.62$ (lagging)

(c) voltage drop across 'R' $= V_R = I.R = 10.3 \times 12 = 123.6\,V$

voltage drop across 'L' $= V_L = I.X_L = 10.3 \times 47.12 = 485.34\,V$

voltage drop across 'C' $= V_C = I.X_C = 10.3 \times 31.83 = 327.85\,V$

$V = \sqrt{(123.6)^2 + (157.49)^2}$

$= 200\,V$

$\phi = \cos^{-1}(0.62) = 51.68°$

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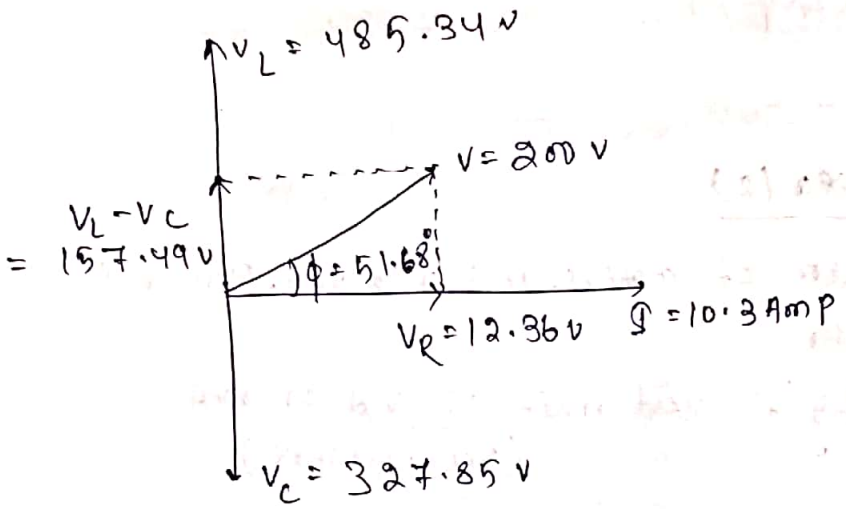
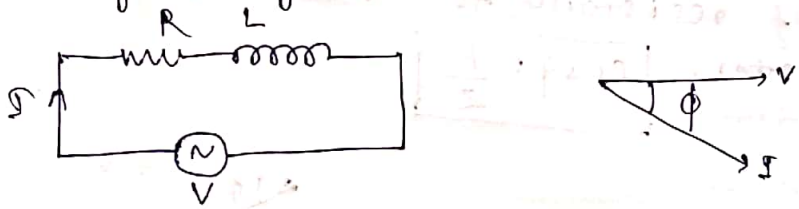


2.9 Concept of power and power factor

Power (Active, Reactive and apparent power)

Let a series R-L circuit draw a current of 'I' when an alternating voltage 'v' is applied to it.



Suppose that current 'I' lags the voltage by an angle 'ϕ'. Then 'S' power drawn by the circuit are as under.

(1) Active / Real / True power (P)

→ The power which is actually consumed in a resistor of circuit is called active power.

→ It is denoted by 'P' and unit is watt or Kilo-watt.

$$P = I^2R = VI\cos\phi$$

(2) Reactive power (Q)

→ The power which is developed in the inductive reactance of the circuit is called reactive power.

→ It is denoted by 'Q' and unit is VAR or KVAR (Volt-Ampere-Reactive)

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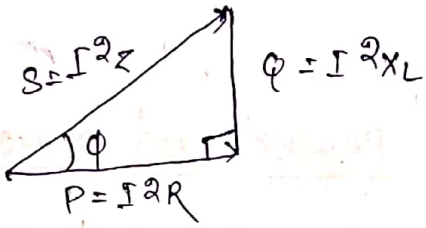
③ **Apparent power (S)**

→ The vector sum of active and reactive power is called apparent power.

→ It is denoted by 'S' and unit is VA or KVA (Volt-Ampere).

→ $S = VI$

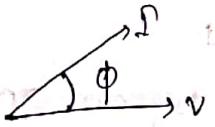
$S = \sqrt{P^2 + Q^2}$

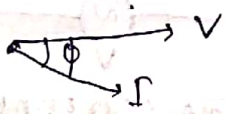


Power factor

→ The cosine angle between voltage and current is called power factor ($\cos\phi$).

→ The ratio of resistance to impedance is also called power factor. $\boxed{\cos\phi = \frac{R}{Z}}$

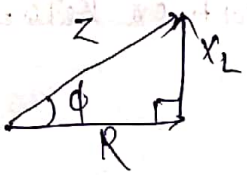




2.10 Impedance triangle and power triangle

Impedance triangle

→ The representation of resistance, reactance, and impedance in a right angle triangle with an phase angle 'ϕ' is called impedance triangle.



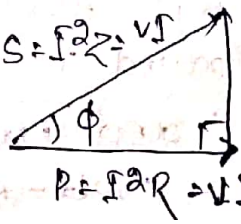
'ϕ' = Phase angle between 'R' and 'Z'

$Z = \sqrt{R^2 + X_L^2}$

power triangle

→ The graphical representation of active, reactive and apparent power in a right angle triangle with an phase angle 'ϕ' is called power triangle.

$S = \sqrt{P^2 + Q^2}$



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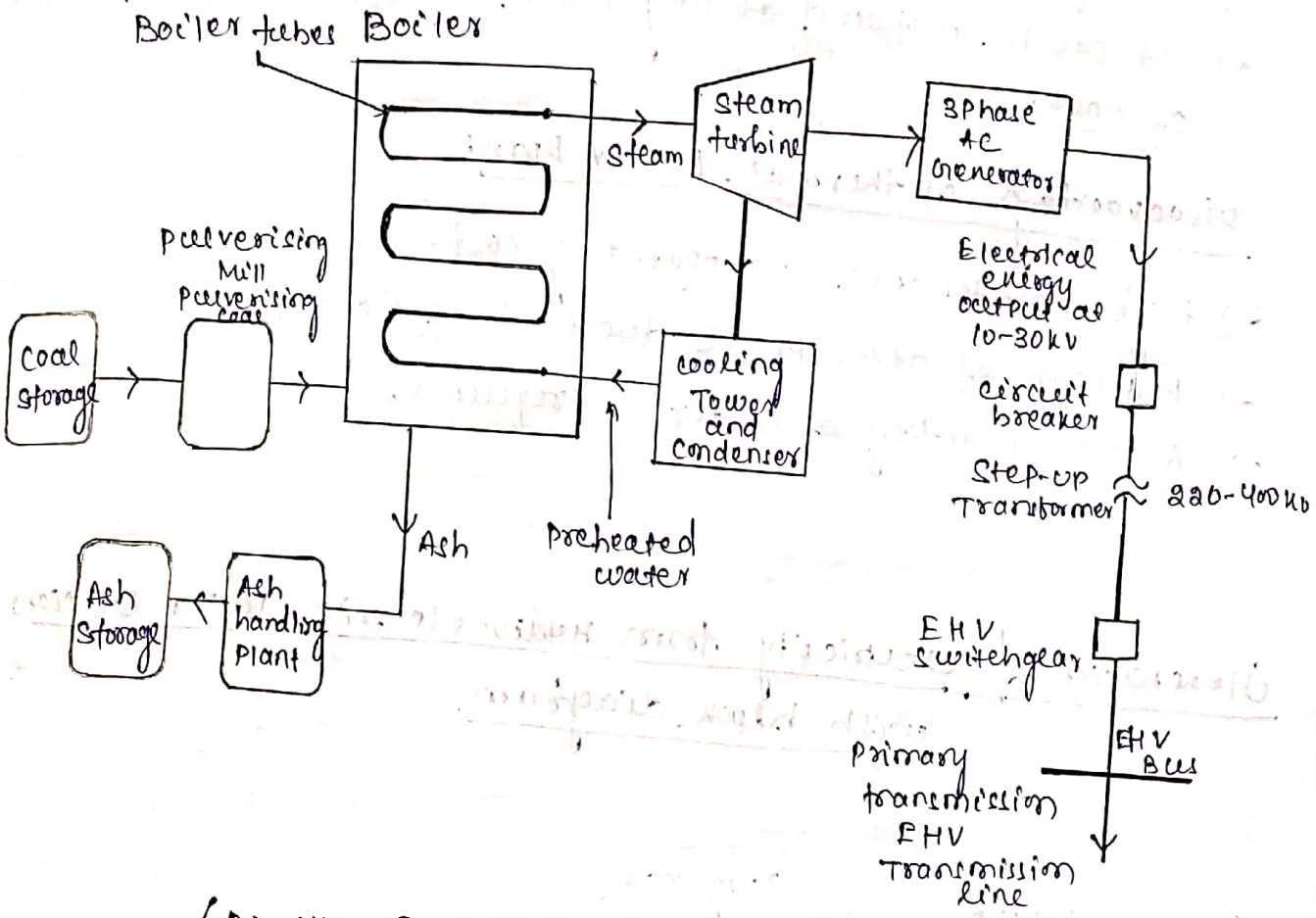
Chapter-3 Generation of Electrical Power

3.1 Generation of electricity from thermal power station with block diagram.



(BLOCK DIAGRAM OF THERMAL POWER PLANT)

→ In thermal power plant heat energy is converted into Electrical energy. A large quantity of water is used for making steam.

→ coal is burnt in the boiler. This heat converts water into steam when water passed through the boiler tube.

→ Here steam turbine is coupled with generators.

→ Then steam from boiler passes into steam turbine and rotates the turbine. For that coupled generator rotates and produce electrical energy.

→ The steam from steam turbine passes into condenser where steam converts into water and this water passes into boiler for re-use.

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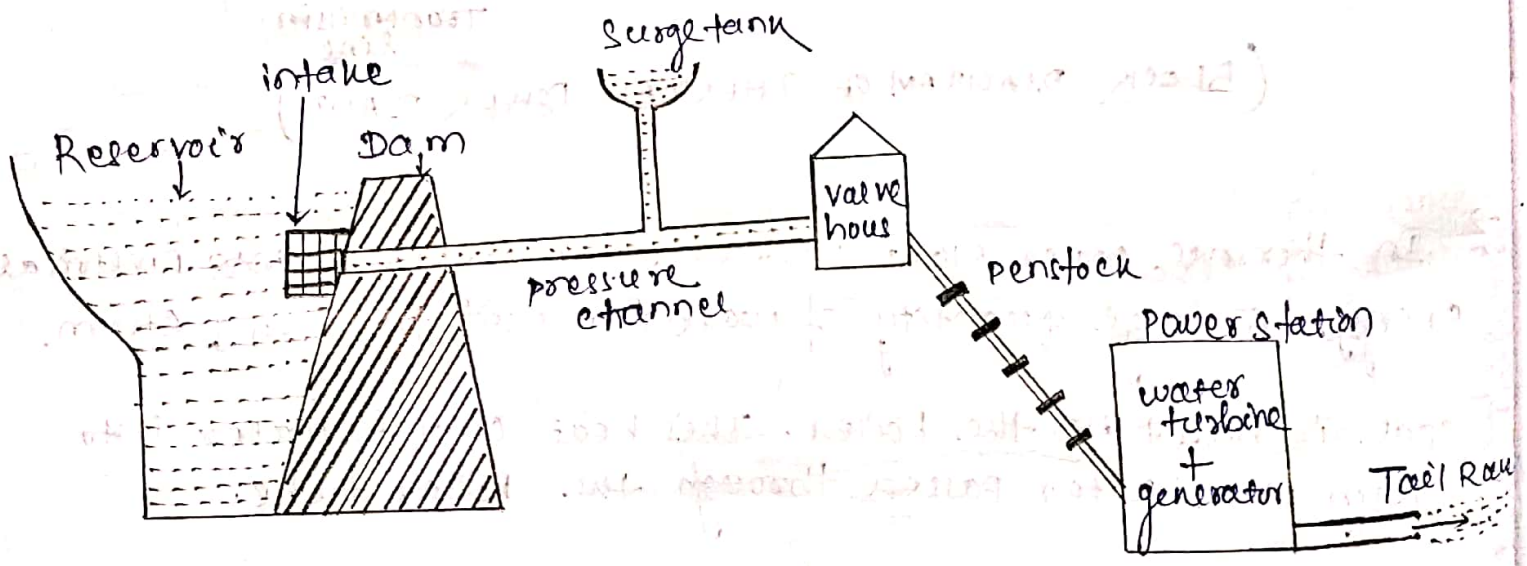
Advantages of thermal power plant

→ The fuel (coal) is cheaper.
→ Less initial cost as compared to other generating plants.
→ It required less space.
→ It can be installed at any place irrespective of the existance of coal.

Disadvantages of thermal power plant

→ High maintenance and operating cost.
→ Pollution of atmosphere due to fuel (coal)
→ A huge quantity of water is required.

Generation of electricity from Hydro-electric power station with block diagram.



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Elements of hydro-Electric power plant :→

(1) storage reservoir :→ It's purpose is to store water.

(2) Dam :→ The dam used to raise the water surface of stream to increase an artificial head.

(3) penstock :→ A penstock is the long pipe that carries the water, flowing from the reservoir towards the power generation unit.

(4) Intake :→ These are the gates built on the inside of the dam to controlled the water flow from reservoir.

(5) surgetank :→ Surge-tank is used to avoid water hammering effect and to save penstock.

→ For hydro-electric power plant, a huge quantity of water is required which is store in reservoir.

→ Through a pressure channel water passes from reservoir to valve house.

→ valve house contain main 'sluice valve' for controlling water flow to the power station.

→ A surgetank is provided to avoid water hammering effect on penstock

→ Then the water from valve house flow into the power station through penstock.

→ In power station, turbine coupled with generator.

→ In power station, water from penstock fall on blade of turbine, where kinetic energy of water is converted into rotational motion of the blade.

→ Due to rotational motion of blade, the coupled generator also rotates and produces electrical energy.

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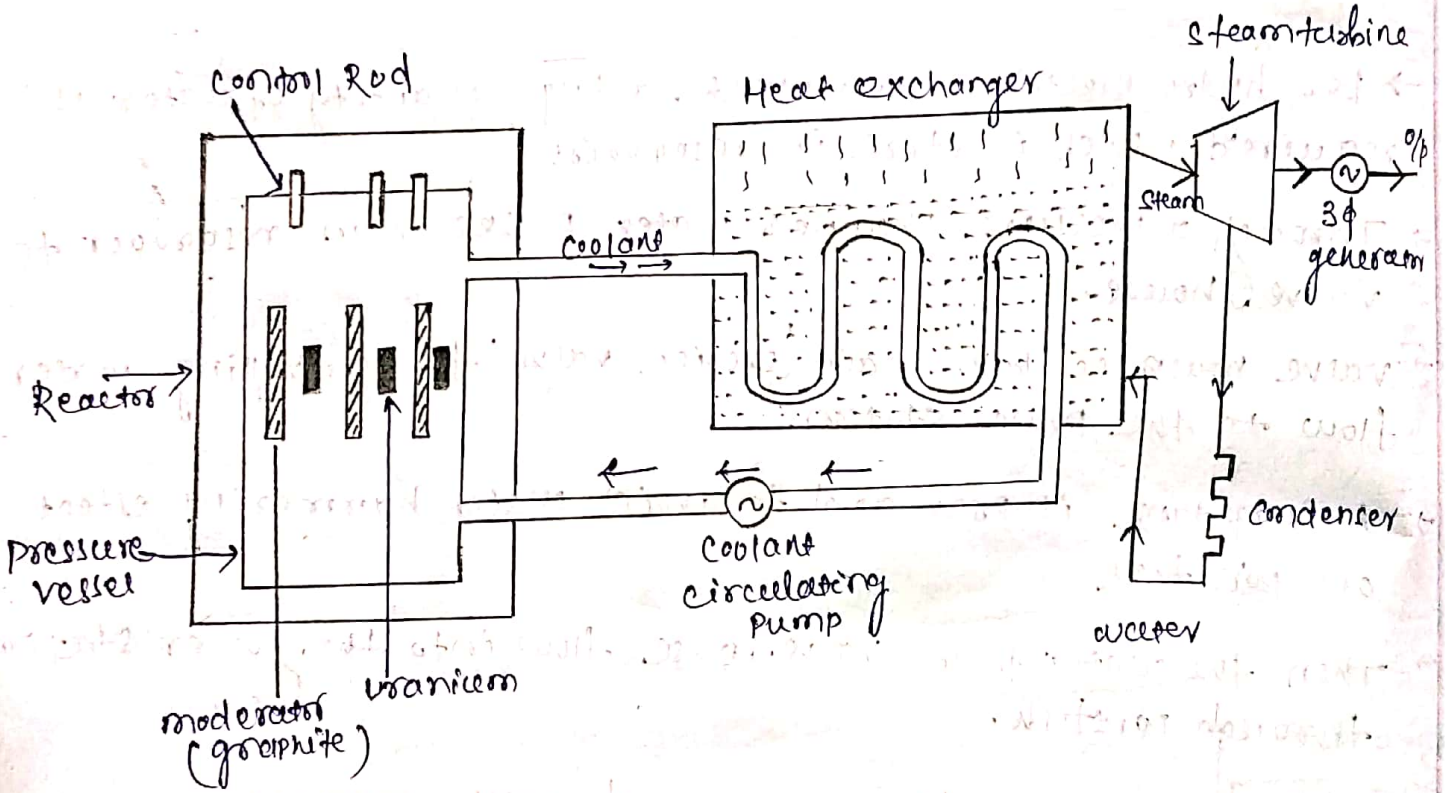
Advantages

→ They donot pollute atmosphere.
→ The lake's water can be used for irrigation purpose.
→ Hydro-power project control flood.
→ Cheapest in operation and maintenance.

Disadvantages

→ Dams are extremely expensive to build.
→ It depends on rain
→ It requires large area

Generation of electricity from Nuclear power station with block diagram.



The whole arrangement of Nuclear power plant can be divided into :→

1. Nuclear Reactor
2. Heat exchanger
3. steam turbine
4. condenser
5. Alternator

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(1) Nuclear Reactor

→ Inside the nuclear reactor a huge amount of heat energy is produced when uranium 235 (U^{235}) is bombarded with moving neutron.

→ The moderator made of graphite rods which slowdown the speed of neutrons.

→ The control rods made of cadmium which is a strong neutron absorber and thus regulates the supply of neutron for fission.

→ The heat produced in reactor is removed by the coolant which consist of liquid sodium.

→ The coolant carries the heat to the heat exchanger.

(2) Heat exchanger

→ The coolant gives up heat to the heat exchanger which is utilised in raising the steam.

(3) Steam Turbine

→ The steam drive the steam turbine. After doing a useful work in the turbine, the steam is exhausted to condenser.

(4) Condenser

→ In condenser, the steam is converted into water and fed to the heat-exchanger for re-use.

(5) Alternator

→ The steam turbine drives the alternator which converts mechanical energy into electrical energy.

Advantages

→ The amount of fuel required is quite small.
→ It require less space as compare to other power plant.

Disadvantages

→ Fuel is expensive and not abundantly available everywhere.
→ It has high capital cost.
→ maintenance charge is high.

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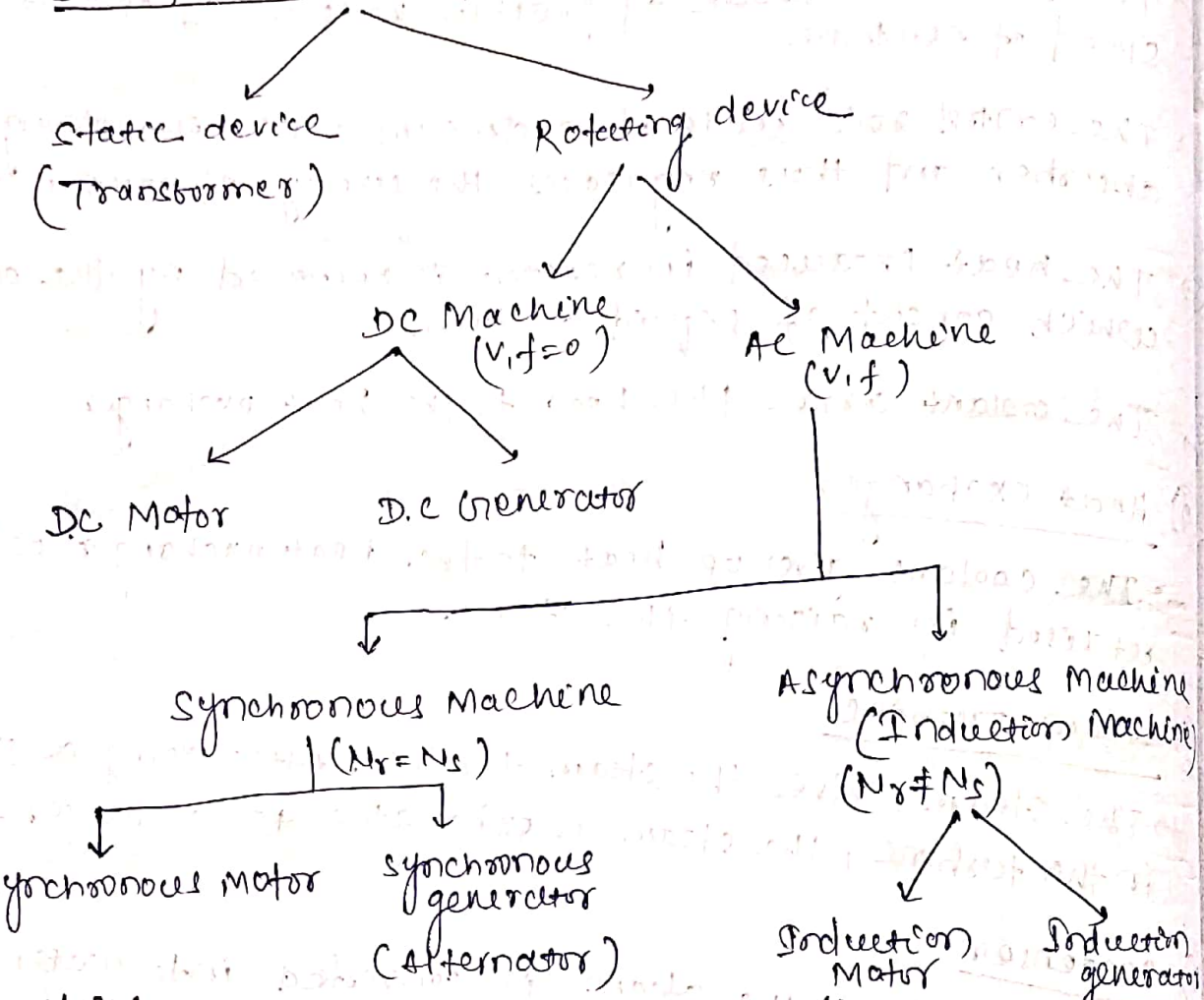
Chapter-4 Conversion of Electrical Energy

4.1 Introduction of DC Machine

Classification of Electrical Machine



D.C Machine

① **DC generator :→**

→ A machine that converts mechanical energy into electrical energy is called a D.C. generator.

→ DC generator works on the principle of Faraday's law ~~of~~ of electro-magnetic induction.

→ The law state that, whenever a conductor cuts the magnetic field flux, emf is induced and this emf causes the flow of current in a closed circuit.

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The basic essential parts of a electrical generator are

(1) A magnetic field

(2) conductor → which cuts the magnetic field.

→ The direction of induced emf can be determined by using Fleming's right hand rule.

(2) DC Motor :→

→ A d.c Machine that converts electrical energy into mechanical energy is called a d.c Motor.

→ A d.c Motor works on ~~the~~ Lorenz's principle.

→ The principle ~~state~~ state that, when a current carrying conductor placed in a magnetic field, a mechanical force acts on the conductor.

→ The direction of Mechanical force can be determined by fleming's left hand rule.

4.2 Main parts of DC Machine

A d.c Machine essentially consist of the following parts

(1) Magnetic frame or Yoke

(2) pole cores and pole shoes

(3) Field coil / Field windings

(4) Armature core

(5) Armature windings

(6) commutator

(7) Brushes & Bearing

(8) interpole

(9) shaft

(10) Base

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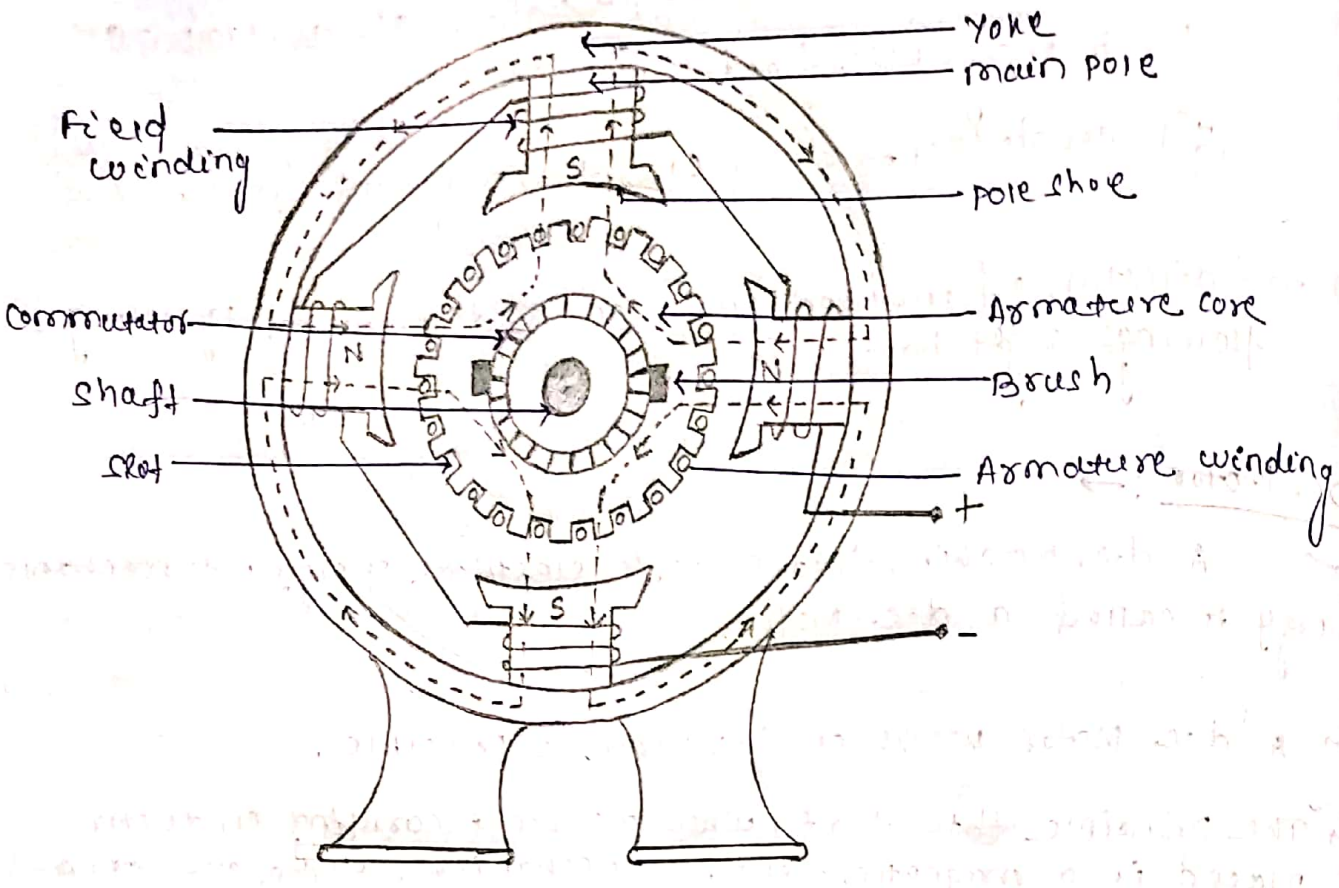

(Cross-section view of a D.C Machine)

① **Yoke** :→ The outer section of the machine is called yoke or magnetic frame.

It serves two purposes

(1) It provides mechanical protection to the whole machine

(2) It carries the magnetic flux produced by poles.

Material used

1) cast iron → for small M/c ($B = 0.8$ wb/m^2)

2) cast steel → for large M/c ($B = 1.5$ wb/m^2)

($\because B = \frac{\phi}{A_i}$)

② **Pole cores & pole shoes**

→ The field magnets consists of pole core and pole shoe.

→ The rectangular form is called pole core over which field windings are provided.

→ The bottom part of pole core is called pole shoe. and it is curved in nature inorder to get uniform flux distribution

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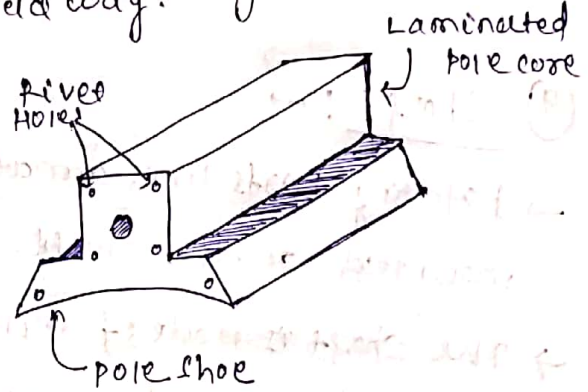
(3) Field winding / Field coil :→

→ Field windings are used to form electro-magnet & that produce the flux when current passes through these coils.
① series field wdg ② shunt field wdg.

(4) Armature core :→

→ It is the rotating part of a D.C Machine and is connected to the shaft.



(5) Armature windings :→

→ The conductors which are placed over the armature slot in a suitable ~~manner~~ manner is known as armature winding.

→ The armature windings are made of copper, in which "working" emf is induced in case of generator.

(6) Commutator :→

→ The function of commutator is to collect the current from the armature winding.

→ In case of generator, it acts as rectifier, that means it converts Ac to DC.

→ In case of Motor, it acts as inverter, that means it converts DC to Ac.

(7) Brush and Bearing :→

→ The current is collected from or supply through the brushes depending upon the machine, wether it is generator or motor.

→ The brushes are usually made of carbon.

→ The function of bearing is to reduce friction between the rotating and stationary part of the Machine.

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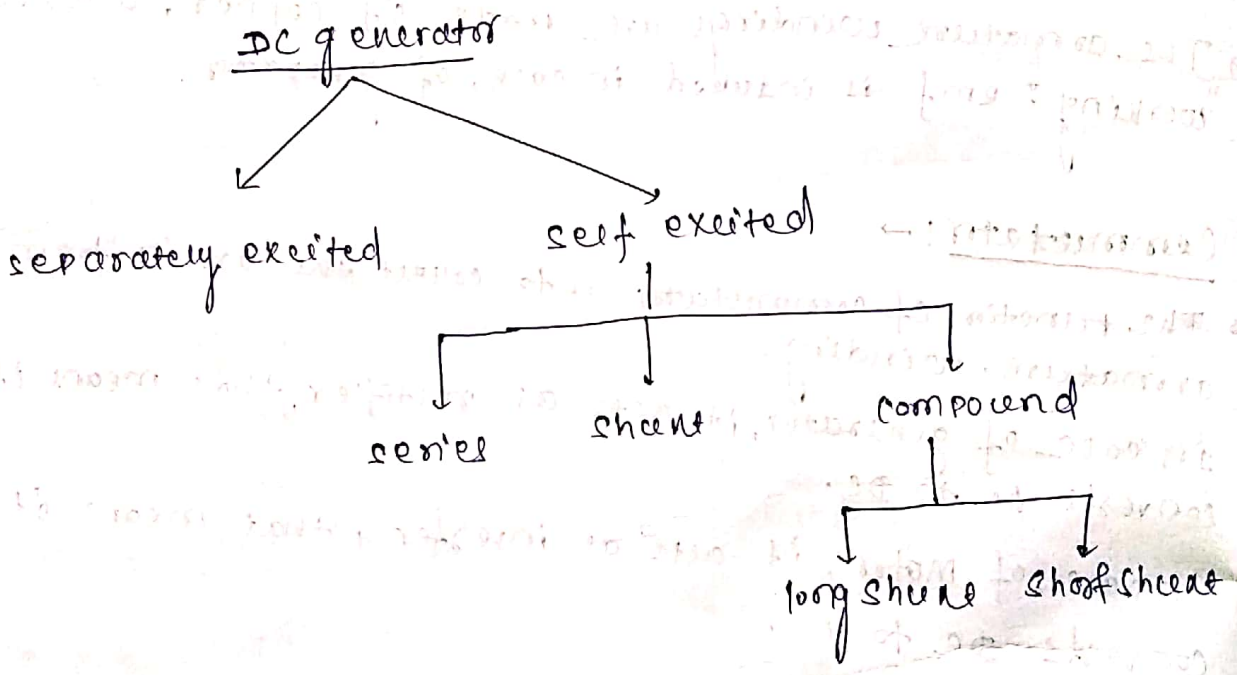
(8) Interpole! →

→ These are small poles placed in between the main poles.
→ These are used to reduce armature reaction.

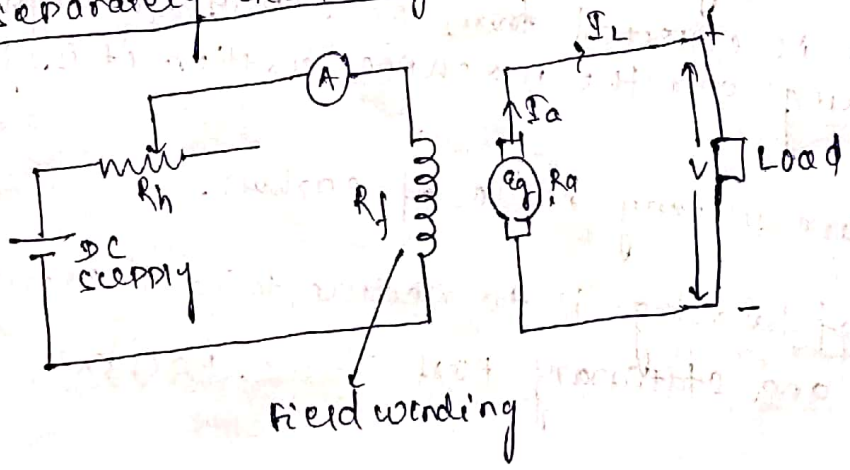
(9) Shaft! →

→ Rotating parts like armature core, commutator, cooling fan's are mounted on the shaft.
→ The shaft is made of mild steel
→ It is used to transfer mechanical energy from prime over to the armature (in generator) & from armature to load (in motor)

4.3 Classification of DC generator



(1) separately excited generator



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→ In separately excited DC generator, an external DC voltage source is used to excite the field.

$I_a = I_L$

I_a = armature current

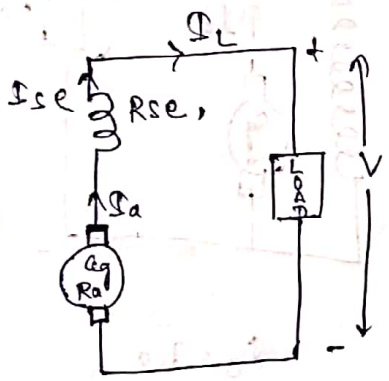
I_L = Line current

$$V = E_g - I_a R_a$$

(2) self excited generator

→ In self excited D.C generator, the field winding is excited by the current produced by the generator it'self.

(a) series generator



$I_a = I_{se} = I_L$

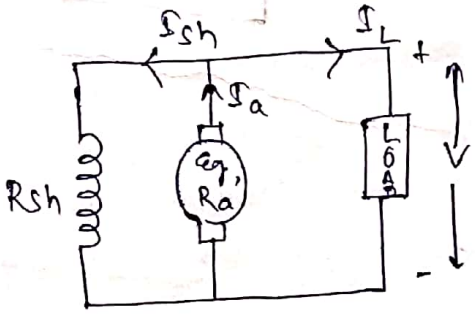
$V = E_g - I_a R_a - I_a R_{se}$

$$V = E_g - I_a (R_a + R_{se})$$

Here the field winding is connected in series with the armature winding.

(b) Shunt generator

Here the field winding is connected in parallel with the armature winding.



$I_a = I_{sh} + I_L$

I_{sh} = shaft current

$V = I_{sh} \times R_{sh}$

$$V = E_g - I_a R_a$$

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(c) compound generator

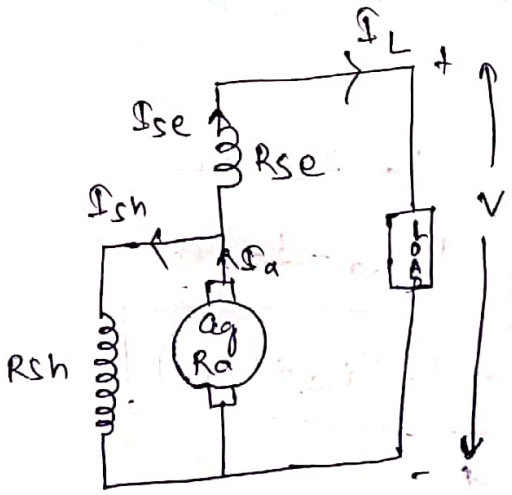
→ In a generator if both series and shunt field windings are present then it is called as compound generator.

→ According to connection their are 2 types of compound generator

(1) short shunt compound generator

(2) long shunt compound generator

short-shunt



$I_{se} = I_L$

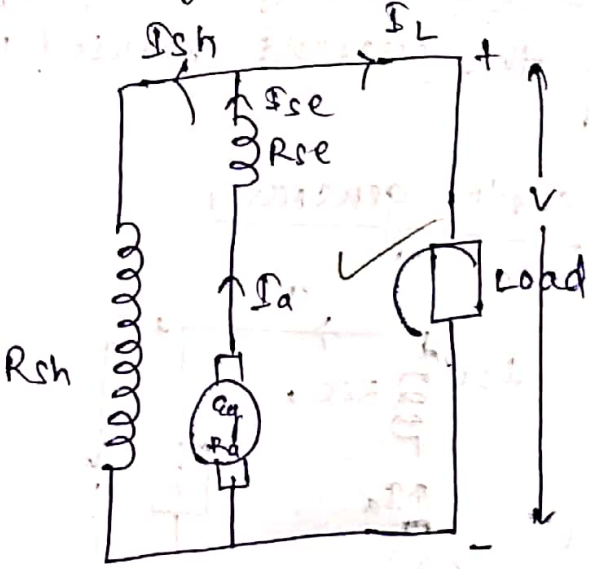
$I_{sh} R_{sh} = E_g - I_a R_a = V + I_{se} R_{se}$

$$\Rightarrow \boxed{I_{sh} = \frac{V + I_{se} R_{se}}{R_{sh}}}$$

$$\Rightarrow E_g - I_a R_a = V + I_{se} R_{se}$$

$$\Rightarrow \boxed{V = E_g - I_a R_a - I_{se} R_{se}}$$

long-shunt



$I_a = I_{se}$

$I_a = I_{sh} + I_L$

$$\boxed{V = E_g - I_a R_a - I_{se} R_{se} = I_{sh} R_{sh}}$$

$$\boxed{I_{sh} = \frac{V}{R_{sh}}}$$

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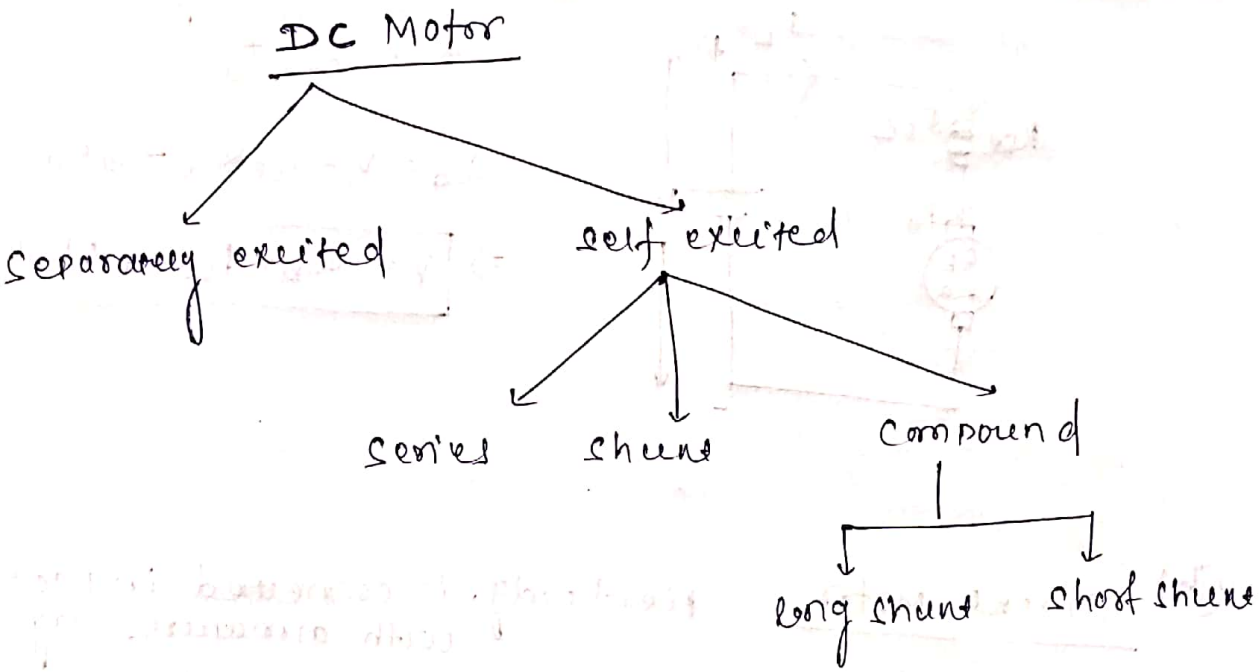
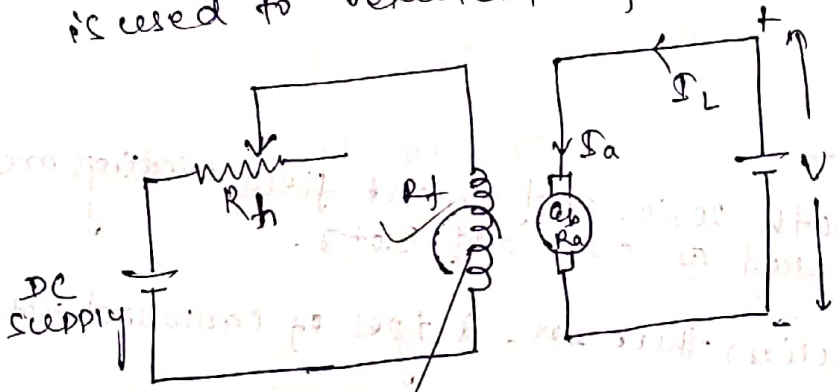
4.4 classification of DC Motor



(1) separately excited DC Motor

→ In separately excited Motor, an external voltage source is used to excite the field.



$I_a = I_L$, $E_b = V - I_a R_a \Rightarrow \boxed{V = E_b + I_a R_a}$

(2) self excited DC Motor

→ In self excited DC Motor, the field windings is excited by the current supply to the Motor.

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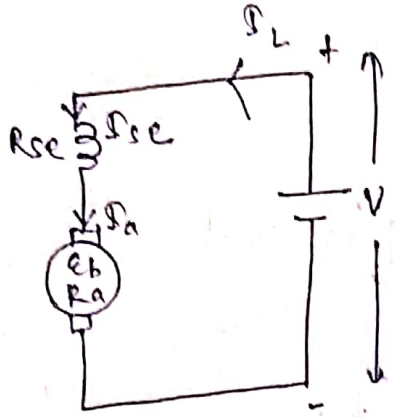
(a) **Series Motor** Field wdg. is connected in series with armature wdg.

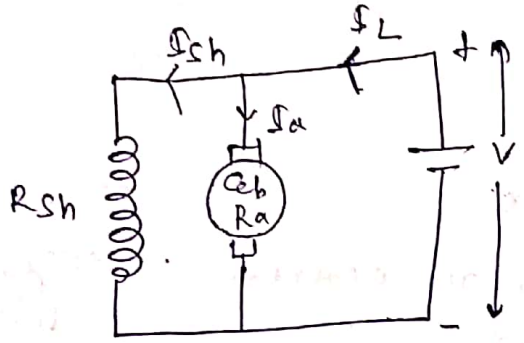


$I_L = I_{se} = I_a$

$E_b = V - I_{se}R_{se} - I_aR_a$

$\Rightarrow \boxed{V = E_b + I_{se}R_{se} + I_aR_a}$

(b) **Shunt Motor** Field wdg. is connected in parallel with armature wdg.



$I_L = I_{sh} + I_a$

$\boxed{V = I_{sh}R_{sh}}$

$\boxed{V = E_b + I_aR_a}$

$\boxed{E_b = V - I_aR_a}$

(c) **Compound Motor**

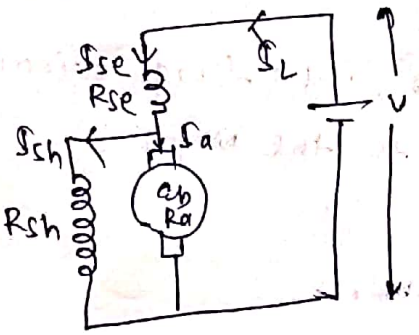
→ In a Motor, if both series and shunt field windings are present, then it is called as compound Motor.

→ According to connection their are 2 types of compound Motor

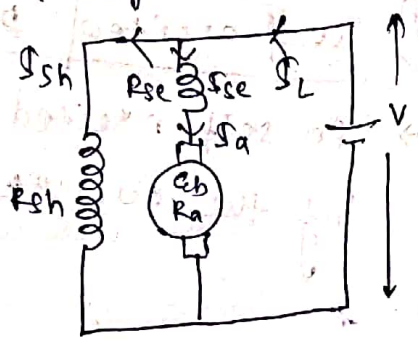
① short shunt compound Motor

② long shunt compound Motor

Short-shunt



Long-shunt



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$I_L = I_{se}$, $\boxed{I_{se} = I_a + I_{sh}}$

$I_{sh} R_{sh} = E_b + I_a R_a = V - I_{se} R_{se}$

$\Rightarrow \boxed{V = E_b + I_a R_a + I_{se} R_{se}}$

$\Rightarrow \boxed{E_b = V - I_a R_a - I_{se} R_{se}}$

$\boxed{I_L = I_{sh} + I_{se}}$, $I_{se} = I_a$

$V = I_{sh} R_{sh} = E_b + I_a R_a + I_{se} R_{se}$

$\Rightarrow V = E_b + I_a R_a + I_{se} R_{se}$

$\Rightarrow \boxed{V = E_b + I_a (R_a + R_{se})}$

$\Rightarrow \boxed{E_b = V - I_a (R_a + R_{se})}$

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Application of DC Motors

Types of Motor	Characteristics	Application
(1) DC Shunt Motor (Constant speed)	→ It is used where the speed is required to remain constant from No-load to full-load → medium starting torque	→ Lathes → Drills → Blowers & fans → Boring mills → centrifugal pumps
(2) DC Series Motor (High starting torque)	→ It is used where high starting torque is required for accelerating a heavy mass. → variable speed	→ Electric traction → cranes → Elevator → conveyors → hoists → air compressor → vacuum cleaner
(3) Compound motor (a) cumulative type → constant speed → High starting torque	→ constant speed is required with irregular loads or suddenly applied heavy load. → High starting torque	→ Elevator → conveyors → Rolling mills → ice machines → printing press

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Application of DC generator

Types of generator	characteristics	Applications
(1) Shunt generator	→ constant terminal voltage	→ Batteries charging
(2) series generator	→ Rising voltage characteristics	→ Booster (In certain type of distribution system, particularly in railway service.
(3) compound generator (a) cumulative type	→ over compounding compensate voltage drop in the distribution line and voltage at consumer terminal remain more	→ DC generator, (Lighting, power servi
(b) Differential	→ constant Current generator	→ Arc welding.

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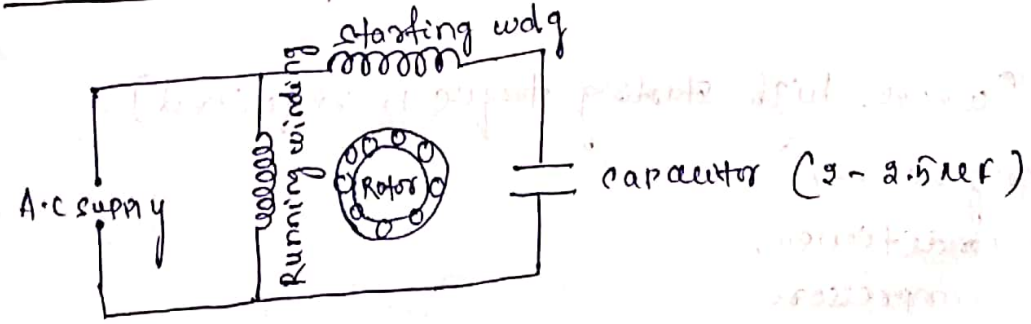
4.6 Types and uses of single phase Induction Motors

Classification of A.C single phase Motor.

- Induction type
  - split phase type Motor
    - capacitor start Motor
    - permanent capacitor Motor
    - capacitor start capacitor run Motor
    - shaded pole Motor
- commutator type
  - universal Motor
  - Repulsion Motor

(1) permanent capacitor Motor



uses :→ ceiling fan, Table fan,

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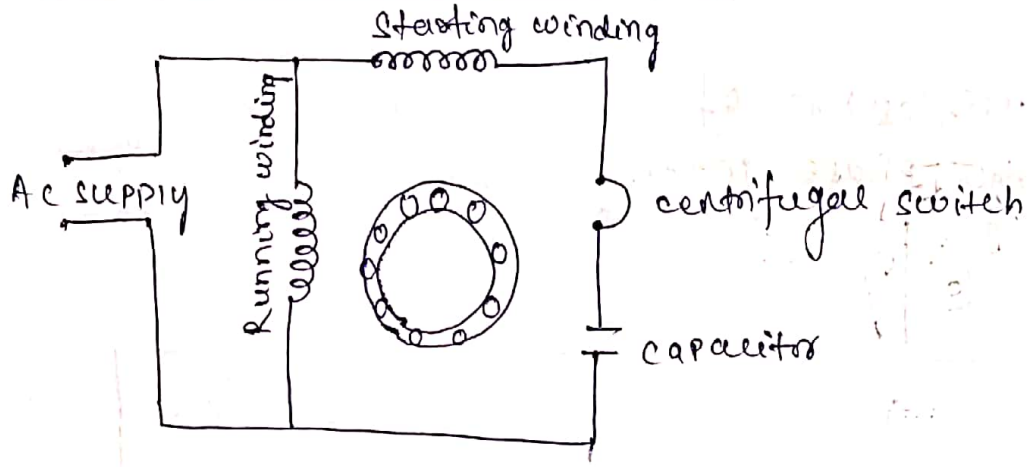
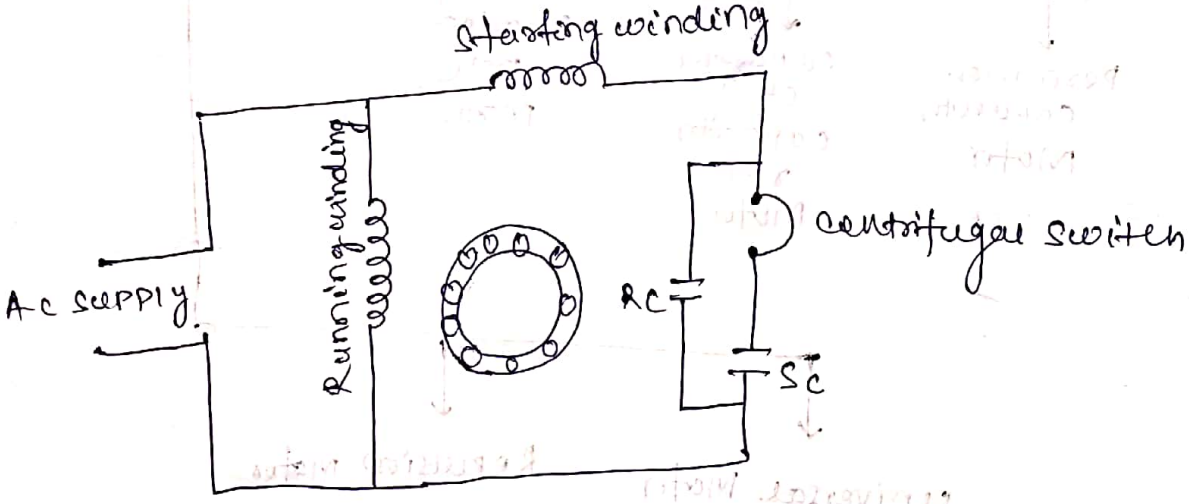
(2) capacitor start induction Motor



uses :→ Lathe machine,
Drill Machine
grinders

(3) capacitor start capacitor run induction motor



RC = Running capacitor
SC = Starting capacitor

uses :→ (where high starting torque is required)
Refrigerators,
air conditioner,
air compressors
blowers

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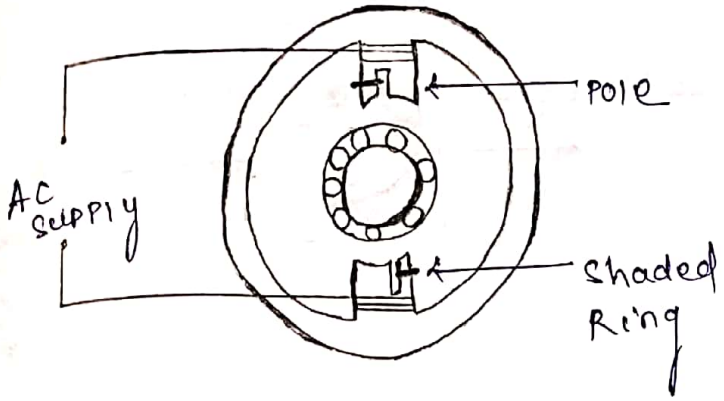
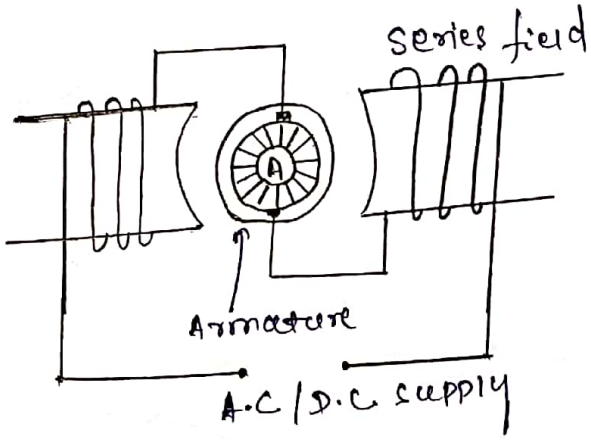
(4) Shaded pole Motor



uses :→ cooler pumps
small fans
hair dryer
electric wall clock

(5) universal Motor → This motor works on A.C and D.C both supply.



uses :→ portable drill machine
sewing machine
vacuum cleaner

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4.7 Concept of Lumen

① **Luminous flux :→**

The total quantity of light emitted by a source of light per second is called luminous flux.

② **Lumen :→**

It is the unit of luminous flux.

Example

crompton

Luminous flux

18 watt ⟶ 1600 Lumen

36 watt ⟶ 2450 Lumen

20 watt ⟶ 2000 Lumen

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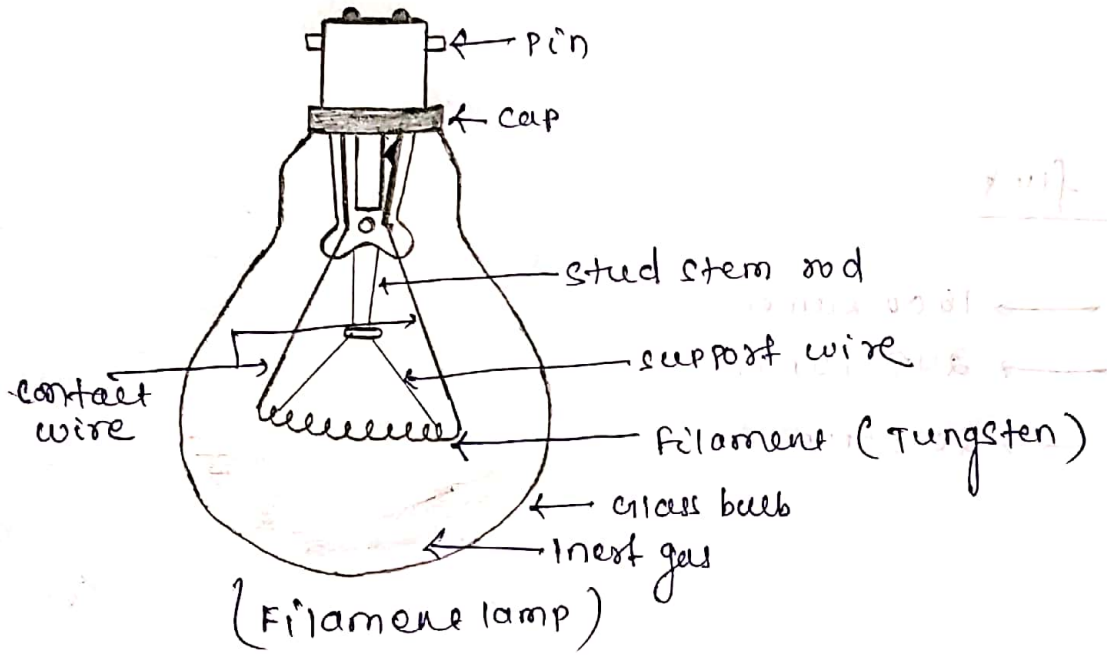
4.8 Different types of lamps (Filament, Fluorescent, LED bulb) its construction and principle

The electric lamp is a source which convert electric energy into heat energy and then lighting energy.

① Filament type :→
(Incandescent lamp)



(Filament lamp)

→ It consist of a glass bulb containing carbon or tungsten filament.

→ The production of light due to heating effect of filament caused by electric current flow through it.

→ The working temperature of carbon filament is about 1600°C to 1800°C, as at higher temperature it starts evaporating and thus, blackens the inner surface of glass bulb due to this carbon filament is rarely used for making the bulb.

→ The tungsten filaments are of two types
① coiled filament

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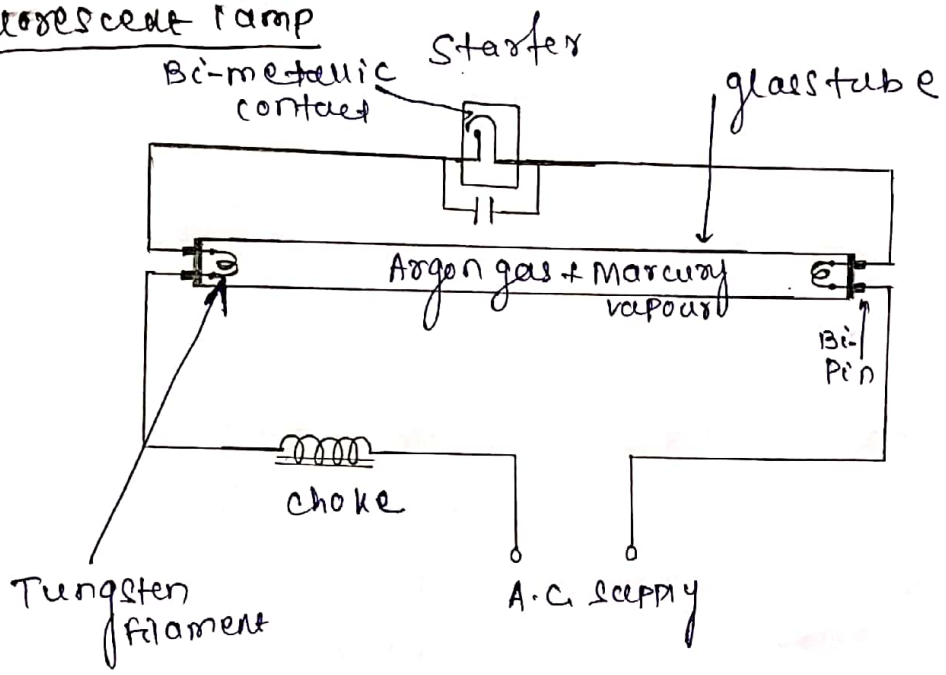
② coiled coil filament.

→ Lamps upto 40 watts are vacuum type where as lamps above 40 watts are gas filled.

→ Normally argon with small percentage of nitrogen gas is used which prevents the blackening of inside of the lamp due to evaporation of tungsten filament operating at high temperature

② Fluorescent lamp



→ Tube is made of glass with fluorescent powder coating to it's inner surface.

→ Tungsten filament is used.

→ The mercury vapour with small quantity of argon gas at low pressure is filled up in the tube.

→ when fluorescent tube is connected to supply through choke and starter, about 1000 volt is induced.

→ Due to this, filament discharges the gas on heating and provides path for the flow of electrons, as gas after discharge acts as a conductor. Mercury vapour are vaporized and give full light.

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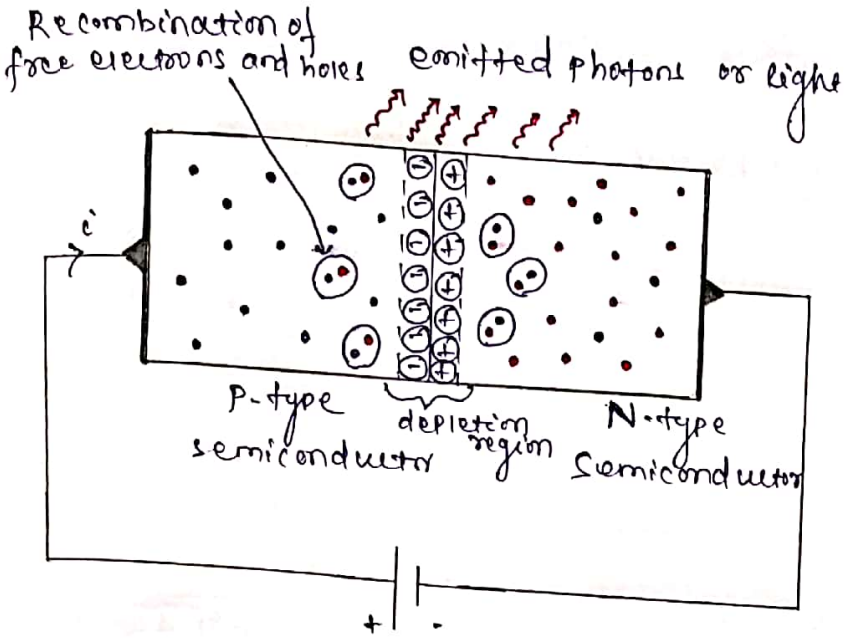
③ LED bulb (Light emitting diode)



→ The light emitting diode is a P-N junction diode. It is made up of a specific type of semiconductor.

→ under the forward biased condition, when a suitable voltage is applied across the diode, electrons and holes are moving fast across the junction.

→ Then electrons are able to recombine with holes within the device and releasing energy in the form of photons or light.

Advantages of LED

1. smaller size
2. Physical Robustness
3. longer life
4. lower energy consumption
5. faster switching

Application of LED

→ Bulb in homes and industries
→ traffic signal
→ used in motor cycles and cars
→ Display

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4.9 Star Rating of home appliances

Energy efficiency :→

→ energy efficiency means using less energy to provide the same service.

→ energy efficiency can be defined as a reduction in the energy used for given service (heating, lighting etc)

Example :→

CFL is more efficient than incandescent bulb as it uses much less electrical energy to produce the same amount of light.

Star Rating :→ More number of stars meant a higher efficiency appliance which consumes less electricity

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Chapter-5 Wiring and power Billing

5.1 Types of wiring for domestic installations

Followings are the type of internal wiring usually employed in industries and house wiring.

1. cleat wiring
2. casing and capping wiring
3. Batten wiring
4. conduit wiring
   - surface wiring
   - underground / concealed type wiring

(1) Cleat wiring

→ In this type of internal wiring the cables used are either VIR or PVC types.

→ The cables are held by porcelain cleats above the wall or ceiling.

→ The cleats are made in two halves, one base and the other cap.

Advantages

→ It is the cheapest system of internal wiring

→ Inspection, alternation and addition can be easily made.

→ Skill required is little.

Disadvantages

→ It is not good looking.

→ It is quite temporary and destroy quickly.

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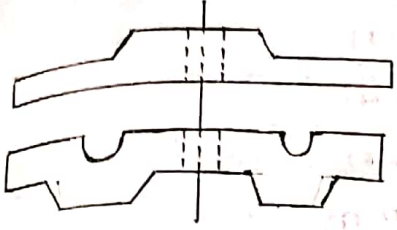
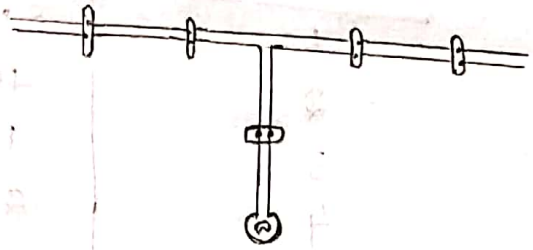




(2) casing and capping wiring

→ In this type of wiring PVC casing and capping are being used.

→ This type of wiring is achieved by using hollow channel made of PVC plastic.

Advantages

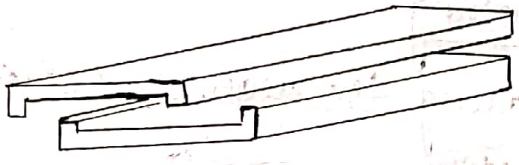
→ Easyly inspect by opening the capping.

→ Easy to install and rewire.

Disadvantages

→ This type of wiring can be used only on surface and cannot be concealed in plaster.

→ Since it requires better workmanship, the labour cost is higher.



(3) Batten wiring

→ In this type of wiring, cables are run on perfectly straight and well varnished teak wood batten.

→ The width of batten depends upon the number and size of cable to be carried by it.

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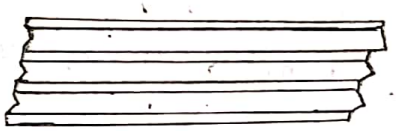
Advantages

→ It's installation is easy and quick
→ It's life is sufficiently long.

Disadvantages

→ Good workmanship is required.
→ This type of wiring cannot be recommended for use in situation open to sun and rain.



(4) Conduit wiring (PVC)

① concealed conduit wiring

→ The conduits are fixed along the wall or ceiling in plaster at the time of construction.

② surface conduit wiring

→ In this type of wiring, the conduits are placed on the surface of the wall and hold with the help of conduit saddle.
→ This type of wiring is applied in the industrial wiring.

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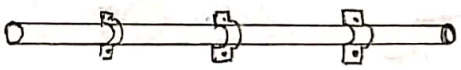
Advantages

- It provide protection against mechanical damage.
- The whole system is waterproof.
- It's life is long.
- It is shock proof, if earthing is properly done.

Disadvantages

- Experience and highly skilled labour is required for carrying out the job.
- It's erection is not easy and required time.



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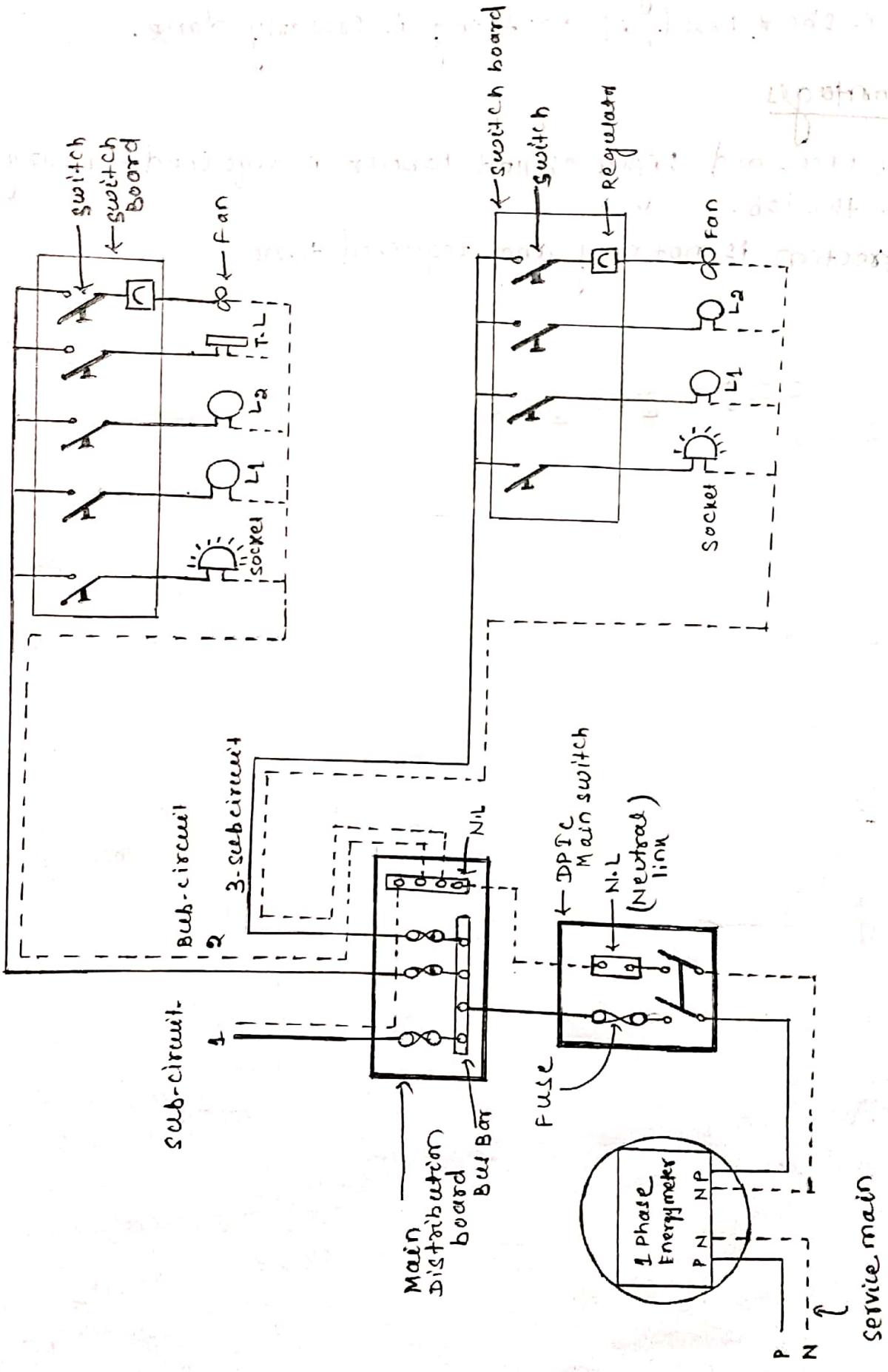
5.2 Layout of household electrical wiring (single line diagram showing all the important component in the system



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5.3 List out the basic protective devices used in house hold wiring.

① Fuse! →

→ Fuse is a current interrupting device which breaks the circuit under short circuit or overload condition.

→ The action of fuse is based upon the heating effect of the electric current.

→ The material commonly used for fuse elements are tin, lead, silver, copper, zinc, aluminium and alloy of lead and tin.

→ The materials used for fuse elements must be of low melting point and high conducting in nature.

Advantages

→ It is a simplest and cheapest protective device.

→ It require no maintenance.

→ It's operation is completely automatic which can break heavy short-circuit current without noise or smoke.

Disadvantages

→ considerable time is lost in rewiring or replacing a fuse after operation.

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(2) MCB (Miniature circuit Breaker)

→ It is a protective device which make a circuit under normal condition and break a circuit under fault condition.

→ It operated manually under normal condition and automatically under fault condition.

(3) Earthing

Connection of non-current carrying parts of electrical apparatus, such as metallic frame, earth terminal of socket etc to the general mass of earth in such a manner that at all times an immediate discharge of electrical energy takes place without danger.

Generally 2 types of earthings are there

1. Pipe earthing
2. Plate earthing

Pipe earthing :→

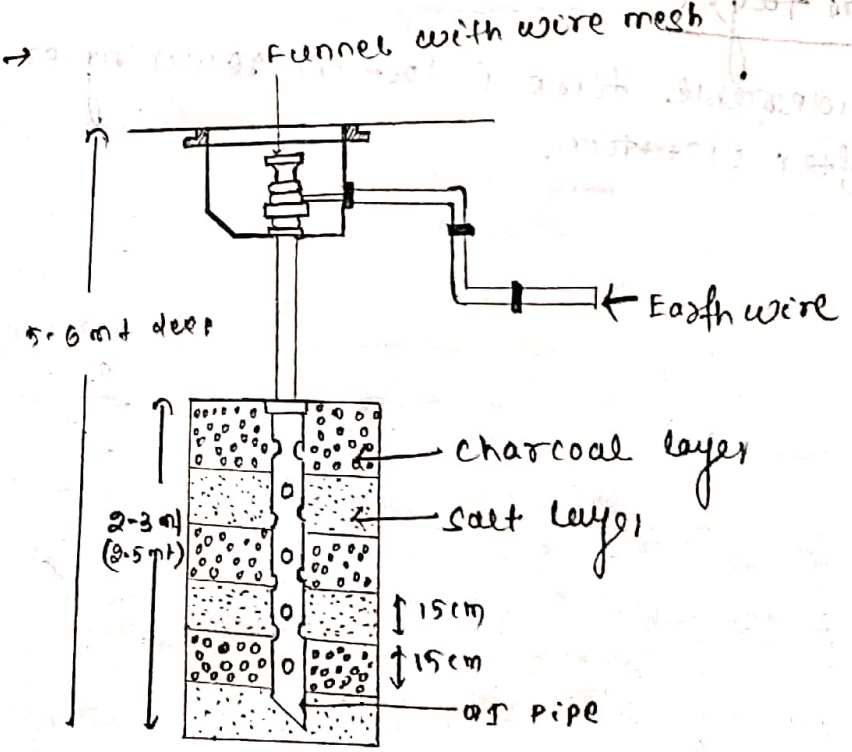

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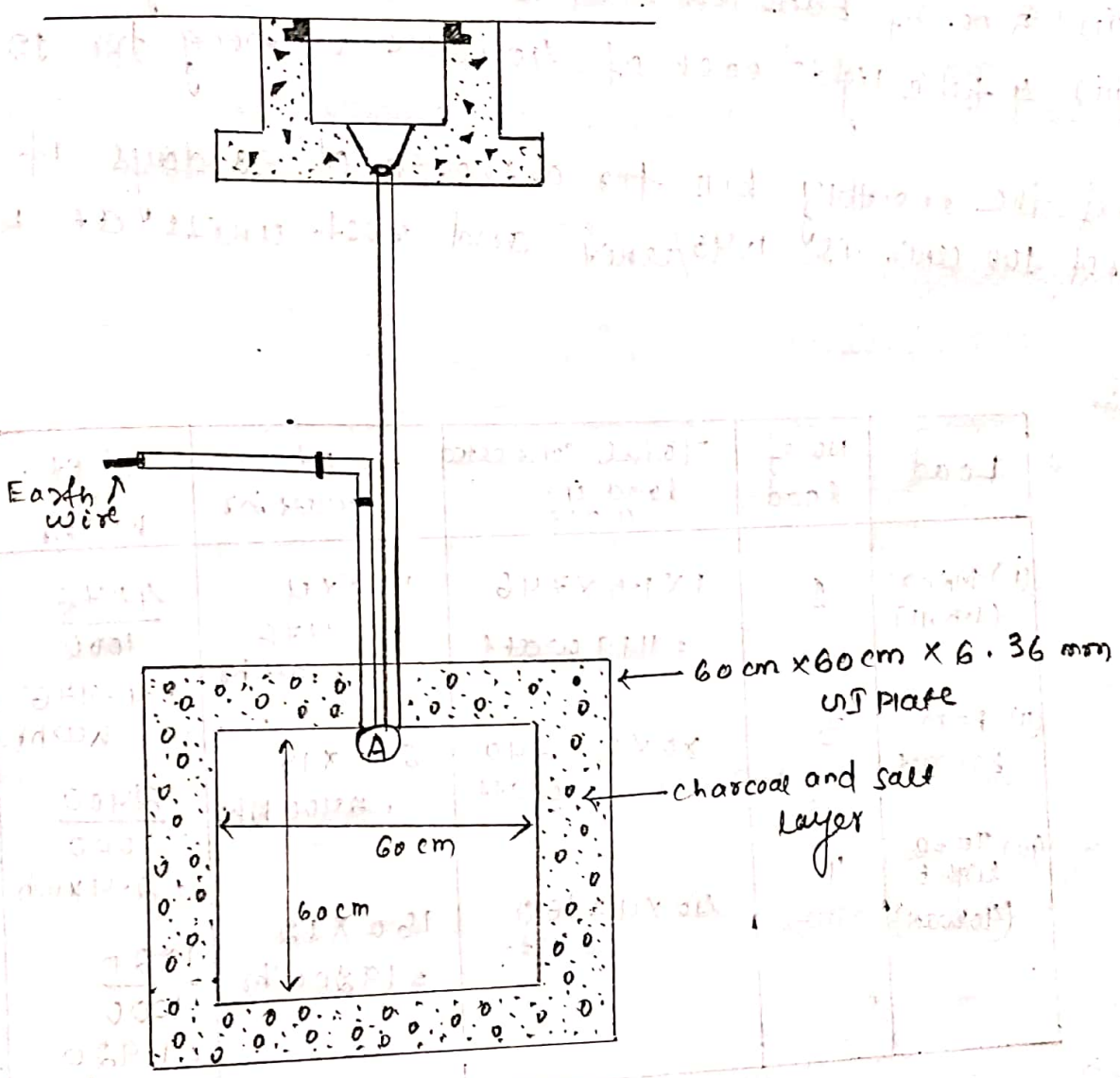
plate earthing :→



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5.4 Calculate energy consumed in a small electrical installation

Q.1 A building has the following appliances.

(i) A 1.5 HP motor running for 4 hrs in a day.
(ii) 3 no. of Fans each of 80 watt running for 10 Hrs in a day
(iii) 4 tube light each of 40 watt running for 12 hrs in a day.

Find the monthly bill for a month of 30 days if the cost of first 100 unit is 1.40/unit and rest units at Rs 4.10/unit

Ans

Load	No. of load	Total connected load in watt	E = Pt watt hr	unit in kWhr
(i) Motor (1.5 HP)	1	1 × 1.5 × 746 = 1119 watt	1119 × 4 = 4476 watt hr	$\frac{4476}{1000}$ = 4.476 kWhr
(ii) Fan 80 watt	3	80 × 3 = 240 watt	240 × 10 = 2400 Whr	$\frac{2400}{1000}$ = 2.4 kWh
(iii) Tube light (40 watt)	4	40 × 4 = 160 watt	160 × 12 = 1920 wh	$\frac{1920}{1000}$ = 1.920 kWhr

Total unit consumed in one day

= (4.476 + 2.4 + 1.92) kWhr

= 8.796 kWhr

Total unit consumed for 30 days

= 8.796 × 30

= 263.88 unit

cost of 1st, 100 unit is Rs. 1.40

= 100 × 1.40 = 140/-

cost of remaining 163.88 unit = 163.88 × 4.10 = 671.90 ≈ 672

Total cost for 30 days = 140 + 672 = 812/-

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Q.2 A building has the following electrical appliances

(i) A heater 1000 watt running for 5 hrs a day.

(ii) 4 fans each 60 watt running for 10 hrs a day.

(iii) 4 tube light each of 40 watt running 8 hrs a day.

Find monthly energy consumed for the month of october and bill if unit cost @ Rs. 4/-

Ans.

Load	No. of load	Total connected load in watt	E = Pt watt.hr	unit in kwhr
(i) Heater (1000w)	1	1000×1 = 1000w	1000×5 = 5000wh	$\frac{5000}{1000}$ = 5 kwh
(ii) fan (60w)	4	60×4 = 240 w	240×10 = 2400 wh	$\frac{2400}{1000}$ = 2.4 kwh
(iii) tube light 40w	4	40×4 = 160w	160×8 = 1280 wh	$\frac{1280}{1000}$ = 1.280 kwh

Total energy consumed in one day

= (5 + 2.4 + 1.28) kwhr

= 8.68 kwh

Total energy consumed for the month of october

= 8.68 × 31

= 269.08 kwh

cost of electrical energy = 269.08 × 4

= 1076.32/-

= 1076/-

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Chapter. 6 Measuring Instruments

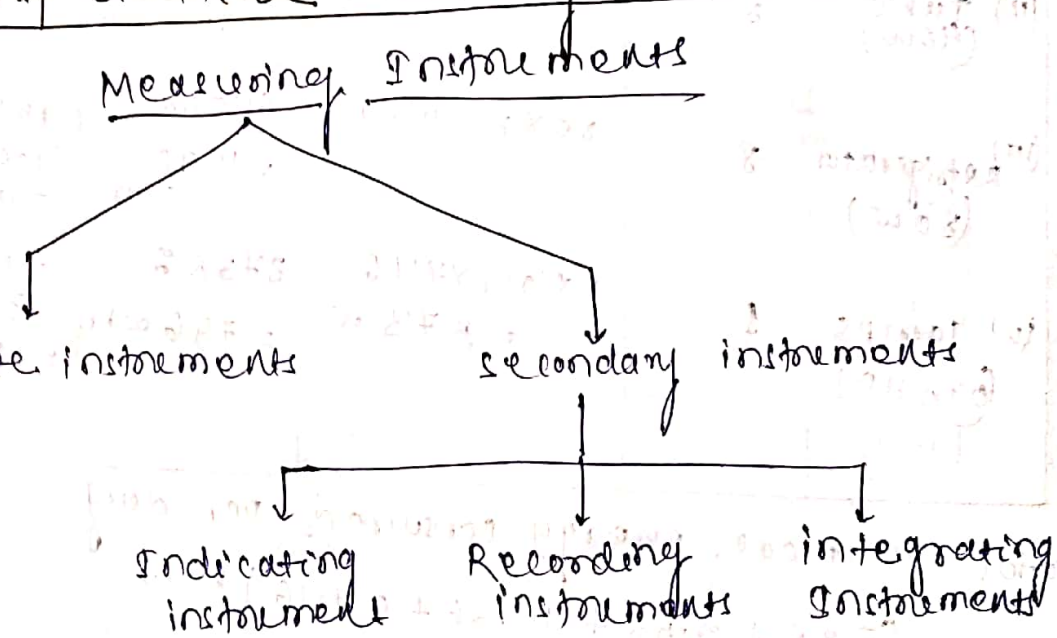
6.1 Introduction to Measuring Instruments

Measuring Instruments

The instruments which are used to measure electrical quantities i.e. voltage, current, power, energy, resistance, frequency etc. are called electrical instruments.

current → Ammeter
voltage → Voltmeter
power → wattmeter
energy → energymeter
resistance → ohmmeter
frequency → frequency meter

Classification of electrical measuring Instruments



Absolute Instrument

→ These instrument does not give direct reading, but it gives interms of instrumental physical constant.

→ It is a time consuming process, But gives all most 100% correct value. Hence, these are used only in research laboratory.

Ex:→ Tangent galvanometer

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Secondary Instrument

→ This instruments which indicate the electrical quantity to be measured directly interms of deflection are known as secondary instrument.

→ It gives direct reading and generally 5 types

(a) Indicating Instrument

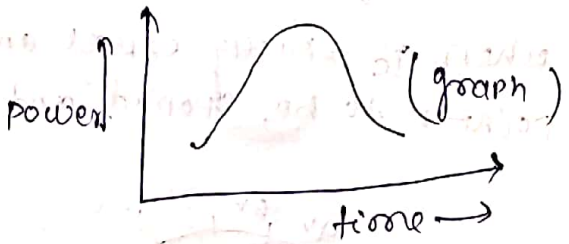
→ These instrument gives the instantaneous value of electrical quantity at the time of measurement.

Ex:→ ordinary Ammeter, voltmeter, wattmeter

(b) Recording Instrument

→ The value to be measured is continuously recorded over a graph paper by using a light weight pen.

Ex:→ Recording ammeter, voltmeter, wattmeter, storage oscilloscope



(c) Integrating Instrument

→ This instruments adds the measure value to the existing value.

Ex:→ energy meter

6.2 Torques in Instruments

For satisfactory working of indicating instruments the following '3' torques are needed.

1. Deflecting Torque (T_D)
2. controlling Torque (T_C)
3. Damping Torque

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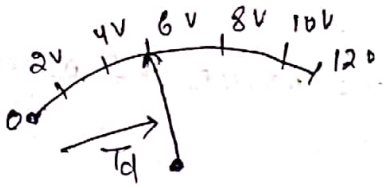
① Deflecting Torque (T_D)

→ The deflecting torque causes the moving system of the instrument to move from it's initial zero position.

→ T_d always acts clockwise direction.



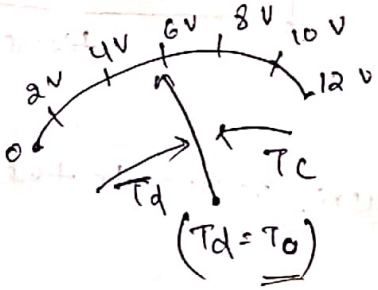
* T_d causes the motion of pointer from '0' position to required value.

② Controlling Torque (T_c)

→ To get the pointer at required final value controlling torque (T_c) is required.

→ The controlling Torque acts in opposite direction to deflecting torque.

→ when T_c exactly equal and opposite to T_d ($T_c = T_d$), then pointer to be stoped and gives the reading.



③ Damping Torque

→ A damping torque is necessary in order to bring the pointer to rest position quickly.

→ The damping torque always acts opposite to the pointer. (Both clockwise and anticlockwise direction)

→ * If damping torque is not present, then the meter pointer start like a motor with high speed. Then T_c comes quickly because spring tighten suddenly. Then pointer makes the

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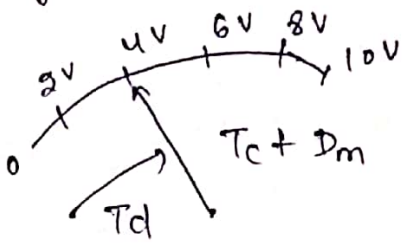
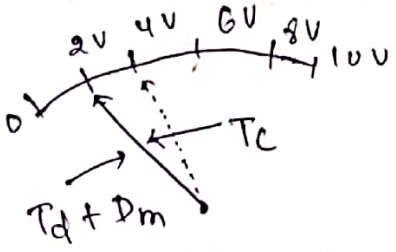
oscillation w.r.t to final value, and takes more time to give the reading.

→ To reduce the oscillation, pointer speed has to be reduced. for this damping torque is required to reduce speed of pointer only.



(Fig-1)

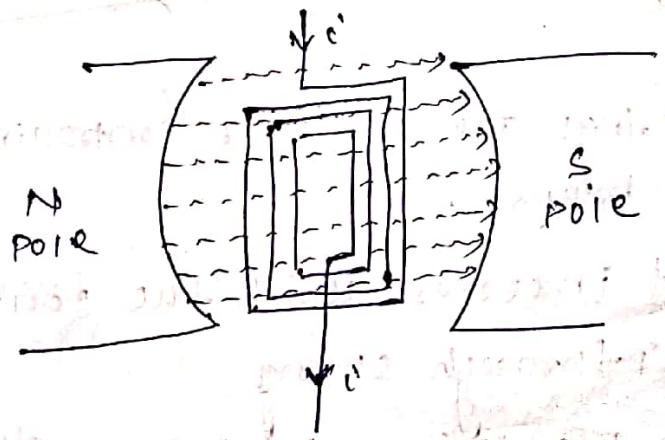


(Fig-2)

Deflecting Torque

According to the Lorenz's principle, when a current carrying conductor placed in a magnetic field, experience a mechanical force i.e $F = B I L \sin\theta$

- B → magnetic field
- I → current
- L → length
- θ = angle between 'B' & 'L'



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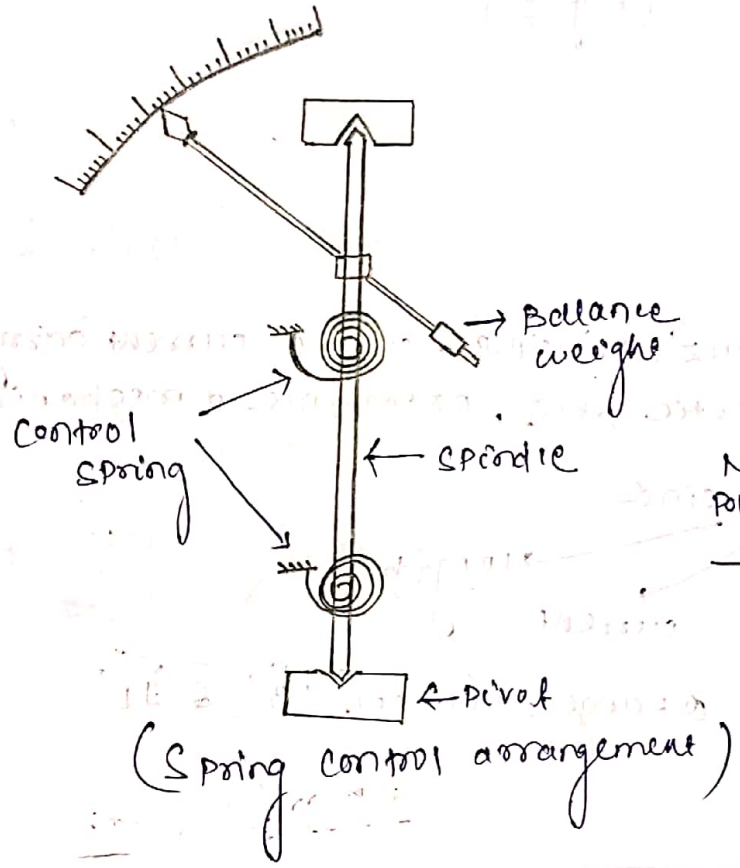
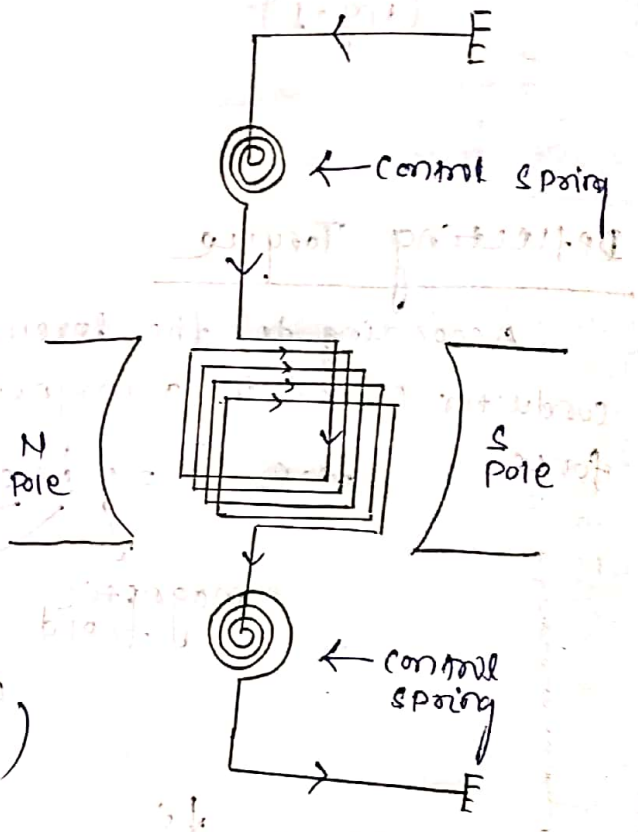
Controlling Torque

The controlling torque in indicating instrument can be obtained either by a spring or by gravity control.

@ **Spring control** (commonly used in modern instruments)



(Spring control arrangement)



→ Here two spiral hair springs are used for controlling purpose which are made of phosphor bronze.

→ The springs are connected in series with the coils so current passes to the coil through spring.

→ When current enter into the spring, the pointer deflects and the spring is twisted in the opposite direction.

→ This twist in the spring produces a restoring torque which is directly proportional to the angle of deflection of the moving system.

→ The pointer comes to the position of rest when $T_c = T_d$

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$T_d \propto I$

$T_c \propto \theta$

as $T_d = T_c$

$\boxed{\theta \propto I}$

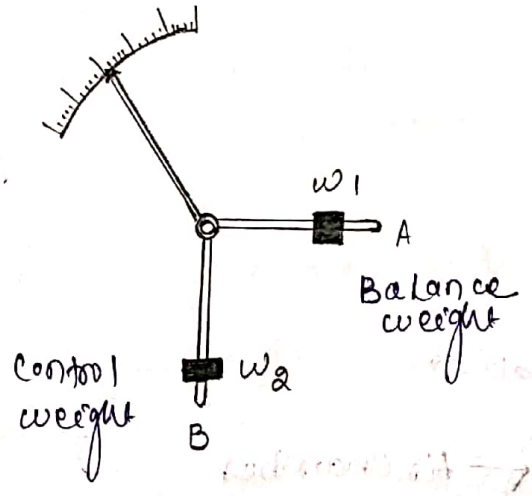
Since deflection 'θ' is directly proportional to the current I, the spring controlled instrument have a uniform scale.

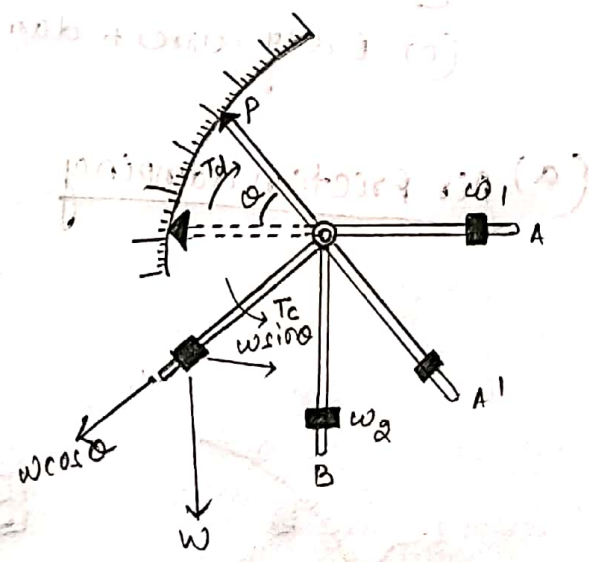
since $\theta \propto I$
it gives uniform scale.

Advantages of spring control

→ It can be placed in horizontal or vertical position.
→ It gives linear scale. $T_c \nearrow \theta$ ($T_c \propto \theta$)
→ scale length is more possible (upto 360°)
→ All indicating instruments are provided with spring control to produce controlling torque.

b) Gravity control (Not much used in modern instruments)





→ mass 'A' and 'B' are attached to the spindle 'S' of the moving system. The basic function of 'A' is to balance the weight of the pointer 'P'. B provides the controlling torque. For zero position of the pointer, the mass 'B' is vertical.

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→ When current flows through the instrument, the pointer is deflected through an angle, mass 'B' also deflected from its original position by an angle 'α'. The controlling torque is proportional the sine of the angular deflection.

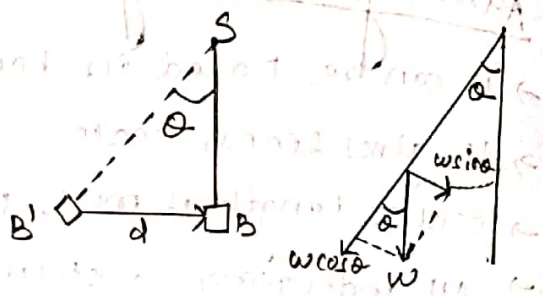
$(T_c \propto \sin\alpha)$

Disadvantages

→ Gravity controlled used instrument must be placed in vertical position only.

→ Scale length is possible upto 90° only.

→ It gives non-linear scale.



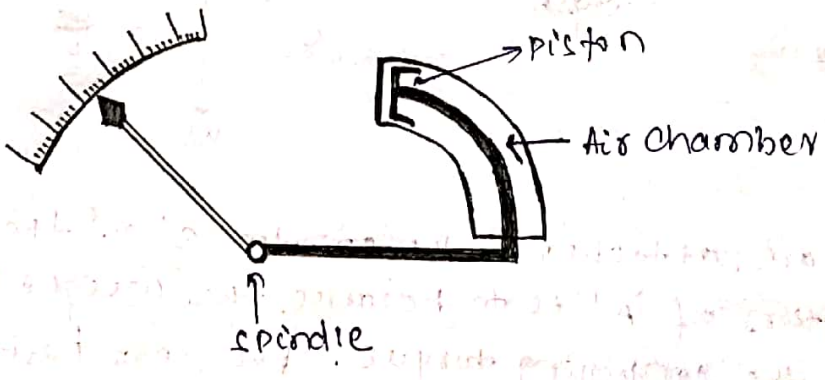
Damping Torque

→ A damping force is necessary in order to bring the pointer to rest in its deflection position quickly.
deflected

→ There are 3 system of damping is generally use.

(a) Air friction damping
(b) Fluid friction damping
(c) Eddy current damping

(a) Air Friction damping



→ In this arrangement, a small aluminium piston is attached to the spindle of the moving system. The piston itself moves in a circular or rectangular chamber with one side open to air.

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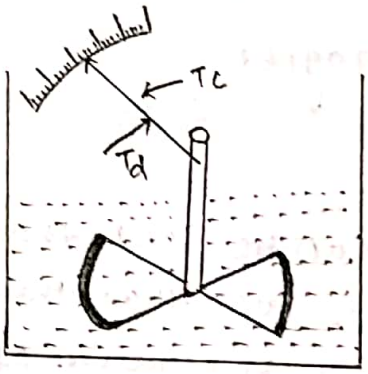
→ damping of the moving system is brought about by compression and suction of the air in the chamber.
→ when the piston moves into the chamber, the air inside it gets compressed. Thus, the pressure created due to compressed air opposes the motion of the piston.
→ similarly, when the piston moves out of the chamber, the motion is again opposed due to the pressure being greater on the open side than on the closed side of the chamber.

(b) Fluid friction damping



→ A highly viscous fluid is used to reduce the speed of pointer.
→ Here Motion of spindle occurs due to friction between disc and fluid.

Disadvantages

→ It is not a portable instrument.
→ Always vertically mounted instrument

(c) Eddy current damping

→ Eddy current damping is the most efficient method of damping.
→ A thin aluminium or copper (non-magnetic) disc is mounted on a spindle of the moving system.
→ The edge of the disc is so adjusted that it moves between poles of a permanent magnet.
→ Thus, when the disc rotates, it cuts the magnetic flux lines and an emf is induced, which causes current, called eddy current, to circulate in the disc.

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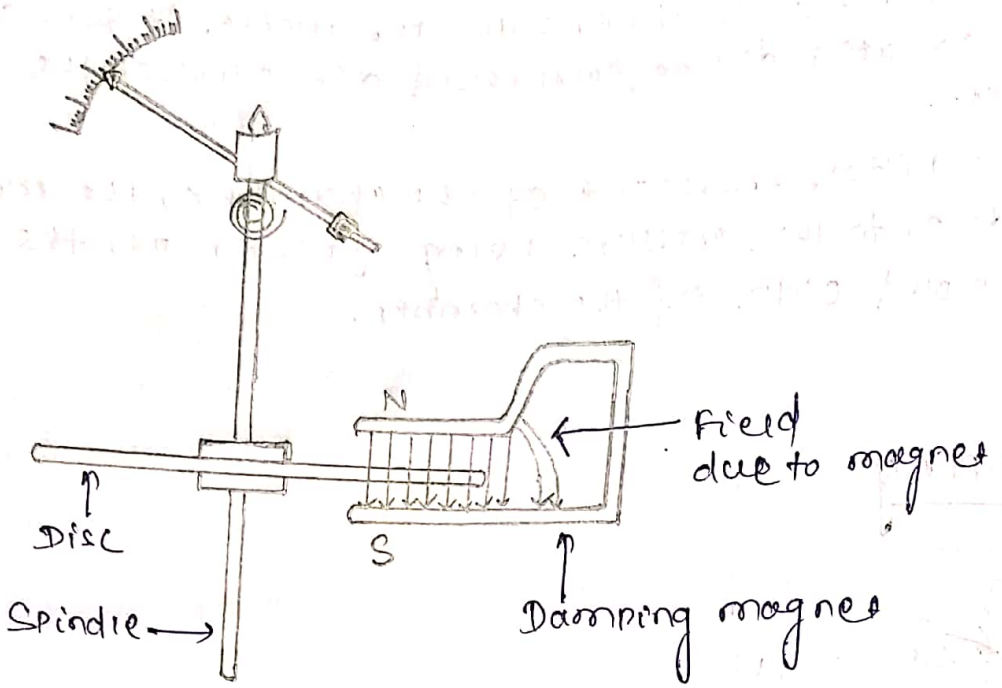

↪ By applying Lenz's law, it can be seen that the direction of the eddy currents is such that they exert a force which opposes the direction of rotation of the disc.

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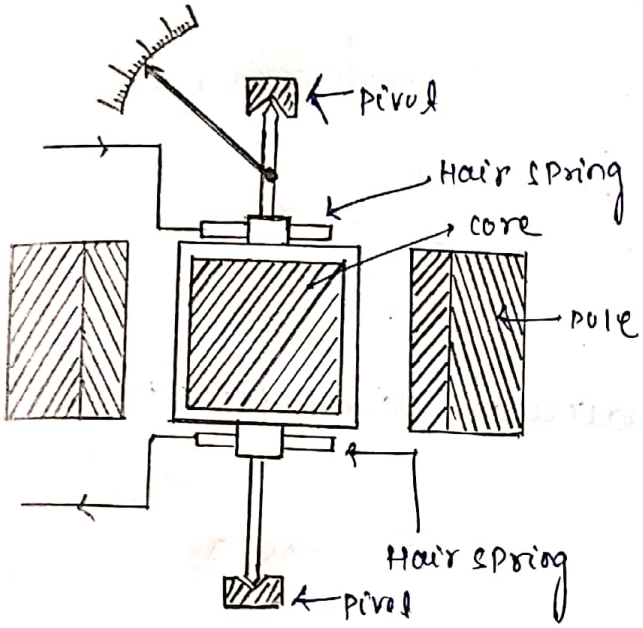
6.3 Different uses of PMMC type of instruments (Ammeter & voltmeter)

PMMC type Instrument (permanent magnet moving coil)



Construction

→ Here a rectangular coil mounted on a Aluminium frame, which is pivoted on jewelled bearing.

→ A moving coil is placed in magnetic field of permanent magnet and this permanent magnet is made of ALNICO

→ Deflecting torque (T_D) is developed due to motion of this coil

→ Here spring control is given for developing controlling torque (T_C). This spring is connected in series with moving coil. Through this spring current enter into the moving coil.

→ A pointer is attached with the pivot and bearing.

→ The damping torque is provided by eddy current method in the form of aluminium frame.

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Working principle :→

According to Lorentz's principle, when the current carrying moving coil present in a magnetic field, a torque is produced. this torque is called deflecting torque (T_d) Because of this T_d, pointer moves in forward direction and gives reading.

$F = BIL$

B = Flux density

I = current in coil

L = length of coil

T_d = force × perpendicular displacement

$= F \times b$

$= BI(L \times b)$

$\Rightarrow \boxed{T_d = BIA}$

$\Rightarrow \boxed{T_d = NBIA}$ N = No. of turns of coil

when $T_c = T_d$

$\Rightarrow K_c\theta = NBIA$

$\Rightarrow \boxed{\theta = \frac{NBIA}{K_c}}$ θ = angle of deflection

Advantages → very accurate and reliable. → No hysteresis loss

→ They have low power consumption. → It can be used as ammeter and voltmeter

→ The scales are uniform

→ It's range can be changed by using a shunt and series resistance.

Disadvantages

→ It can be used only by DC supply

→ It is costly as compared to moving iron instrument.

→ some errors are caused due to ageing of control springs and the permanent magnet.

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6.4 Different uses of MI type of instruments (Ammeter & Voltmeter)

Moving Iron Instrument

Moving iron Instruments are of 2 types

(a) Attraction type (single piece iron)

(b) Repulsion type (double piece iron)

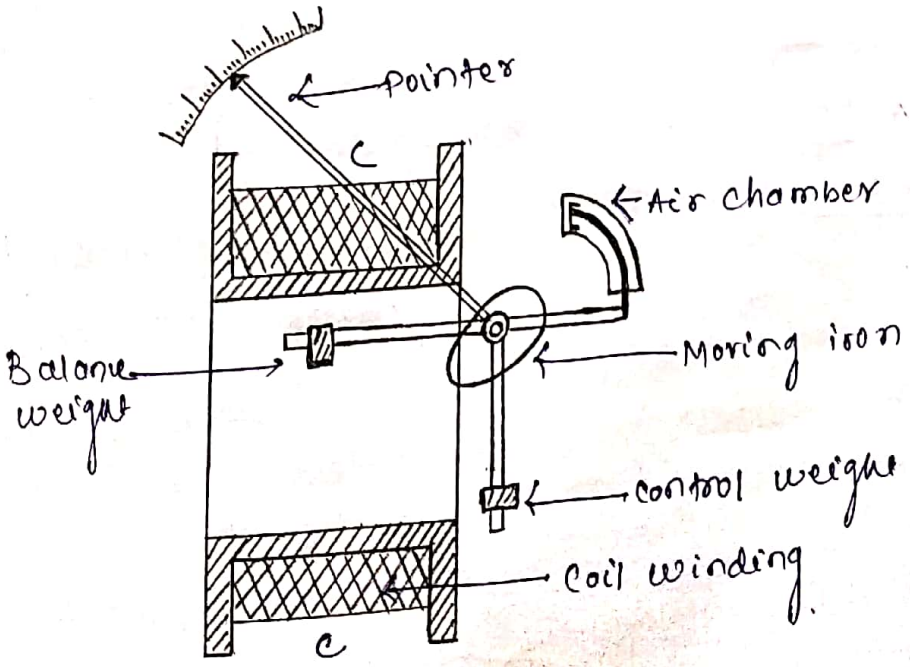
(a) Attraction type

Construction :→

→ Here a non-magnetised soft iron piece is used for moving purpose, which is attached with spindle. Here deflecting torque (T_d) is developed due to rotation of iron piece.

→ controlling Torque (T_c) is developed by using gravity control

→ Damping torque is developed by using air damping method.



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Working

→ when current passes through the coil, it will behaves as a magnet and produced magnetic field, i.e electrical energy converted into magnetic energy.

→ Because of this magnetic energy, iron piece is attracted by magnetic field, for this motion of iron piece, pointer moves and gives reading.

Advantages

→ It is cheaper

→ It can be used for both AC and DC supply

→ It is simple in construction.

Disadvantages

→ It's scale is not-uniform ($T_d \propto I^2$)

→ It consume more power

→ Stray losses affect it's reading.

$T_d \propto \phi \propto I$

→ $\boxed{T_d \propto I^2}$

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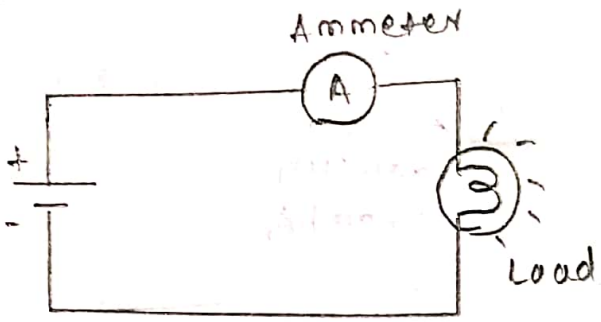
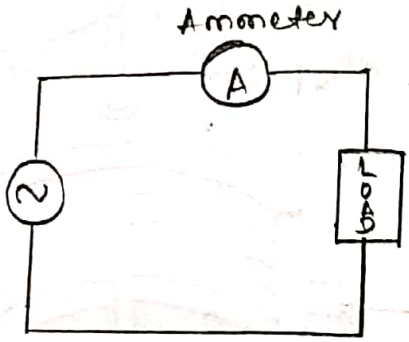
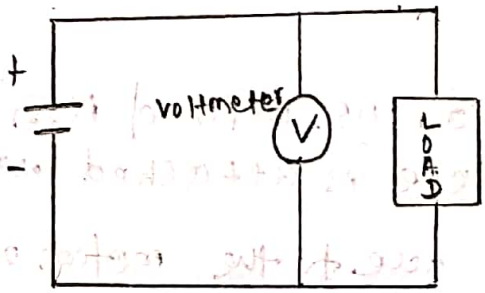
6.5 Draw the connection diagram of A.C/D.C Ammeter, voltmeter, energy meter and watt meter (single phase only)

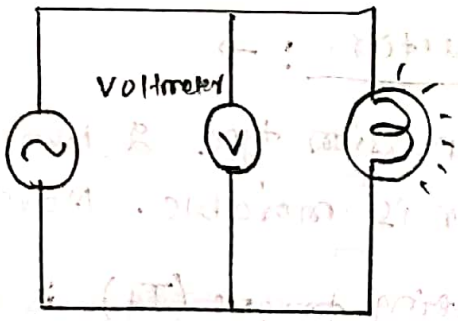
Ammeter (A.C/D.C) connection





Voltmeter connection (A.C/D.C)





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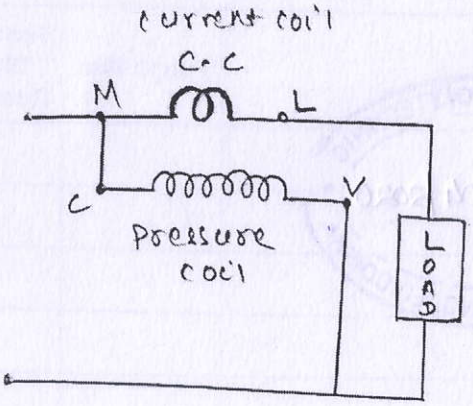
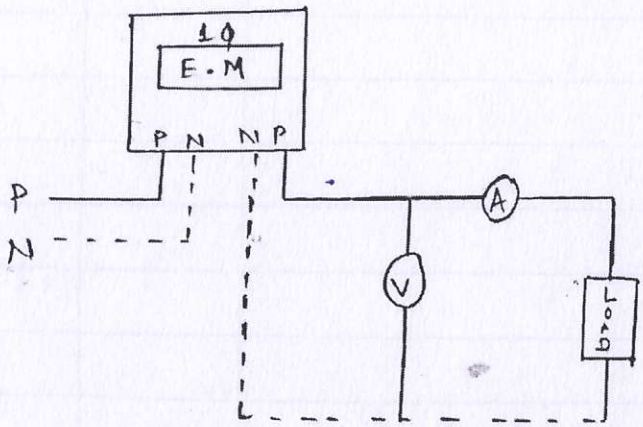
Wattmeter Connection



Energymeter connection



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B.ETC

Department of Electronics & Telecom Engineering
No. Chapter
Dt - 1 -
Government Polytechnic, Sambalpur, Rengali

Electronic Devices

1.1 Basic concept of Electronics and its applications

Electronics is the branch of science and engineering which deals with the flow of electrons through vaccum or gas or semiconductor.

Electronics is derived from the word electron, which is present inside the atom of all materials.

As such electronics is the branch of engineering which essentialy deals with electronic devices and their utilization.

Applications of Electronics

Electronics plays important role in allmost all spheres of life. Some of the important applications are –

a) Communication & Entertainment:

Electronics plays a very vast role in the field of communication. Starting from telephone, telegraph to wireless, sattellite communications, world wide communication in real time, in audio, video, form over a short range of time

are the contribution of Electronics.

on the field of entertainment - voice & music recording and playing. visual display systems, and almost all aspects of entertainment are flourished with electronics.

b) Industrial Application:

Industrial tasks like conveyance, transportation, extraction, lighting, process control, cutting, bending, melting, smelting, packaging etc are being performed electronically.

c) Defence applications

RADARS, SONARS, AWACS etc are electronic systems used in military applications. Missile launching, Aeroplane war plane landing etc are controlled by electronics principles.

d) Medical applications

. medical diagnosis and treatment processes like x-ray, Endoscopy, Electrocardiography are performed by electronics systems. Oscilloscopes, various electronic measuring instruments are used in the field of medical science.

e) Automobile field:

In automobile field, ignition systems, breaking systems, control of fuel flow, speed measurement and monitoring, control of engine performance, fault tracing and automatic control systems are performed with the help of electronics.

f) Digital Electronics: measurement and recording instruments, display units are operated with digital electronics. Almost all measuring and control instruments are now a days converting from its analog mode to digital electronics mode.

g) Instrumentation: operations like calibration, sophistication, accuracy, maintenance etc. are coming under instrumentation which is mostly electronicaly performed.

1.2. Basic concept of Electron emission and its types.

Electron emission: The liberation of electrons from the surface of a substance (usualy metals) is known as electron emission.

In some materials (usualy metals) the valence electrons in the outermost orbit are very loosely held by the nucleus.

These electrons are called free electrons. The force by which a metal surface prevents the free electrons from escaping is called surface barrier of that metal.

If sufficient amount of external energy is applied to the metal, the kinetic energy of the free electrons will be increased over the surface barrier and they will be liberated from the surface

The amount of energy required by an electron to overcome the surface barrier of a metal to escape from its surface is called work function of that metal.

* work function has the unit of (energy) eV (electron volt)

Types of electron emission:

Electrons are emitted from the surface of a metal if sufficient energy (equal to work function of the metal) is supplied externaly. This external energy may come from heat, electric field, light or by bombardment of charged particles on the metal surface. Accordingly there are 4 methods of electronic emission.

a) Thermionic emission: The metallic surface is heated to very high temperature (about 2500°c) so as to enable the free electrons to leave the surface. This type of electron

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emission is called thermionic emission. (2)

Thus thermionic emission is the process of electron emission from a metal surface by supplying thermal energy (heat) to it. The emitter is required to have small (low) work function.

Richardson - Dushman equation: The amount of thermionic emission increses rapidly with rise in emitter temperature, which increses the emission current. The emission current density is given by Richardson-Dushman eqn -

$$\boxed{J_s = AT^2 e^{-b/T}} \quad amp/m^2$$

where J_s = emission current density = current per square meter of emitter surface (amp/m²)

T = absolute temp. of emitter (°K)

A = constant depending upon the type of emitter. (amp/m²/K²)

b = a constant for the emitter

and $\boxed{b = \frac{\phi e}{K}}$ where ϕ = work function of emitter

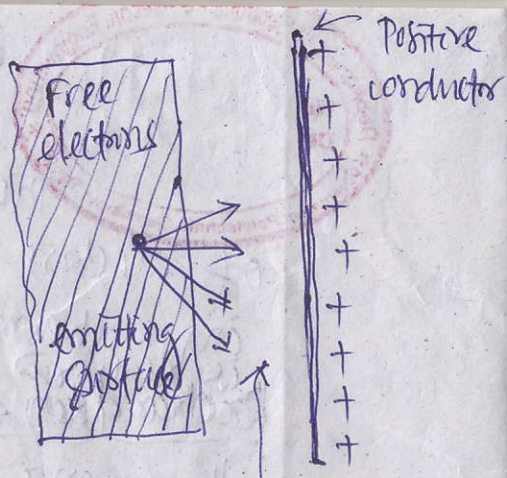
e = charge of electron (1.602×10^{-19} coul)

K = boltzman constant = 1.38×10^{-23} J/K

$$\therefore b = \frac{\phi \times 1.602 \times 10^{-19}}{1.38 \times 10^{-23}} = 11600\phi \text{ K.}$$

(b) **Field emission:** The process of electron emission from the surface of a material by applying very strong electric field (+ve field) at the surface is known as field emission.

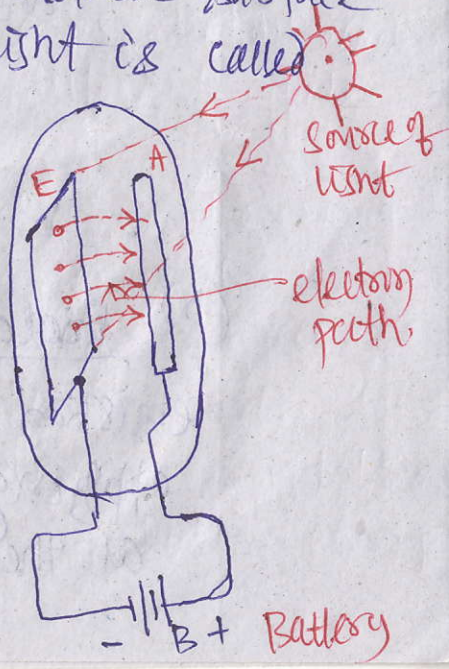
A very high voltage (+vely charged) conductor is placed close to the metal surface. The very high +ve field attracts electrons from the metalic surface. because the force of attraction exceeds the ~~potent~~ surface barrier.



Electric field of the order of million volts per centimeter distance between the emitting surface and the +ve conductor is required to cause field emission. The temperature at the time of field emission may be equal to room temperature (very low as compared to thermionic emission) Hence field emission is also sometimes called as cold cathode emission or auto-electronic emission.

c) Photoelectric emission:

Electron emission from a metalic surface by the application of light is called photoelectric emission.



when rays of light of proper intensity strikes the surface of certain metals (photo emissive metals like Pottasium, Sodium, cesium), the

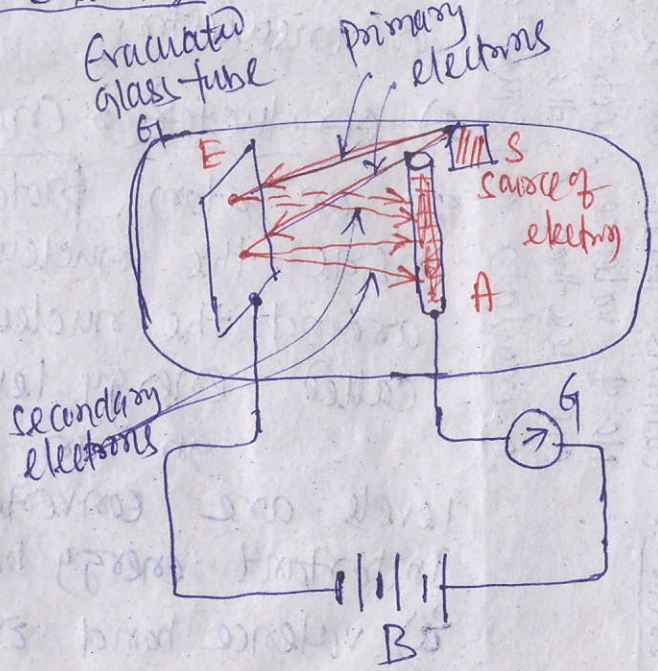
energy of photons of light is transfered to the free electrons. If the energy of the striking photons is greater than the work function of the metal (called emitter or cathode) then electrons are liberated from the metal surface.

Such electrons are called photoelectrons and are collected by a +vely charged anode. A potential difference is maintained between the anode and cathode. The whole arrangement is called a phototube.

The amount of photoelectric emission depends upon the intensity of light falling on the metal surface and the frequency of radiation.

(d) Secondary emission:

Electron emission from a metallic surface by the bombardment of high speed electrons or other particles is known as secondary emission.



As shown in the figure, when very high velocity electrons (primary electrons) strikes a metal surface, they give part or full of their kinetic energy to the free

electrons in the metal, thus enabling them to overtake the work function of the metal and get liberated (called secondary electrons).

These secondary electrons collected by the anode, produces emission current. Intensity of emission current depends upon the emitter material and mass and energy of the bombarding particles.

1.3 Classification of material according to electrical conductivity.

According to electrical conductivity, materials can be classified into 3 categories a) conductor b) semiconductor c) non conductor or insulator.

~~a) conductor~~ a) Energy Band Structure.

In an atom, proton and neutron are positioned inside the nucleus, where as electrons revolve around the nucleus in different orbits called energy levels.

In an isolated atom, the energy levels are converted into energy bands. Important energy bands in an atom are a) valence band ii) conduction band.

There is an energy difference or gap between these two bands called forebidden energy gap.

valence electron: Electrons present in the outermost orbit of an atom are called valence electrons. No. of valence electrons can be maximum upto 8. If the no. of valence electrons are less than 4, they the material is a conductor, more than 4, it is non conductor or insulator and equal to 4 is a semiconductor.

i) valence band: The electrons in the outermost orbit of an atom are called valence electrons. These electrons posses highest energy and the energy band that contains valence electrons, is called valence band. This band may be completely or partly filled.

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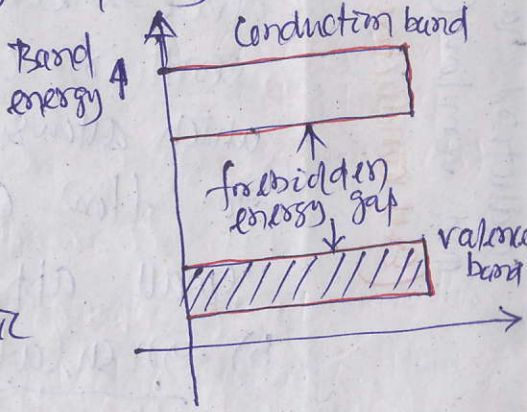


ii) conduction band: when the valence electrons will get some external energy they will be liberated from the surface (free from atomic bond) and will move to a next higher energy band. These electrons are called free electrons and are responsible for conduction of electrical current in the material. The band consisting these free (conduction) electrons is called conduction band.

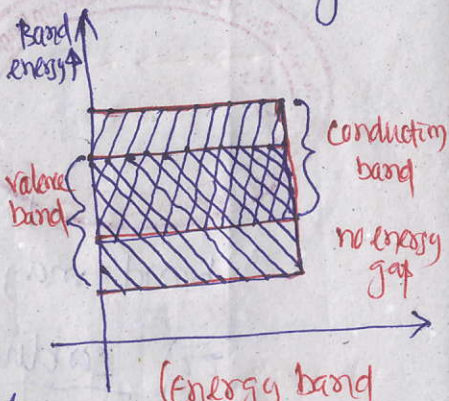
iii) Forbidden energy gap: The energy gap between valence band and conduction band is called forbidden energy gap. No electron can remain in forbidden energy gap.

a) conductors: The materials (usualy metals) which allows the passage of electric current through it without any obstruction or resistance are called conductors.

considering the energy band structure of conductors – they have filled valence

Conductors have very high conductivity and very low (zero) resistivity. (Ex of conductors - copper, Aluminium, Silver, etc)

bands and filled conduction bands. Actually these two bands are partly overlaping with each other and there is no forbidden energy gap. So large no. of free electrons are present in conduction band which allows large current to flow across it, with small applied potential difference.

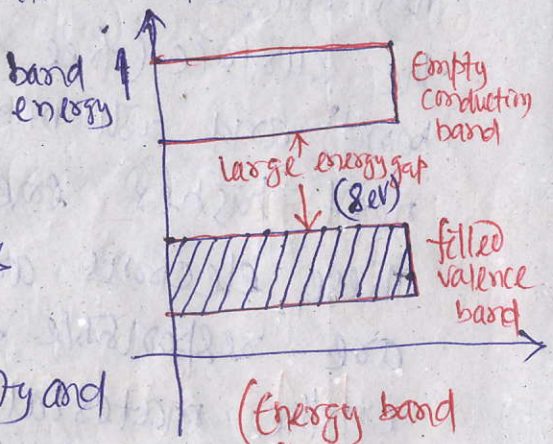


(Energy band structure of conductor)

b) Insulators:

Insulators (non conductors) are materials through which electric current cannot pass through. Insulators have very less (zero) conductivity and very high resistivity.

(Ex. of insulators: wood, glass, mica etc)

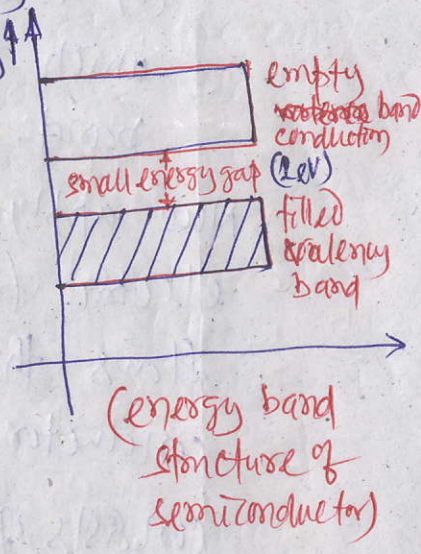


(Energy band structure of insulators)

In terms of energy band structure - insulators have completely filled valence band and completely empty conduction band with a very wide forbidden energy gap in between. As no free electrons are available in the conduction band, electric current can not flow through it.

c) Semi conductors. Semiconductors are materials (ex: carbon, germanium, silicon)

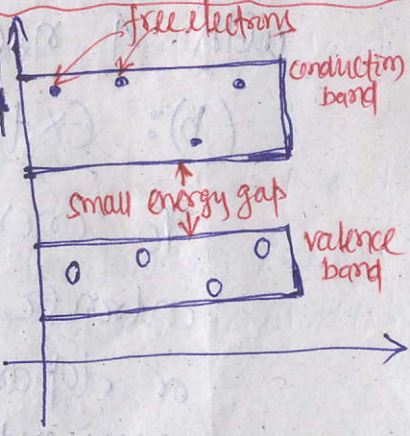
whose electrical conductivity lies between those of conductor and insulators.



(energy band structure of semiconductor)

Under ordinary condition, semiconductors have filled valence band and empty conduction band but with a small forbidden energy gap (1eV). So applying a small electric field, valence electrons will jump to conduction band and the material will conduct electric current. Now increasing temperature, more no. of valence electrons will jump to conduction band, thus increasing the conductivity of the semiconductor.

1.4: Intrinsic and Extrinsic semiconductors



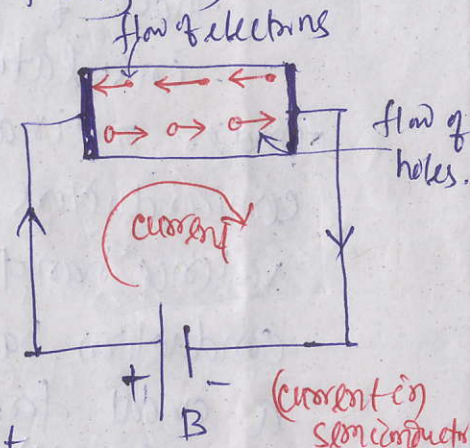
a): Intrinsic semiconductor:

A semiconductor in its extremely pure form is called intrinsic semiconductor.
Ex: Pure germanium, silicon.

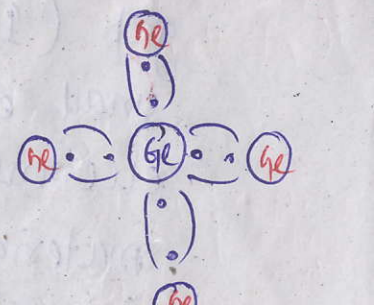
At absolute zero temperature, it has filled valence band and empty conduction band. But with slight increase in temperature (say upto room temperature), some valence electrons will move to conduction band and move there freely. The absence of electron (-ve charge)

in valence band produces a hole (+ve charge) which also can move freely in valence band.

Now applying an external electric field, current flows through the semiconductor. This current consists of electron current (opposite in direction) and hole current (in direction).



If we will consider bond structure of intrinsic semiconductor (Ge or Si) it has valency = 4, so 4, outer electrons makes covalent bond with 4 nearby germanium atoms as shown in fig.



~~extrinsic~~ (bond structure of pure semiconductor)

(b): Extrinsic semiconductor.

To increse the conductive ability, pure or intrinsic semiconductors are added with impurity or dopants, forming an impure or extrinsic semiconductors. The dopants are added (this process is called doping) in atomic level and the proportion is $1 : 10^8$ (impurity atom to base atoms). The dopant atom will have ~~cod~~ valency $4 \pm 1 = 5$ or 3. where 4 is the valency of Ge & Si. According there are two types of extrinsic semiconductors.

ii) n-type extrinsic semiconductor :

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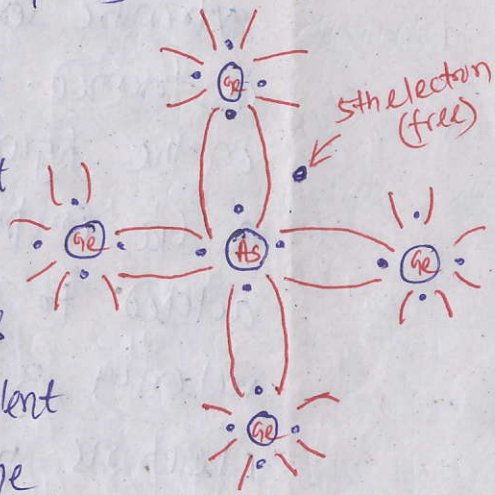
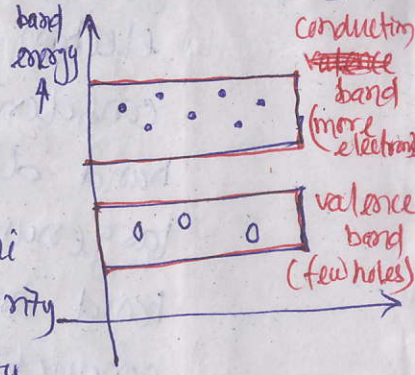
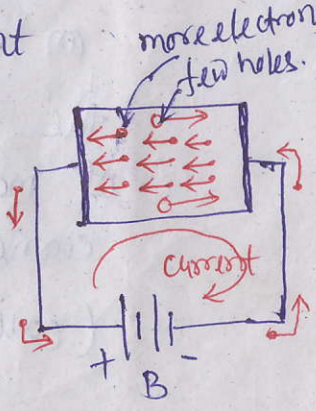
n-type (or negative type) extrinsic semiconductors are produced when pure Ge or Si is added with some pentavalent impurity atoms (Ex- Arsenic, Antimony etc).



considering the atomic structure, when pentavalent arsenic (As) is added, it has 5 valence electrons out of which 4 makes covalent bonds with 4 nearby Ge atoms and the 5th electron remains free and moves to the conduction band. With the application of little heat or electricity no. of free electrons in conduction band ~~is~~ becomes much more than the no. of holes in valence band.

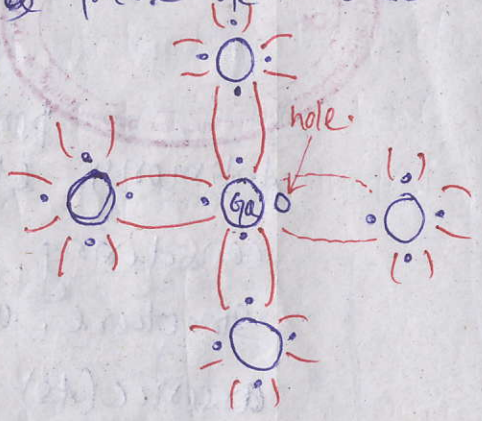


So in n-type extrinsic semiconductors, electrons are majority carriers and holes are minority carrier and total circuit current is mostly due to electrons. This can be practically verified by applying an external electric field as shown in the figure.

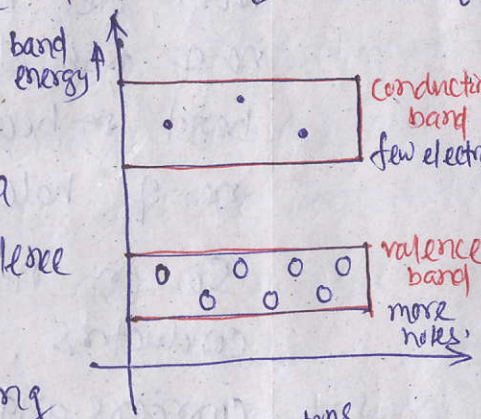


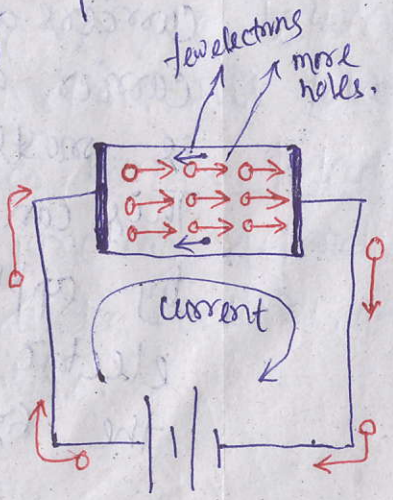
(ii) p-type extrinsic Semiconductor:

When trivalent impurities like Boron, gallium, indium are added to pure Ge or Si the p-type (+ve type) extrinsic semiconductor is formed. As shown in the figure, when a Ga impurity atom is added to Ge, Ga has valency 3. So the 3 valence (outermost) electrons make covalent bonds with 3 neighbouring Ge atoms and one more electron of Ga atom is required to make bond with the 4th surrounding Ge atom. This absence of electron is called a hole.



Considering the energy band diagram, there are a large number of holes in valence band and few electrons in conduction band. By applying an external electric field the circuit current consists of mostly holes (majority carriers) and few electrons (called minority carriers)





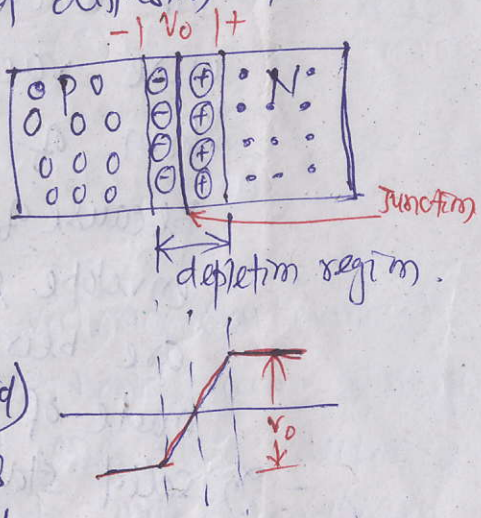
1.5. Difference between vaccum tube & semiconductor devices.

Both vaccum-tube devices and semiconductor (solid state) devices serves the same purpose. The initialy invented electronic devices were vaccum tubes (or gas filled tubes) in the form of diode, triode, tetrode, pentode -- etc. Because of certain disadvantages like glass envelope structure, large volume etc, they are being replaced by solid state devices made of off semiconductor materials like Ge or Si

- In solid state devices junctions formed which is not there in vaccum tubes. The solid state devices are named as P-N junction diodes, transistors, FETs, IGBTs, MOSFETs etc.

1.6. a) PN Junction diode.

When a p type semiconductor comes in close contact of an n-type semiconductor a p-n junction is formed. Actually the junction is fabricated by special techniques like growing, alloying and diffusion methods.



At the instance of junction formation, holes from p-side and electrons from n-side diffuse to the opposite side and combine with each other and depleted away (make a void) width of the junction increases till their energy is just sufficient to cross the junction, then the width of the junction remain fixed. The junction region on either side have no charge carriers and only ions (+ve ions on N side and -ve ions on P side). This region is called depletion region or space charge region.

A potential difference exists between the two ends (across) the junction. This potential is called junction potential or barrier potential.

Barrier potential of a junction depends upon factors like semiconductor material, amount of doping and temperature.

For silicon, $V_0 = 0.7V$

for germanium $V_0 = 0.3V$.

PN Junction as a diode.

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A P-N junction is also called a PN junction diode or simply diode. The terminal connected to P side is the anode(A) and terminal at n side is the cathode(K)

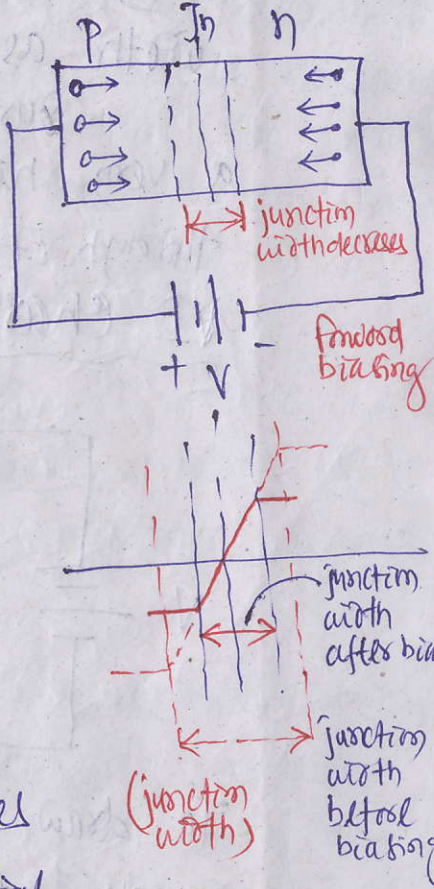


Symbol.

working principle: A diode works only when it is properly biased. Biasing is applying an electric field (voltage) across the terminals. Biasing is of two types a) forward biasing and (b) reverse biasing.

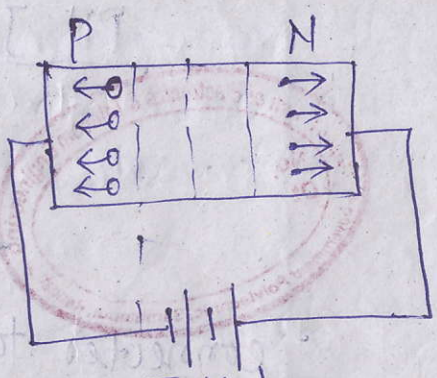
a) Forward biasing:

when +ve plate of the battery connected to p side and -ve plate to n side of a P-N junction, it is said to be forward biased. By forward biasing holes & electrons from P & N sides ~~com~~ moves towards the junction and so junction width decreases and in turn the barier potential also reduces.

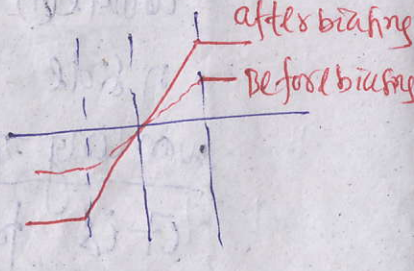


The junction offers very low resistance to the flow of current through it.

b) Reverse biasing:

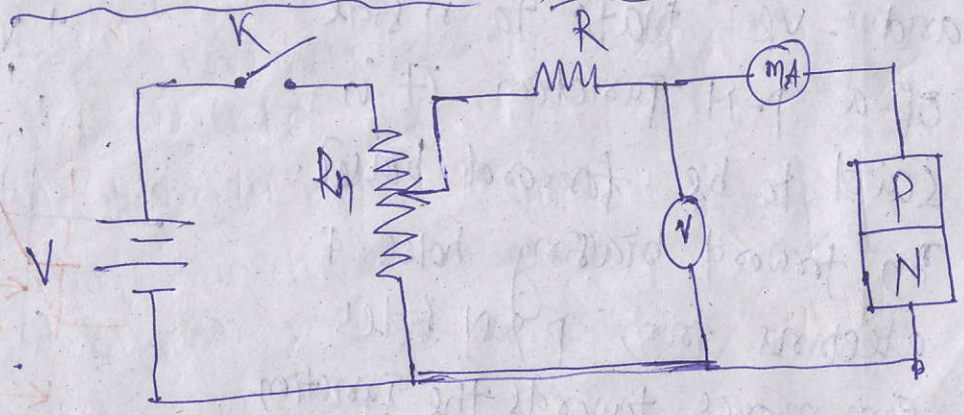


when -ve plate of the battery is connected to p side and +ve plate to N side of a PN junction it is said to be reverse biased. Holes from P side and electrons from n side get attracted by the reverse bias and moves away from the junction, increasing the junction width as well as barrier potential.



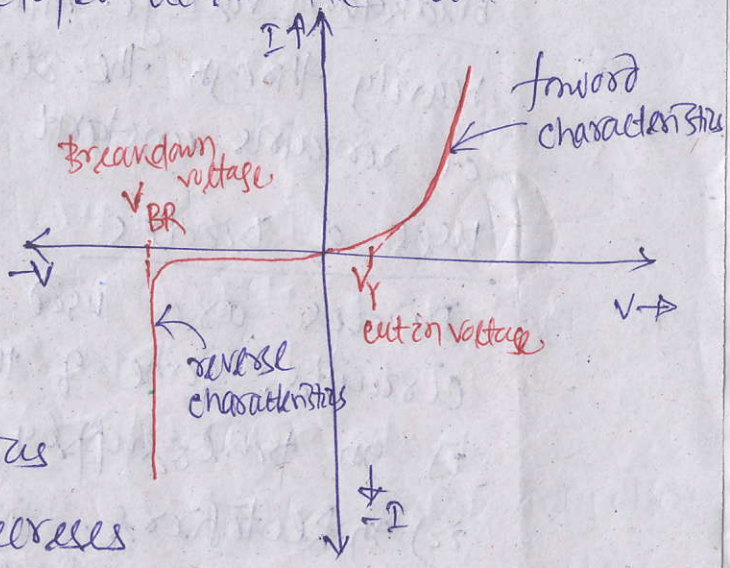
During reverse bias the junction offers a very high resistance to the current flowing through it.

VI characteristics of PN junction diode.



To draw the VI characteristic of a PN junction diode, the circuit connection as shown in figure is made. The diode is biased by the external voltage V.

The voltage developed across the diode and current flowing through the diode can be changed by varying the rheostat.



a) Forward bias:

During forward bias the junction width decreases and it offers a low resistance. so forward current can flow through the diode. For '0' voltage, current is zero. when forward voltage increased in small increments up to certain voltage, there will be no current this is due to the fact that the forward voltage has to overcome the junction potential barrier, then only current can flow. So, the amount of forward voltage at which forward current can flow through a PN diode is called cut in or threshold voltage (V_γ). After threshold, increasing voltage, current increases.

b) reverse bias: During reverse bias, junction width increases and it offers a very high resistance to current flow. Increasing the reverse voltage, a point will be reached when the diode will breakdown (lost its property of P & N semiconductors). This voltage at which breakdown occurs is called

breakdown voltage. After breakdown current flow heavily through the diode and voltage across it remains constant at (V_{BR}), breakdown voltage

Uses of Diodes

Diodes are used in almost all electronic circuits. Some of the applications are –

i) In power supply applications.
ii) In Rectifiers.
iii) In inverters and converters.
iv) For freewheeling operation.
v) For stabilization purposes.

b) Zener diode:

An ordinary diode when reverse biased and the bias voltage increases at certain value the diode will breakdown. After breakdown current increases sharply very heavily and voltage remains constant at breakdown value. The sharpness of the breakdown curve depends upon the doping concentration. A properly doped crystal diode which has a sharp breakdown voltage is called a Zener diode.



Symbol.

– A Zener diode is an ordinary P-N junction diode except the fact that it is properly doped to produce sharp breakdown voltage.
– It is always connected in reverse biased condition.

- Zenor diode has a sharp breakdown voltage called Zenor voltage (V_Z)

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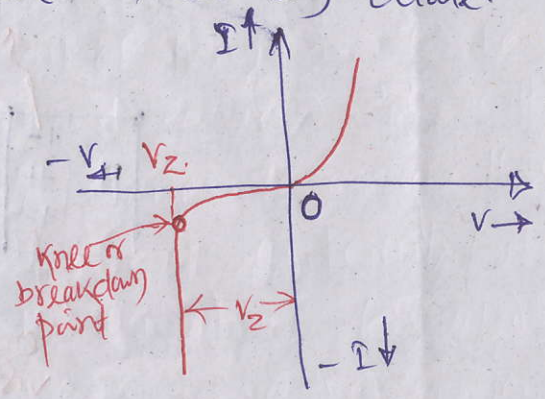
- If it is forward biased, it behaves like an ordinary diode.

V-I characteristics:



V.I characteristics of a zenor diode is similar to that of an ordinary PN junction diode. only fact is that the diode is operated in reverse biased condition and in break down region.

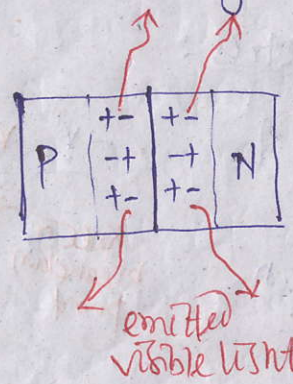
Uses of Zenor diode

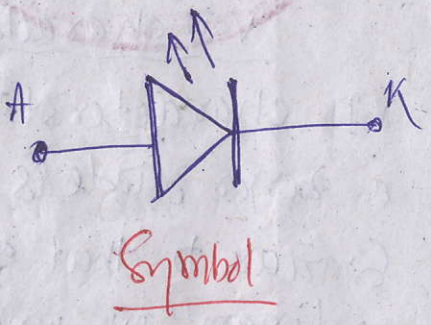
1. In voltage stabilization circuits.
2. As a voltage regulator.
3. As a -ve voltage source.

c) Light Emitting diodes (LEDs)

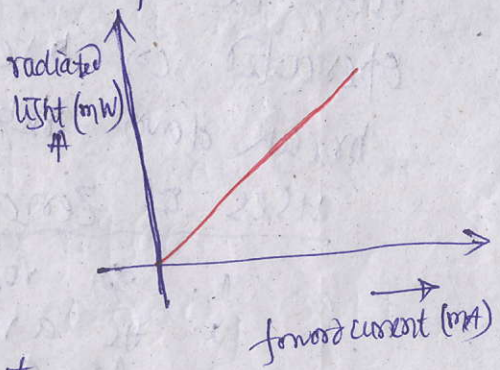
- Light emitting diodes are producing visible light of different colour (wavelength) basing upon the principle, that - when holes and electrons from p side and n side respective recombine with each other they gives out some energy, in the form of heat and light. In ordinary diodes this energy is lost in the form of heat, but in some special purpose diodes, using Galium arsenide (GaA) Galium phosphide (GaP) etc as the P&N

type materials, during junction formation, visible intense coloured light can come out due to hole-electron recombination. These diodes are called light emitting diodes (LEDs).





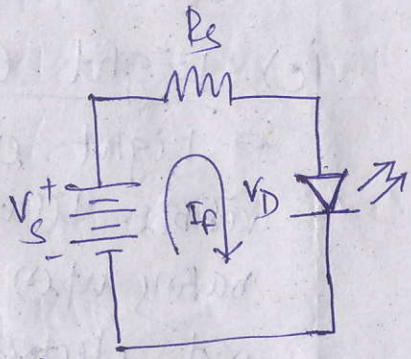
Light is emitted from the junction, only when the diode is forward biased. When forward biased, forward current flows. Increasing forward bias, forward current increases and intensity of emitted light also increases.



LED voltage & current:

In the fig. is shown an LED connected to a voltage source V_s, through a resistance R_s. If V_D is the voltage across the LED, then voltage across R_s is $V_s - V_D$. Then the forward current flowing in the circuit

$$I_F = \frac{V_s - V_D}{R_s}$$



1.7. Integrated circuits.

In a big electronics circuit (of computer, TV etc) thousands of discrete components like resistors, diodes, capacitors, transistors etc are used and interconnected. If all of them are to be separately placed and connected, they will require a large space. To overcome this difficulties a large no. of components (resistors, capacitors, diodes, transistors) are fabricated inside a small chip of semiconductor material. This chip is called integrated circuit (IC) or IC chip.

An integrated circuit (IC chip) is one in which circuit components like transistors, diodes, resistors etc are fabricated in such a way that they automatically become the integral part of the same chip and their interconnections also established.

- An IC is very small in size, typical size of an IC is 0.2mm × 0.2mm × 0.001mm.
- no component can be taken out separately as it is fabricated well inside the chip.
- no component or any part their of can be projected out of the chip.

Advantages of ICs

1. Increased reliability due to lesser no. of components.

2. Extremely small size as all components and interconnections are fabricated inside the chip.
3. Less weight and occupies less space.
4. Low power requirements.
5. Greater ability to operate at extreme values of temperature.
6. Low cost because of simultaneous production of hundreds of alike circuits on a small semiconductor wafer.
7. The circuit layout is greatly simplified because integrated circuits are constrained to use minimum number of external connections.

Disadvantages:

1. If any one component goes out of order, the whole IC is to be replaced.
2. Capacitors of value exceeding 30 pf can not be fabricated in IC form.
3. Inductors and transformers can not be fabricated in IC form.
4. It is not possible to produce high power ICs (greater than 10W)
5. There is lack of flexibility i.e., parameters of the various components inside the IC can not be altered.

— x —

Assignment questions

Ch-1. Electronic Devices

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Q.1. Define electronics ? [2]

Q.2. Mention some important applications of electronics ? [5]

Q.3. Explain electron emission ? [2]

Q.4. what are the different types of electronic emission ? [5]+[5]
explain each type briefly ?

Q.5. Explain how valence electrons describe the electrical behaviour of a material ? [3]

Q.6. Explain how materials can be classified depending upon their electrical conductivity or characteristics ? [5]

Q.7. what is energy band structure of an atom ? define valence band, conduction band and forbidden energy gap ? [2+5]

Q.8. Draw energy band diagrams of conductor, semiconductor and non conductor ? [5]

Q.9. Explain how semiconductor can be classified ? what are the different types ? [5]

Q.10. Differentiate between intrinsic and extrinsic semiconductor ? [5]

Q.11. Explain how p type & n type extrinsic semiconductors are produced from pure (intrinsic) semiconductor ? [5]

Q.12. Differentiate between vacuum tube and semiconductor devices? [5]

Q.13. Explain how P-N junction acts as a diode? [5]

Q.14. what is biasing of a P-N junction? How a P-N junction behaves during forword bias and reverse bias? [2+5]

Q.15. Draw the circuit diagram for obtaining the V-I characteristics of a P-N junction diode? and draw the VI characteristic? [5+5]

Q.16. Explain i) cut in voltage/knee voltage/ threshold voltage and ii) Breakdown voltage of a diode from the V-I characteristics? [5]

Q.17. what are the different uses of diode? [5]

Q.18. what is a zener diode? what are its uses? [5]

Q.19 what is an LED? [5].

Q.20 what is integrated circuit? [5]

Q.21. what are the advantages and disadvantages of an IC? [5].

Q.22. Define the terms a) surface barier b) work function? [2]

Q.23. what general condition must be satisfied before an electron can escape from the surface of a material? [5].

Multiple choice questions

1. The outermost orbit of an atom can have a maximum of _____ electrons.

a) 2 b) 4 c) 8 d) 16.

2. When the outermost orbit of an atom has less than 4 electrons, the material is generally a _____.

a) conductor b) insulator.

c) semiconductor d) non of the above.

3. The valence electron have _____.

a) very small energy b) least energy

c) maximum energy d) non of the above

4. A large no. of free electrons exist in ___

a) semiconductors b) conductors.

c) insulators d) none of the above.

5. When the outermost orbit of an atom have exactly 4 electrons, the material is generally ___

a) metal b) non metal

c) semiconductor d) ~~all the~~ none of the above

6. When the outermost orbit of an atom have more than 4 electrons, the material is generaly a _____

a) metal b) non metal

c) semiconductor d) none of the above.

Q.7. workfunction of metals is generally measured in the unit of - - - -

a) Joules b) erg c) watt d) electron volt

Q.8. The electrons emitted by a thermionic emitter are called - - - -

a) free electrons b) loose electrons

c) thermionic electrons d) bound electrons.

Q.9. field emission is utilized in - - - -

a) vacuum tubes b) TV picture tubes.

c) gas filled tubes d) mercury pool devices

Q.10. Thermionic emitters are required to have - - - workfunction.

a) low b) high c) medium d) very high.

Q.11 The electrons in the 3rd orbit of an atom have - - - energy than the electrons in the 2nd orbit.

a) more b) less c) same d) none of the above

Q.12. when an electron jumps from higher orbit to a lower orbit, it - - - - energy.

a) absorbs b) emits c) sometime absorbs sometime emits d) none of the above.

Q.13. A semiconductor has - - - band.

a) almost empty valence b) almost empty conduction

c) almost full conduction d) none of the above.

Ch-2 Electronic Circuits

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2.1. Rectifiers and its uses:

Rectifier is an electronic circuit (or device) which converts ac signal into dc signal. The ac electrical signal available for our domestic use is of 220-240V Peak to Peak Sinusoidal voltage signal of frequency 50 Hz. It runs our fans, acs, motors etc. But most of the electronic devices like phones, TVs etc needs dc voltage. So rectifiers are used to convert ac signal into dc signal.

Uses

i) Rectifiers are used in power supplies

ii) on the dc power supply unit of almost all electronic devices.

2.2. Types of rectifiers.

Rectifiers can be of two types —

a) Half wave rectifier (HWR)

b) Full wave rectifier (FWR)

Full wave rectifier can again be divided into two types —

i) centre-tap full wave rectifier

ii) Bridge full wave rectifier.

a) Half wave rectifier.

In the figure 1(a) is shown the basic circuit of a half wave rectifier. It consists of a single diode (D) and the load resistance R_L. The ac input voltage is applied with the

help of a transformer. i.e, the HWR is connected to the secondary of the transformer. Fig 2(a) shows the input voltage waveform. Fig 2 (b) and (c) respectively shows output voltage waveform and output current waveform. output voltage is the voltage across R_L and output current is the current flowing through R_L.

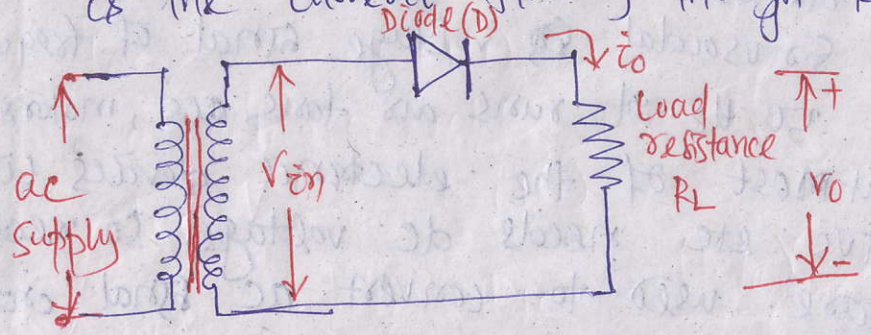


Fig 1(a) Basic cut of HWR.

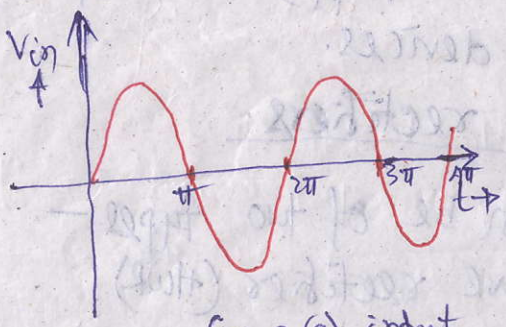


fig 2(a) input voltage.

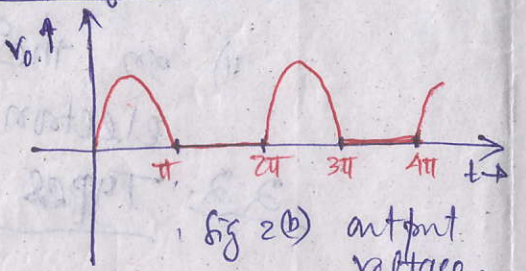


fig 2(b) output voltage.

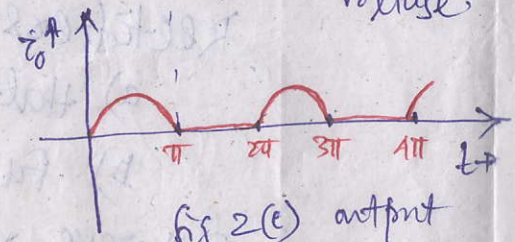


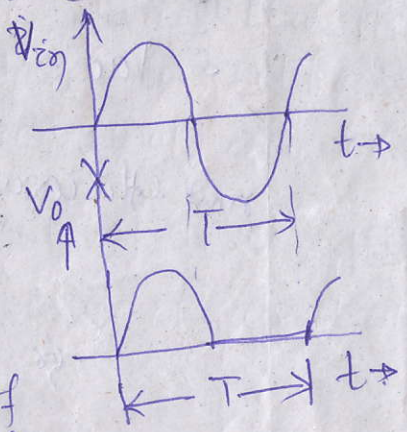
fig 2(c) output current

Circuit operation:

The ac input voltage is applied to the rectifier through a transformer. During +ve half cycle of the ac input, the diode is forward biased (The cut in or threshold voltage is assumed to be zero volt) and conducts during the entire +ve half cycle. Assuming forward resistance (R_f) of the diode to be negligibly

small, the current in the circuit (load current) $i_o = \frac{v_{in}}{R_L}$ and output voltage $V_o = i_o \cdot R_L = V_{in}$ during +ve half cycle of the input, the output equals to the input.

During -ve half cycle of the input, the diode is reverse biased. The reverse resistance of the diode (R_R) is very very large ($\simeq \infty$), so CT acts as an open circuit and so load current $i_o = 0$ and $V_o = i_o \cdot R_L = 0$ also. The output voltage and current waveforms are as shown in fig 2(b) & 2(c).



output frequency of HWR

output frequency of a HWR is same as input signal frequency (50 Hz). as shown in the figure, the duration of one complete cycle (time period) is same for both input as well as output signal. so their frequencies are also same.

Efficiency of HWR

Efficiency of the HWR is defined as the ratio of dc power output to ac power input.

$$\text{efficiency } \eta = \frac{\text{output dc power}}{\text{input ac power}}$$

dc output power (P_{dc})

dc power output = (dc output current)^2 × R_L

or $P_{dc} = I_{dc}^2 \times R_L$

$$I_{dc} = \frac{1}{2\pi}\int_0^{\pi} i_o \cdot d\theta = \frac{1}{2\pi}\int_0^{\pi} \frac{V_m \sin\theta}{r_f + R_L} \cdot d\theta$$

$\because V_o = V_m \sin\theta$ and $i_o = \frac{V_o}{r_f + R_L}$

where r_f → forward resistance of the diode

As i_o is available between 0 to π only, now the limits of integration are from 0 to π

$$= \frac{V_m}{2\pi(r_f+R_L)} \int_0^{\pi} \sin\theta \cdot d\theta = \frac{V_m}{2\pi(r_f+R_L)} \left[-\cos\theta\right]_0^{\pi}$$

$$= \frac{V_m}{2\pi(r_f+R_L)} \times 2 = \frac{V_m}{(r_f+R_L)} \cdot \frac{1}{\pi} = \frac{I_m}{\pi}$$

$$\therefore P_{dc} = I_{dc}^2 \times R_L = \left(\frac{I_m}{\pi}\right)^2 \times R_L$$

ac input power (P_{ac})

$$P_{ac} = I_{rms}^2 (r_f + R_L)$$

for a halfwave rectified wave $I_{rms} = \frac{I_m}{2}$

$$\therefore P_{ac} = \left(\frac{I_m}{2}\right)^2 (r_f + R_L)$$

now efficiency $\eta = \frac{P_{dc}}{P_{ac}} = \frac{(I_m/\pi)^2 \times R_L}{\left(\frac{I_m}{2}\right)^2 \times (r_f+R_L)}$

$$\text{or} \quad \eta = \frac{0.404 \cdot R_L}{r_f + R_L} = \frac{0.406}{1 + r_f/R_L}$$

as $r_f \ll R_L$, $r_f/R_L \ll 1$.

so $\boxed{\eta = 0.406 = 40.6\%}$

Advantages & Disadvantages of HWR.

Advantages
1) The circuit is simple and contains few components.
2) The circuit is less costly.

Disadvantage
1. efficiency is less.
2. The output power is less.
3. The -ve half cycle of the input is not at all utilised.

b) Full wave Rectifier

It is the rectifier, which utilises the full waveform of the ac input (both halves)

to produce the dc output.

FWR can be of two types -

a) centre-tap full wave rectifier

b) bridge full wave rectifier.

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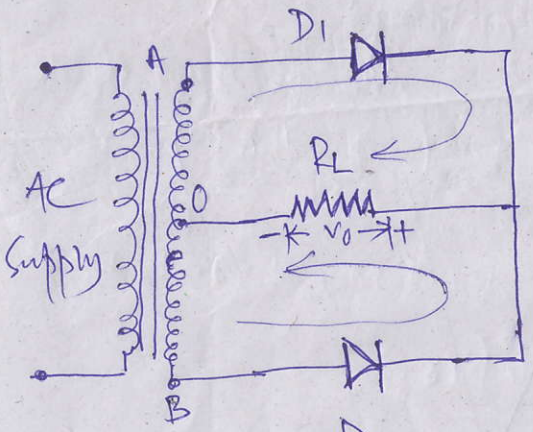
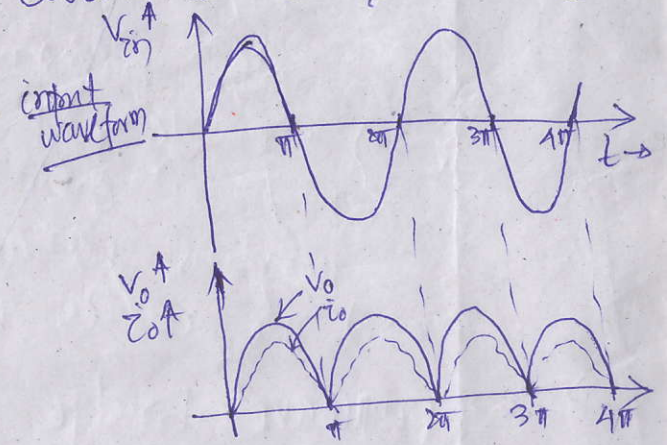
a) centre tap full wave rectifier:

Two diodes are connected to the secondary winding of a transformer and the load is connected between centre point (tap) of the transformer and junction of the two diodes cathodes. The circuit is as shown in figure.



centre tap FWR ckt

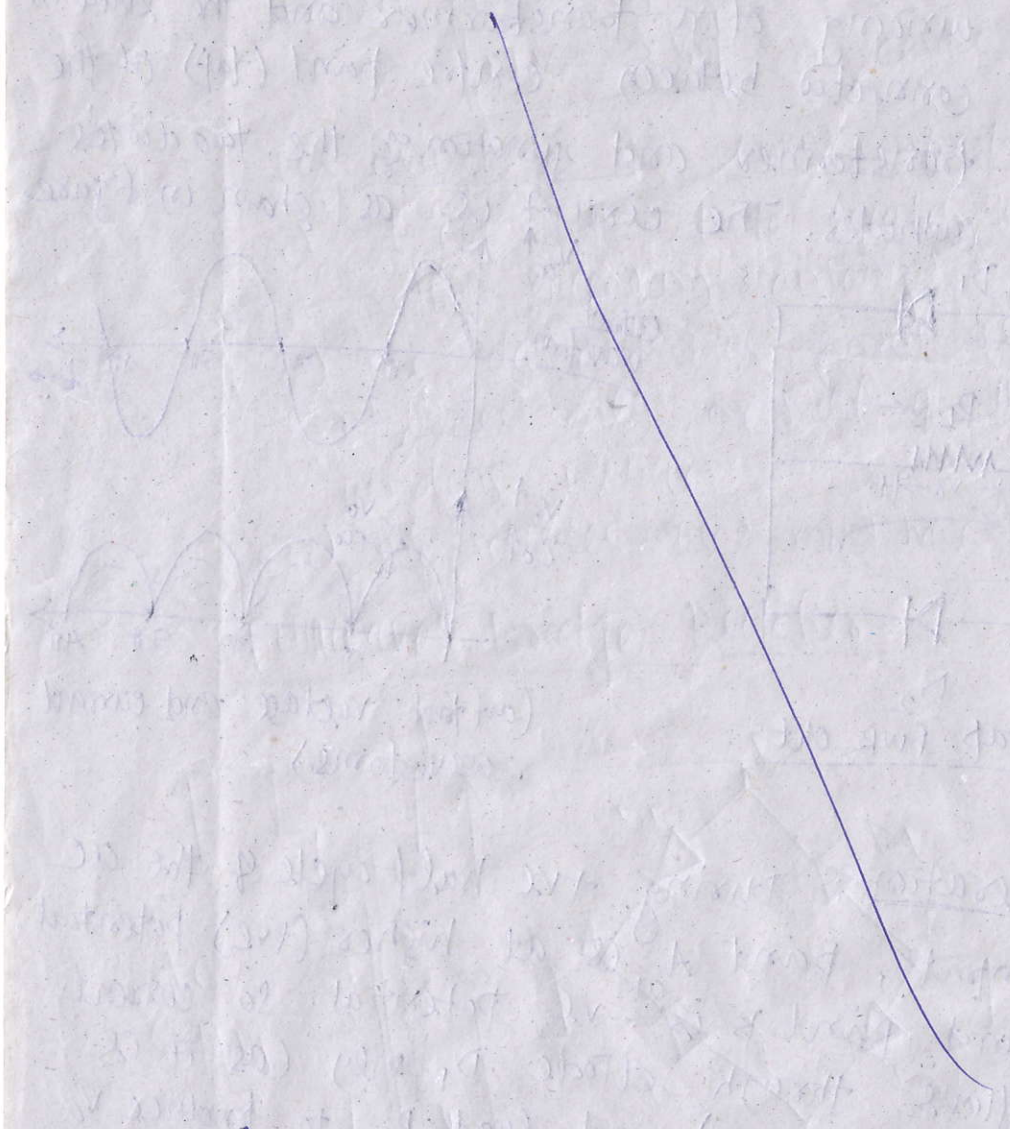


(output voltage and current waveforms.)

Operation: During +ve half cycle of the ac input, point A is at higher (+ve) potential and point B is at -ve potential. So current flows through diode D_1 only (as it is forward biased) and load R_L to produce V_o as shown in the figure.

During -ve half cycle point B is at +ve potential and A is -ve, so D_1 is off and D_2 conducts. current flows through D_2 and load R_L. current through R_L is in the same direction as it was before (not reversed)

So at the output we are getting dc voltage.



Peak inverse voltage: It is the maximum reverse voltage that a diode can withstand without damage.

During +ve half cycle of ac input, diode D_2 is not conducting (reverse biased) and a voltage of maximum value of $2V_m$ appears across it. Similarly in -ve half cycle, max. voltage across the reverse biased diode D_1 is also $2V_m$.

So $\boxed{PIV = 2V_m}$ in centre tap FWR.

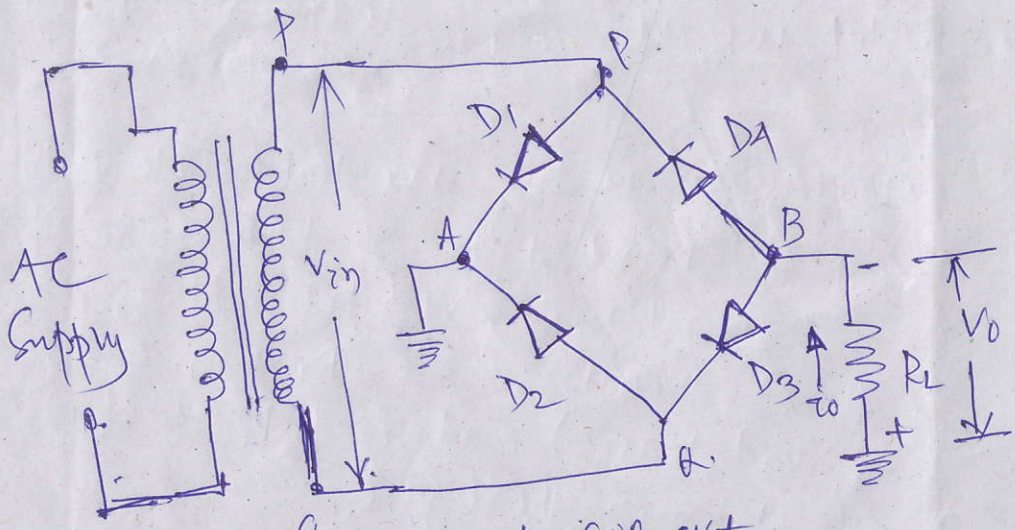
Disadvantages of FWR (centre tap)

i) It is difficult to locate the centre tap on the secondary winding.

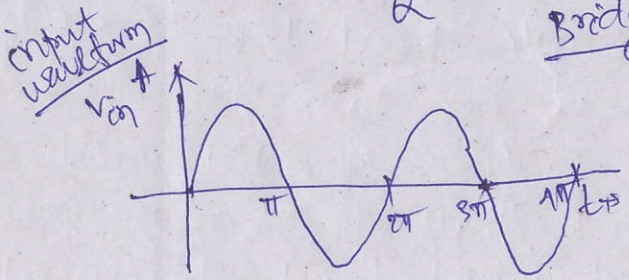
ii) The dc output is small as each diode utilizes only one half of the secondary winding voltage.

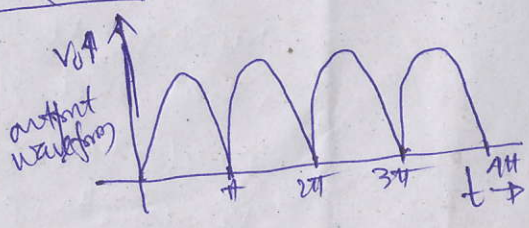
iii) The diodes used must have high PIV.

Fullwave Bridge Rectifier.



Bridg FWR ckt





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on the fig. is shown a fullwave bridge rectifier ckt. It uses 4 diodes in the 4 arms of the bridge. The load resistance is connected between two corner points A & B and ac input voltage is applied between the two other corner points P & Q.

Operation: During +ve half cycle of the ac input voltage (0 to π) point P is at higher potential (+ve) and point Q is at lower potential (-ve). So current flows through the sequence P - D_1 - A - load R_L - D_3 - Q. Diodes D_1 & D_3 are forward biased (ON) and D_2 D_4 are reverse biased (OFF). So during this period (0 to π), the output V_o is equal to input V_i.

During -ve half cycle of the input signal (π to 2π) point Q is at higher potential and P is at lower potential. So Diodes D_2 & D_4 are forward biased and D_1 & D_3 are reverse biased. So current flows from Q - D_2 - A - load R_L - B - D_4 - P. So we get another +ve half cycle ~~on both the cas~~ at the output for the -ve half cycle of the input V_i.

on both the cases current flows in the same direction through load resistance R_L i.e, A to B. So the output current is unidirectional (dc) and output voltage V_o ($= i_o \times R_L$) is also dc. This is shown in the output waveform.

Peak inverse voltage: As it is the maximum reverse voltage developed across a diode when it is reverse biased —

1. During +ve half cycle of ac input (0 to π)

diodes D_2 & D_4 are reverse biased (D_1 & D_3 are ON so offers short ckt) — the maximum voltage developed across each diode is equal to V_m.

ii) During -ve halfcycle of ac input (from π to 2π) D_1 & D_3 are reverse biased (D_2 & D_4 are short), so maximum reverse voltage across D_1 & D_3 is V_m.

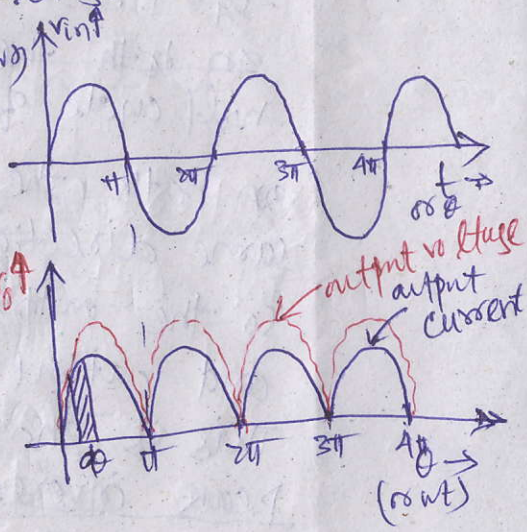
So on a FWR, PIV of the diodes, $\boxed{PIV = V_m}$

Advantages 1) No need of a centre tapped transformer
2) output is twice of that of a centretapped rectifier
3) PIV is half of that of the centre tapped rectifier

Disadvantages i) It required four diodes.
ii) As two diodes conducts during one halfcycle of the input signal, their internal resistances (though very small) comes in series which produces a measurable resistance, which is not desired, as it will affect the efficiency.

Efficiency of FWR.

Consider the FWR circuit, its input voltage and output voltage and current waveforms are as shown



Let r_f and R_L be the forward resistance of diode and load resistance respectively.

instantaneous current in the ckt, $i = \frac{v}{r_f + R_L} = \frac{V_m \sin\theta}{r_f + R_L}$

$= I_m \sin\theta$ where $I_m = \frac{V_m}{r_f + R_L}$

dc output power

we know for a fullwave rectified wave $I_{dc} = \frac{2I_m}{\pi}$

$\therefore$ dc output power $= P_{dc} = I_{dc}^2 \cdot R_L = \left(\frac{2I_m}{\pi}\right)^2 \cdot R_L$

ac input power:

ac input power is $P_{ac} = I_{rms}^2 \cdot (r_f + R_L)$

for a fullwave rectified wave $I_{rms} = \frac{I_m}{\sqrt{2}}$

$\therefore P_{ac} = \left(\frac{I_m}{\sqrt{2}}\right)^2 \cdot (r_f + R_L)$

$\therefore$ fullwave rectification efficiency –

$$\eta = \frac{P_{dc}}{P_{ac}} = \frac{(2I_m/\pi)^2 \cdot R_L}{(I_m/\sqrt{2})^2 (r_f + R_L)}$$

$$= \frac{8}{\pi^2} \frac{R_L}{r_f + R_L} = 0.812 \frac{R_L}{r_f + R_L} = \frac{0.812}{1 + \frac{r_f}{R_L}}$$

The efficiency will be maximum, if $r_f \angle\angle R_L$ then r_f/R_L is very very less in comparison to 1

and $\boxed{\eta = 0.812 = 81.2\%}$

nature of rectifier output & ripple factor

The output of a rectifier is not pure dc but actualy pulsating dc in nature. So it contains dc component along with ac component. This ac component is also called as ripple.

The ratio of rms value of ac component to the dc component in the rectifier

output is known as ripple factor.

$$\text{ripple factor} = \frac{\text{rms value of ac component}}{\text{value of dc component}} = \frac{I_{ac}}{I_{dc}}$$

Mathematical analysis:

As the output current of a rectifier contains ac component as well as dc component, its rms value is $I_{rms} = \sqrt{I_{dc}^2 + I_{ac}^2}$

$$\text{or, } I_{rms}^2 = I_{dc}^2 + I_{ac}^2$$

$$\text{or, } I_{ac}^2 = I_{rms}^2 - I_{dc}^2.$$

$$\text{or } I_{ac} = \sqrt{I_{rms}^2 - I_{dc}^2}$$

dividing both sides by I_{dc} —

$$\frac{I_{ac}}{I_{dc}} = \frac{\sqrt{I_{rms}^2 - I_{dc}^2}}{I_{dc}}$$

$$\therefore \boxed{\text{ripple factor} = \frac{I_{ac}}{I_{dc}} = \frac{1}{I_{dc}}\sqrt{I_{rms}^2 - I_{dc}} = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}}$$

i) for half wave rectifier :-

$$I_{rms} = I_m/2, \quad I_{dc} = I_m/\pi$$

$$\therefore \text{ripple factor} = \sqrt{\left(\frac{I_m/2}{I_m/\pi}\right)^2 - 1} = 1.21$$

ii) for fullwave rectifier :-

$$I_{rms} = I_m/\sqrt{2}, \quad I_{dc} = \frac{2I_m}{\pi}$$

$$\therefore \text{ripple factor} = \sqrt{\left(\frac{I_m/\sqrt{2}}{2I_m/\pi}\right)^2 - 1} = 0.48$$

It is seen that pulsating component is very less in FWR output than that in HWR output.

2.3 Filters : classification and function. (4)

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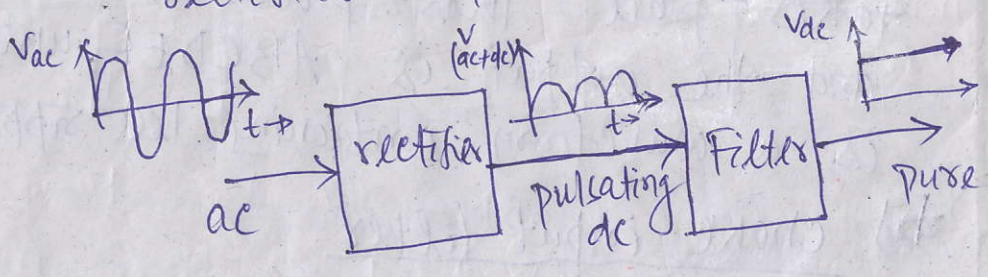
Filter is an electronic circuit which filters out the pulsating ac components present in the rectifier output and produces pure dc output.



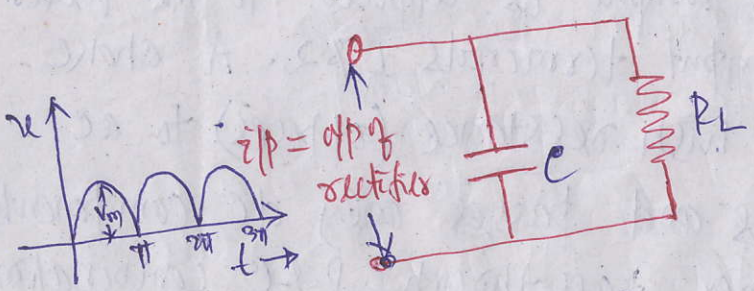
Basicaly there are 3 types of filters-

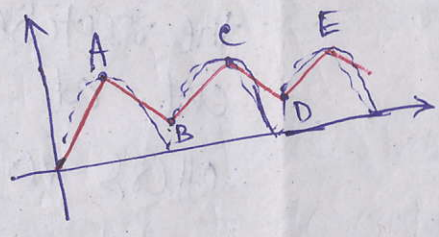
a) capacitor filter b) choke input filter

c) capacitor input or π (pie) filter.

a) capacitor filter

In the below figure is shown a capacitor filter which contains a single capacitor to which the load resistance R_L is connected in parallel and input is the pulsating dc output of a rectifier.

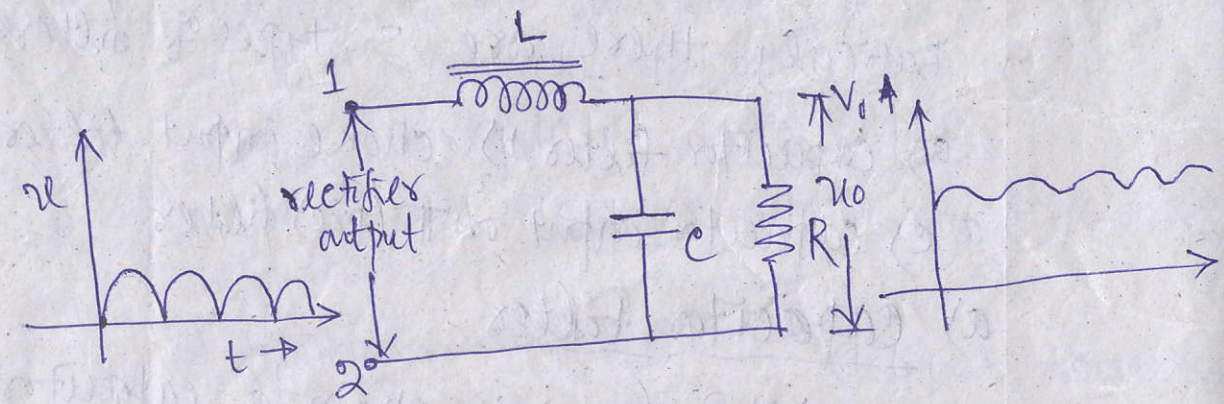




when rectifier output increses it charges the capacitor and at peak value of input the capacitor is fully charged to V_m (point A in the

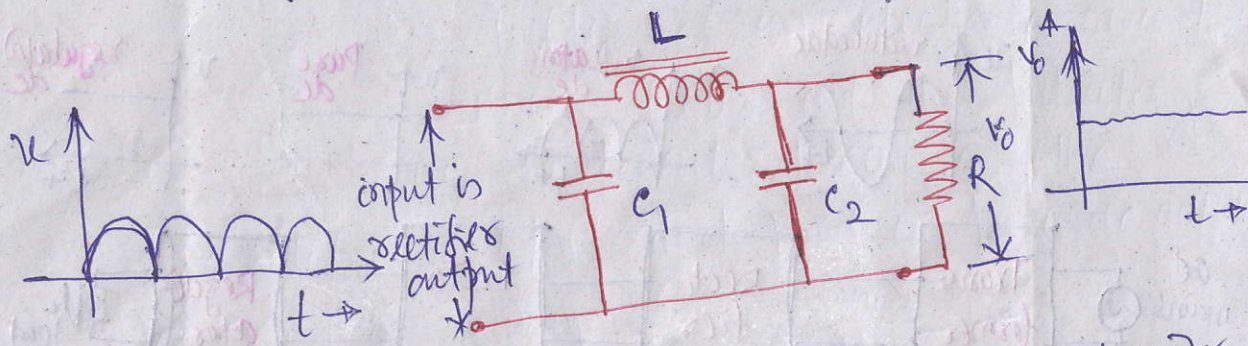
output). Then when input decreases from V_m to 0, the capacitor discharges through R to a value as represented by point B. Again in the next input cycle charging (B to C) and discharging (C to D) of capacitor takes place. This process continues and the output is ABCDEF, which is a waveform containing less ripples.

b) Choke input filter



In the fig. is shown a choke (inductor) input filter which contains an inductor in series with a capacitor filter C and a resistance R. The pulsating output of the rectifier output is applied to the filter ckt. at input terminals 1 & 2. A choke offers very high resistance (opposes) to ac components and passes only dc components to further pass through R & C combination. So the final output is a dc contains very less pulsating components.

c) capacitor input (or π) filter :



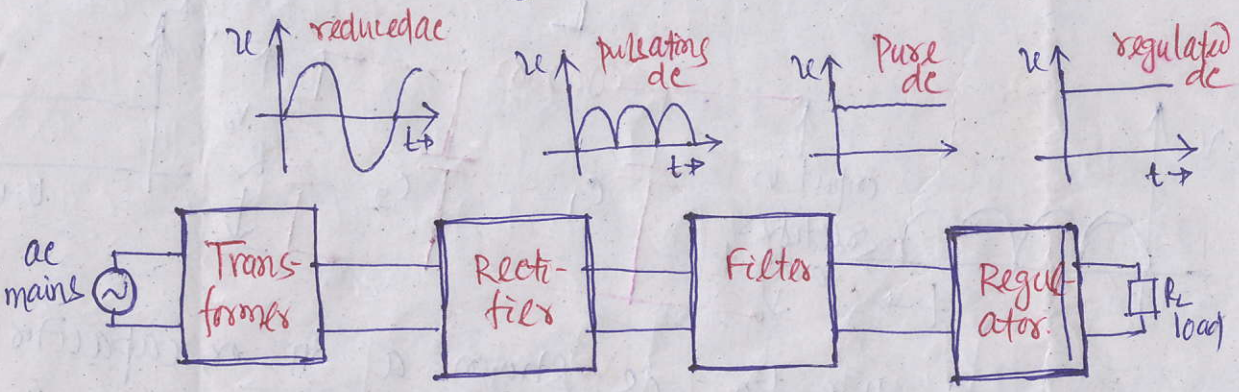
In the fig. is shown a π or capacitor input filter which contains two capacitors in parallel path and an inductor (choke) in series path. The operation can be explained as -

a) capacitor C_1 : It offers low reactance to ac and high reactance to dc; as it in the parallel path, dc component goes forword to the next component that is inductor and by passes the ac component.

b) inductor L : It is in series path and offers high reactance to ac component and so opposes it and passes the dc component unopposed through it. So ac components are further filtered out.

c) capacitor C_2 : It is in parallel path and offers high reactance to dc components (passes it) and low reactance to ac component (opposes). So the remaining amount of ac component is filtered out and almost pure dc goes to the load to produce output.

2.4 working of DC Power Supply (Block diagram)



In the figure is shown the basic block diagram of a regulated dc power supply. If the regulator is their then it is called unregulated power supply.

The regulated dc power supply consists of following blocks —

a) Transformer: Usualy a stepdown transformer is used which reduces the amplitude of the ac mains supply and provides it to the rectifier.

b) Rectifier: the rectifier converts ac input to pulsating dc at its output.

c) Filter: Filter ckt, filters out the pulsating (ac) components and provides pure dc at its output.

d) Regulator: Regulator is used in only regulated power supply, to regulate the output (load) voltage and current.

2.5 (a) Transistor and its types:

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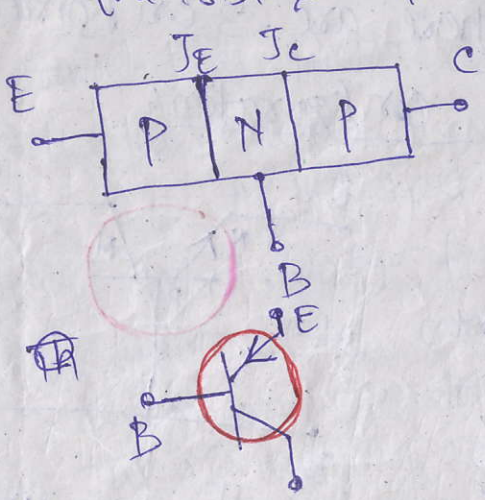
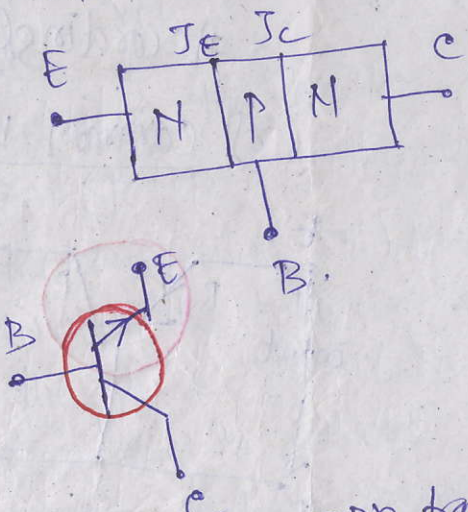
Transistor is a 3 terminal, 2-junction, alternate P-N, semiconductor device. A p or n type semiconductor is sandwitched between a pair of opposite type. Accordingly there are two types of transistors. PNP and NPN as shown below.



Symbol of PNP transistor



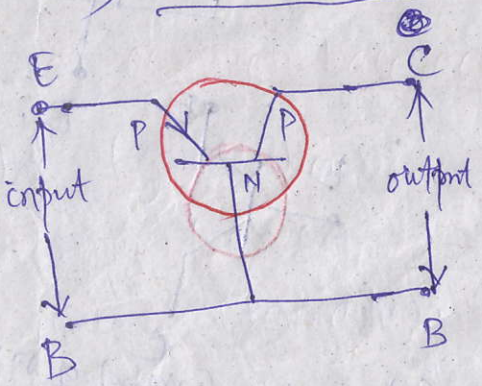
Symbol of npn transistor

- The terminals connected to the extreme (C) ends are one is emitter (E) & other is collector
- The middle one is base (B).
- The emitter is wider than base and heavily doped, the base is the thinest pille and lightly doped and collector is moderately doped and the thickest (most wide).
- The junction between emitter & base is called emitter-base junction or emitter-junction or emitter diode
- The junction between collector & base is called collector base junction, or collector junction or collector diode.

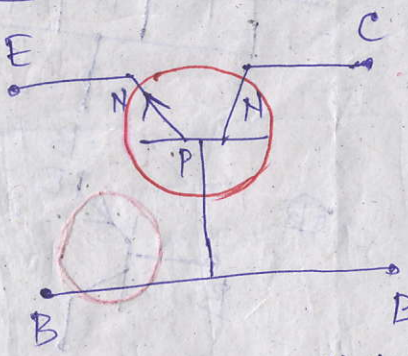
(b) Transistor configurations

Transistor is a 3 terminal device but in its operation it is connected as a two port or four terminal device, by converting any one terminal into two, or in otherwords it can be said as one terminal (B, E or C) is made common to both input and output. Accordingly there are 3 configuratime—

i) common base configuration:

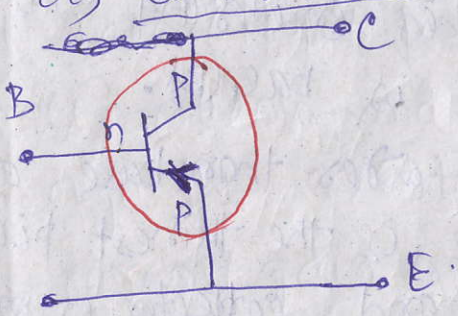


(common base PNP config.)

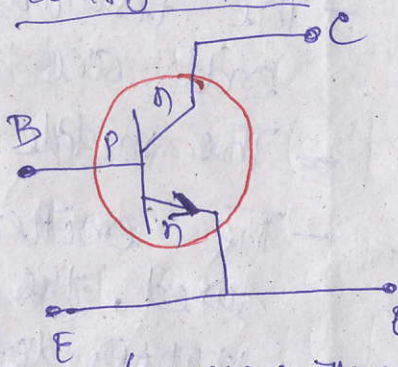


(common base NPN config.)

ii) common emitter configuration:

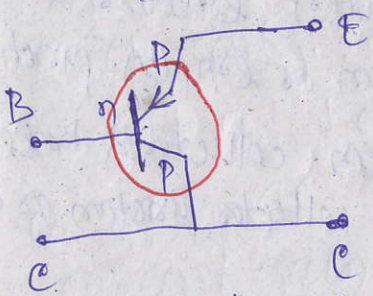


(common emitter PNP config)

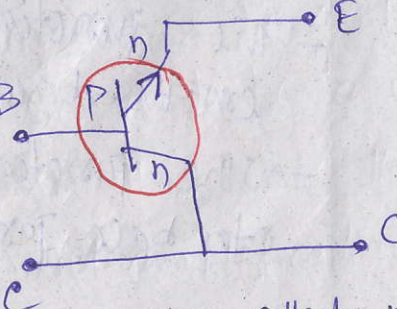


(common emitter npn config)

iii) common collector configuration:



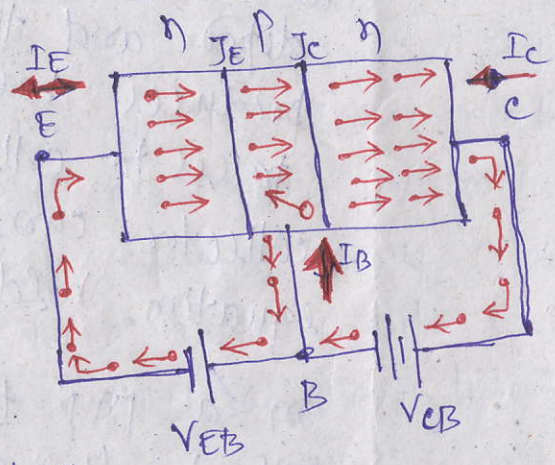
common-collector PNP config.



common collector npn config

(c) operation of a transistor (npn type)

In the fig. is shown an npn transistor in common base configuration. Emitter junction is forward biased by V_{EB} and collector junction is reverse biased by V_{CB}.



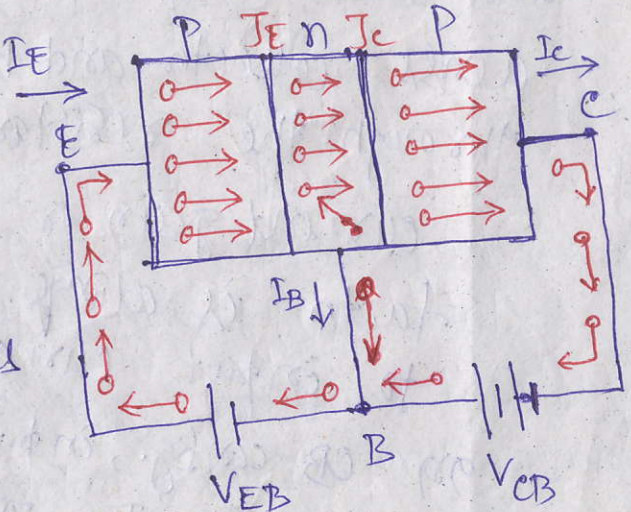
Forward bias pushes electrons towards the junction, this constitute the emitter current I_E. As the base region (P type) is thin and lightly doped, only few electrons (about 5%) coming from emitter side combines with the holes in base region and constitute the base current I_B. The remaining electrons passes to collector region (n-type) and produces collector current (I_C).

So the total emitter current $\boxed{I_E = I_B + I_C}$

operation of pnp transistor

Emitter junction is forward biased and collector junction is reverse biased.

The forward bias, pushes the holes in emitter region (P type) towards base which produces emitter current I_E. Few holes (about 5%)



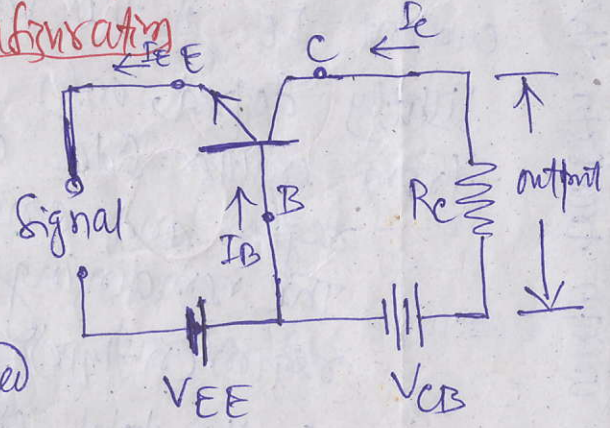
In a pnp transistor, the current is mostly due to electrons.

combine with the few electrons present in lightly doped and thin (n type) base region and produces base current (I_B). Remaining holes passes to collector region and constitute collector current (I_C). Here also the same equation holds good $\boxed{I_E = I_B + I_C}$

on a pnp transistor, the current is mostly due to flow of holes.

Expression of current gain

i) common base configuration



on the fig. is shown an npn transistor in CB configuration. The signal to be amplified is applied between emitter and base terminals (input port) and output is taken across collector and base terminals (output port) through the resistance R_C.

current gain or current amplification factor is always the ratio of output current to input current (in case of dc operation) on CB config., input current is I_E and output current is I_C. The signal to be amplified is an ac signal. on this case the current gain or current amplification factor

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(α) is defined as the ~~ratio~~ ratio of change in collector current to change in ~~base~~ emitter current at constant collector to base voltage (V_{CB}).

$$\alpha = \left.\frac{\Delta I_C}{\Delta I_E}\right|_{\text{at const } V_{CB}}$$

It can be assumed that total collector current I_C consists of two parts — i) amplified emitter current ($= \alpha I_E$) and leakage current which can be represented as I_{CBO} (that is the collector to base current when emitter is open).

$$\therefore I_C = \alpha I_E + I_{CBO} \quad \text{——— (1)}$$

we know $I_E = I_C + I_B$

putting in (1) $I_C = \alpha(I_C + I_B) + I_{CBO}$ — (2)

or, $I_C - \alpha I_C = \alpha I_B + I_{CBO}$

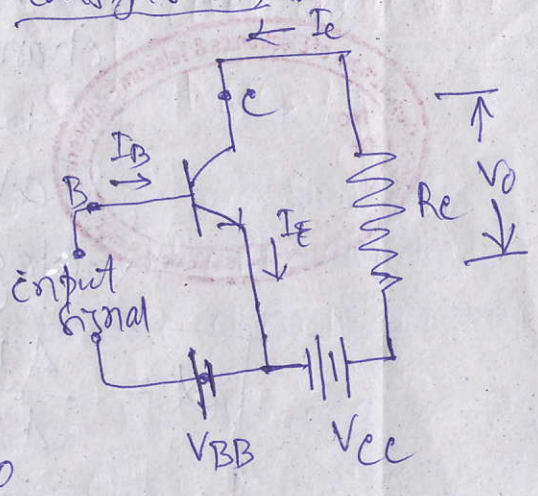
or, $I_C(1-\alpha) = \alpha I_B + I_{CBO}$

or, $$I_C = \frac{\alpha}{1-\alpha} I_B + \frac{I_{CBO}}{1-\alpha}$$

from eqn (2), $I_C - I_{CBO} = \alpha(I_C + I_B)$

or $$\alpha = \frac{I_C - I_{CBO}}{I_C + I_B}$$

ii) common emitter configuration:



current amplification factor or current gain of CE configuration (β) is defined as the ratio of change in collector current to change in base current at constant V_{cc}.

$$\boxed{\beta = \frac{\Delta I_C}{\Delta I_B}\Big|_{\text{at constant } V_{cc}}}$$

relation ship between α & β.

$$\alpha = \frac{\Delta I_C}{\Delta I_E} \quad \text{and} \quad \beta = \frac{\Delta I_C}{\Delta I_B}$$

for a transistor $I_E = I_B + I_C$

or, $\Delta I_E = \Delta I_B + \Delta I_C$

or, $\Delta I_B = \Delta I_E - \Delta I_C$

putting in the eqn for β, $\beta = \dfrac{\Delta I_C}{\Delta I_E - \Delta I_C}$

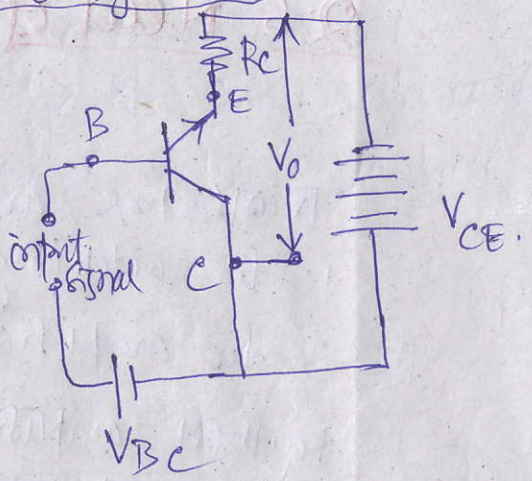
dividing N^r & D^r by ΔI_E, $\beta = \dfrac{\Delta I_C / \Delta I_E}{1 - \frac{\Delta I_C}{\Delta I_E}} = \dfrac{\alpha}{1-\alpha}$

$$\therefore \boxed{\beta = \frac{\alpha}{1-\alpha}}$$

Similarly $\beta(1-\alpha) = \alpha$ or, $\beta = \alpha + \alpha\beta = \alpha(1+\beta)$

or $\boxed{\alpha = \dfrac{\beta}{1+\beta}}$

iii) Common collector configuration.



current amplification factor or current gain of a transistor in common collector configuration (γ) is given as the ratio of change in emitter current to that in base current.

$$\gamma = \left.\frac{\Delta I_E}{\Delta I_B}\right|_{\text{const } V_{CE}}$$

relationship with α.

now $\alpha = \frac{\Delta I_C}{\Delta I_E}$, $\gamma = \frac{\Delta I_E}{\Delta I_B}$

we know, $I_E = I_B + I_C$ or, $\Delta I_E = \Delta I_B + \Delta I_C$

or, $\Delta I_B = \Delta I_E - \Delta I_C$

now $\gamma = \frac{\Delta I_E}{\Delta I_B} = \frac{\Delta I_E}{\Delta I_E - \Delta I_C}$

dividing N^r & D^r by ΔI_C

$$\gamma = \frac{\Delta I_E / \Delta I_C}{\frac{\Delta I_E}{\Delta I_C} - 1} = \frac{1/\alpha}{1/\alpha - 1} = \frac{1}{1-\alpha}$$

$$\therefore \gamma = \frac{1}{1-\alpha}$$

$$\alpha = \frac{\gamma - 1}{\gamma}$$

So we have $\alpha = \frac{\beta}{\beta+1} = \frac{\gamma-1}{\gamma}$

2.6 Need of Biasing and different types of biasing

Transistors are used for two purposes -
1. for switching (as an - ON-OFF switch)
2. for amplification (enhancing strength of weak signal)

Faithful amplification is the process of raising the strength of a weak signal without any change in its general shape.

For faithfull amplification, the transistor must full fill the 3 basic conditions —

1. Flow of proper zero signal collector current
2. maintaining minimum proper base emitter voltage (V_{BE}) at any instant [$V_{BE} \geq 0.3V$ for Ge, $0.7V$ for Si]
3. maintaining minimum proper collector-emitter voltage (V_{CE}) at any instant [$V_{CE} \geq 0.5V$ for Ge, $1V$ for Si]

Above 3 conditions are fullfilled when the transistor is operated in the active region of operation (of its output characteristics) i.e, base-emitter junction is forward biased and base-collector junction is reverse biased.

Transistor biasing: Transistor biasing is the method by which we can ensure flow of proper zero signal collector current and maintain proper base-emitter voltage and collector-emitter voltage at any instant

Types of Biasing 1) Base resistor method 2) Emitter bias method 3) Biasing with collector feed back resistor 4) voltage divider bias

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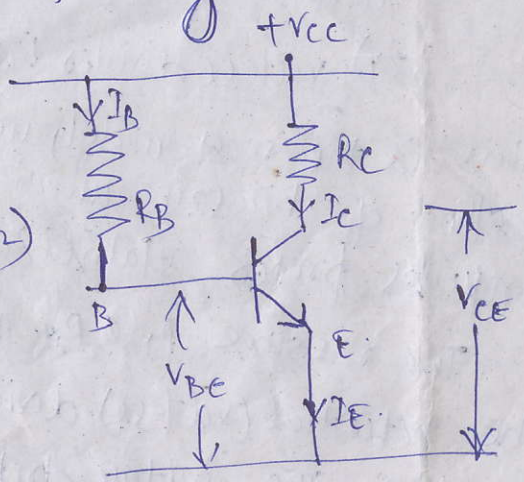
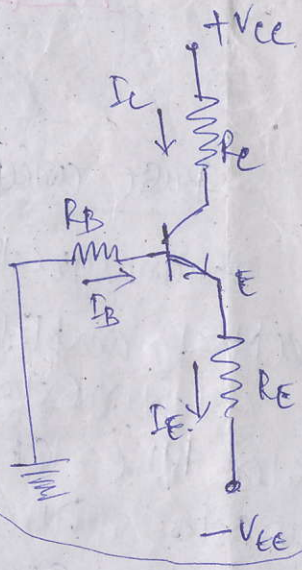
i) Base resistor method of biasing



In this method of biasing a very high resistance (several hundred kΩ) is connected between the base and +ve terminal of supply for npn transistor (base & -ve terminal of supply for PNP transistor).

The required zero signal base current I_B flows through R_B by the supply V_{cc}. The value of I_B (and hence $I_c = \beta I_B$) can be varied by varying the values of R_B.

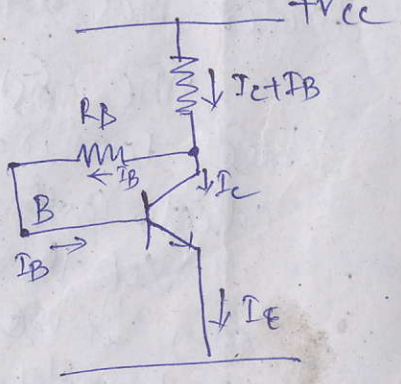
ii) Emitter bias method



In emitter bias method two voltage supplies are used. (usually both are equal & opposite) along with an emitter resistance R_E.

This bias provides better performance of amplification.

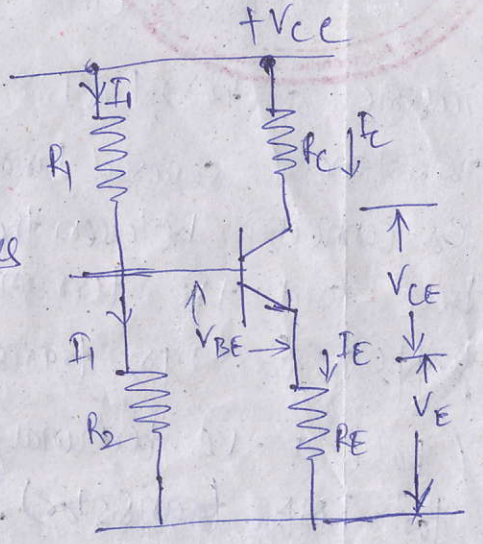
iii) Collector feedback bias



On this method the base resistor R_B is connected to collector to provide a feedback circuit. Here the zero signal base current I_B (and hence $I_c = \beta \cdot I_B$) is not

controlled by V_{CC} but controlled by V_{CB}.

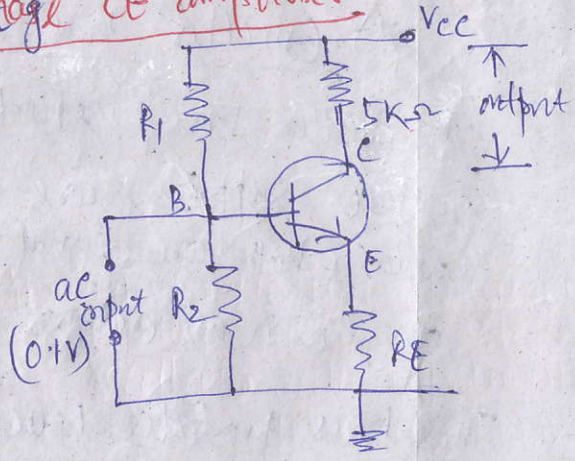
iv) voltage divider bias:



This is the most widely used method of biasing which provides proper stabilization.

Two resistors R_1 & R_2 provides the potential (voltage) divider network. The voltage drop across R_2 $\left(= V_{CC} \cdot \frac{R_2}{R_1+R_2}\right)$ forward biases the base emitter junction and zero signal base current ($\therefore I_C = \beta I_B$) flows in the transistor.

2.7. Amplifiers (concept), working principle of single stage CE amplifier.



Basic concept:

To analyze the basic concept of amplification by a transistor, let consider the CE, npn transistor with potential divider bias as shown in fig.

The signal to be amplified is applied at the base terminal, and the output is taken from the collector (output) terminal.

Let the input signal is weak and can produce only a voltage change of about 0.1 V. Let this small voltage change produces a small base current

which is then amplified by the transistor (β times) and produces a larger collector current ($I_C = \beta I_B$). This current passing through the high collector resistance (usually 1 to 10 K-Ω) produces a large output voltage.

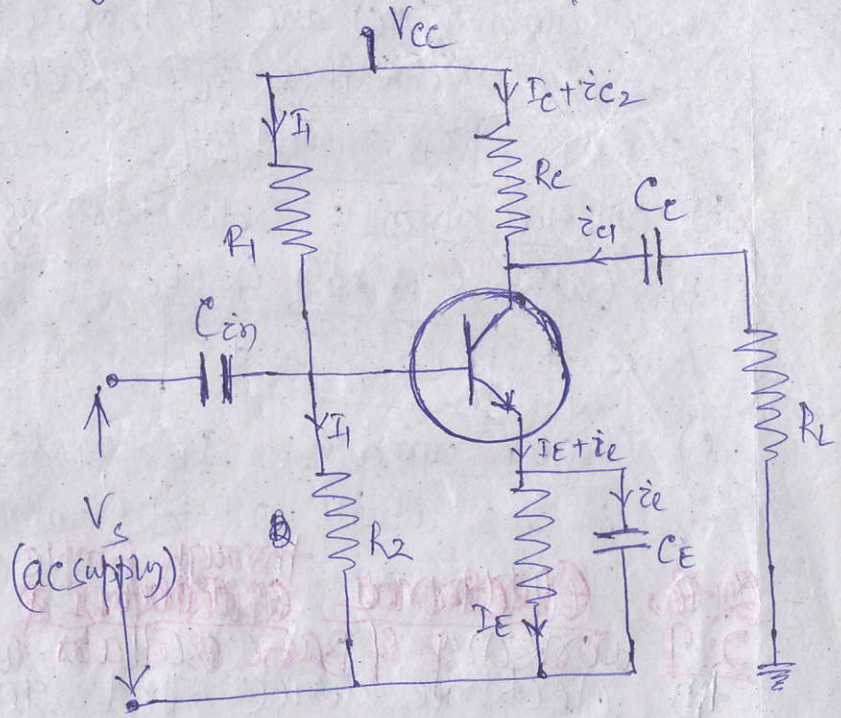
For ex. let the 0.1 V change in base ckt, produces a current change of 2mA in collector ckt (I_C) and let $R_C = 5$ K-Ω, then output voltage $V_0 = 2mA \times 5K\Omega$

$= 10$ V.

input voltage was $= 0.1$ V.

∴ voltage amplification factor or voltage gain $= \frac{10}{0.1} = 100$

Single stage Common Emitter Amplifier.



On the fig. is shown a single stage CE transistor amplifier. Different components and circuitry can be described as follows.

i) Biasing circuit: The resistances R_1, R_2 & R_E form the biasing and stabilization circuit. By proper biasing the operating point is made proper and stable.

ii) Input capacitor C_{in}: Input capacitor C_{in}

couples the input ac signal to the base of transistor. It only allows ac signal to flow into the transistor & blocks any dc signal.

iii) Emitter bypass capacitor C_E: Emitter bypass capacitor C_E allows the amplified ac signal to bypass the emitter resistance R_E.

iv) output coupling capacitor C_c: It couples the amplified output to next stage or to the load.

Various current components in the circuit can be designated as follows —

a) Base current: without applying ac signal, the base current (dc) due to biasing is I_B and due to ac signal it is i_b. Therefore total base current $\boxed{i_B = I_B + i_b}$.

b) Collector current: dc part is I_c and ac part (applying signal) is i_c, so total collector current $\boxed{i_C = I_C + i_c}$

c) Emitter current: I_E is dc current and i_e is ac current and total current $\boxed{i_E = I_E + i_e}$

Q.8, 2.9 Explain through simple block diagram working of Basic oscillator with diff. elements

An electronic device that generates sinusoidal oscillations of desired frequency is called sinusoidal oscillator.

An oscillator contains 3 basic components, one is the oscillatory circuit or tank circuit, 2nd unit is a transistor amplifier and 3rd unit is a feed back circuit. The interconnection as shown in

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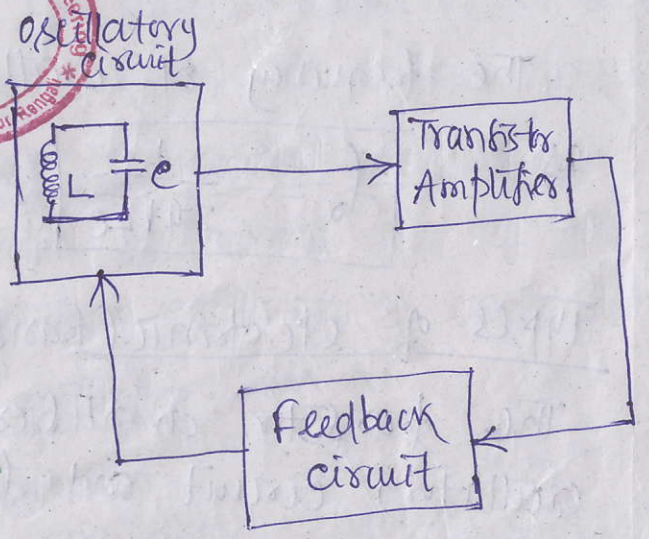
the figure Q can produce sinusoidal oscillations



working principle of the oscillator.

The tank circuit consists of a capacitor and an inductor in parallel with each other. The capacitor is initially charged. when the connection is made it starts discharging, so the inductor starts charging. The electrical energy stored in the capacitor converts to magnetic energy in the inductor. when the capacitor is fully discharged, the inductor becomes fully charged. Now inductor discharges and capacitor starts charging but this time in opposite direction.

This process of charging and discharging between L & C (conversion of energy from electrical to magnetic and vice-versa) continues. If there will be no losses in L or C, then this oscillation will continue indefinitely. This oscillation signal is amplified by the transistor amplifier. To compensate any loss in L or C or in the process of energy conversion, a part of the

output is fed back to the input (tank circuit) by the feedback circuit.

The frequency of oscillation is given as - $$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Types of electronic (transistor) oscillators -

The transistor amplifier along with the oscillatory circuit and feedback network can produce continuous undamped oscillations of any desired frequency.

Different types of oscillators differs from each other in the way of feedback employed to compensate the losses in the oscillatory circuit. Different oscillators are -

1. Tuned collector oscillator 2. Hartley oscillator
3. Wien bridge oscillator 4. phase shift oscillator.
5. Colpitt's oscillator 6. crystal oscillator.

2.8 Electronic oscillation and its classification

An electronic device that generates sinusoidal oscillations of desired frequency is known as sinusoidal oscillator.

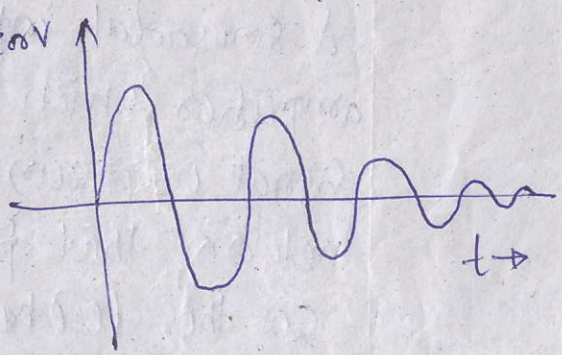
An oscillator actualy does not generate frequency or energy, it only

acts as an energy converter. It takes dc energy i/p and converts it into ac energy (signals) of desired frequency.

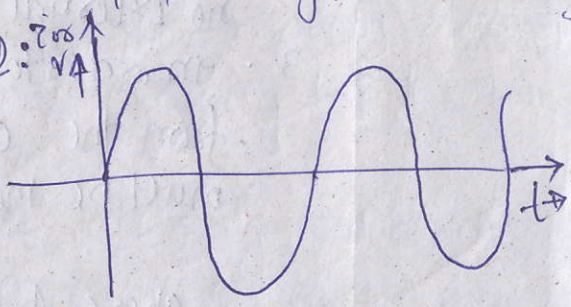
Types of Sinusoidal oscillations

Sinusoidal oscillations are of two types –
a) Damped oscillation b) undamped oscillations

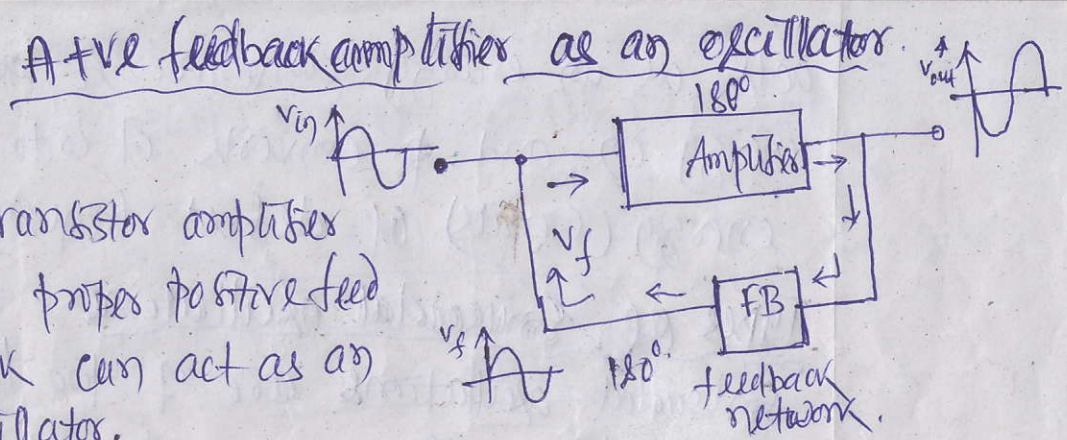
Damped oscillation: The oscillation in which the amplitude of the signal decreases from cycle to cycle, is called damped oscillation. It is due to the fact that in every cycle of operation, some amount of energy is lost. This loss goes on increasing cumulatively from cycle to cycle, so the amplitude goes on decreasing.



Undamped oscillation: If the amount of energy lost during the cycle can be compensated by supplying it externally, then the amplitude of signal will remain constant in every cycle, this type of oscillation is called undamped oscillation.



+ve feedback amplifier as an oscillator.



A transistor amplifier with proper positive feedback can act as an oscillator.

A sinusoidal input signal is amplified by the amplifier which produces 180° phase shift. This signal is again passed through a feedback network that produces another 180° phase shift so the feedback signal is in phase with the input signal. Now the input signal is taken out and the feedback signal is amplified. The above facts can be summerised as —

1. A transistor amplifier with proper positive feedback will work as an oscillator.
2. The circuit needs only a quick trigger to start the oscillation. once oscillation started, no external signal source is needed.
3. In order to get continuous undamped output from the circuit, the following condition must be met — $\boxed{m_v \cdot A_v = 1}$

where A_v = voltage gain of amplifier without feedback.

m_v = feedback fraction.

This relation is called Barkhausen criterion.

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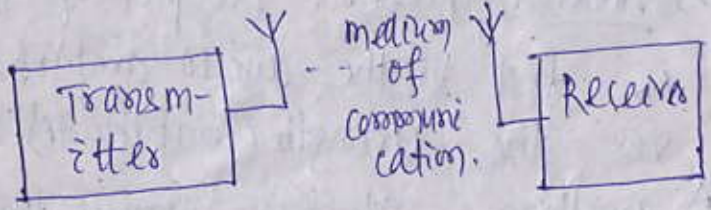
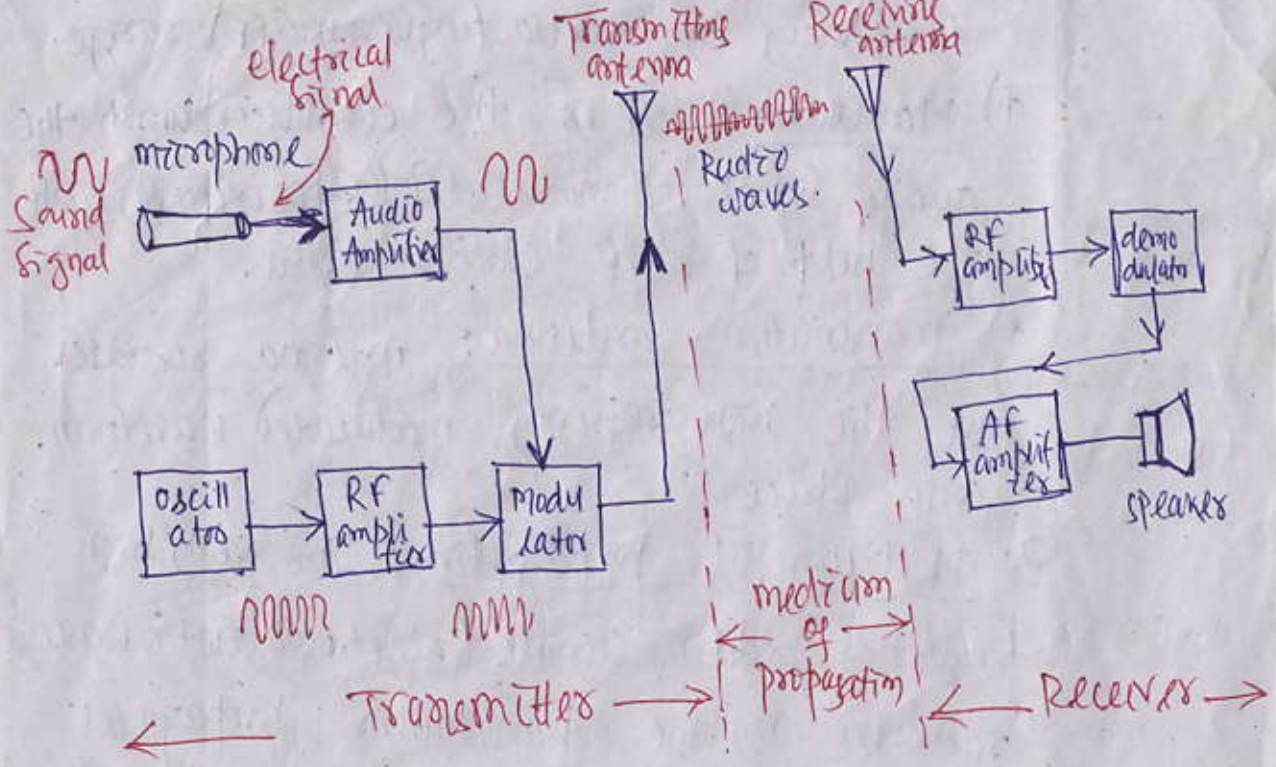
Ch: 3 Communication System

3.1 Basic communication system:

Communication is the process of connecting or transporting information from the transmitter (sender) to the receiver (may be at a distant place), through a medium. The entire system consists of 3 parts.



The above block diagram can be extended as-



① Transmitter converts the audio signal into electrical signal, modulates it with high frequency RF carrier and transmits to air (space) which is the medium. Different components in transmitter are-

a) Microphone: microphone converts sound signal to electrical signal. There is a very thin film called diaphragm which vibrates with the air pressure exerted on it and produces electrical signal in audio range (20 Hz to 20 KHz)

b) Audio amplifier: output of the microphone is fed to the audio amplifier which improves the strength (amplitude) of the audio signal

c) Oscillator: It is a circuit which produces high frequency signal called carrier signal having frequency in radio frequency (RF) range.

d) Modulator: It is the circuit in which the audio signal is modulated (superimposed) with the help of RF carrier signal.

e) Transmitting antenna: Antenna radiates out the high frequency modulated waveform into space.

2. Medium of propagation: The very high frequency radio signals (electromagnetic waves) radiated by the transmitter propagates (moves) in all directions in space (air medium) with the velocity of light (3×10^8 m/

3. Receiver: It is the part of communication system in which the received RF signal is again converted to low frequency audio signal and converted to sound signal by a loudspeaker.

a) Receiving antenna: It is an antenna (called ariel) which receives the high frequency (RF) electromagnetic waves from space and provides it to RF amplifier.

b) RF amplifier: The received EM signals are amplified by RF amplifier, to increase its strength (amplitude)

c) Demodulator or detector: Demodulator does the reverse operation of a modulator. i.e, the audio signal is separated from the RF signal.

d) Audio amplifier: Audio amplifier (some times multistages) amplifies the weak audio signal to increse its strength.

e) Loud speaker: It does the reverse operation of a microphone, i.e, converts the electrical signals into sound signals.

3.2: Concept of modulation & Demodulation

Modulation is the process of varying some characteristics (i.e, amplitude, frequency or phase) of a carrier wave with the help of modulating signal (information signal)

modulation is done by a modulator at the transmitter end of the communication system.

If we want to transmit a sound (audio) signal or picture (video) signal, then it is the modulating signal. It will modulate the amplitude, frequency or phase of a carrier signal.

Demodulation is a process in which the modulating signal is recovered from the modulated signal (transmitted through the transmitting antenna) with the help of the same carrier signal. (used during modulation) Demodulation is done by a demodulator or detector in the receiver end of a communication system.

difference between modulation and demodulation

Modulation

1. It is the process of changing some characteristics like amplitude, phase or frequency of a carrier signal by the modulating signal.
2. Depending upon the characteristic, which is modulated, the name of the modulation process is given like amplitude modulation, phase or frequency modulated.
3. Modulation is superimposing (mixing) of modulating

Demodulation

1. It is the process of recovering the modulating signal, from the modulated signal, with the help of the carrier signal.
2. The modulating signal is recovered from the amplitude, frequency or phase modulated signal.
3. Demodulation is decomposing the modulated signal into modulating and carrier signals.

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signal and carrier signal to produce modulated signal.

④ Modulation is done in the transmitter part of the communication system.

⑤ modulating signal + carrier signal ⟹ modulated signal.

④ Demodulation is done in the receiver part of the communication system.

⑤ modulated signal ⟹ modulating signal + carrier signal.

3.3 Different types of modulation

A carrier signal can be represented as -

$$x_c(t) = V_c \sin(\omega_c t + \varphi_c)$$

where $x_c(t)$ ⇒ instantaneous value of the carrier signal at any time instant 't'

V_c ⇒ peak or amplitude of the signal.

ω_c ⇒ angular frequency of the signal

$\omega_c = 2\pi f_c$, where f_c is the linear frequency.

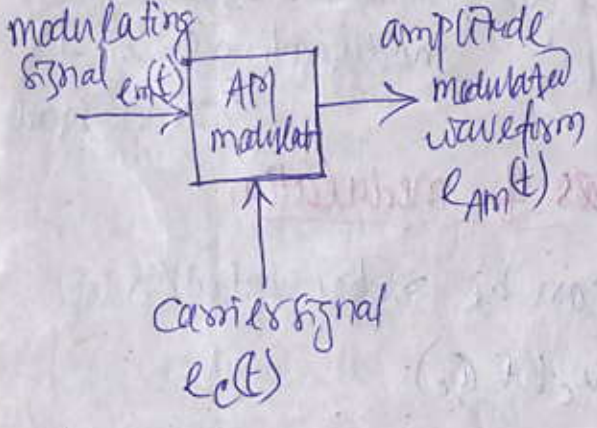
φ_c ⇒ phase of carrier signal.

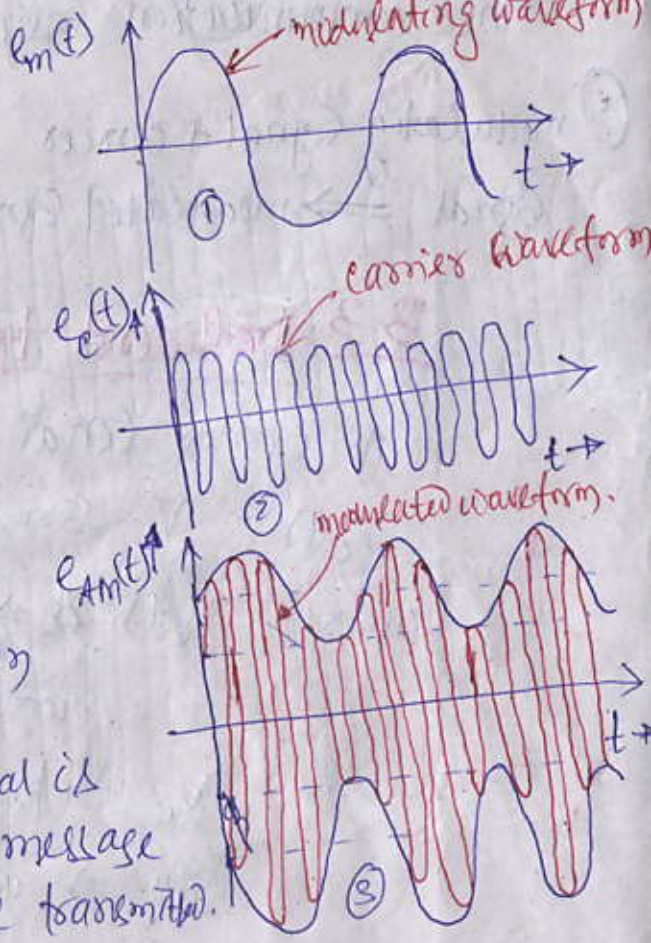
$$\omega_c = \frac{d}{dt}(\varphi_c)$$

We can change (modulate) the amplitude or frequency or phase of the carrier signal and accordingly the modulation will be amplitude, frequency or phase modulation respectively.

3.3(a) amplitude modulation

The process by which amplitude of a carrier signal is varied in accordance with the modulating signal is called amplitude modulation.





- In the figs are shown 3-waveforms.
- The modulating signal is $e_m(t)$ which is the message signal required to be transmitted.
- A high frequency carrier $e_c(t)$ is utilized for such modulation i.e, amplitude of the carrier signal is varied according to the modulating signal, resulting the amplitude modulated waveform $e_{AM}(t)$.
- Only amplitude of the carrier signal varies keeping frequency and phase constant (unchanged).
- In amplitude modulation, amplitude of the

carrier signal varies according to the modulating signal in both halfes (+ve & -ve) so that the amplitude modulated waveform is an envelope (as shown in fig ③)

modulation index or modulation factor

Modulation index or modulation factor is defined as the ratio of change in amplitude of the carrier to the amplitude of the carrier

$$m = \frac{\text{change in amplitude of carrier signal}}{\text{amplitude of carrier signal.}}$$

or $\boxed{m = \frac{E_m}{E_c}}$

where $e_m(t) = E_m \sin \omega_m t$ is the modulating signal and $e_c(t) = E_c \sin \omega_c t$ is the carrier signal.

and $e_{am}(t) = E_c \sin \omega_c t + \frac{m \cdot E_c}{2} \sin(\omega_c - \omega_m)t + \frac{m \cdot E_c}{2} \sin(\omega_c + \omega_m)t$ is the amplitude modulated waveform.

3.3(b) Frequency Modulation

The process by which frequency of the carrier signal changes in accordance with the modulating signal (keeping its amplitude & phase unchanged) is called frequency modulation.

In frequency modulation, the frequency (fc) of the carrier signal $e_c(t) = E_c \sin \omega_c t$ changes according to the modulating signal $e_m(t) = E_m \sin \omega_m t$ producing the frequency modulated waveform $e_{fm}(t)$ given by $e_{fm}(t) = E_c \sin\left(\omega_c t + \frac{\delta}{f_m} \sin \omega_m t\right)$

where δ = maximum frequency deviation

and $\delta = K E_m f_c$

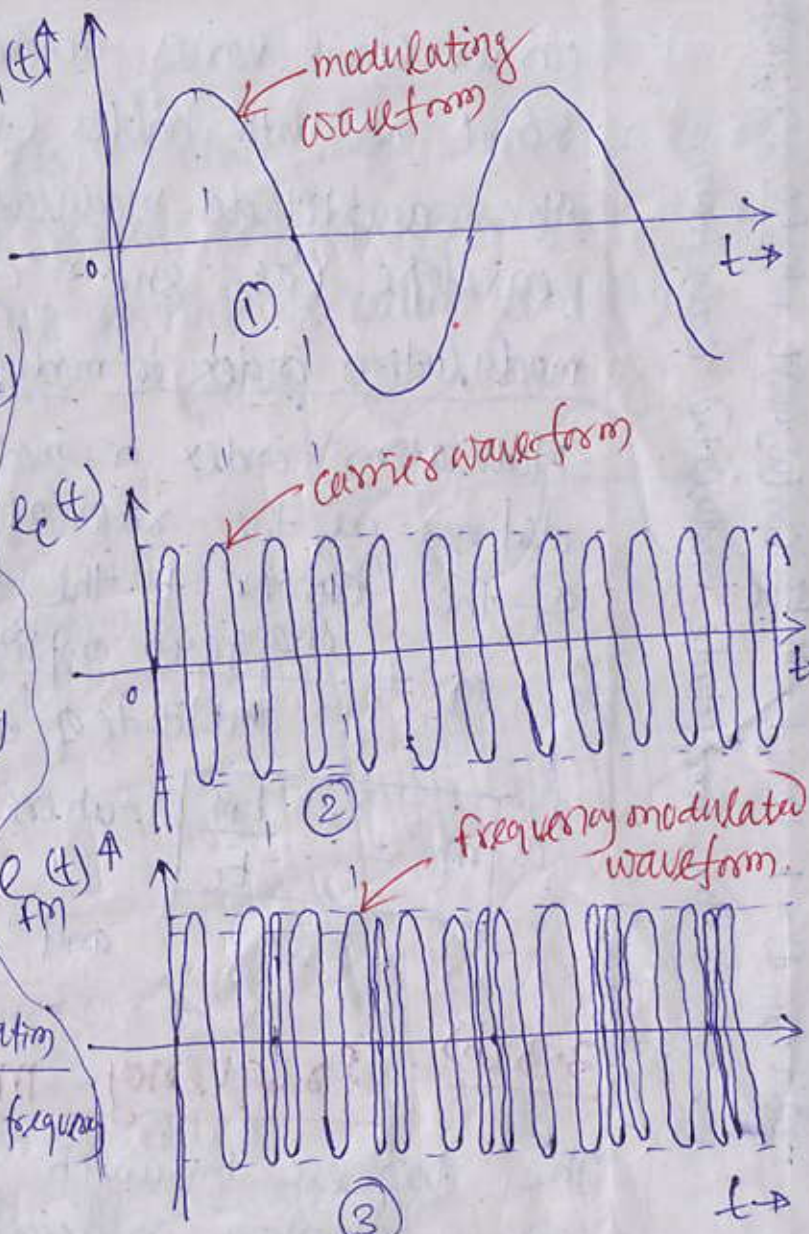
where $K \Rightarrow$ proportionality constant

frequency modulation index(m_f)

frequency modulation index is defined as the ratio of maximum frequency deviation to the frequency of the modulating signal.

$$m_f = \frac{\text{max. freq. deviation}}{\text{modulating signal frequency}}$$

or $\boxed{m_f = \frac{\delta}{f_m}}$



As seen from fig ③, the frequency of the frequency modulated waveform varies according to the modulating signal (i.e, where the amplitude of the modulating signal is more, frequency at that point is more in the modulated signal).

Advantages and Disadvantages of Frequency modulation

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Advantages:

i) High transmission efficiency
ii) Noiseless reception.
iii) Better audio quality.

Disadvantages:

i) wider channel is required.
ii) Equipements used are complex and costly.
iii) Smaller area of reception (only upto line of sight)

3.3(c) Phase Modulation

The process by which phase of the carrier signal is varied in accordance with the modulating signal (keeping its amplitude and frequency unchanged) is called phase modulation.

In phase modulation, the phase deviation is proportional to the amplitude of the modulating signal (E_m) but is independent of its frequency (f_m). In this case the phasor of the modulated wave leads the reference position during +ve half cycle of the modulating signal and lags the

reference position during the -ve half cycle of the modulating signal.

PM can be obtained from FM and vice-versa.

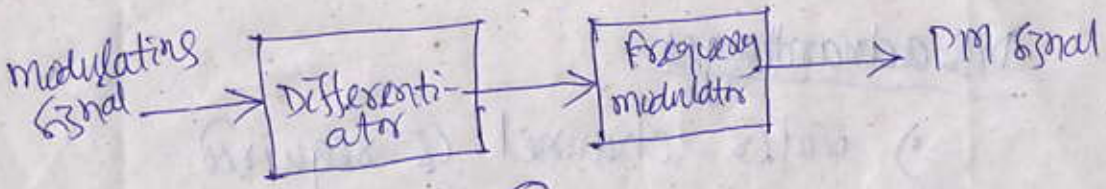


fig (a)

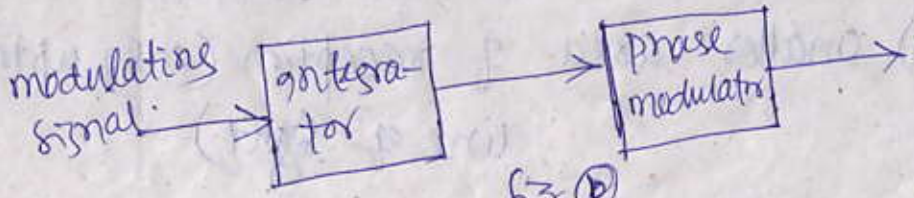


fig (b)

We know, $\omega = \frac{d\theta}{dt}$ where $\omega \rightarrow$ ang. freq.
$\theta \rightarrow$ phase.

- derivative of phase is frequency and integration of frequency is phase.
- Therefore if a modulating signal is first differentiated and then applied to a frequency modulator, then phase modulated signal (PM) will be obtained [fig (a)].
- Similarly, if the modulating signal is first integrated and then applied to a phase modulator, then frequency modulated (FM) signal will be obtained [fig (b)]

— x —

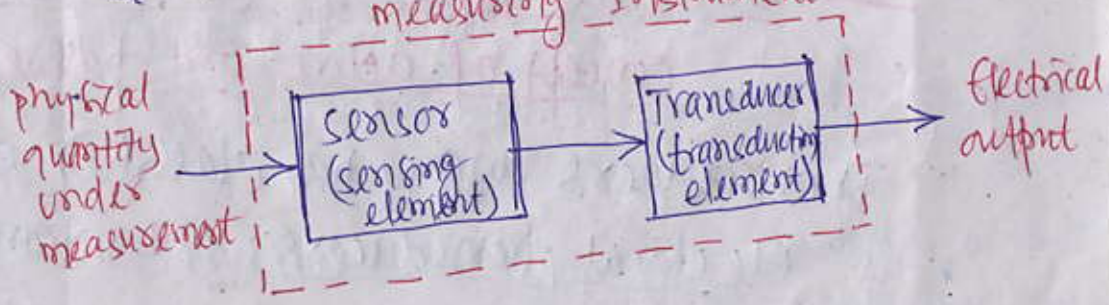
Ch-A: Transducers and measuring instruments.

A-1 Concept of Transducer and sensor with their differences

Transducer is a device which converts energy from one form to other. The energy may be of any form like electrical, mechanical, chemical, thermal, solar, tidal, muscular etc--

Sensor is a device, which can sense the presence of any form of energy or the effect which is in a sensible (measurable) form. sensors are also called detectors.

All measuring instrument (device) consists of two basic elements, the first one is the sensor or detector and second is the transducer.



Difference between sensor and transducer.

Sensor	Transducer
1. Sensor is a device which detects the presence of the measurable quantity.	1. Transducer is a device which converts energy from one form to another.
2. It is the primary or first element of a measuring instrument.	2. It takes the output of the sensor and converts to suitable form for measurement.
3. Sensor, for its performance may not depend upon a transducer.	3. A transducer always depends upon a sensor before measuring the quantity.
4.	4.

A.2 Different types of transducers and concept of active and passive transducers

Transducers may be classified as —

1. Electrical transducers: The transducer which produces electrical energy at its output is an electrical transducer. The output may be in the form of voltage, current

or frequency etc.

2. Displacement transducers: These transducers convert mechanical displacement into electrical energy.

3. opto electronic transducers: These transducers converts optical (light) energy into electrical energy.

Concept of active & passive transducers.

Electrical transducers are the important and most popular transducers - which converts non electrical quantities like force, pressure, ~~dis~~ etc into electrical energy form. ~~and~~

Various classifications of electrical transducers-

(i) Active and passive transducers.

Active transducers developes their own voltage or current as the output. for this they obtain energy from the physical quantity to be measured.

Ex: thermocouples, piezoelectric transducers photovoltaic cell etc.

passive transducers dont develope output of their own and need an external power source for the purpose.

Ex: Strain gauges, thermistor, LVDT etc.

(ii) primary and secondary transducers.

primary transducers converts physical quantity under measurement directly into electrical output after sensing the quantity.

Ex: thermocouple.

Secondary transducers, in which physical quantity is sensed and is converted first into an analogous output, which is further converted into an electrical quantity.

Ex: LVDT used with Bourdon tubes to measure pressure.

(iii) Analog and Digital transducer

In Analog transducer the output is displayed in analog form.

Ex: Strain gauge & LVDT.

In digital transducer the of output is displayed in digital form.

Ex: digital multimeter, digital CRO

4.3 Working principle of photoemissive, photoconductive & photovoltaic transducers.

The photoelectric transducer absorbs the radiation of light which falls on their semiconductor material. The absorption of light energizes the electrons of the material and hence the electrons start

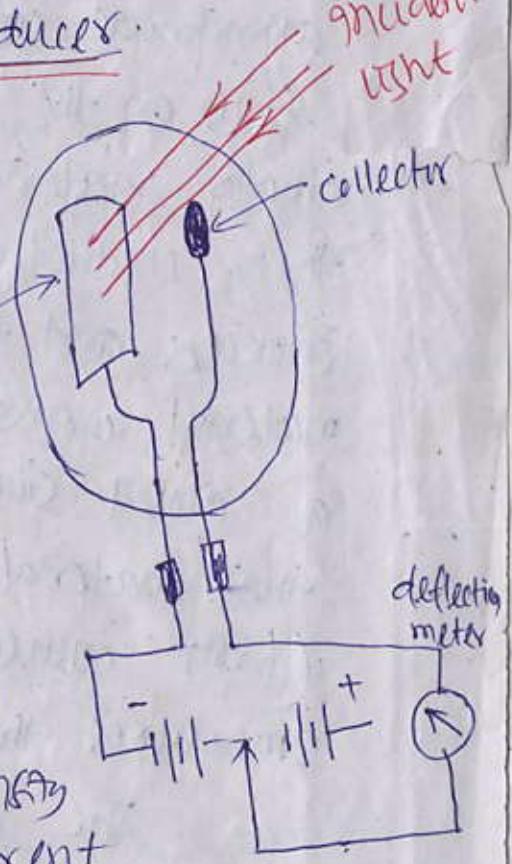
moving. The mobility of the electrons produces one of the 3 effects — (2)

1. The resistance of the material changes.
2. The output current of the semiconductor changes.
3. The output voltage of the semiconductor changes.

photoelectric transducers are of 3 types-

1. photoemissive transducer.

when light of appropriate intensity falls on the photo cathode (emitter) electrons are emitted. These electrons are collected by a highly +ve anode. Cathode is made -ve.

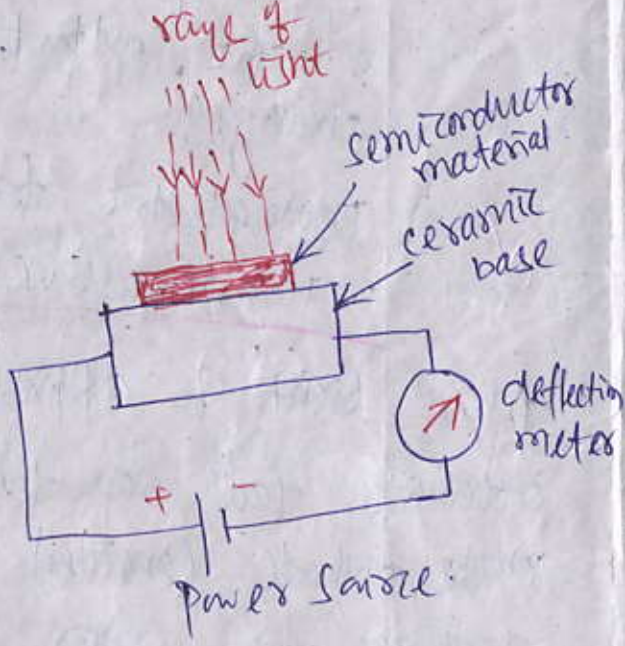


No. of electrons liberated is proportional to the intensity of light and produces current in the external circuit which can be measured by a meter.

Thus the measured current is a direct measure of the intensity of light.

photo conductive (cell) transducer

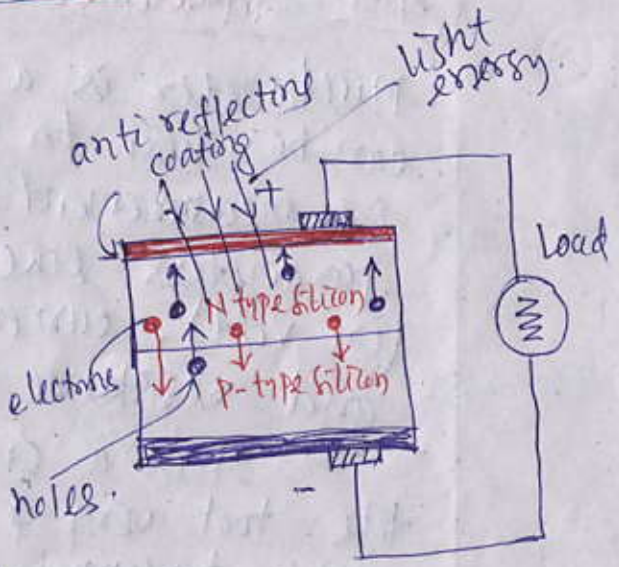
In a photo conductive cell, the conductivity (or resistivity) property of the semiconductor material is utilised. The semiconductor material like cadmium selenide, Ge, Se are used as photo sensing element.



when light of appropriate intensity falls on the semiconductor material, their conductivity increases and the material works like a closed switch. current starts flowing through the material which turns to be a conductor (from insulator) and the deflection meter measures the current.

The current is directly proportional to the increase in (change) conductivity or decrease in resistivity which is directly proportional to the intensity of light.

photovoltaic transducer



It is a type of active transducer in which a junction is made between a P-type and an N-type silicon material. Anti reflecting coatings are made over them and terminals are taken out. A suitable load is connected.

when light of appropriate wavelength (intensity) falls on the semiconductor material (both P & N types), they absorb light energy and converts it into heat energy. So holes from P type & electrons from N-type cross over the junction and conductivity increases in the form of current in the external circuit. with an appropriate load connected across the terminals, the entire arrangement can be utilized as a voltage source and so called a photovoltaic cell.

4.4. Multimeter and its application.

Multimeter is a measuring instrument which can be used for multipurpose measurements i.e, measurement of a number of electrical parameters like voltage, both ac & dc (in volt), current AC & dc (in ampere) and resistance (in ohm)

It is a small, handy and very versatile tool very much close to all maintenance personnel.

It can measure in units like Ampere (current), volt (voltage) and Ohm (resistance) therefore it is also called AVO meter.

It is available in analog or digital form. due to better accuracy and less error in reading and measurement now a days, digital multimeters are frequently used.

A multimeter (both analog and digital) has two selector switches on its front (face) panel.

1. Function selector ~~section~~ : This switch selects the function to be measured (like ac or dc voltage, ac or dc current and resistance).

2. Range selector : After a function is being selected by the function selector, the maximum range is selected (by guess) by the range selector. If the measuring quantity is above the range, then it will show overload, so that next higher range is to be selected

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Applications of multimeter.

1. As it can measure a number of electrical parameters (both in ac & dc circuits), it is used in almost all measuring purposes.
2. In trouble shooting of electronic appliances it plays a vital role.
3. In calibrating units, multimeters are used for calibration.
4. In electrical network analyzers or in electronic circuit analyzers, multimeters are used.
5. In maintenance and repair workshops/ workplaces multimeters are used.

4.5 Analog & Digital Multimeters.

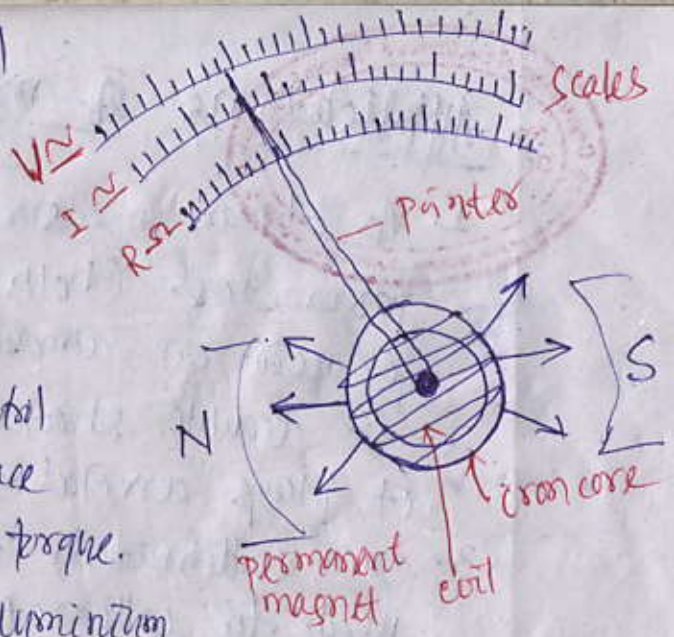
Multimeters are available in two forms
1. Analog multimeter 2. Digital multimeter.

The 3 basic parameters like current, voltage and resistance, which are measured by the multimeter, are actualy measured by measuring the voltage only, which is then converted to current or resistance as the relationship in Ohm's law $\boxed{V = I \cdot R}$.

construction of APMM

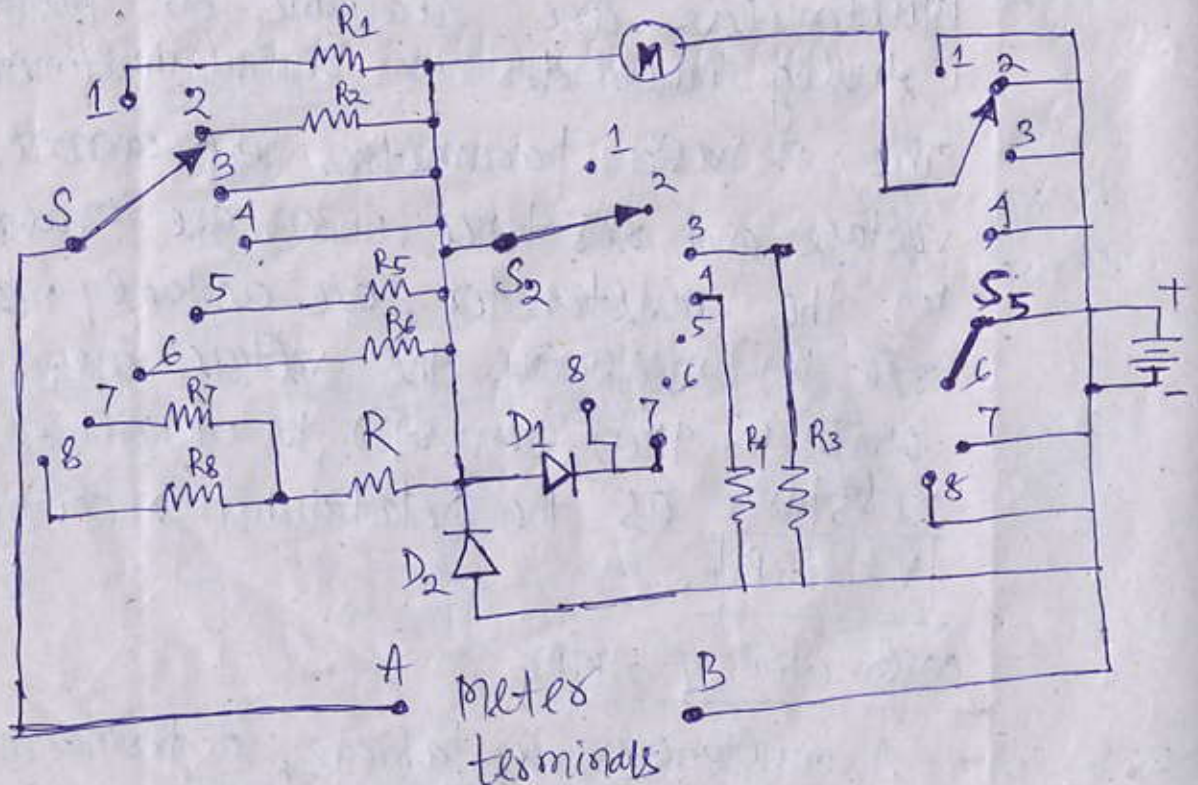
- A multimeter is basically a permanent magnet moving coil D'Arsonval meter.

- It has a coil wound on an aluminium former which can freely move in the field of a magnet.



- There are two control springs which produce controlling/restoring torque.
- With the coil an aluminium pointer is attached which moves on calibrated scale.
- The coil is mounted on a fixed iron core, which makes the magnetic field of the permanent magnet as radial within the air gap, in which the coil is to move.

Schematic diagram of AMM.



Measurement of dc current & dc voltage.

- In the fig (a) is shown the arrangement for dc current measurement when the function selector is on current (DC)
- any range of dc current can be measured by the universal ~~range~~ shunt AB.
- A no. of low resistances are connected in parallel with the meter, through the selector switch.

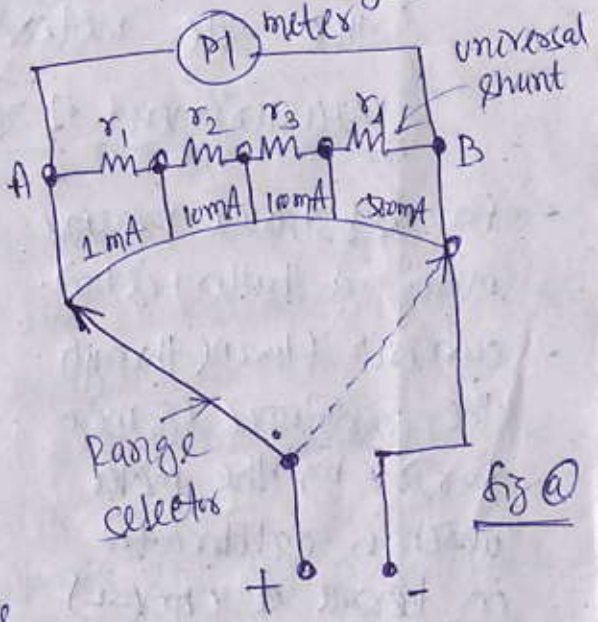


fig (a)

- In the fig (b) is shown the arrangement for dc voltage measurement - when the function selector is on voltage (DC) and the range selector is set to a particular range.
- A number of high resistance values are connected in series called the universal multiplier AB.

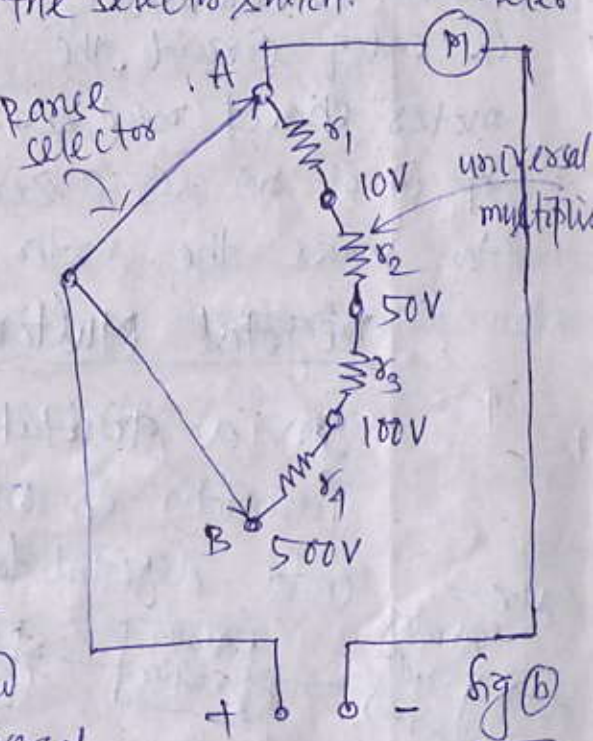
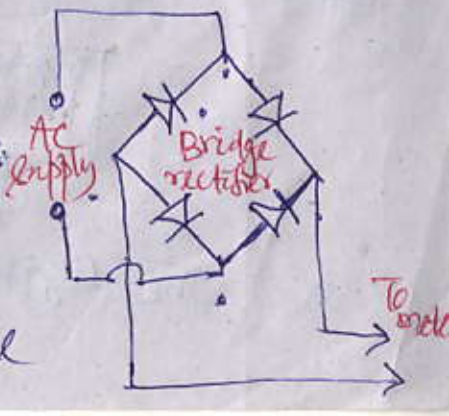


fig (b)

Measurement of ac current & voltage:

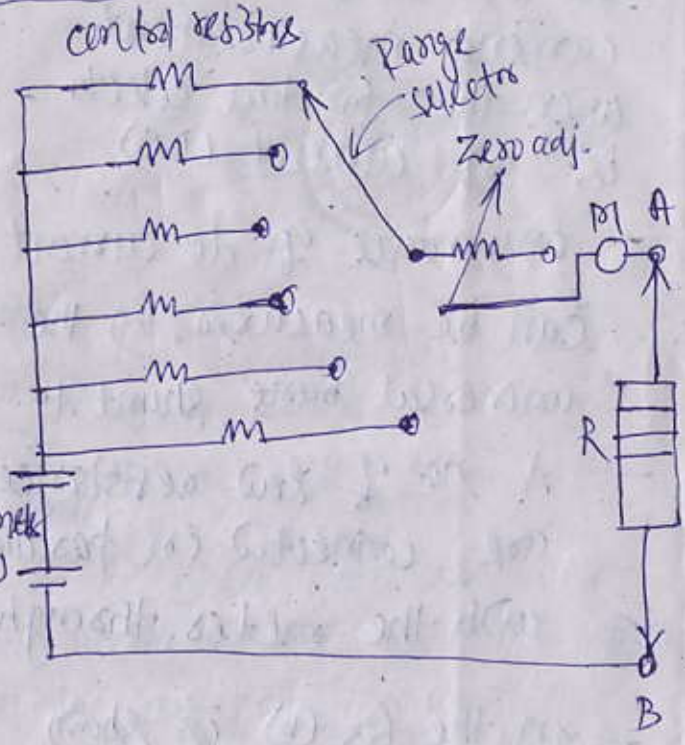
For measurement of ac current and voltage, a bridge rectifier is used to convert the ac value



into dc form and then it is measured by the dc meters.

Measurement of resistance

- For resistance measurement a battery is used.
- current flowing through the resistance is measured by the meter which is calibrated in terms of ohm(Ω)
- when the resistor under measurement is out of circuit, the meter should read zero.

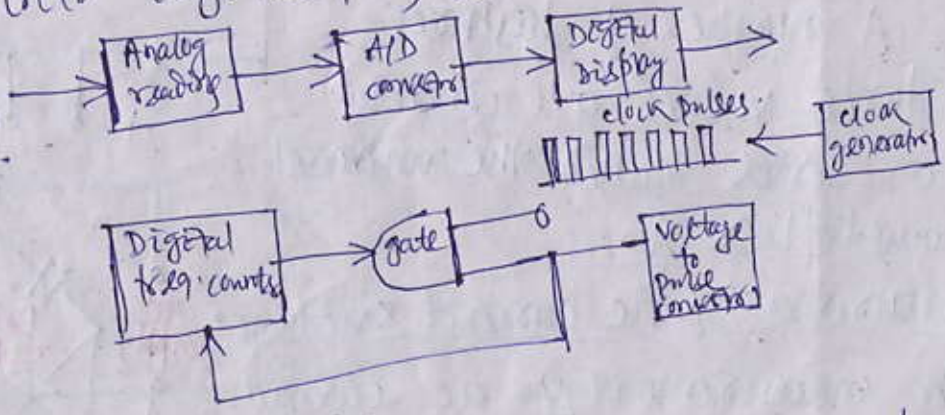


If it is not so, a zero adjustment resistor is used to make the meter zero, before measurement.

Digital Multimeter (DMM)

In a digital multi meter, the analog quantity is measured and then converted into digital form with the help of an ADC.

(ADC – Analog to Digital converter)



The digital multimeter contains three elements-

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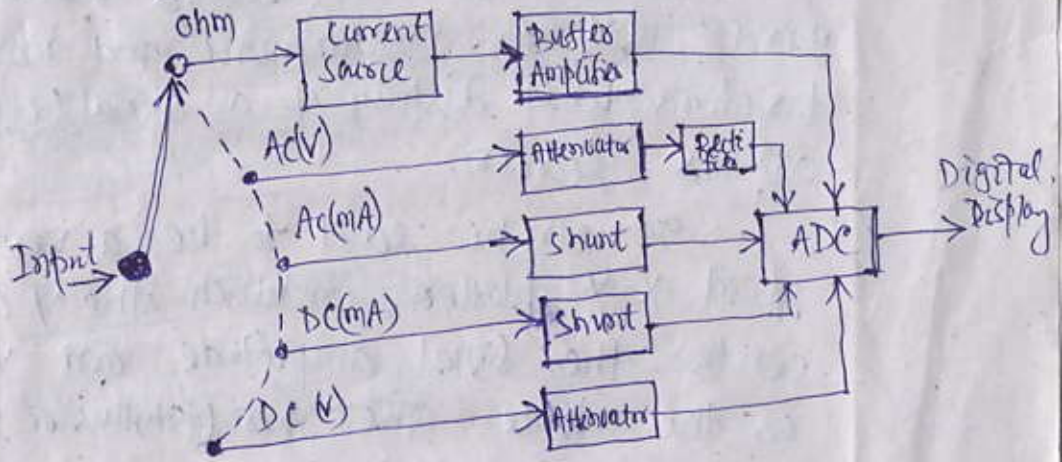
A digital meter contains 3 elements. (4)

1. clock generator which produces fixed freq. clock pulses.
2. A circuit which converts the quantity to be measured into pulses (where width is linearly proportional to the amplitude of the quantity).
3. A digital frequency counter.

Block diagram of Digital multimeter.

A digital multimeter is basically a digital voltmeter and may be used for measurement of dc/ac voltages, dc/ac currents & resistance. All quantities other than voltage is first converted into equivalent dc voltage. So the fig. is shown the block diagram.



Differences between A Meter & D Meter.

A Meter	D. Meter
① These display quantity in terms of deflection of a pointer on a calibrated scale.	① These instruments display a quantity in decimal number format.
② It has comparatively poor accuracy.	② It has much better accuracy.

③ Resolution is comparatively poor.	③ Resolution is very high.
④ Analog instruments consume large power.	④ They consume negligible power.
⑤ They load the circuit while measurement is made.	⑤ They don't load the circuit.
⑥ Simple in construction	⑥ Complex in construction
⑦ Less affected by environment	⑦ Greatly affected by environment
⑧ Suffer from parallax and other human errors	⑧ Free from human errors

4.7 Cathode Ray Oscilloscope (CRO)

CRO is the most versatile electronic equipment used for measurement and many other functions like display of a signal (its waveshape) on its screen.

It can be said to be a very high speed X-Y plotter, in which the Y axis represents the signal amplitude and X-axis is the time. The pen (stylus or needle) of this plot is the luminous spot which moves on the screen and draws the waveshape of the signal.

Block diagram of the CRO

Important components of a CRO are -

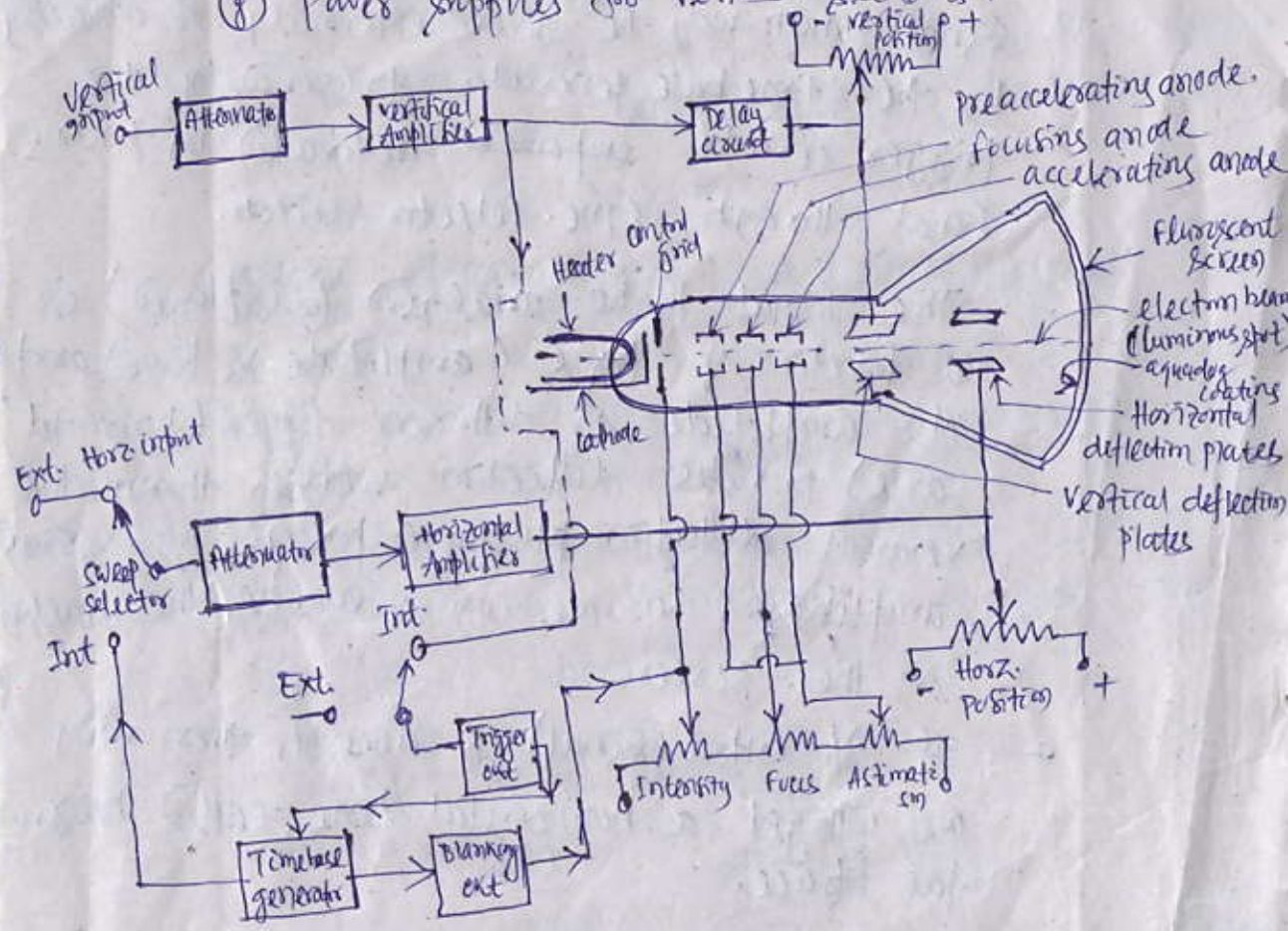
a) Electron gun assembly — consisting heater, cathode and control grid, accelerating and focussing anodes

b) Horizontal & vertical amplifiers and H/V deflection systems.

(e) Time base circuits, synchronizing circuits and blanking circuits.

(g) Astigmatism. (e) Attenuators (f) CRO probes

(g) Power supplies for various sections.



Block diagram of CRO:

working of CRO:

- An electron beam is generated from a cathode, heated by a heater. The surface of the cathode is coated with a material of low work function.
- control grid controls the flow of electrons in the beam
- The electron beam get accelerated by the pre accelerating and accelerating anodes and get focused on the centre of the screen by focusing anodes which are supplied with +ve voltages.

- The signal to be displayed (or analyzed) is called Y-input (or vertical input) is provided to the vertical amplifier and then to the vertical deflection plates.
- The X (horizontal input) is a sawtooth (time base) signal which may be given externally or internally by the time base generator triggered by the trigger circuit ~~empower~~ activated by taking signal through sync. selector switch.
- The signal to be analyzed (displayed) is a function of time (amplitude Vs time) and its amplitude at different times (horizontal axis) provides deflection voltages through the vertical deflection plates empowered by vertical amplifiers. So we can visualise the waveform on the screen.
- If Y input (signal) is absent, then only we will get a horizontal line, called horizontal trace.
- The electron gun assembly, deflection plate assembly are mounted inside a thick hollow cylindrical evacuated glass envelope (tube) called cathode ray tube CRT, terminated with glass cover called screen at one end and at the other end with pins for external power/signal connection.

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{Communicative English Notes as per Revised Syllabus 2018-Onwards 1st Sem & 2nd Sem}

Unit-I (a)

LITERATURE APPRECIATION

1. Reading comprehension

Reading is one of the most important skills for any student in any program. Students are required to read a variety of different texts and reading materials from novels to blue prints, labels to poetry (depending on your program!)

It isn't just a matter of reading words. Students need to be able to make sense of what they read, make inferences, communicate the information clearly to others, and more.

You can improve your reading skills by reading as much and as widely as possible; read newspapers, magazines, adverts, stories, poetry, song lyrics…Challenge yourself by learning new vocabulary or by reading something then repeating back (without looking) what you have just read.

1. **Tips to get started:**

- Look over the whole piece of writing. Notice its title.
- Notice its length.
- Read the first line of each paragraph to get an idea of how the writer has organized the piece.
- Read the first line of the last paragraph to get an idea of how it may finish.

2. **Read with concentration.**

Concentrate on the words **AND** the meaning of groups of words. If there are vocabulary words that are unknown to you, read the sentence and try to understand what is meant by the sentence, so that you can guess at the meaning of the word.

When concentrating is challenging, try these strategies:

- Read the questions **before** you read the piece. It may help to know what you are looking for!
- Read **out loud**. Your own voice can sometimes focus your mind **AND** eliminate outside distractions.
- Discuss the meaning **as if** you were telling someone else what you think it means. Sometimes having to express your thoughts can clarify them.

3. **Practice specific reading skills:**

- Skim reading for gist
- Scanning for necessary information.
- Recalling details/facts/information.
- Understanding main ideas.
- Making inferences

➢ **<u>Skim reading for gist</u>**

Skim reading can be a useful technique to have when researching. This skill involves reading a

longish text or parts of one in order to get the gist (the main idea) of what it contains. The aim is not to get a detailed understanding but rather an overview of a text that may be relevant to your enquiry. Open and skim read the whole text first and then skim each of the five sections it contains below. Use the questions to give your skim reading a purpose and to check that you have understood the gist. Then read the feedback. Open the hint if you would like some guidance on skim reading techniques first.

- **Scanning for necessary information**

Scanning consists of letting your eyes move quickly through the text until you find what you are looking for. As long as you know how the text is organised, this can be done quickly and without reading every word.

This is a technique many of us use every day. For example, I may scan the telephone directory to find a name. Or when I go to a restaurant, I scan the menu to find the vegetarian options.

Scanning texts is easy if you are familiar with their organisation. For example, I know that the menu of my favourite restaurant lists the main course under the heading 'Mains', so I scan this list looking for the word 'vegetarian', 'vegetable' or simply 'V'.

In academic texts information is often grouped under headings, so to find a specific detail, you need to first locate the appropriate heading. If there are no headings, remember that the topic sentence of each paragraph is like a heading, as it tells you what the paragraph is about. In a paragraph, details can usually be found in the sentences that follow the topic sentence so this is where you need to look.

When you think you have found the relevant section or paragraph, look for key words or figures.

- **Close reading for Inferences and Evaluation**

Sometimes when you are reading you must go beyond the printed word on the page, to what is hinted at or likely to be true, given the set of facts. Inferences can only be made when there are facts to back them.

Example: The old man staggered along the sidewalk, his torn, grey coat flapping in the wind.

You might **infer** that the man is drunk, but really the facts don't substantiate that inference. That would be a guess. It could be that the man has been mugged, that he is sick, or that he has had a medical crisis such as a heart attack. All of these could be the case, or some other explanation may be possible. Unless the facts support the inference, it could be incorrect.

You can make accurate inferences when you:

- think about all the ideas that are presented.
- think about the suggested or implied meaning of the words used.
- ensure they are supported by facts.

The following words in a reading may suggest you need to make an inference:

'implies that …"	'infers that …"	"might be described as…"
'indicates that …"	'seems to be …"	'can assume that
.."suggests …"	'probably …"	"can conclude that …"

- **<u>Understanding Main Ideas and supporting points</u>**

The **main idea:**

- is the most important idea in the passage.
- can be found at the beginning, in the middle or at the end of the passage.
- may be stated clearly or it may be implied.
- is supported by all the sentences in the passage.

- **<u>Guessing the meaning of unfamiliar words</u>**

- Start by quickly scanning the text. Look at titles, sub-titles, pictures etc. This prepares your brain to receive the information
- When doing multiple choice quizzes, read the questions first before reading the text – then you'll know what information you are looking for
- Try to **get interested** in the details (readers recall what they are interested in)
- Decide what is **most important** and what is probably not worth remembering (you can't remember everything)
- **Reread** if you need to
- Go back and reread **after** you have read the question

****

NOTE-MAKING

Notes are short written record of facts to aid the memory. Notes are usually taken to record a speech or dictation while listening to it or after reading a book, magazine or article. They are referred back whenever needed and may be reproduced in the desired way.

The necessity of note making

Knowledge is vast and unlimited, but our memory is limited. We cannot remember all the information all the time. Hence note-making is necessary. With the help of notes we can recall the entire information read/heard months ago. Note-making is quite useful to students preparing so many subjects. At the time of examinations, it is not possible to go through voluminous books. At such critical times, notes are quite handy. Hence note-making fulfils three useful functions:

1. It keeps a lot of information at our disposal for ready reference.
2. It helps us reconstruct what was said or written and thus accelerates the process of remembering/recall. .
3. It comes in handy in delivering a speech, participation in a debate/discussion, writing an essay and revising lessons before an examination.

How note making helps us

While making notes we do not simply read the passage/listen to speech but consider various points made by the writer/speaker and draw our own inferences about what is being presented. Thus note-making helps us in understanding the passage in a better way and organising our thoughts systematically.

Characteristics of good notes

1. Short and Compact: Good notes must be short and compact.
2. Complete Information: They must contain all the important information.
3. Logical: They must be presented in a logical way.
4. Understandable: They should be understandable when consulted at a later stage.

Mechanics of note making

While making notes we follow certain standard practices. These may be listed as follows:
(a) Heading and Sub-headings
(b) Abbreviation and Symbols
(c) Note-form
(d) Numbering and Indentation

Heading and sub-headings

The heading reflects the main theme whereas the sub-headings point out how it has been developed. The selection of proper heading and sub-heading reveals the grasp of the passage by the students. In the absence of proper assimilation of main ideas and subsidiary points it is impossible to make notes.

(*c*) **Short forms.** Taking first and last letters

e.g.	bk	for	book	Pt	for	Point
	Dr	for	Doctor	retd	for	Retired
	dft	for	draft	relgn	for	Religion
	Dept	for	Department	rec'd	for	received
	estd	for	established	shd	for	should
	ft	for	foot/feet	Std	for	Standard
	Govt	for	Government	Stn	for	Station
	Ltd	for	Limited	Secy	for	Secretary
	Mr	for	Mister	Wt	for	Weight
	Ms	for	Miss/Mrs	Yr	for	Year
	Org'zn	for	Organization	Yd	for	yard

(*d*) **Some other contractions**

e.g.	A/c	for	account	edn	for	education
	bldg	for	building	kg	for	kilogram
	bks	for	books	m	for	metre
	can't	for	cannot	N/A	for	not applicable
	civil'zn	for	civilization	rdng	for	reading
	cm	for	centimetre	shan't	for	shall not
	C/o	for	care of	won't	for	will not
	MS	for	manuscript	M/S	for	messers

USE OF FULL STOP IN AN ABBREVIATION

(*a*) Often a full stop is put after an abbreviation which does not end with the last letter of the word; such as

Col.	for	colonel	Co.	for	company
Div.	for	division	info.	for	information

(*b*) The abbreviations that end with the last letter of the word do not require any full stop at the end, such as

Govt	for	government	Mr	for	Mister
Ms	for	Miss	Pt	for	Pandit
Dr	for	Doctor	Wrt'g	for	writing
10th	for	Tenth	Wt	for	weight

Note. Confusing abbreviations should be avoided, e.g., the abbreviation 'under' may stand for understand, understood and understanding. Similarly 'indst' may stand for industry, industrial, industrious.

Note-Form

While making notes the whole information is listed in note-form in points only. Notes should not be written in complete sentences as we can't remember the whole information. So only the main points are listed one under the other and numbered.

It implies the logical division and sub-division of the listed information by using figures, letters, dashes and spaces.

All examples and figurative speeches are eliminated.

Numbering and indenting

Indentation

Indentation means leaving space at the beginning of a line of print or writing.First write the title and then write down the notes in a logical order. From the main headings to the sub-headings, the numbering should be spaced a little to the right.

Main Sections : 1, 2, 3, 4, etc..
Sub Sections : (*a*), (*b*), (*c*), (*d*), etc.
Sub-sub sections : (*i*), (*ii*), (*iii*), (*iv*), etc.

Indented Format

1. .....
   (*a*) .....
      (*i*) .....
      (*ii*) .....
   (*b*) .....
   (*c*) .....
      (*i*) .....
      (*ii*) .....
      (*iii*) .....

or you may use **Decimal System**
Main Sections : 1, 2, 3, 4, etc.
Sub Sections : 1.1, 1.2, 2.1, 2.2, 2.3, etc.

Sub-sub Sections : 1.1.1, 1.1.2, 2.1.1, 2.1.2, etc.

Indented Format

1. .....
   1.1 .....
   1.2 .....
2. .....
   2.1 .....
   2.2 .....
      2.2.1 .....
      2.2.2 .....

CONCLUSION

Conclusion
Note-making is a useful skill. You must develop it with constant practice..

How to write note making

Follow the following steps:

Step 1: (i)Read the passage carefully.

(ii)Try to get the theme and subject of the passage. You may ask yourself: "What is this passage about?" This will provide you the gist.

Step 2 : Read carefully. Identify main ideas and important supporting details.

Step 3 : Make notes of the main ideas under headings and add sub-points under sub-headings.

Step 4 : Use proper layout/format, e.g.,

(a) Indented, linear form

(b) Sequential form

(c) Tabular form

(d) Flow chart

(e) Pie chart, graphs or diagrams, etc.

Step 5 : Use recognisable abbreviations wherever possible

SUMMARY WRITING

What is a summary?

A summary is a record in a reader's own words that gives the main points of a piece of writing such as a newspaper article, the chapter of a book, or even a whole book. It is also possible to summarize something that you have heard, such as a lecture, or something that you have seen and heard, such as a movie. A summary omits details, and does not include the reader's interpretation of the original.

You may be used to reading English in order to answer questions set by someone else. In that case, you probably read the questions first and then read the passage in order to find the correct answer. However, when you read in order to write a summary, you must read in order to decide for yourself what the main points are. This involves reading to understand the message that the writer has for the reader, rather than reading in order to get the correct answer to someone else's questions. Since people have different backgrounds and read for different purposes, it is possible that different readers will interpret a writer's message in different ways. Even if they agree, they will probably write their summaries in different ways. In other words, there is unlikely to be only one "correct" summary. On the other hand, to write a summary it is necessary to understand a passage as a whole, and therefore at a deeper level, than when one's purpose is just to answer questions.

When are summaries used?

1. In general terms, writing summaries is a good way of improving one's ability to read because it forces the reader to focus on understanding the whole of something rather than on just following each word or sentence.

2. In academic terms:

a) If you are reading something that is very important for your studies and/or difficult to understand, writing a summary helps you to make sure that you have understood it. You can also refer to it later to refresh your memory, for example when you are revising for an exam, or when you are talking about it in class. (It is also a good idea to turn lecture notes into summaries.)

b) When writing academic papers people often need to insert summaries of something that they have read or heard. For example, you might want to summarize the the main points of a book that is relevant to your topic. In such cases, it is extremely important to use your own words, or quotation marks if you are actually quoting, in order to avoid plagiarism. (We will talk more about plagiarism later in the course.)

STEPS IN WRITING A SUMMARY

1. Make notes of the article

Make notes of the article first, usually in examinations like that conducted by CBSE, you'll be asked to write summary using your notes.

2. Complete the sentences from your notes

Take each subheading of your notes, and complete the same sentences. Make sure your completed sentences are grammatically correct.

3. Add more points from the main article

After completing sentences from your notes, you may add some other important points from the main article which you feel would add value to the summary.

4. Trim down the summary to fit word limit

Now trim down little tid-bits from the draft summary you made so as to fit into the word limit. Usually, you can limit the words to 1/3rd of the actual word count of the article.

Precautions to be taken while writing summaries.

1. Use normal English in summaries, just the way you write essays, articles, etc. Never have incomplete sentences like those in Telegrams, notes, etc.

2. Avoid long sentences, make short but complete sentences.

3. The entire paragraph should gel well when read. It shouldn't appear disjointed.

4. Avoid lifting-off exact sentences from the article as it'll make your summary longer. Rather, rephrase the same sentence in your own words.

5. Do not write summaries directly from the article. Make it only from the notes you made. You've already worked hard to strip useful content from the article in note making. This will save your precious time while summarizing.

6. Never jump the word-limit; always stick to a word-limit of 80-100 words for an article of around 450 words.

SUPPLY A SUITABLE TITLE

A good **title** contains the fewest possible words that adequately describe the contents and/or purpose of your research paper. The **title** is without doubt the part of a paper that is read the most, and it is usually read first. ... On the other hand, a **title** which is too short often uses words which are too general.

Things to note before choosing TITLE of a passage:

1.Remember that you have been asked to choose the "most appropriate" title among the given options, not what you may consider to be the "best" or "perfect" title for the passage. What this also indicates is that if you can eliminate some options as inappropriate for one reason or another, you could possibly arrive at the correct answer.

2.Title must not only cover the core idea (the content) of the passage, but should also express the author's tone. For example, consider a title that says "The dismal state of Indian hockey". From this, you immediately not only realize that the passage will talk about the sport of hockey, but also know what the author's feelings or tone would be towards the current state of affairs. This is due to the usage of the adjective "dismal".

3. The title you mark as the correct option should be neither too broad nor too narrow in scope. Too 'narrow' titles may focus on only a couple of paragraphs of the passage and not the passage as a whole.

4. Remember that a title is like a common theme that runs through the passage i.e. it integrates the various ideas or issues discussed.

5. A title is not a conclusion. This is a mistake that students commonly make. The title is not meant to reflect the conclusion (inference) rather; a title summarizes the author's ideas or points succinctly & must come from what is directly stated in the passage.

Unit-I (b)

Standing Up For Yourself

By Yevgeny Aleksandrovich Yevtushenko

Yevgeny Aleksandrovich Yevtushenko (18 July 1933 – 1 April 2017) was a Soviet and Russian poet. He was also a novelist, essayist, dramatist, screenwriter, publisher, actor, editor and director of several films.

This text is basically an excerpt taken from his autobiography A Precocious Autobiography. In this prescribed text, the narrator is an adult narrating his childhood experiences. The narrator has both happy and unhappy experiences in his childhood. His parents were divorced. His mother left him. These circumstances made him lonely. The street becomes his teacher. He cultivated all bad habits. Another good habit he developed was the spit of fearlessness which he has kept intact till today.

The narrator's father lived somewhere in Kazakhstan with his new wife and their two children. Seldom he got letters from his father. In short, there was no genuine relationship between father and son. His mother spent his time in singing and giving entertainments for the troops. After divorce, his father lived with his new wife and his mother spent time in singing and giving entertainment for the troops. As a result, he became lonely and the street became his master. It taught him both good and bad habits. The two habits that remained with him all his life were his preparedness to face the battle of life any moment and the spirit of fearlessness. Ans. In my opinion the best lesson that the street taught to the writer was habits of fearlessness. It taught him not to be afraid of anyone.

His big and broad shoulder made Red look older than he really was. He roamed carelessly in the street with legs wide. He walked like a seaman on the floor of a ship. He dressed himself in a peculiar manner. He put on a cap. From under his cap, the writer noticed its peak at the back of his head. A villain as he was, Red intentionally dressed and walk in the manner described. His lieutenants also

wore their cap back to front, because they, like Red wanted to evoke fear in everyone's mind When we read the expression 'tripped at his heels', the pet animal that comes to my mind is a dog. His way of forcing money out of other boys was to stop them and say simply but firmly the one word 'money'. He ruled the street by stopping any boy and saying simply but firmly nothing but the one word 'money'. His hangers-on emptied his pockets, and they beat him ruthlessly in case he resisted. The narrator was certainly afraid of Red.

. The first thing that the narrator did to overcome his fear of Red was to write a poem about him.. The people in the street learnt the poem by heart. They were filled with great joy and excitement. Their hatred for Red ruled the roost. The narrator's poem about Red filled the people in the street with great joy and excitement. They gave up their fear of Red and expressed their hatred for him with great satisfaction. Red addressed the narrator as a poet slowly with a mischievous smile on his face. He commented sarcastically that at last he wrote verses and asked if they rhymed. Ans. Red struck the narrator's head with a metal knuckles duster. As a result, he fell down with blood gushing out of his head and lost consciousness. He was confined to bed for several days. This was the result of his first encounter with Red. The narrator was not happy at all with his reward as a poet. A more difficult situation for the narrator was to overcome his fear when he saw Red after his injury. The result of his second encounter with Red was his determination to defeat fear of Red despite suffering shame and experiencing futile anger at his cowardice.

To grow stronger, the narrator trained himself with a pair of parallel bars meant for gymnastic exercises.Besides,he resorted to weights. He got a text-book on ju-jitsu in exchange of a week's ration card..He trained himself for three weeks before the final encounter with Red..The final encounter took place on the lawn in their yard, when Red was lost in playing a card game called vingt-et-un with his hangers-on. The narrator kicked and scattered cards played by Red and his lieutenants. Red reacted to the narrator's attack in a state of surprise and asked him mockingly if he was looking for more. .The narrator tackled Red by making a fast sudden blow to him. Confused, he came towards the former furiously. The narrator cut him to size by catching his wrist and squeezed

slowly. Crying loudly in pain, Red rolled on the ground. His fingers suffered injuries. The narrator made him sob and rub the tears over his small-pox-marked face with his dirty fist. At the end, Red stopped himself to be the monarch of the street after this incident and the narrator learned that for every strong man there is a special Ju-Jitsu and he chose the profession of poet at the end simultaneously he also learned to stand up for himself in his life.

Think it out 1..

1.The writer is an adult while he narrates his childhood experiences.

2.The narrator did not have a happy childhood. After his parents divorced, he was left to fend for himself. He lived virtually in the streets, and his education was in tatters.

3.He had no contact with his father after his parents were divorced. His father working in far-off Kazakhstan never wrote him a letter.

4.The narrator's mother, who used to be a geologist, resigned from her job. She became a singer giving concerts for soldiers.

5.The statement, "My education was left to the streets' implies that he had no access to a decent education. Instead, he spent his time in the streets exposed to the coarseness and criminality of street kids.

6.In my opinion the best lesson the street taught him was to overcome his fear of those mightier than him.

Think it out 2..

1. Scars from daily fights and constant battle with the odds of streets had robbed him his childlike innocent look. He had big and broad shoulders which made him look so much older than his age of 16.

2. He had two or three younger accomplices who acted as his aides in his criminal assaults on innocent passers-by. They hung around Red and helped him in looting the victims.

3. Red wore a cap that was swept backwards. His hair in the front fell out of the cap.

4. Perhaps, he purposely dressed and walked so menacingly, so that he could instill fear in others.

5. The lieutenants were his comrades who formed the gang. In order to show their solidarity with Red, they too wore their caps in similar manner.

6. A dog is the pet that follows its master as loyally as the lieutenants followed Red.

7. Red used to accost a pedestrian, utter the word 'money'. His lieutenants then subdued the victim by force and empty his pocket of any cash.

8. He resorted to intimidation and force to counter anyone who came in his way. If necessary, he would use his knuckle-duster to do bodily harm to the stranger.

9. Yes, initially he was. He said, "Everyone was afraid of Red. So was I." Later, he overcame his fear through determination.

Think it out 3..

1. In order to overcome his fear of Red, the narrator wrote a poem about him.

2. The people in the street were thrilled by the poem's sarcasm.

3. By triumphant hatred, it means that the poem had the desired effect of irking Red, the bully everyone disliked. They rejoiced at the annoyance of Red.

4. Red sneered at the narrator saying that he writes the verses & asked if they rhyme.

5. In his first encounter with Red, the narrator got badly injured as he was struck on his head by Red's knuckle duster.

6. No, the narrator says this cynically.

7. For narrator, overcoming the fear of Red was more difficult.

8. In the second encounter, the narrator didn't even dare to go in front of Red & felt too ashamed because of this.

Think it out 4..

1. In order to be stronger, the narrator trained with parallel bars and weight that made his muscles stronger. He also practiced a Japanese method of wrestling called ju-jitsu from a book. This technique enabled a person to effectively take on another much stronger foe.

2. The narrator got a textbook on ju-jitsu by forsaking a week's ration entitlement towards the cost.

3. Before his final encounter with Red, the narrator trained for three weeks. He practiced the new method with two boys.

4. The final encounter took place in the community yard where the narrator lived. Red was engrossed in playing vingt-et-un with his friends by sitting on the lawn.

5. The narrator had decided to confront Red frontally. The narrator went up to Red & defiantly kicked and scattered the cards he was playing with.

6. Red was surprised by the audacity and belligerence of the narrator. He sprang to his feet to counter the narrator.

7. The narrator lunged forward and gave Red a hard blow which left him seething in pain.

8. Clearly, Red found the narrator too skilled and strong to counter. He had to drop his knuckle-duster when the narrator squeezed his wrist.

9. During his last encounter with Red, the narrator learned that he need not fear a person way too stronger than him. The stronger adversary can be neutralized by suitable fighting skill.

10. The narrator prepared himself to be a poet.

11. True: Courage means conquering fear. Timidity before a stronger foe only emboldens him. So, the right approach is to take him head on.

STOPPING BY WOODS ON A SNOWY EVENING

By

Robert Lee Frost

Robert Lee Frost (March 26, 1874 – January 29, 1963) was an American poet. His work was initially published in England before it was published in America. Known for his realistic depictions of rural life and his command of American colloquial speech,[2] Frost frequently wrote about settings from rural life in New England in the early twentieth century, using them to examine complex social and philosophical themes.

Frost was honored frequently during his lifetime and is the only poet to receive four Pulitzer Prizes for Poetry. He became one of America's rare "public literary figures, almost an artistic institution."[3] He was awarded the Congressional Gold Medal in 1960 for his poetic works. On July 22, 1961, Frost was named poet laureate of Vermont.

Written by Robert Frost, this poem was published in 1923. It was written to capture the conflict between man and nature and also to highlight the difference between wishes and obligations we face in our lives. However, it has become one of the most popular poems in English literature.

As the poem is about nature, it has been written from the perspective of an adult, who stops by the woods to enjoy the mesmerizing beauty of nature. The expression of stopping given in the first stanza continues until the traveler decides to restart his journey. The expression of not knowing the woods and then realizing one’s duties mark the central point of the poem. However, what stays in the minds of the readers is the eye-catching and bewitching beauty of woods in the snowy evening. The speaker thinks about who owns the woods that he or she is passing through, and is fairly sure of knowing the landowner. However, the owner's home is far away in the village, and thus he is physically incapable of seeing the speaker pause to watch the

snow fall in the forest.

The speaker thinks his or her horse must find it strange to stop so far from any signs of civilization. Indeed, they are surrounded only by the forest and a frozen lake, on the longest night of the year.

The horse shakes the bells on its harness, as if asking if the speaker has made a mistake by stopping. The only other sound besides the ringing of these bells is that of the wind and falling snowflakes, which the speaker likens to the feathers of goose down.

The speaker finds the woods very alluring, drawn both to their darkness and how vast and all-encompassing they seem. However, the speaker has obligations to fulfill elsewhere. Thus, though he or she would like to stay and rest, the speaker knows there are many more miles to go before that will be possible.

THE INCHCAPE ROCK

BY

ROBERT SOUTHEY

Robert Southey (/ˈsaʊði/ or /ˈsʌði/;12 August 1774 – 21 March 1843) was an English poet of the Romantic school, one of the Lake Poets along with William Wordsworth and Samuel Taylor Coleridge, and England's Poet Laureate for 30 years from 1813 until his death in 1843. Although his fame has been eclipsed by that of Wordsworth and Coleridge, his verse still enjoys some popularity.

About the Poem

The Inchcape Rock by Robert Southey is a ballad that tells us about the legends of the Inchcape Rock, a reef in the North Sea about 18 km off the east coast of Angus, Scotland.

The story is about the good Abbot of Aberbrothok and the devilish Sir Ralph the Rover. The Abbot achieved the great feat of installing a bell on the dangerous Inchcape rock that had previously caused many shipwrecks. His bell rang during the storms and issued an alert for the passing ships. So, the seamen knew where the rock is and could avoid the danger of an accident. They blessed the Abbot for his good work.

But it was the Rover who felt jealous at the fame of the Abbot and planned to cut down the bell from the Inchcape rock. And so, he did. This Ralph the Rover was actually a sea-pirate. So he needed to destroy the bell to accomplish his desire to rob more ships by putting them in danger. But finally, he himself was the victim of the Inchcape rock. One day his ship was left in the midst of storms, lost the direction and crashed against the rock. Thus, the Rover was punished for his

sinful work. Here the poet Robert Southey delivers a message through his poem: As you sow, so shall you reap. So, the poem The Inchcape Rock is didactic in nature like most of.

Stanza-wise Summary & Explanation

In the first stanza of the poem the poet describes the calmness of the sea. The air, the sea, the ship – all were still. The sails of the ship were getting no motion from the wind. Its keel was steady in the ocean.

The second stanza describes the mild sea waves. The waves were rising and falling so little that they did not make any sign or sound. The waves were gently flowing over the Inchcape Rock without moving or ringing the bell.

The third stanza is about the bell. The 'good old Abbot of Aberbrothok' positioned the Inchcape bell there on the Inchcape Rock. During the storms it floated on a buoy and rang wildly swung by the high tides to alert everyone that the dangerous rock was there.

In the next four lines, the poet tells us how the bell guided the mariners in the bad weather. The seamen could not see the Rock as it stayed hidden under the high waves during the storms. But they could hear the ringing bell and went away from the perilous (dangerous) rock. So the bell saved their lives. Then the seafarers blessed the Abbot for his good job.

The fifth stanza delivers a cheerful atmosphere, as it generally happens before every disaster. On a particular bright day everything looked joyful. The sea-birds were whirling over the sea and screaming in joy.

In the sixth stanza of the poem Sir Ralph is introduced for the first time. On that fine day, the buoy (an anchored floating sign to show the reef) on the Inchcape Rock was clearly visible, as it was a blackish spot in the green ocean. Sir Ralph the Rover went onto the deck of his vessel and gazed at dark spot of the buoy. The next stanza deals with Ralph's feelings and thoughts. He was delighted at the good spring atmosphere. He was making whistling sounds and singing in joy. He was actually overjoyed. But no one knew that a sinful thought in his mind was behind this happiness.

In the eighth stanza the Rover himself speaks and reveals his desire. His eyes were fixed on the floating buoy on the Inchcape Rock. Sir Ralph the Rover ordered his crew to take the boat to the Inchcape Rock. Then he says that he is going to plague (kill or destroy) the good work of the Abbot of Aberbrothok.

The ninth stanza describes that the Rover's men took the boat to the Inchcape Rock. There he bent over the boat and cut the bell from the Rock.

The next stanza pictures how the bell was sinking down making the bubbling sound. Bubbles rose and burst around. Sir Ralph was happy thinking that the bell would save no more ships and the seamen would no longer bless the Abbot.

Sir Ralph the Rover then sailed away from the rock. Thereafter he had robbed and looted many ships which met accidents crashing to the Inchcape Rock. He is now a rich man with all the looted treasures. And today he is going to the Scotland shore with his ship.

The twelfth stanza describes the gloomy atmosphere on the day the Rover is sailing to Scotland. The sun is hidden behind the thick fog. Strong winds were blowing all the day, and now, in the evening it has stopped blowing.

The next four lines continue the gloom. The Rover is now on the deck of his ship. They can't see land as it is very dark. Sir Ralph assures that the moon will appear soon and so there will be light.

In the fourteenth stanza one of Ralph's men says that he hears the roaring sound of the waves breaking against something. So, he hopes they should be near the shore. He also regrets that the

Inchcape Bell is no more, as it could guide them in this situation.But no sound was there. The tides were strong. The Rover and his team are drifting along with the ship. Suddenly the vessel gets a jerking. They all realize that the vessel has hit the Inchcape Rock.

Sir Ralph the Rover pulls his hairs in frustration. He curses himself for his evil deeds. Meanwhile the water fills in every corner of the vessel and it starts sinking in the sea.

In the last stanza of the poem as the Rover is dying, he hears a sound like the ringing of the Inchcape Bell. It was actually his death knell that the Devil himself was ringing beneath the water.

Thus, the Rover gets punishment for his sinful works. Robert Southey is a poet who always delivers a teaching through his poems. This too is not an exception.

To my True Friend

by

Elizabeth Pinard

This poem is about my best friend. Though we are far apart, she will always be the most important person in my life. She was always there for me, there to encourage me, there to comfort me. She was my biggest supporter in both the good and the bad. She helped me find self-acceptance and she showed me how wonderful loving others unconditionally is.

We were at boarding school together until November 1999. Sadly we don't live close by each other so I haven't seen her in a long time. I cherish my memories of her so much. I will never give up hope that our paths are destined to cross again. She was the sweetest part of my life for so long, I miss her positive outlook on life, her ready smile and most of all the way she genuinely cared about me. She will always have a special place in my heart.

In London in minus fours

By

Louis Fischer

Think it out 1

Answer 1.. .. Gandhi represented the voice of large sections of Indians. His charm and personality made him eminently qualified to represent India in the Round Table Conference. So, he was chosen as the sole representative of Congress in the London Conference.

Answer2 . .. Gandhi made his way into the hearts of the poor Londoners by his jovial nature and his disarming modesty. During his morning strolls, he charmed everyone whom he encountered on the way through his smiles and greetings. Even the children were attracted to him. At times, Gandhi used to call on people at their homes. The rapport he built with the British endeared him to one and all.

Think it out 2

Answer 1.. .. To the journalists question about his scanty dress, Gandhi replied saying that they wore 'plus-fours', where as he wore'minus-fours'.

Answer 2 ….Gandhiji wore his usual frugal dress even while going to meet the King. He wore a loincloth, sandals, and a shawl. His dollar watch hung from his waist.

Answer 3. ..Gandhi had a ready repartee who asked him if he was properly dressed for his meeting with the King. Gandhi quipped that the King had enough clothes on his body for both of them.

Answer 4 ..Gandhi enjoyed himself in London by meeting many famous personalities like Lord lrwen, David Lloyd George, Marshal Smuts, Bernard Shaw. He also had some public meetings. However, Winston Churchill refused to see him.

Answer 5 ..Gandhi's idea was to completely severe all links of India with the British colonial authority. However, he was not in favour of cutting off relations with the Britain. To this end, he wanted India to remain in the Commonwealth as a free nation rubbing shoulders with the British government in equal terms.

Answer 6 .. By ‘creative independence’, Gandhi visualized a free India. Freedom had to foster love, friendship, work, progress, prosperity, unity, and security for the independent people. Freedom for namesake was not what Gandhi wanted.

Think it out 3

Answer 1. Gandhij’s qualities like charm, frankness, humility, and accessibility turned his opponents into his friends.

Answer 2 ..Gandhi remained steadfast on his noble principles. He never allowed jealousy, vengeance or rivalry to creep into his mind. He was fair and honest with both friend and foe alike. His life was open and transparent. He readily apologized for the smallest discourtesy to anyone. Thus, he won many friends even among those whom he criticized.

Answer 3 ..Mahatma Gandi’s work outside the Round Table Conference was to convince the people about the genuineness of India’s sorrows and her craving for freedom.

Answer 4 ..The second Round Table conference failed as Lord Reading stubbornly refused to give any tangible relief to India with regard to the demand for freedom. Lord Reading reiterated that Britain would continue to colonize India.

Answer 5 ..Mr. Gandhi built a rapport with the Scotland detectives by treating them equally and in the friendliest way. He visited their homes. He didn’t maintain any distance with them during public appearances. On returning to India, he sent them two watches as his personal presents.

The Magic of Teamwork

By

Sam Pitroda

Introduction:

-The key problem in India is always implementation, not lack of policies. We have great policies and ideas about how to do things, but somehow things don't get done. The main prerequisite to successful implementation is teamwork, and yet I find this severely lacking in the Indian way of working.

When the Japanese came to work in India to develop the Maruti Suzuki car, a joke went around that one Indian was equal to 10 Japanese: Indians were very smart, capable and dedicated individuals. But 10 Indians were equal to one Japanese: Indians lacked team spirit and cooperation. And that truly sums up the situation regarding our team skills.

What makes matters even worse is our "crab" mentality - if someone is trying to climb higher and achieve more, the others just drag him down. The signal that the others send out is, "I wouldn't do it; I wouldn't let you do it; and if by chance you start succeeding, we will all gang up and make sure that you don't get to do it."

The question is: Where does this attitude come from, and how do we recognize and handle it?

1.Hierarchical System

Part of the problem is our cultural background. We've had feudal and hierarchical social systems, where people look at one person, as opposed to a group of people, for all the answers - the father, in the case of the family, and the boss, in the professional world. In this system, whoever is senior supposedly knows best. This was fine in earlier times when knowledge and wisdom were passed on orally; but in modern society, there is no way that one person can know everything. Today, you may find that a young computer-trained person has more answers for an accounting problem than a

senior accountant has. Until we understand how best to leverage this diversity of experience, we will not be able to create and fully utilize the right kind of teams.

In my younger days in the US, I attended an executive seminar for Rockwell International, where about 25 senior company executives had congregated for a week of strategic discussion. In the evenings, we would break out into five different groups of five people each. In those group workshops, someone would delegate tasks, saying: “You make coffee; you take notes; you are the chairman; and you clean the board.” The next day, there would be different duties for each group member. No one ever said, “But I made coffee twice.” I thought to myself, if this were happening in India, people would be saying, “But I’m the senior secretary - why should I make the coffee and you be the chairman?” Hierarchy comes naturally to our minds.

2.What Derails a Team?

Group work requires a thorough understanding of the strengths and weaknesses of individuals irrespective of their hierarchy. Because of our background, we often don’t learn how to exercise and accept leadership - to lead and to follow - simultaneously. Some gravitate toward exercising leadership, and others gravitate toward accepting the lead of others. But in true teamwork, everyone needs to do both. Being a good team player implies respect for others, tolerance of different points of view and willingness to give. The ability to resolve conflicts without either egotism or sycophancy is a very important aspect of being a team player: You have to agree to disagree.

I find that people in India somehow tend to focus on achieving total agreement, which is almost always impossible. So before work begins, people want everyone to agree on everything. Instead, they should say, “OK. This is what we agree on, so let’s start working on this. What we don’t agree on, we will resolve as we go along.” For things to move forward, it’s important to work on the agreed-upon aspects and not get bogged down in the areas of disagreement.

Yet another snake that kills teamwork is people’s political agendas. You’ve got to be open, clear and honest to be a good team player. Most people though, have a hidden agenda - they say

something but mean the exact opposite. I call it “split-level consciousness.” To say and mean the same thing is a very critical part of a good work ethic.

3.Criticizing the Individual or the Idea?

In my days at C-DoT, when there were 400 employees, I asked an American psychiatrist to come to India as a consultant and give me a report on the “psychological health of C-DoT” - something that had never been done before in India. He spent several days in the organization and talked to a lot of people, trying to understand the situation. His analysis opened my eyes to a lot of things I did not realize because all my life I had worked in the US. People complained to him that Sam Pitroda was ruthless and criticized them in front of everyone else. And until then I had thought that I was simply being open! If someone had not been doing well, I would tell the person directly to his face in a general meeting. The employees said that was insulting, and that they should be pulled aside individually to be told of the inefficiency. But in today’s world, you cannot afford to do that every time. Besides, I figured that criticizing someone in a meeting was for the benefit of all present, and everyone could learn from that individual’s mistakes.

It was then that I learned how Indians do not differentiate between criticizing an idea and criticizing an individual. So in a group, if you tell someone that his idea is no good, he automatically takes it personally and assumes that you are criticizing him. No one can have a good idea every day on every issue. If you disagree with my idea, that does not mean that you have found fault with me as a person. Thus, it is perfectly acceptable for anyone to criticize the boss - but this concept is not a part of the Indian system.

In India you find that bosses kick the people below them, and butter up the people above. It should be exactly the opposite - butter up the people below, and don’t be afraid to kick those at the top. For a boss to be comfortable accepting criticism from subordinates, he must feel good about himself. Self-esteem is a key prerequisite to such a system being successful.

4.Mental vs. Physical Workers

Here's a personal story that will bring out another serious problem facing India - the dichotomy and difference in respectability between physical and mental workers which seriously affects team performance. I had a driver named Bhumi Ram, who I thought was one of the best drivers in the world. He used to open the door for me whenever I entered or exited the car. Right in the first few days I told him, "Bhumi Ram bhai, you are not going to open the door for me. You can do that if I lose my hands." He almost started crying. He said, "Sir, what are you saying? This is my job!" I told him that I didn't want to treat him like a mere driver. He had to become a team player. I told him that whenever he was not driving, he should come into my office and help out with office work - make copies, file papers, send faxes, answer phone calls or simply read - rather than sit in the car and wait for me to show up. Diversifying tasks increases workers' self-esteem and motivation and makes them team players. Now, even if I call him for work in the middle of the night, he is ready - because I respect him for what he does.

5.Team Interactions

Unfortunately, when good teams do get created, they almost invariably fall apart. In the '80s, there was a great political team consisting of Rajiv Gandhi, Arun Nehru, V.P. Singh, Arun Singh and others. If that team had remained intact, India would have been a different country today. They were all the same age, were good friends, and had backgrounds outside of politics. But the team self-destructed. They developed conflicts and couldn't resolve them - and the nation paid the price. In our system today it is very difficult to build teams because nobody wants to be seen playing second fiddle.

It is very hard in India to find good losers. Well, you win some and you lose some. If you lose some, you should move on! You don't need to spend all your time and energy attacking the winner. You try harder, and perhaps next time you will win.

In India we have people of different cultural backgrounds, religions, ethnicities and caste groups - a fertile ground for diversity in the workplace. We should actually be experts in working with diversity. But it can only happen when we get rid of personal, caste and community interests.

It all changes when we are out in the US. Here, we are a small ingredient in a huge salad bowl. We

are willing to compromise and accept differences because we ourselves are different. In the US, we act as the minority. In India, we act as the majority - and we never think about how the minority feels in that environment.

In the US you become part of the team very easily, helped on by the general environment here that encourages teamwork. People appreciate good work and pat you on the back; your boss is open and doesn't mind criticism - you can tell her that she's not right and she will say, yeah, maybe you have a good idea. The young are respected; there is no hierarchical system. There could be a 40-year-old CEO with a 55-year-old VP. It has nothing to do with age; capability and expertise are what counts. But you don't yet see these attitudes taking hold in India.

Managers in the US corporate environment who work with Indians - and in fact, with Asians in general - need to recognize that these individuals have a tendency to feel they are not getting recognition or are not being respected. It must be realized that these individuals have lower self-esteem to begin with and therefore have to be pampered and encouraged a little more because they need it. This makes them feel better and work better.

6.No Substitute for Teamwork

Teamwork is key to corporate and national governance, and to get anything done. The fundamental issues are respect for others, openness, honesty, communication, willingness to disagree, resolution of conflict, and recognition that the larger goal of the team as a whole trumps individual or personal agendas.

**********END OF UNIT-1**********

UNIT- II

VOCABULARY

Use of synonyms, antonyms

Synonyms are words that have the same or very similar meanings. All words can have a synonym. Nouns, verbs, adjectives, adverbs and prepositions can have a synonym as long as both words are the same part of speech.

Synonyms – Adjectives: Beautiful, lovely, gorgeous, stunning, striking

Synonyms – Nouns: House, home, dwelling, residence, abode, quarters

Synonyms – Verbs: Jump, bound, leap, hop, skip

Synonyms – Prepositions: in, inside, within

Antonyms are words that have opposite meanings. For example, the antonym of long is short. Often words will have more than one antonym but as with synonyms it depends on the context. For instance, the word warm could have the antonym cool or chilly. In order to choose the correct antonym, you have to look at all the meanings and how the word is used. Cool can mean stylish as well as chilly so the word cool may not be the best choice.

Antonyms fall within the three categories: graded antonyms, relational antonyms, and complementary antonyms.

1.Graded antonyms are word pairs that have variations between the two opposites. For example, big and little are antonyms but there are a lot of changes before you get to the opposite meaning like this:

Big, huge, bulky, full-size, slight, petite, little

Other examples are:

Happy – sad

Healthy – sick

Smart – stupid

2.Relational antonyms are pairs that have a relationship. Each word wouldn't exist without the other. There can't be a parent without a child or it's either all or nothing. Other examples include:

Open – close

Husband – wife

Front – back

Hello – goodbye

3. Complementary antonyms are word pairs that have no degree of meaning. There are only two opposite possibilities.

Dead- alive

True – false

Male- female

Daughter – son

On – off

**********END OF UNIT-2**********

Unit-III

Application of Grammar

Chapter-1

Countable and Uncountable Nouns.

Nouns can be countable or uncountable. Countable nouns can be counted, e.g. an apple, two apples, three apples, etc. Uncountable nouns cannot be counted, e.g. air, rice, water, etc. When you learn a new noun, you should check if it is countable or uncountable and note how it is used in a sentence.

1.Countable nouns

❖ For positive sentences we can use a/an for singular nouns or some for plurals.

There's a man at the door.

I have some friends in New York.

❖ For negatives we can use a/an for singular nouns or any for plurals.

I don't have a dog.

There aren't any seats.

2.Uncountable nouns

Here are some examples of uncountable nouns:

- bread
- rice
- coffee
- information
- money
- advice
- luggage
- furniture

❖ We use some with uncountable nouns in positive sentences and any with negatives.

There's some milk in the fridge.

There isn't any coffee.

❖ In questions we use a/an, any or how many with countable nouns.

Is there an email address to write to?

Are there any chairs?

How many chairs are there?

❖ And we use any or how much with uncountable nouns.

Is there any sugar?

How much orange juice is there?

❖ But when we are offering something or asking for something, we normally use some.

Do you want some chocolate?

Can we have some more chairs, please?

❖ We also use some in a question when we think the answer will be 'yes'.

Have you got some new glasses?

❖ Other expressions of quantity

A lot of (or lots of) can be used with both countable and uncountable nouns.

There are lots of apples on the trees.

There is a lot of snow on the road.

Notice that we don't usually use many or much in positive sentences. We use a lot of instead.

They have a lot of money.

However, in negative sentences we use not many with countable nouns and not much with uncountable nouns.

There are a lot of carrots but there aren't many potatoes.

There's lots of juice but there isn't much water.

Chapter-2

Articles

Articles (a, an, the) are determiners or noun markers that function to specify if the noun is general or specific in its reference. Often the article chosen depends on if the writer and the reader understand the reference of the noun.

The articles a and an are indefinite articles. They are used with a singular countable noun when the noun referred to is nonspecific or generic.

The article the is a definite article. It is used to show specific reference and can be used with both singular and plural nouns and with both countable and uncountable nouns.

Indefinite Article (A,An)

A and an are used with singular countable nouns when the noun is nonspecific or generic.

- I do not own a car.
    - In this sentence, car is a singular countable noun that is not specific. It could be any car.
- She would like to go to a university that specializes in teaching.
    - University is a singular countable noun. Although it begins with a vowel, the first sound of the word is /j/ or "y." Thus, a instead of an is used. In this sentence, it is also generic (it could be any university with this specialization, not a specific one).
- I would like to eat an apple.
    - In this sentence, apple is a singular countable noun that is not specific. It could be any apple.

A is used when the noun that follows begins with a consonant sound.

- a book
- a pen
- a uniform (Note that uniform starts with a vowel, but the first sound is /j/ or a "y" sound. Therefore a instead of an is used here.)

An is used when the noun that follows begins with a vowel sound.

- an elephant
- an American

- an MBA (Note that MBA starts with a consonant, but the first sound is /Ɛ/ or a short "e" sound. Therefore, an instead of a is used here.)

Sometimes a or an can be used for first mention (the first time the noun is mentioned). Then, in subsequent sentences, the article the is used instead.

- He would like to live in a large house. The house should have at least three bedrooms and two bathrooms.
    - In the first sentence (first mention), a is used because it is referring to a nonspecified house. In the second sentence, the is used because now the house has been specified.

Definite article (The)

The is used with both singular and plural nouns and with both countable and uncountable nouns when the noun is specific.

- The book that I read last night was great.
    - In this sentence, book is a singular, countable noun. It is also specific because of the phrase "that I read last night." The writer and reader (or speaker and listener) know which book is being referred to.

- The books assigned for this class are very useful.
    - In this sentence, books is a plural, countable noun. It is also specific because of the phrase "for this class." The writer and reader (or speaker and listener) know which books are being referred to.

- The advice you gave me was very helpful.
    - In this sentence, advice an uncountable noun. However, it is specific because of the phrase "you gave me." It is clear which piece of advice was helpful.

Here are some more specifics:

The is used in the following categories of proper nouns:

- Museums and art galleries: the Walker Art Center, the Minneapolis Institute of Art
- Buildings: the Empire State Building, the Willis Tower
- Seas and oceans: the Mediterranean Sea, the Atlantic Ocean
- Rivers: the Mississippi, the Nile

- Deserts: the Sahara Desert, the Sonora Desert
- Periods and events in history: the Dark Ages, the Civil Wa

- Bridges: the London Bridge, the Mackinac Bridge
- Parts of a country: the South, the Upper Midwest

In general, use the with plural proper nouns.

- the Great Lakes
- the French
- the Rockies (as in the Rocky Mountains)

The is often used with proper nouns that include an "of" phrase.

- the United States of America
- the University of Minnesota
- the International Swimming Hall of Fame

Use the when the noun being referred to is unique because of our understanding of the world.

- The Earth moves around the sun.
- Wolves howl at the moon.

Use the when a noun can be made specific from a previous mention in the text. This is also known as second or subsequent mention.

- My son bought a cat. I am looking after the cat while he is on vacation.
- I read a good book. The book was about how to use articles correctly in English.

The is used with superlative adjectives, which are necessarily unique (the first, the second, the biggest, the smallest, the next, the only, etc.).

- It was the first study to address the issue.
- She was the weakest participant.
- He was the only person to drop out of the study.

- No article is used when a plural countable noun is generic or nonspecific.
    - I bought new pens and pencils at the store. (general, not specific ones)
    - Cats have big eyes that can see in the dark. (cats in general, all of them)

    - Babies cry a lot. (babies in general, all of them)

- No article is used when a noncount noun is generic or nonspecific.
    - I bought milk and rice at the store. (generic reference)
    - We were assigned homework in this class. (generic reference)
    - There has been previous research on the topic. (generic reference)

Sometimes article usage in English does not follow a specific rule. These expressions must be memorized instead.

Here are some examples of phrases where article usage is not predictable:

- Destinations: go to the store, go to the bank, but go to school, go to church, go to bed, go home
- Locations: in school, at home, in bed, but in the hospital (in American English)
- Parts of the day: in the morning, in the evening, but at night
- Chores: mow the lawn, do the dishes, do the cleaning

There are also numerous idiomatic expressions in English that contain nouns. Some of these also contain articles while others do not.

Here are just a few examples:

- To give someone a hand
- In the end
- To be on time

Chapter-3

Determiners

Determiners are required before a singular noun but are optional when it comes to introducing plural nouns. For example, consider the placement and usage of the common determiner the in the sentences below:

The bunny went home.

I ate the chocolate cookie for dessert.

Metal cans are recyclable.

The metal cans are recyclable.

There are four different types of determiners in English: articles, demonstratives, quantifiers, and possessives.

1.Articles

Articles are among the most common of the determiners. There are three singular articles: a, an, and the. Articles specify (or determine) which noun the speaker is referring to. A and an are indefinite articles and are used when you are talking about a general version of the noun. For example:

A dog is a good pet.

An ostrich would beat a chicken in a race.

In these examples, the sentence is talking about dogs or ostriches in general, meaning any dog. When your meaning is general, use an indefinite article. Note that a is used before words that begin with consonants while an is used before words beginning with vowels.

On the other hand, the is a definite article, meaning the speaker is referring to a specific noun. For example:

We went to the best restaurant in town.

The dog is barking too loudly.

Here the speaker is referring to a particular dog and a particular restaurant. It's not a general category, but only one animal or place that's important. When your meaning is specific, use a definite article.

2.Demonstratives

Demonstrative pronouns are also used as determiners in English. There are four of them: this, that, these and those. Demonstratives are used in a situation in which the speaker can point to the item they mean, making them even more specific than a definite article. For example:

Do you want this piece of chicken?

I don't want to go to that movie.

These black raspberries are sour.

He wanted those boys to go away.

This and these refer to items nearby; that and those refer to items far away. Note also that this and that are singular while these and those are plural.

3.Quantifiers

Quantifiers are determiners that indicate how much or how little of the noun is being discussed. They include words such as all, few and many. For example:

He took all the books.

She liked all desserts equally.

Few children like lima beans, so the cafeteria stopped serving them.

Many kittens are taught to hunt by their mothers.

Note that all can be used with other determiners to specify which particular items are meant .

4.Possessives

When referring to a noun that belongs to someone or something, you can use possessive pronouns to show ownership. Possessive pronouns include my, your, his, her, its, our, and their. For example:

Where is your car?

The dog growled and showed its teeth.

My best friend is a cat.

As always, the determiner comes before the noun and any modifying adjectives. In English, you can use the same possessive whether the noun it references is singular or plural.

Few Important Rules to Remember:

- Determiners always come first in the noun phrase.
- Determiners are required with singular nouns.
- To speak about a singular noun generally, use an indefinite article (a or an).
- To speak about a plural noun generally, do not use a determiner.
- To speak about a singular noun specifically, use a definite article, demonstrative pronoun, possessive pronoun or quantifier.

Chapter-4

Modals

Modals (also called modal verbs, modal auxiliary verbs, modal auxiliaries) are special verbs which behave irregularly in English. They are different from normal verbs like "work, play, visit..." They give additional information about the function of the main verb that follows it. They have a great variety of communicative functions.

Here are some characteristics of modal verbs:

They never change their form. You can't add "s", "ed", "ing"...

They are always followed by an infinitive without "to" (e.i. the bare infinitive.)

They are used to indicate modality allow speakers to express certainty, possibility, willingness, obligation, necessity, ability

List of modal verbs

Here is a list of modal verbs:

can, could, may, might, will, would, shall, should, must

The verbs or expressions dare, ought to, had better, and need not behave like modal auxiliaries to a large extent and my be added to the above list

Use of modal verbs:

Modal verbs are used to express functions such as:

Permission

Ability

Obligation

Prohibition

Lack of necessity

Advice

possibility

probability

Examples of modal verbs

Here is a list of modals with examples:

Modal Verb	Expressing	Example
must	Strong obligation	You must stop when the traffic lights turn red.
logical conclusion / Certainty	He must be very tired. He's been working all day long.	
must not	prohibition	You must not smoke in the hospital.
can	ability	I can swim.
permission	Can I use your phone please?	
possibility	Smoking can cause cancer.	
could	ability in the past	When I was younger I could run fast.
polite permission	Excuse me, could I just say something?	
possibility	It could rain tomorrow!	
may	permission	May I use your phone please?
possibility, probability	It may rain tomorrow!	
might	polite permission	Might I suggest an idea?
possibility, probability	I might go on holiday to Australia next year.	
need not	lack of necessity/absence of obligation	I need not buy tomatoes. There are plenty of tomatoes in the fridge.
should/ought to	50 % obligation	I should / ought to see a doctor. I have a terrible headache.
advice	You should / ought to revise your lessons	
logical conclusion	He should / ought to be very tired. He's been working all day long.	
had better	advice	You 'd better revise your lessons

Modal verbs are followed by an infinitive without "to", also called the bare infinitive.

Examples:

You must stop when the traffic lights turn red.

You should see to the doctor.

There are a lot of tomatoes in the fridge. You need not buy any.

Chapter-5

Tense

Tenses play a crucial role in the English language. It denotes the time an action takes place, whether sometime in the past, in the present or will take some time in the future. There are three main tenses in English.

1.**Present Tense**

Simple Present Tense

A sentence is presented in simple present tense when it is used to describe an action that's happening at present and does not indicate when the action is expected to end. Simple present tense is used when:

The action that is taking place in general.

The action is not only occurring now; it repeats after regular intervals of time.

To indicate facts those are generally true.

The action for relating habits and routines that happen all the time, be it in the future, past or present.

Structure:

Verb "+s/es" form is used;

If subject is 3rd person singular. The verb is used in its original form;

If subject is 1st and/or 2nd person singular.

If subject is 1st and/or 2nd person plural.

If subject is 3rd person plural.

Some Examples:

The sun sets in the west.

All the cars stop at this crossing.

Michael teaches social studies in a school.

That notice reads, “No parking”.

Rajdhani leaves at seven in the morning.

The teacher said if she works hard she will pass.

There goes the taxi.

Do you play tennis?

He does not go to the temple.

Does he write novels?

Present Progressive or Present Continuous

Though the simple present and present continuous tenses are used interchangeably, present continuous usually defines an act that is going on at the time of speaking.

The sentences with present progressive tense are used when:

Something is taking place now, while speaking and has a definite end as well.

When something is already decided and arranged as well to perform it.

To indicate an undesirable habit.

Structure:

Use first form of the verb "+ing"

Singular 3rd person subject — use 'is'

Plural 1st, 2nd and 3rd person and singular 2nd person subject — use 'are'

1st person singular — use 'am'

In other words, it is "Subject + be (is, am, are) + Verb+ -ing + Object"

Some Examples:

Please wait for a moment, Shyam is talking to Mary.

We are late; he will be waiting for us at the restaurant now.

Mom, I am playing football.

Are they still living here?

She is having her breakfast now.

I'm planning to meet the Director tonight.

Present Perfect Tense

It's probably the most used tense form in English Grammar and is also considered difficult to understand. The Present Perfect Tense explains the incident that has happened in the past and that continues until the present time.

Examples:

For almost five generations, my family members have been engineers.

In order to avoid delays in my work, I have been doing it regularly.

I have always wanted to ride on this vehicle.

Present Perfect Continuous Tense

Usually, Present Perfect Continuous Tense is used for a situation that has occurred in the past and which continues until that moment.

Structure:

Use the first form of the verb + "–ing"

Singular subject (has been), Plural subject or I (have been)

'Since'— if the point of time is mentioned.

'For' — if the duration of time is specified.

Examples:

I have been eating apples today.

You have not been studying for the past month.

We haven't been playing with Mary since Tuesday.

2.Past Tense

Simple Past Tense

Simple past tense is used to narrate an action of the past. The verb in the past tense ends with an '-ed' and hence, there are seven ways of marking the irregular verbs in the past tense. The most common being the change of the vowel as in 'drink' - 'drank'.

Construction

Subject + verb + Object

Examples:

Katie worked in that office for almost four years.

He passed away in 1999.

We went for the movie yesterday.

Three years ago, I studied at the Canada University.

Past Continuous Tense

This from of tense indicates activities that have already happened in the past and have been completed before the time of mention. These sentences are formed with the help of an auxiliary verb and giving the main verb an 'ing' ending.

Structure

Subject + was/were + Verb in its -ing form + Object

Examples:

He was washing the dishes, while she was cooking dinner.

I was working at 11p.m yesterday.

We were playing football when it started to rain.

She was reading a thriller novel when I called her.

What were you doing when Sam arrived?

I was walking down the street yesterday when the police van was patrolling the city.

Past Perfect Tense

This tense refers to a non-continuous action that was already completed in the past. Such sentences are formed by using the Simple Past form of the auxiliary verb 'to have', followed by the past participle form of the verb.

Structure

Subject + had + past participle form of verb + Object

Example:

I had never seen such a beautiful before.

She understood the movie only because she had read the book.

Clara had never been to a club before last night.

We didn't get a room in the hotel because we had not booked in advance.

Past Perfect Continuous Tense

A continuous action that was completed sometime in the past falls under Past Perfect Continuous tense. Such sentences are framed by using the modal, 'had' + 'been' + the present participle of the verb (-ing).

Structure:

Subject + had + been + Verb (ing) + object

Example:

I had been playing the guitar all morning.

I had been sleeping all the way from the beginning of the class.

He had been trying to call her.

Until this year, Neha had been going to a village school.

The baby had been crying out loud for minutes when her mother fed her.

3.Future Tense

Simple Future Tense

This tense is used for those sentences which refer to the actions which will occur later, in future. This requires a future tense auxiliary verb even though the verb would be unmarked.

Examples:

You will be done before me.

She will not come tomorrow.

Will you come to play with me after school?

I will keep in touch with you.

I will reach home by 7p.m.

He will stay with us for 3 days.

Future Continuous Tense

This tense defines those acts which will be continued at a future point of time. In order to form a future continuous tense sentence, a future auxiliary verb is required followed by a main verb that ends with -ing.

Structure:

'will' + 'be' + present participle of the verb (ing).

Construction:

Use first form of the verb (+ing)

1st and 2nd person — ‘Shall be’

3rd person — ‘Will be’

However, nowadays this distinction of 'will' and 'shall' is not followed. Instead, 'will' is used wherever absolute conviction is required to be expressed while the usage of 'shall' depends on individual writing style.

Examples:

We assume that our representative will be winning the elections that are to be held at the end of April.

Today, she will be walking all the way to her house from her office.

I will be watching the new movie next week.

By this time tomorrow, I will be at home watching T.V

Future Perfect Tense

This tense is used to express an act that is predicted to be finished within a certain span of time in the future. Such sentences are formed by 'will' + 'have' + 'past participle of the verb'.

Examples:

By the end of the year, he will have saved enough for his sister’s wedding.

You will have left for London by the time this bridge gets renewed.

Calvin will have gone by the time you reach there by bus.

I will have walked 15 kms by this time.

How long will it have been since we were here together?

Future Perfect Continuous Tense

This tense form indicates an action that is continuous and, at some point in the future, it will be completed. It is formed using the modal 'will/shall' + 'have' + 'been' + 'the past participle of the verb (-ing)'.

Examples:

Next Saturday, I will have been working on this assignment for three years.

Tomorrow, at this time, I shall have been playing cricket since morning.

I will have been studying English for two hours by the time you arrive here.

Chapter-6

Voice

Definition of Voice -

A form of verb that tells us whether the Action is done by subject itself or it faces the result of action done by others. Sometime Action is done by the Subject directly and other times indirectly.

e.g.

He takes tea. (The action of taking tea is being done by the subject" He" directly).

Tea is taken by him. (The action of taking tea is being done by the same subject indirectly).

There two type of voice - Active and Passive.

In Active Voice, the verb agrees the subject. It means the subject is active.

In Passive Voice, the verb agrees the object. It means the subject is passive.

Some Common Rules for Active and Passive Voice -

Subject is changed in to Passive Voice and vice versa.

Pronouns get changed when they change their positions in the following way -

I ↔ Me

We ↔ Us

You ↔ You

He ↔ Him

She ↔ Her

It ↔ It

They ↔ Them

Only Verb III is used in Passive Constructions.

Active and Passive Voice Related with Tense -

Present Indefinite -

Active Voice - Sub + V1+ s/es + Obj .

Passive Voice - Obj + is/am/are/ V3+ by + Sub.

Examples -

She helps the poor.

The poor are helped by her.

Past Indefinite Tense -

Active Voice - Sub + V2 + Obj.

Passive Voice - Obj + was/were + V3+ by + Sub.

Examples -

They played football in the evening.

Football was played by them in the evening.

Future Indefinite -

Active Voice - Sub + will/shall + V1 + Obj.

Passive Voice - Obj + will/shall + be + V3+ by + Sub.

Examples -

We will take lunch now.

Lunch shall be taken by us now.

Present Continuous -

Active Voice - Sub + is/am/are + V1+ ing + Obj.

Passive Voice - Obj + is/am/are + being + V3+ by + Sub.

Examples -

She is singing a beautiful song this time.

A beautiful song is being sung by her this time.

Voice of Past Continuous Tense -

Active Voice - Sub + was/were + V1+ ing + Obj.

Passive Voice - Obj + was/were + being + V3+ by + Sub.

Examples -

The teacher was reading newspaper.

Newspaper was being read by the teacher.

Future Continuous -

Active Voice - Sub + will/shall + be + V1+ ing + Obj.

Passive Voice - Obj + will/shall + be + being + V3+ by + Sub.

Examples -

They will be playing chess this time.

Chess will be being played by them this time.

Present Perfect -

Active Voice - Sub + has/have + V3 + Obj .

Passive Voice - Obj + has/have + been + V3+ by + Sub.

Examples -

Children have taken their breakfast.

The breakfast has been taken by children.

Past Perfect -

Active Voice - Sub + had + V3 + Obj.

Passive Voice - Obj + had + been + V3+ by + Sub.

Examples -

I had written a poem.

A poem had been written by me.

Future Perfect -

Active Voice - Sub + will/shall+ have + V3 + Obj.

Passive Voice - Obj + will/shall+have + been + V3+ by + Sub.

Examples -

She will have completed her homework.

The home work will have been completed by her.

Present Perfect Continuous -

Active Voice - Sub + has/have + been + V1 + ing + Obj + since/for +time.

Passive Voice - Obj + has/have + been + being + V3+ by + Sub + since+for +time.

Examples -

Rudra has been watching TV since Morning.

TV has been being watched by Rudra since morning.

Past Perfect Continuous -

Active Voice - Sub + had + been + V1 + ing + Obj + since/for +time.

Passive Voice - Obj + had + been + being + V3+ by + Sub + since+for +time.

Examples -

She had been cooking food for two hours.

Food had been being cooked by her for two hours.

Future Perfect Continuous -

Active Voice - Sub + will/ shall+ have + been + V1 + ing + Obj + since/for +time.

Passive Voice - Obj + will/shall + have + been + being + V3+ by + Sub + since+for +time.

They will have been writing a novel for two months.

A novel will have been being written by them for two months.

Rule No 2 - Voice Related with Modals -

Active Voice - Sub + any Modal + V 1 + Obj.

Passive Voice - Obj + same Modal + be + V 3 + by + sub.

Examples -

Rudra can speak English.

English can be spoken by Rudra.

You need not read this book.

The book need not be read by you.

Rule No 3 - Sentences with W-H Families (Interrogative Sentences) -

Active Voice - What are you doing here?

Passive Voice - What is being done by you here?

Rules of changing some Interrogative Pronouns -

Who is changed in to by whom?

Whom in to Who

How many in to by how many

Chapter-7

Subject Verb Agreement

A singular subject (she, Bill, car) takes a singular verb (is, goes, shines), whereas a plural subject takes a plural verb.

Example: The list of items is/are on the desk.

If you know that list is the subject, then you will choose is for the verb.

Rule 1. A subject will come before a phrase beginning with of. This is a key rule for understanding subjects. The word of is the culprit in many, perhaps most, subject-verb mistakes.

Hasty writers, speakers, readers, and listeners might miss the all-too-common mistake in the following sentence:

Incorrect: A bouquet of yellow roses lend color and fragrance to the room.

Correct: A bouquet of yellow roses lends . . . (bouquet lends, not roses lend)

Rule 2. Two singular subjects connected by or, either/or, or neither/nor require a singular verb.

Examples:

My aunt or my uncle is arriving by train today.

Neither Juan nor Carmen is available.

Either Kiana or Casey is helping today with stage decorations.

Rule 3. The verb in an or, either/or, or neither/nor sentence agrees with the noun or pronoun closest to it.

Examples:

Neither the plates nor the serving bowl goes on that shelf.

Neither the serving bowl nor the plates go on that shelf.

This rule can lead to bumps in the road. For example, if I is one of two (or more) subjects, it could lead to this odd sentence:

Awkward: Neither she, my friends, nor I am going to the festival.

If possible, it's best to reword such grammatically correct but awkward sentences.

Better:

Neither she, I, nor my friends are going to the festival.

OR

She, my friends, and I are not going to the festival.

Rule 4. As a general rule, use a plural verb with two or more subjects when they are connected by and.

Example: A car and a bike are my means of transportation.But note these exceptions:

Exceptions:

Breaking and entering is against the law.

The bed and breakfast was charming.

In those sentences, breaking and entering and bed and breakfast are compound nouns.

Rule 5a. Sometimes the subject is separated from the verb by such words as along with, as well as, besides, not, etc. These words and phrases are not part of the subject. Ignore them and use a singular verb when the subject is singular.

Examples:

The politician, along with the newsmen, is expected shortly.

Excitement, as well as nervousness, is the cause of her shaking.

Rule 5b. Parentheses are not part of the subject.

Example: Joe (and his trusty mutt) was always welcome.

If this seems awkward, try rewriting the sentence.

Rule 6. In sentences beginning with here or there, the true subject follows the verb.

Examples:

There are four hurdles to jump.

There is a high hurdle to jump.

Here are the keys.

The word there's, a contraction of there is, leads to bad habits in informal sentences like There's a lot of people here today, because it's easier to say "there's" than "there are." Take care never to use there's with a plural subject.

Rule 7. Use a singular verb with distances, periods of time, sums of money, etc., when considered as a unit.

Examples:

Three miles is too far to walk.

Five years is the maximum sentence for that offense.

Ten dollars is a high price to pay.

BUT

Ten dollars (i.e., dollar bills) were scattered on the floor.

Rule 8. With words that indicate portions—e.g., a lot, a majority, some, all—Rule 1 given earlier in this section is reversed, and we are guided by the noun after of. If the noun after of is singular, use a singular verb. If it is plural, use a plural verb.

Examples:

A lot of the pie has disappeared.

A lot of the pies have disappeared.

A third of the city is unemployed.

A third of the people are unemployed.

All of the pie is gone.

All of the pies are gone.

Some of the pie is missing.

Some of the pies are missing.

Rule 9. With collective nouns such as group, jury, family, audience, population, the verb might be singular or plural, depending on the writer's intent.

Examples:

All of my family has arrived OR have arrived.

Most of the jury is here OR are here.

A third of the population was not in favor OR were not in favor of the bill.

Anyone who uses a plural verb with a collective noun must take care to be accurate—and also consistent. It must not be done carelessly. The following is the sort of flawed sentence one sees and hears a lot these days:

Rule 10. The word were replaces was in sentences that express a wish or are contrary to fact:

Examples:

I wish it were Friday.

She requested that he raise his hand.

In the first example, a wishful statement, not a fact, is being expressed; therefore, were, which we usually think of as a plural verb, is used with the singular it. (Technically, it is the singular subject of the object clause in the subjunctive mood: it were Friday.)

Normally, he raise would sound terrible to us. However, in the second example, where a request is being expressed, the subjunctive mood is correct.

Note: The subjunctive mood is losing ground in spoken English but should still be used in formal speech and writing.

**********END OF UNIT-3**********

Unit -IV

Formal Writing Skills

Chapter-1

Paragraph Writing

Paragraphs & Topic Sentences

A paragraph is a series of sentences that are organized and coherent, and are all related to a single topic. Almost every piece of writing you do that is longer than a few sentences should be organized into paragraphs. This is because paragraphs show a reader where the subdivisions of an essay begin and end, and thus help the reader see the organization of the essay and grasp its main points.

Paragraphs can contain many different kinds of information. A paragraph could contain a series of brief examples or a single long illustration of a general point. It might describe a place, character, or process; narrate a series of events; compare or contrast two or more things; classify items into categories; or describe causes and effects. Regardless of the kind of information they contain, all paragraphs share certain characteristics. One of the most important of these is a topic sentence.

TOPIC SENTENCES

A well-organized paragraph supports or develops a single controlling idea, which is expressed in a sentence called the topic sentence. A topic sentence has several important functions: it substantiates or supports an essay's thesis statement; it unifies the content of a paragraph and directs the order of the sentences; and it advises the reader of the subject to be discussed and how the paragraph will discuss it. Readers generally look to the first few sentences in a paragraph to determine the subject and perspective of the paragraph. That's why it's often best to put the topic sentence at the very beginning of the paragraph. In some cases, however, it's more effective to place another sentence before the topic sentence—for example, a sentence linking the current paragraph to the previous one, or one providing background information.

Although most paragraphs should have a topic sentence, there are a few situations when a paragraph might not need a topic sentence. For example, you might be able to omit a topic sentence in a paragraph that narrates a series of events, if a paragraph continues developing an idea that you introduced (with a topic sentence) in the previous paragraph, or if all the sentences and details in a paragraph clearly refer—perhaps indirectly—to a main point. The vast majority of your paragraphs, however, should have a topic sentence.

PARAGRAPH STRUCTURE

Most paragraphs in an essay have a three-part structure—introduction, body, and conclusion. You can see this structure in paragraphs whether they are narrating, describing, comparing, contrasting, or analyzing information. Each part of the paragraph plays an important role in communicating your meaning to your reader.

Introduction: the first section of a paragraph; should include the topic sentence and any other sentences at the beginning of the paragraph that give background information or provide a transition.

Body: follows the introduction; discusses the controlling idea, using facts, arguments, analysis, examples, and other information.

Conclusion: The final section; summarizes the connections between the information discussed in the body of the paragraph and the paragraph's controlling idea.

Types of Paragraph:

- **Narration:** Tell a story. Go chronologically, from start to finish.
- **Description:** Provide specific details about what something looks, smells, tastes, sounds, or feels like. Organize spatially, in order of appearance, or by topic.
- **Process:** Explain how something works, step by step. Perhaps follow a sequence—first, second, third.
- **Classification:** Separate into groups or explain the various parts of a topic.
- **Illustration:** Give examples and explain how those examples prove your point.

Example:

Value of Discipline

Discipline is the law of nature. It is in man's best interest to observe discipline in all walks of life. Discipline is the backbone of character. Without discipline, nothing great can be achieved in life. A man who does not observe discipline in life has to suffer. He becomes lethargic and arrogant. He is disliked by all. A student who does not obey his teachers and does not do his homework does not get success. An employee who does not work sincerely in office may be sacked any time. If sportsmen do not observe discipline cannot hope to win any match.

In the army, discipline is of utmost importance. Discipline leads to harmony whereas indiscipline leads to confusion. No life is worth living without discipline. A disciplined person is an asset to himself, to his family, to his society, to the nation and to mankind. Discipline works everywhere. It controls the physical movements and our morals. There is no sphere in heaven and the Earth where discipline does not dominate.

Environmental Pollution

The problem of environmental pollution is becoming more and more serious day by day. The ecological cycle is being disturbed by the people. Man is exploiting nature to the extent that natural resources are depleting. The main reason for environmental pollution is over population and poverty. The increased demand for food and other resources forces man to cut down forests which leads to an increase in the carbon dioxide ratio in the atmosphere. This results in heating up of the atmosphere. This is called global warming. Due to this, seasons are also undergoing a change.

All this forecasts disaster for human beings and other living beings. In order to bring pollution under control we need to conserve our forests, reduce the use of paper, petrol etc. Earth must be saved at any cost for the sake of survival. The need of the hour demands a check in environmental pollution. The government should take necessary steps in this direction.

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Chapter-2

Notice Writing

Notices are a means of formal communication targetted at a particular person or a group of persons. It is like a news item informing such person or persons of some important event. This can be an invitation to a meeting, an announcement of any event, to issue certain instructions, make appeals etc.

It is generally written and then displayed at a public place, where it is accessible to all. They can be pasted on notice boards. If it is meant for a wider audience it can even be published in a newspaper. The government when it issues notices must publish it in national and local papers.

Format

Since notices are a formal document it should follow a structure or a format. Keep in mind there is no one correct rigid format. Different formats used by different people/organizations can show some variations. But it is ideal to follow a somewhat similar format for ease of understanding and uniformity. Let us look at the most used format of notices.

Name of Issuing Organization/Authority: Right at the very top, you print the name of the person or company that is issuing the said notices. This will help the reader identify the notices as important or unimportant to him.

Title: When writing notices we mention a title "NOTICE" at the top. This helps draw attention to the document. Notices are generally posted at a public place or published in newspapers. It is important that they do not get lost in a sea of information. So a bold title clearly mentioned helps draw the attention.

Date: After the tile to the left-hand side we print the date on which the notices have been published. Since this is a formal document date is an important aspect of it since these documents stay on record.

Heading: Then we move on to an appropriate heading to the notices. This heading should make abundantly clear the purpose of the notices.

Body: After the heading, we write the brief and to the point body of the notice. The main content of the notice features in the body.

Writer's Name: At the end of the notices we write the name and designation of the notice-writer. The notices have to also be signed by the same person to lend it authority and validity.

Content

Notices should cover some important points that are to be communicated to the readers. Let us summarize the five points that the content of the notice will cover, the five W's.

What: What is the notice about? The notice should be clear about what is going to happen (event), or what has already happened (occasion). This is the crux of the message and should be written clearly. There should not be any ambiguity.

Where: If the notice is about an event, then the location of such an event must be written clearly. The venue or the location are important details, so make sure to include this in the notice.

When: This is the time and the date of the event or meeting. If possible, the duration of the event should also be mentioned to people can schedule their time accordingly.

Who: This will be who the notice is addressed to. Who all are supposed to adhere to the notice should be clearly mentioned to avoid confusion.

Whom: And final detail should be whom to contact or get in touch with. This mentions who the appropriate authority is to contact.

Things to remember regarding notice writing

Be precise and to the point. The ideal length of notice is 50 words, so precise language is appreciated.

It is a formal form of communication so the language used should be formal as well. No flowery text.

Keep the sentences short and use simple words. Since notices are fairly brief it is best to keep it simple.

Use passive voice as far as possible.

Present your notices in a proper format in a box. The presentation should be neat and thus be appealing to the eye.

Example

Q: On the occasion of Diwali your housing society has planned a feast for all its members. As the chairman of your society write a notice inviting all the members of the society to this gathering. Provide all the necessary details.

ABC Co-operative Housing Society

NOTICE

25th October 2017.

Diwali Gathering

On the auspicious occasion of Diwali, the Society has organized a gathering followed by dinner. All members of the society are requested to attend the event in the clubhouse of the society at 8:00 pm on the 30th of October.

XYZ

Chairman of
ABC Co-operative
Housing Society

Chapter-3

AGENDA

The purpose of an agenda is to let participants in a meeting know what business is going to be discussed and in what order. It often indicates who will be at the meeting and shows which items require action. Usually it's important for the agenda to be distributed ahead of time. An agenda also stands as an official record for an organization and any discussion of an item can be challenged if it was not included on the agenda. Thus it's important that the agenda be complete and specific. If you write the agenda for a meeting, confer with the person running the meeting to be sure you include the important items and in the right order. You may be asked also to include a suggested time limit for discussing each item.

IMPORTANCE OR NECESSITIES OF AGENDA

Agenda is the explicit topics to be discussed in a meeting the members. No one can ignore the importance of an agenda. The necessity or importance's of an agenda are as follows:

1. As it is circulated in advance, the members of the committee or meeting can take preparation to discuss the topics accurately.
2. It helps to take a prompt decision.
3. Since it has a set of order, it helps the chairperson to conduct the meeting smoothly.
4. It can ensure covering all the topics that will be discussed in a meeting.
5. It helps to control the unnecessary talking in the meeting.
6. It helps to write the minutes and resolution of the meeting.
7. As it is served earlier, the members of the meeting can exchange their thought and ideas informally before holding the meeting.

SOME SUGGESTIONS

• In the heading, include the official name of the organization and the day, date and time of the meeting. It is better to use the official Letter-Pad.

• Set forth the order of business, starting with the call to order, approval of the agenda and approval of minutes from the previous meeting.

• Number the items.

• List any committee reports next, followed by items for discussion. This order is flexible, however, depending on participants' schedules and needs.

• Conclude with a call for follow-up on old business and any new business and finish with adjournment.

• Put items in the list in parallel form.

• Indent subtopics.

• Leave space between items

• Keep the format readable.

FORMAT OF AN AGENDA

An Agenda normally includes the following elements −

•**Meeting Agenda Title** − at the top; preferably center-aligned

•**Meeting Information** − Description of the purpose

•**Objective** − description of Agenda

•**Date** − for maintaining records of correspondence

•**Location** − the place of meeting

•**Time** − the actual time of commencement of the meeting

•**Meeting Type** − brainstorming or Discussion or Assessment

•**Time of Arrival** − time to begin the meeting

•**Time of Adjournment** − time the meeting ends

•**Attendees** − Number of people present, with their names

•**Preparation for Meeting** −

o **Please Read** − instructions to be followed

o **Please bring** − things supposed to be carried that day

o **Action Items** −

Last Action Responsible Authority Due Date

New Action Responsible Authority Due Date

o **Other notes** - Other instruction or information to be taken down.

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Chapter-4

Report Writing

A report is a written account of something that one has observed, heard, done, or investigated. It is a systematic and well organised presentation of facts and findings of an event that has already taken place somewhere.

A well written report must possess the following traits:

- adherence to the specifications of report brief;
- analysis of relevant information;
- structuring material in a logical and coherent order;
- presentation in a consistent manner according to the instructions of the report brief;
- making appropriate conclusions that are supported by the evidence and analysis of the report.

Report Writing Format

1.Format of a magazine report

Heading- A descriptive title which is expressive of the contents of the report.

By line- Name of the person writing the report. It is generally given in the question. Remember, you are not supposed to mention your personal details in your answer.

Opening paragraph (introduction) – It may include the '5 Ws' namely, WHAT, WHY, WHEN and WHERE along with WHO was invited as the chief guest.

Account of the event in detail- The proper sequence of events that occurred along with their description. It is the main paragraph and can be split into two short paragraphs if required.

Conclusion- This will include the description of how the event ended. It may include quote excerpts from the Chief Guest's speech or how did the event wind up.

2.Format of a newspaper report

Headline- A descriptive title which is expressive of the contents of the report.

By line- Name of the person writing the report along with the designation. It is generally given in the question. Remember, you are not supposed to mention your personal details in your answer.

Place and date of reporting- It is generally not mentioned in a magazine report separately, but here, it is.

Opening paragraph- It includes expansion of the headline. It needs to be short as it is a general overview of the report.

Account of the event in detail- It is generally written in two parts: First, complete account of what happened in its chronological sequence (preferably) and second, the witness remarks.

Concluding paragraph- This will include the action that has been taken so far or that will be taken. It is the last paragraph.

Tips to attempt a question on report writing

Make sure you use language which is suitable for the audience you are addressing to. Usage of complex vocabulary for addressing children is not advisable.

- Make sure you write in paragraphs.
- Practice previous year question papers.
- Read as many samples as you can. It will give you an idea as to how they are actually written.
- Read the question at least twice and highlight the important information. It is very important to understand the question and read between the lines. Albert Einstein once said,
- "If you can't explain it simply, you didn't understand it well enough."

- Plan before you pen. Just make a list of all your important points on the rough sheet (last sheet of your answer booklet) so that you do not forget relevant points while writing. This also helps you in maintaining a sequence, which is very important.
- Presentation is very important.
- Make sure you double check for grammatical accuracy and spellings. They carry marks.
- Leave adequate number of lines between paragraphs to make it look clean.
- Underlining the main points is very important. But it is advised to do it after finishing your exam.

- Use a pencil and scale for underlining.
- Make small sentences. It restricts the scope of grammatical inaccuracies.

Example:

Q1. MMD College, Nashik, recently organised a science symposium on the topic: 'Effect of pollution on quality of life'. You are Amit/Amita Raazdan, editor of the school magazine. Write a report on the event for your college magazine. (120 – 150 words)

Answer:

Report on Science Symposium held at MMD School, Nashik

A symposium was organised on 1 March 2018 in the school on the topic "Effect of Pollution on Quality of Life". All the science students were a part of the elucidative programme.

The event stared with the felicitation of the guest speakers. Thereafter, the participants were espoused by Sh. Suraj Prakash. He acquainted them with the objectives and goals of the workshop. The resource person Dr. Hari Om Gupta reflected his profound knowledge on the topic and highlighted how important it is to curb the menace of pollution.

An exalting demonstration of effects of pollution on our lives galvanized the engrossed participants. After the lunch break Dr. K.K. Arora, Resource Person, exhibited the possible steps that can be undertaken at the personal level to reduce pollution. It was followed by another session on the basic concept behind pollution reduction which triggered the young minds into thinking innovative ways.

An interactive concourse ignited the inquisitiveness of participants. They have committed themselves completely to bring about a change in the situation. The informative workshop culminated with a vote of thanks proposed by the head of the science department.

Q2. You are Karan/ Kirti of L.M. Memorial College, Dwarka. Your college has adopted a village as a social responsibility. Students are being taken to teach the children of that village on a regular basis. Write a report, for your college magazine, on the various other programmes organized there in 150-200 words.

Answer:

VILLAGE ADOPTION- A STEP TOWARDS BEING SOCIALLY RESPONSIBLE

-BY KARAN/ KRITI

On the occasion of World Literacy Day, L.M. Memorial College , Dwarka has taken an oath to embrace the village named Rajpur.

The college has taken the responsibility of educating the people residing in the village. Selected students from each standard are taken there every weekend, during college hours to impart knowledge. The first 6-month motive is to make each and every person capable of reading and writing. Free books and stationery is being provided for quality education. Children are given time to spend with each other, play games and interact. Apart from the educational needs, special care is devoted to hygiene and sanitation. Girls are being given awareness on the importance of menstrual hygiene as well. Various talent hunts have been organised which left everyone overawed. The immense enthusiasm and zeal in the people to learn is the main driving factor.

A family kind of environment is being created. The school treats the people of the village as its own students and is unbiased. By adopting a village, the school is making its students sensitive towards the needs of the environment at a young age. It is committed towards raising the leaders of tomorrow.

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Chapter-5

Personal Letters/Informal Letters

This type of personal writing is represented by personal correspondence, thank you letters, letters of congratulation or condolences. All of these can be printed or handwritten.

Formatting of a personal letter is similar to business one, but the differences are in style and punctuation.

1.The heading in the upper right corner may consist of an address and date. We do not use punctuation at the end of the heading lines.

2.The salutation placed at the left-hand margin is rather friendly and informal. We do use comma here, e.g. Dear Gran, Beloved Mum, Dearest Susie,

3. The body may consist of one or more paragraphs, dealing with personal topics.

4. The complimentary close is followed with a comma:

e.g. Love, Jane Sincerely yours, Tom Yours, Alan

5. Signature is written below the complimentary close.

Letter to the Principal, Librarian, Head of the Deptt, and Hostel Superintendent

The Principal,

Name of College,

Name of city (or college address)

(line drop)

Subject: subject of application

(line drop)

Salutation (i.e. respected sir/madam)

I humbly state that.....

_____

_____

_____

_____

Body of application

_____

(line drop)

Yours obediently,

Your name

Class/section

Date

Instructions:

- The trend of writing "To," at the start just above "The Principal" has long been discarded. It is no more used now.
- "Subject line" is mandatory in latest format. Your subject line should clearly tell what your application is about.
- Salutation should include only formal greeting-you should not write "Dear Sir" nor "Hello sir". You should write "Respected sir" OR only "Sir"
- You should not start you application by "I beg to state that" OR "I beg to say that" OR "I Beg leave to say that" etc. This method is out of fashion and validity. It is no more in practice. The latest style is that you can start with "I humbly state that" OR "I want to state that" OR "I would like to state that" etc.
- The body of your application should include all necessary details but not unnecessary things. Be formal and professional. Do not use casual words or expressions.
- Always write yours obediently at the end, if your are writing an application. In case of a letter, you should write "yours faithfully" OR "Yours truly"

Example

Write a letter to the principal of your college for sick / medical leave

The Principal,
Govt. Post Graduate College for Women,
Kasur.

Subject: Application for medical leave

Mam,
I want to state that I suddenly fell ill yesterday evening. I was taken to doctor who told me that I had a sever attack of diarrhoea. I had projectile vomiting, nausea and mild fever. During just 10 hours of sickness, my health had badly fallen. I am in hospital right now. I am getting my treatment. I am not in position to attend college for two days.
Kindly allow me leave for two days so that I may take rest and treatment. I will come to college as soon as feel better.

Your obediently,
Priti
Sec-D

Write a letter to the principal of your college for leave to attend your brother's marriage

The Principal,
Mount Carmel College,
Bangalore.

Subject: Application for leave

Sir,
I humbly state that the marriage of my elder brother is fixed on November 16, 2020. I have to give a helping hand to my father and brother. There is a lot of preparation to be made. Being an active participant in household chores, I have to ensure my full participation in the preparations for the marriage.

So, I will be very busy on 15-18 of November. My engagement in preparations is mandatory. So, I will not be able to attend the college for the said dates. Kindly grant me leave for four days (November 15-18). I am a brilliant student at your college. I always show good performance in the in-house tests. I assure you that I will work hard to compensate for my loss in studies.

I will be highly thankful to you for this act of kindness.

Yours obediently,
Rohit Kumar
Sec-B

Write a letter to the Hostel Superintendent of your college hostel for sick / medical leave

The Warden

Ganga Hostel

Delhi University

New Delhi

Date- 29 April 2017

Subject- Application for leave for two days.

Dear Sir,

With due respect, I, XYZ of Room number 26, Brahmaputra Hostel want to request you to grant me a leave for two days. There has been an emergency in my home because of which I've to leave for it as soon as possible. I hope that you will grant me the leave for the same.

Thanking you in anticipation.

Yours truly

XYZ

Room number 26

Brahmaputra Hostel

****

Chapter-7

Writing Business letters/Formal Letters

The most common form of written communication is the letter. Letter writing is an indispensable activity of human society. We write letters to Mends and relatives to maintain contacts with them. However, in the present times with the boom in methods of communication, many of us don't have the time or the inclination, or the temperament and the art to write letters. So telephone, fax and e-mail have replaced personal (informal) letters.

I. BUSINESS LETTERS
Making enquiries/asking for information
Replying to enquiries/giving information
Placing orders and sending replies
Cancelling orders
Letters making complaints

II. OFFICIAL LETTERS
Registering complaints
Making enquiries
Making requests/appeals

III. LETTERS TO THE EDITOR
Giving suggestions on an issue (usually of public interest)
Expressing views on an issue already raised in an article/write-up/in a published letter.

IV. LETTERS OF APPLICATION
Job Application Format is the first step in the job application process.

V. MISCELLANEOUS

I. BUSINESS LETTERS

A business letter is different from a personal letter in form, tone and content. In personal letters we may follow an informal, Mendly or personal tone, content or style. But business letters demand a formal and matter of fact treatment. These letters are generally written to or by commercial and business firms and enterprises, so they must be simple and systematic, brief and specific in content and formal in treatment of the subject.

Commercial correspondence occupies an important role in the modem world of commerce, trade and industry. So students are advised to master the art and craft of writing good business letters.

WRITING GOOD BUSINESS LETTERS

- Be brief, clear and to the point.
- Use separate paragraphs for separate topics.
- The first para should indicate the theme of the letter.
- Make a factual statement of facts.
- Use simple and direct language. Avoid the use of long and high sounding words and ambiguous construction.
- Even while lodging a complaint or making criticism, you should be polite and charming.

- Avoid common-place and clumsy expressions.
- Use a proper layout/format for these formal letters. The block format is more in vogue in formal letters whereas the indented format may be used in informal letters.
- Use of punctuation marks is dispensed with in the block format.
- Remember the following points about block format: .
  - ✓ There is no indentation.
  - ✓ Each block begins with the margin on left hand side.
  - ✓ Extra space should be left between different sections and paragraphs.
  - ✓ Omit punctuation marks in address and date. A comma (,) may be put after the salutation.

COMMON FEATURES OF FORMAL LETTERS

The block-wise format of different kinds of letters are given below:

(a) BUSINESS LETTERS

Tel. No …….
Our Ref.……...
Your Ref. (if needed) …….
Sender's Address …….
……
……
Pin ……
Date …….

Inside Address……
……
……
Pin.…….
Sir/Madam

Subject
……
……
Introductory para
……
…….
……
…….

Main body of the letter
……
…….
……
…….
……
…….
……
…….
Concluding para
……
…….

……
……
Yours faithfully
……
Signature
Full Name …….
Designation …….

end. (if needed) …….
c.c. (if needed) ……

(b) OFFICIAL LETTERS AND LETTERS TO THE EDITOR

Sender's Address …….
……
……
Pin ……
Date …….

Inside Address……
……
……
Pin…….
Sir/Madam

Subject
……
……
Introductory para
……
……
……
……
Main body of the letter
……
……
……
……
……
……
……
……
Concluding para
……
……
……
……
Yours faithfully
……
Signature
(Full Name in capitals)
Designation (if needed)

Format/Layout:

CONTENT
It includes your creativity in presenting ideas which are relevant to the topic of the letter. The content of the letter must be well-organised to ensure clarity and effective communication. The content is divided into three main parts:

Introductory part
Main part
Concluding remarks
The introductory paragraph introduces the theme.
The main part deals with the problem/issue. It is the real content of the letter.
The closing part of the body gives conclusions or offers suggestions.
Some Tips:
—Be brief and to the point
—Mention specific issues only
—Tone: polite but formal

In letters to editors state the problem clearly. Try to present both sides of the picture. In case of a discursive topic or one requiring argumentative presentation, give the pros and cons of the situation. Always offer useful suggestions to overcome the problem.
EXPRESSION

(a) Fluency is your ability to present your ideas in a coherent and organised way. Before answering in the 'fair', you must prepare a rough draft and jot down your ideas. You may follow the process detailed below:

- ✓ Think about the letter/topic.
- ✓ Collect all the ideas and put them down roughly.
- ✓ Organise the ideas by putting common ideas together.
- ✓ Arrange them sequentially.
- ✓ End on a positive note.

(b) Accuracy involves grammatical correctness as well as structuring of sentences. Your effort should not be to use complex, long and unwieldy sentences, but to present your content in simple, straightforward language.

Note the following points about the use of language:
(a) Business/Official Letters:

- ✓ simple and direct
- ✓ formal tone
- ✓ straightforward manner

(b) Letters to Editors :

- ✓ greater flexibility
- ✓ suitable to subject/content
- ✓ formal, direct and pointed

Note. I have the honour to state ……..
is obsolete and is no longer used.
It is! easier and simple to say—
I wish to say…….. /I want to say…….

Study the general layout of the formal letters carefully. We are talking of the block format which has no indentation or punctuation. Each paragraph/point begins on the left hand side margin. There is gap after each block.

Sender's Address. Top left-hand comer. Omit punctuation marks.

The Date. Just below the Sender's address. These days marks of punctuation are not used. You may write
17 March 20XX
March 17, 20XX
17th March 20XX.

Inside Address. The Name and Designation of the addressee is written on the left hand side, two lines below the line of date.

The Salutation. On the left hand side below the 'Inside Address'. The usual form of salutation is 'Sir' or 'Dear Sir' for individuals, 'Sirs' or 'Dear Sirs' for firms or companies. In America, they write 'gentlemen' instead of 'Dear Sirs'. Use 'Madam' while addressing a lady.
In case the addressee is personally known to the writer, names are also used as:
Dear Mr Gupta
Dear Miss Sapna
Dear Mrs. Sood

Subject. The subject heading is written just below the salutation and above the 'Body of the Letter'. It helps in quick disposal of the letter.

The Body/Content of the Letter. This is the most important part of the letter. Mention specific business only. Fluency and accuracy in presentation of well-organised relevant ideas is essential.

The Complimentary Close. Written on the left-hand side a couple of lines below the last fine of the body of the letter. The usual complimentary endings are:
yours faithfully
yours truly

However, if the name of a person is used in the salutation, the complimentary close can be 'yours sincerely'.

Signature. A formal letter requires your full signature with the name and designation coming just below it. The 'signature' is put just below the complimentary close.

Enquiry letter

An Enquiry letter is a formal letter, written to enquire and get details regarding something that a person is interested in. It could be written with respect to an item that a person is interested in buying, a course that a person wants to study, a vacation trip that a person wants to go on, etc. As the sender of an Enquiry letter needs information about something, the enquiry letter must mention the contact details of the sender where the said information has to be sent. It must contain the particulars of the thing enquired about. It must also list down all the aspects of the thing about which the sender wants the detailed information.

Format of Enquiry letter

The Format of an Enquiry Letter is as follows –

1. Sender's address: Include email and phone number, if required.

2. Date: Below address. Leave one space or line.

3. Receiver's address

4. Subject of the letter

5. Salutation (Sir / respected sir / madam)

6. Body

Paragraph 1: Introduce yourself and the purpose of writing the letter

Paragraph 2: Detail of the enquiry

Paragraph 3: Conclude / end

7. Complimentary Closing

8. Sender's name, signature and designation (if any)

Example:

Park Lane,

Kolkata,

February 25,

Manisha Cookware

Delhi Gate,

Meerut

Subject: Inquiry about the Exchange Scheme

Dear Sir,

I saw your advertisement in Amar Ujala today, where you have discussed regarding an exchange scheme. The scheme is regarding the exchange of old utensils with the new non-sticky cookware. I have some old utensils, which I wanted to exchange against the one offered through the exchange scheme.

I request you to kindly explain more about the scheme and all its terms and conditions. Also update me if there is a possibility sending and receiving the items through parcel, or the physical presence is mandatory.

Thanking You,

Your's Sincerely

Archit Gupta

****

Order Letter

An Order Letter is written to place an order for any items. It mentions the and details of the items required. It must specify details like address for delivery, deadline for delivery, mode of payment, etc.

Features of an Order Letter are as follows –

- Formal letter: An Order letter is a type of Formal Letter.
- It is written to place an order for goods, articles or items.
- As it is a formal letter, we have to follow the format and write within the word limit (1oo – 120 words).

The Format of Order Letter is as follows -

1. Sender's address: Include email and phone number, if required.
2. Date: Below address. Leave one space or line.
3. Receiver's address
4. Subject of the letter
5. Salutation (Sir / respected sir / madam)
6. Body

Paragraph1: Introduce yourself and the purpose of writing the letter

Paragraph2: Detail of the articles ordered

Paragraph3: Conclude / end

7. Complimentary Closing
8. Sender's name, signature and designation (if any)

Example:

Color World

15; New Market, Dhaka-1200

1st September 2012

Manager,

Sales Division

National Paints Co. Ltd.

20, Tongi,Gajipur.

Sub: Order for various paints.

Dear Sir,

Thank you for your quotation and the price list. We are glad to place our first order with you for the following items:

SL. No:	Description	Quantity	Weight	Unit price	Amount (Tk.)
1	Enamels paint	25 Tins	100 1bs	1000	25.000
2	Synthetic paint	20 Tins	200 1bs	2000	40.000
3	White paint	10Tins	10 1bs	500	5000

Since the above goods are required immediately as our stock is about to exhaust very soon. We request you to send the goods through your "Motor" van as the carriage inward is supposed to be borne by you. We shall arrange payment within ten (10) days to comply with 5/10, Net 30 terms. Please send all commercial and financial documents along, with goods. We reserve the right to reject the goods if received late.

Yours faithfully,

Manish Singh

Purchase Manager,

Color world

****

Complaint Letter

A Complaint Letter is a type of letter written to address any type of wrong-doing, offence, grievance, resentment arising out of a product, service, etc. It is used to raise your concern about unfair things and seek a productive outcome. It is a fundamental right and duty of a citizen to seek justice arising out of any injustice, and the first step toward it is, filing a Complaint. It inspires other troubled consumers, influences the concerned authorities to take proper action and makes the defaulters more liable, responsible and responsive.

It can be of the following types-

Personal Complaint letter- The type of complaint letter you write on your own individual level pertaining to your individual grievances is referred to as personal complaint letter.

Professional Complaint letter- It is that type of complaint letter that is written on the behalf of the organisation pertaining to issues that are affecting the organisation as a whole.

Format of a Complaint Letter

- ✓ SENDER's ADDRESS- The sender's address is usually put on the top left-hand corner of the page.
- ✓ DATE- The sender's address is followed by the date just below it, i.e. on the left side of the page. This is the date at which the letter is being written. It is to be written in expanded form.
- ✓ RECEIVER's ADDRESS- Whether to write "To" above the address depends on the writer's preference. Make sure you write the title/name/position etc of the receiving official, as the first line of the address.
- ✓ SALUTATIONS- This is where you greet the person you are addressing the letter to. Bear in mind that it is a formal letter, so the greeting must be respectful and not too personal. The general greetings used in formal letters are "Sir" or "Madam".
- ✓ SUBJECT- Then we sum up the purpose of writing the letter in one line. This helps the receiver focus on the subject of the letter in one glance. It is important to underline the subject.

- ✓ BODY- This is the main content of the letter. It is either divided into three paragraphs or two paragraphs if the letter is briefer. The tone of the content should be formal. Do not use any offensive language. Another point to be kept in mind is that the letter should be concise and to the point. And always be respectful and considerate in your language. It should include-

- ✓ Short introduction paragraph- Provide details about the product or service that is the subject of the complaint. Include dates, location and the specifications about the item or service.
- ✓ State the issue with item or service. Provide details as to the cause. This may include malfunction, billing issues, details that were not disclosed, etc.
- ✓ Indicate how you would like them to resolve your problem. Provide specifics about what you're seeking.
- ✓ Indicate you are including copies of transaction document.
- ✓ Indicate you look forward to their reply within a specific time period.
- ✓ Indicate that they can contact you about the issue and provide your contact details
- ✓ COMPLIMENTARY CLOSE- At the end of your letter, we write a complimentary closing. The words "Yours Faithfully" or "Yours Sincerely" are used.
- ✓ SIGNATURE- Here finally you sign your name. And then write your name in block letters beneath the signature followed by your designation. This is how the recipient will know who is sending the letter.

Example:

QUESTION: **Write a letter to M/s. Oxford Publishing House, London complaining that the books sent by them were not those you had ordered for. Ask for replacement. You are Varun Joshi, Sector-20, Chandigarh.**

Examination Hall
Sector-20, Chandigarh

February 20, 2019

M/s. Oxford Publishing House
Consumer Complaint Division
London

Subject- Complaint regarding receipt of wrong set of books.

Sir/Madam

On February 1, 2019 I bought a book set (Order No. 000154) to be delivered to Chandigarh, Sector-20.

To my dismay, I have not received the set I ordered for and have instead, received the wrong book set. I am highly disappointed.
To resolve the problem, I would appreciate it if you could replace the wrong book set with the one originally ordered. Please let me know as soon as possible what action you propose to take.I look forward to hearing from you within the next ten days.

Enclosed are copies of the transaction document and the receipt.
I look forward to your reply and a resolution to my problem and will wait until the aforementioned time before seeking help from a consumer protection agency or the Better Business Bureau. Please contact me at the above address or by phone at 098100XXXXX.

Sincerely,
Varun Joshi
Enclosure(s)- Copy of receipt and transaction docs.

QUESTION: **You are Sanjeet of 122, Arjun Nagar, New Delhi. A number of scooters and cars are parked in your locality without any order, causing blockage of the streets. Write a letter to the local Secretary of the Resident's Association complaining against this problem.**

Answer:
122, Arjun Nagar
New Delhi

February 20, 2019

Secretary
Resident's Association
New Delhi

Sir

Subject- Complaint regarding the issue of bad parking habits in the locality.

I would like to drive your attention to the bad parking habits of residents in our locality. It is resulting in a lot of chaos and no place for parking for those who come back late.

Despite defining the area assigned to each vehicle, cars are parked amidst two parking spots. One vehicle occupies the space for 2-3 vehicles leading to mismanagement. Two-wheelers are placed nowhere near the allotted zone. This creates problem for other people as they have to then spend a lot of time finding parking spots in other localities. It induces frustration and tension for safety of vehicles.

Various notices and warnings have been given to the rule-violators, but to our dismay, no betterment can be seen. I request you to take strict action as this is leading to fights between the residents. An effective and speedy action is expected considering the depth of the situation.

Yours Sincerely
Sanjeet

****

Chapter-8
Cover Letter
(Job Application along with C.V.)

Cover letters are one of the most simple but difficult letters to write. Many students find it difficult to write about themselves. Sometimes the task is easier when you start off writing as if you were talking to a friend rather than a potential employer. Once the content is down then you can work to make it more professional and tailored to a professional audience.

Cover letters are your opportunity to write something personal and meaningful, rather than simply documenting information like on a resume. It is an opportunity for you to express your values, interest, and level of professionalism as well as your knowledge of the company. You can use the cover letter to convey specific examples of your accomplishments and experience.

Guidelines:

1. Always address your cover letter to an actual person, rather than "to whom it may concern". If you have put an honest effort in to seeking a contact name and are unable to find one then an acceptable compromise would be to address it to the head of the human resource department.

2. Always follow the standard format unless the employer requests specific information.

3. Most cover letters are written in block letter style. Single spaced with double space between paragraphs.

4. Standard letter format spacing is important. It shows the employer you know how to write a professional letter. Follow the sample provided.

5. Keep your cover letter to one page, unless the employer has requested additional information that would require additional pages.

6. Minimize I statements. (ex. I am very interested in this position because I would be a great fit).

7. Use a warm and energetic tone, but be confident. (rather than stating "I think I would be a good fit for this position because…" , state, " I would be great fit for this position because…".)

8. Use positive words such as: excitement, enthusiasm, interest.

9. Be authentic but be careful of cliché's such as "Ever since I was a little girl, I've always loved animals"

10. Always focus on what you have to offer them, not what they have to offer you.

11. Use the same header, font size and font style as your resume. Print the same high grade paper as your resume.

12. Don't forget to sign your letter.

Curriculum vitae

A curriculum vitae, often shortened to CV, is a Latin term meaning "course of life." A CV is a detailed professional document highlighting a person's experience and accomplishments. Employers often require a CV when considering applications. This document shares an overview of your career history, education, relevant awards and honors, scholarships, grants, research, projects and publications.

A CV may also include professional references, as well as coursework, fieldwork, hobbies and interests relevant to your profession. You might also choose to add a personal profile that lists your skills and positive attributes to ensure employers have a well-rounded view of your personality and achievements.

CV should include the following:

- ✓ **Contact information**. Include your full name, address, phone number and email address.
- ✓ **Academic history**. List all schooling from high school through postdoctoral (if applicable). Include the title of the degree you earned, the year you graduated and the name of the school.
- ✓ **Professional experience**. Include the organization where you worked, the job title, the dates you were employed and a summary of your experience and achievements.
- ✓ **Qualifications and skills**. List a combination of hard and soft skills you've developed throughout your career.

- ✓ **Awards and honors**. For each award, add the name, year received, the organization that gave you the award and any pertinent details (such as how often it's presented).
- ✓ **Publications and presentations**. For publications, provide a full citation including your co-authors, date, summary, volume, page, DOI number. For presentations, provide the title, date and venue where you presented.
- ✓ **Professional associations**. List the organization's name, location or chapter and the dates of active membership.
- ✓ **Grants and scholarships**. Provide the name of the grant or scholarship, date awarded and the institution that provided the award.
- ✓ **Licenses and certifications**. Include the name of the license or certificate, the date you earned it and the institution that awarded it.

CV Format

Three CV format types. All three types of CVs should include the above information. The primary difference between formats is the order of these elements.

1. Chronological

-This is the most common type of CV. For a chronological CV, list your academic history and professional experience first after your contact information. This type of CV focuses largely on your academic and professional experience.

Contact information
Academic history
Professional experience
Qualifications and skills
Awards and honors
Publications and presentations
Grants and scholarships
Licenses and certifications
Professional associations

A chronological CV is best if you have consistent employment within the same industry, and your work experience displays advancement within your field.

2. Functional

-This CV format places more emphasis on your skills, awards and honors. If you are writing a functional CV, you should place your relevant skills near the top under your contact information. In a functional CV, you will allocate more space to your qualifications, skills, awards and honors and less space to your professional experience. Here are the sections you should include:
Contact information
Qualifications and skills
Awards and honors
Academic history
Professional experience
Publications and presentations
Grants and scholarships
Licenses and certifications
Professional associations

A functional CV may be the right choice if you have recently graduated and are entering the job market for the first time, have multiple gaps in employment or you're changing careers.

3. Combination

-This CV type is a hybrid of the chronological and functional formats and allows adequate space for details about both your professional and educational history, as well as your skills and accomplishments. The elements you place first depend on your experience, career goals and what you believe is most relevant to the types of positions you're seeking.

For example, if you're hoping to earn a teaching position at a university and you've spent the past ten years as an educator, you should list your professional background first.

Example:
Question 1:
India Assurance Company, New Delhi has given an advertisement in 'The Hindustan Times' for the recruitment of management trainees to be groomed as managers of their company. Apply for the same, giving your detailed bio-data (curriculum vitae). Invent all necessary details. You are Aman/Aditi, 54-A, Gulab Road, Lucknow.
Answer:
54-A, Gulab Road

Lucknow

10 March 20XX

The Personnel Manager

India Assurance Company

New Delhi.

Sub: Recruitment of Management Trainee

Sir,

With reference to your advertisement in The Hindustan Times dated 5th March 20XX for management trainees to be groomed as managers for your company, I would like to be considered for the said post. My Bio-data is enclosed for your perusal and consideration. If I am found suitable, I can appear for the interview at any time suitable to you. In case of selection, I assure you of my unstinted co-operation and devotion in the discharge of my duties.

Yours faithfully,

Aditi

(Aditi)

Encl.: Bio-data

Curriculum vitae

Name Aditi Kukreja

Father's Name Prof. S.N. Kukreja

Address 54-A, Gulab Road, Lucknow

Date of Birth 7th August 1975

Educational Qualifications

- B.Com., Delhi University
- MBA from Symbiosis, Pune
- Diploma in Computer Application from NUT, Lucknow

Experience 1 year

Present Employment Working with Global Telesystems, Lucknow

Marital Status Unmarried

Personal Details

- Age 27 years
- Height 5′-3
- Weight 60 kg
- Mother Tongue- Hindi 'Languages
- known- English, Punjabi, French
- Hobbies- Reading, Listening to music, Painting

References 1. Professor Suresh Mohan, IT College, Lucknow

2. Professor Kapil Ranjan, Symbiosis, Pune

**********END OF UNIT-4**********

Unit-V

ELEMENTS OF COMMUNICATION

A. Introduction to Communication

Definition: The Communication is a two-way process wherein the message in the form of ideas, thoughts, feelings, opinions is transmitted between two or more persons with the intent of creating a shared understanding.

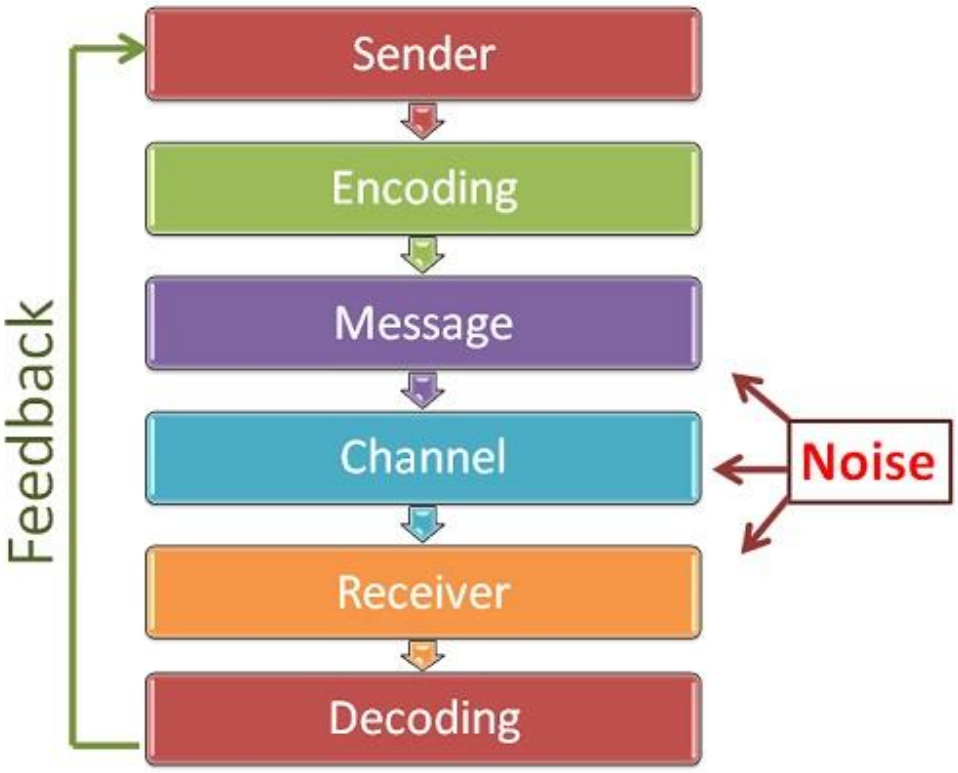
an act of conveying intended information and understanding from one person to another is called as communication. The term communication is derived from the Latin word "Communis" which means to share. Effective communication is when the message conveyed by the sender is understood by the receiver in exactly the same way as it was intended.

Communication Process

The communication is a dynamic process that begins with the conceptualizing of ideas by the sender who then transmits the message through a channel to the receiver, who in turn gives the feedback in the form of some message or signal within the given time frame. Thus, there are Seven major elements of communication process:

1. **Sender:** The sender or the communicator is the person who initiates the conversation and has conceptualized the idea that he intends to convey it to others.
2. **Encoding:** The sender begins with the encoding process wherein he uses certain words or non-verbal methods such as symbols, signs, body gestures, etc. to translate the information into a message. The sender's knowledge, skills, perception, background, competencies, etc. has a great impact on the success of the message.
3. **Message:** Once the encoding is finished, the sender gets the message that he intends to convey. The message can be written, oral, symbolic or non-verbal such as body gestures, silence, sighs, sounds, etc. or any other signal that triggers the response of a receiver.
4. **Communication Channel:** The Sender chooses the medium through which he wants to convey his message to the recipient. It must be selected carefully in order to make the message effective and correctly interpreted by the recipient. The choice of medium depends on the interpersonal relationships between the sender and the receiver and also on the urgency of the message being sent. Oral, virtual, written, sound, gesture, etc. are some of the commonly used communication mediums.
5.

6. **Receiver:** The receiver is the person for whom the message is intended or targeted. He tries to comprehend it in the best possible manner such that the communication objective is attained. The degree to which the receiver decodes the message depends on his knowledge of the subject matter, experience, trust and relationship with the sender.
7. **Decoding**: Here, the receiver interprets the sender's message and tries to understand it in the best possible manner. An effective communication occurs only if the receiver understands the message in exactly the same way as it was intended by the sender.
8. **Feedback:** The Feedback is the final step of the process that ensures the receiver has received the message and interpreted it correctly as it was intended by the sender. It increases the effectiveness of the communication as it permits the sender to know the efficacy of his message. The response of the receiver can be verbal or non-verbal.



Communication process diagram

One-Way and Two-Way Communication

One-way communication is where there is no facility and/or expectation of a reply or feedback. An advertisement or notice on a board is an example. Its advantages are that is simple, quick and cheap. However, it allows no clarification or opportunity to correct inaccuracies and this may cause frustration in the receiver. It is often associated with authoritarian leadership and downward channels of communication.

Two-way communication is more time-consuming because the receiver has the opportunity to feedback and to question what has been said or written. The receiver is invited to contribute to the process so this kind of communication is often associated with democratic forms of leadership. If the message is complex, two-way communication is far more effective, and probably accurate, than one-way communication.

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B. Professional Communication

The term professional communication refers to the various forms of speaking, listening, writing, and responding carried out both in and beyond the workplace, whether in person or electronically. From meetings and presentations to memos and emails to marketing materials and annual reports, in business communication, it's essential to take a professional, formal, civil tone to make the best impression on your audience, whether its members be your colleagues, supervisors, or customers.

Types of Professional Communication

Formal - this may be through email, memos, company reports, team meetings, letters, strategy documents and so on. These communications are processed through the formal organization structure and are sanctioned by the organization itself.

Informal - this may be either verbal or non-verbal. It may be communicated through social / group gatherings, or perhaps, simply through the company 'gossip' or the company 'grapevine'. These channels are regarded as 'unofficial' as they are not established by the organization.

Communication Network

Meaning of Communication Network:

The routes or paths through which communication takes place are called ‘channels’ and the sum total of the channels is known as ‘communication network’. It refers to the pattern of channels of communication between the participants.

A communication network refers to how information flows within the organization. Information within an organization generally flows through a system, rather than being a free flow. This means that the flow of information is managed, regulated. and structured.Communication networks may be formal or informal..

Formal Communication Network – A formal communication network is one which is created by management and described with the help of an organizational chart. An organizational chart specifies the hierarchy and the reporting system in the organization. Therefore, in a formal network, information is passed on only through official channels such as memos, bulletins and intranet (email within the organization).

The organizational chart implies that information can flow in any of three directions – vertically, i.e., upward or downward, and horizontally.

1. **Upward Communication** – This may be defined as information that flows from subordinates to superiors. Some of the reasons for upward communication include discussing work related problems, giving suggestions for improvement and sharing feelings about the job and co-workers.

This type of communication has both benefits and disadvantages. One of the biggest benefits is problem-solving. Once a subordinate has brought a problem to his superior's notice, chances are that the problem will not recur, since the subordinate learns from his superior how to tackle it the next time. Thus, his ability to solve new problems and therefore his managerial ability, improves. Another benefit that could arise from upward communication is that valuable ideas and suggestions may sometimes come from lower level employees. Therefore organizations should encourage this kind of communication.

A third benefit is that employees learn to accept the decisions of management and thereby work as a team.

The biggest problem associated with this type of communication is that it may lead to "handing down" of decisions by superiors. When subordinates frequently seek the superior's guidance, the latter may adopt an authoritarian approach and merely give instructions, disregarding the subordinate's opinion completely.

2**. Downward Communication** – This may be defined as information that flows from superiors to subordinates. The most common reasons for downward communication are for giving job instructions, explaining company rules, policies and procedures and giving feedback regarding job performance. A number of studies have indicated that regular downward communication in the form of feedback given to employees is the most important factor affecting job satisfaction. Therefore organizations today are trying to encourage more of this type of communication.

There are both benefits and disadvantages associated with this type of communication. Downward communication that provides regular feedback will be beneficial if the feedback or review of performance is constructive. A constructive review is one where a manager "counsels" an employee, or advises him on how to improve his performance. On the other hand, a destructive review can

destroy employee morale and confidence. Regular downward communication also creates a climate of transparency or openness, where information is passed on through official channels, rather than through rumors.

Thirdly, downward communication boosts employee morale, since it indicates that management is involved in their progress.

The problems with this type of communication are the danger of doing destructive reviews, as mentioned, and that of "message overload." This means that superiors many sometimes burden their subordinates with too many instructions, leading to confusion.

3. **Horizontal Communication** – This type of communication is also known as "lateral" communication. It may be defined as communication that takes place between co-workers in the same department, or in different departments, with different areas of responsibility. For example, Sales Managers and Advertising Managers in the Marketing department, or Marketing Managers and Finance Managers.

The reasons for this type of communication are for coordination of tasks, sharing of information regarding goals of the organization, resolving interpersonal or work related problems and building rapport.

The biggest potential benefit of horizontal communication is the sense of teamwork that is created. Regular communication of this type ensures that all co-workers work together towards achieving a common goal in the overall interest of the organization. The biggest potential problem is that conflicts such as ego clashes are bound to arise, when co-workers at the same level communicate on a regular basis.

Informal Communication Network – Another name for informal networks is the "grapevine". In this type of network, information does not flow in a particular direction, as we have seen with formal networks. The information is also not passed on through official channels such as memos, notices or bulletin boards. The information need not be circulated within the organization, but could be passed on outside the work environment, wherever co-workers or colleagues meet socially. Thus, informal networks are based more on friendship, shared personal or career interests.

Example – Co-workers may meet outside the work environment at a company picnic, party or a car pool and discuss areas of common interest that may or may not be work related. Information may then be passed on to each other about happenings in the company, such as layoffs, the company's plans for acquisitions and so on.

This type of informal network is not just for idle rumors and may be useful in many ways. First of all, it sometimes fills in the "transparency gaps" left by formal networks. Such gaps usually occur during times of crisis such as strikes or layoffs. The strikes and layoffs may not be officially announced. Secondly, it may help to confirm important information, such as the fact that the company is going in for a major acquisition. Thirdly, the grapevine can be used for a constructive purpose by the organization.

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C. Barriers to Communication

Barriers to communication will reduce productivity within the firm and, if serious, may cause diseconomies of scale in a firm. Barriers to communication are often referred to as 'noise'. Noise is anything that gets in the way of effective communication and 'blocks' or distorts the message.

This may be physical noise e.g. a lawnmower outside of the classroom window. However, it can be many other factors. Attitudes and beliefs, bigotry and experience will affect the perception of a message. If you believe your boss is always out to 'put you down', and she suggests extra training, this may be perceived as a punishment or threat, even if it is intended simply to make you more effective.

Other factors creating 'Noise' may include:

Distance, different time zones
Language or jargon that is not understood by the recipient
The corporate culture may not promote the sharing of communication
Information overload - receivers cannot cope with the volume
Time e.g. different time zones
Stress
Poor resources e.g. limited access to technology
Preconceptions
Past experience
Lack of education and training
Poor selection of medium of communication

Types of Communication Barriers

1) Environmental Barrier
2) Semantic Barrier
3) Organizational Barrier
4) Cultural Barrier
5) Psychological Barrier
6) Individual Barrier

1. Physical Barriers to Communication

i.Distance – When two persons are at a distance apart, one cannot hear other's voice clearly. The poor person in Chennai and poor person in New-york will not contact each other through telephone with the fear of telephone bill.

ii. Lack of time – If the superior is very much busy, then he will not have time to meet subordinates due to lack of time.

iii. Noise – Too much noise will make men not able to hear the news.

iv. External disruptions – High Temperature and high humidity make men uneasy and so they may not be in a good mood to get information.

v. Organisational blocks – Two persons in different organisation cannot contact each other whenever they want.

2. Semantic Barrier

Semantic refers to the relationship of signs to their reference. It is the study of meaning in language. The words usually have a variety of meanings and the sender and the receiver have to choose one meaning from among many. The Oxford English Dictionary show an average of over 25 different meanings for each of the 500 most frequently used words in the English language. When two individuals attach different meanings to a word, a breakdown in communication can occur. The use of jargon can also create a barrier to communication.

3. Organizational Barrier

The Pictures are visual aids worth thousand words. An organisation uses extensive use of picture like blueprints, charts, maps, and films. A viewer may come to know the whole story when he sees themes. Sometimes picture may create confusion in the mind of an observer.

This depends upon the general organisational policy governing the communication network of the organisation. Such policy might be a written text explaining various aspects of communication, especially the upward, downward and lateral since it is desirable to bring an effective communication flow in the organisation.

The barrier on this aspect is given below:

i. Restrictions Imposed by Rules of Organisation

ii. Status/Hierarchical Positions Restrict the Flow of Communication

iii. Complex Situation of the Organisation

4. Cultural Barrier

- As the world is getting more and more globalized, any large office may have people from several parts of the world. Different cultures have a different meaning for several basic values of society. Dressing, Religions or lack of them, food, drinks, pets, and the general behaviour will change drastically from one culture to another.

Hence it is a must that we must take these different cultures into account while communication. This is what we call being culturally appropriate. In many multinational companies, special courses are offered at the orientation stages that let people know about other cultures and how to be courteous and tolerant of others.

5. Psychological Barrier

- Communication will be disrupted if state of mind of both sender and receiver of communication is not in an ideal position.

(a) Premature evaluation – If a person has pre-conceived notions against the communication, then he will evaluate the meaning of message before the sender completes his message.

(b) Loss by transmission and poor retention – Successive transmission of the message results in inaccurate information. Usually people cannot retain the information for long time if they are inattentive or not interested.

(c) Lack of attention – Non-listening of message due to pre-occupied mind of the receiver acts as a major psychological barrier.

6.Individual Barrier

- This barrier is created by the sender and receiver are known as individual barriers. This type of Barriers relates to the factors that are personal to the sender and receiver and act as a hindrance in the communication process. If a superior thinks that an exacting communication may negatively affect his authority, he may restrain such communication.

Such barriers include the following:

- Differences in personality
- Perceptual differences
- Fear
- Stereotyping
- Lack of Awareness
- Lack of Confidence in Subordinates
- Ignoring Communication

Measures which can be used to overcome the barriers of communication are:

(a) Clarify the ideas before communication – Before communicating to employees, a manager should make an analysis of the subject matter/problem. The purpose of communication must be very clear.

(b) Consult others before communicating – A manager while making plan for communication should encourage participation of subordinates which will ensure their support and cooperation.

(c) Communicate according to the needs of receiver – First of all, the understanding level of employees should be considered and then adjustments be made in communication by the manager.

(d) Be aware of languages, tone and content of message – Language, tone and content of message should be so adjusted according to the situation that it is easily understood by the receiver and stimulates them.

(e) Convey things of help and value to listeners – To get good response from the subordinates, it should be ensured that the message relates to their interests.

(f) Ensure feedback – For success of communication, response of the listeners should be encouraged by the manager.

(g) Communicate for present as well as future – For communication to be successful, managers should incorporate existing commitments as well as future goals of the organization.

(h) Follow up communication – Sometimes it is difficult to implement instructions in totality by the subordinates. To overcome this, regular follow up should be done by managers.

(i) Be a good listener – Lot of problems can be solved due to attentive listening quality of the manager.

D. Non- Verbal Communication

Definition: The Non-Verbal Communication is the process of conveying meaning without the use of words either written or spoken. In other words, any communication made between two or more persons through the use of facial expressions, hand movements, body language, postures, and gestures is called as non-verbal communication. The Non-Verbal Communication, unlike the verbal communication, helps in establishing and maintaining the interpersonal relationships while the verbal's only help in communicating the external events. People use non-verbal's to express emotions and interpersonal attitudes, conduct rituals such as greetings and bring forward one's personality.

The non-verbal communication in the form of signals, expressions add meaning over the verbals and help people to communicate more efficiently. It supplements whatever is said in words, such as people nod to acknowledge and move their hands to give directions.

1. Facial Expressions

Facial expressions are responsible for a huge proportion of nonverbal communication. Consider how much information can be conveyed with a smile or a frown. The look on a person's face is often the first thing we see, even before we hear what they have to say.

While nonverbal communication and behavior can vary dramatically between cultures, the facial expressions for happiness, sadness, anger, and fear are similar throughout the world.

2. Gestures

Deliberate movements and signals are an important way to communicate meaning without words. Common gestures include waving, pointing, and using fingers to indicate numeric amounts. Other gestures are arbitrary and related to culture.

In courtroom settings, lawyers have been known to utilize different nonverbal signals to attempt to sway juror opinions. An attorney might glance at his watch to suggest that the opposing lawyer's argument is tedious or might even roll his eyes at the testimony offered by a witness in an attempt to undermine his or her credibility. These nonverbal signals are seen as being so powerful and influential that some judges even place limits on what type of nonverbal behaviors are allowed in the courtroom.

3. Paralinguistic

-Paralinguistic refers to vocal communication that is separate from actual language.

This includes factors such as tone of voice, loudness, inflection, and pitch. Consider the powerful effect that tone of voice can have on the meaning of a sentence. When said in a strong tone of voice, listeners might interpret approval and enthusiasm. The same words said in a hesitant tone of voice might convey disapproval and a lack of interest.

Consider all the different ways that simply changing your tone of voice might change the meaning of a sentence. A friend might ask you how you are doing, and you might respond with the standard "I'm fine," but how you actually say those words might reveal a tremendous amount of how you are really feeling.

A cold tone of voice might suggest that you are actually not fine, but you don't wish to discuss it. A bright, happy tone of voice will reveal that you are actually doing quite well. A somber, downcast tone would indicate that you are the opposite of fine and that perhaps your friend should inquire further.

4. Body Language and Posture

Posture and movement can also convey a great deal of information. Research on body language has grown significantly since the 1970s, but popular media have focused on the over-interpretation of defensive postures, arm-crossing, and leg-crossing.

5. Proxemics

People often refer to their need for "personal space," which is also an important type of nonverbal communication. The amount of distance we need and the amount of space we perceive as belonging to us is influenced by a number of factors including social norms, cultural expectations, situational factors, personality characteristics, and level of familiarity.

For example, the amount of personal space needed when having a casual conversation with another person usually varies between 18 inches to four feet. On the other hand, the personal distance needed when speaking to a crowd of people is around 10 to 12 feet.

6. Eye Gaze

The eyes play an important role in nonverbal communication and such things as looking, staring and blinking are important nonverbal behaviors. When people encounter people or things that they like, the rate of blinking increases and pupils dilate. Looking at another person can indicate a range of emotions including hostility, interest, and attraction.

People also utilize eye gaze as a means to determine if someone is being honest. Normal, steady eye contact is often taken as a sign that a person is telling the truth and is trustworthy. Shifty eyes and an inability to maintain eye contact, on the other hand, is frequently seen as an indicator that someone is lying or being deceptive.

7. Haptics

Communicating through touch is another important nonverbal behavior. There has been a substantial amount of research on the importance of touch in infancy and early childhood. Touch is also often used as a way to communicate both status and power.

Researchers have found that high-status individuals tend to invade other people's personal space with greater frequency and intensity than lower-status individuals.

8. Appearance

Our choice of color, clothing, hairstyles, and other factors affecting appearance are also considered a means of nonverbal communication. Research on color psychology has demonstrated that different colors can evoke different moods. Appearance can also alter physiological reactions, judgments, and interpretations.

Culture is an important influence on how appearances are judged. While thinness tends to be valued in Western cultures, some African cultures relate full-figured bodies to better health, wealth, and social status.

9. Artifacts

Objects and images are also tools that can be used to communicate nonverbally. On an online forum, for example, you might select an avatar to represent your identity online and to communicate information about who you are and the things you like. People often spend a great deal of time developing a particular image and surrounding themselves with objects designed to convey information about the things that are important to them.

Uniforms, for example, can be used to transmit a tremendous amount of information about a person. A soldier will don fatigues, a police officer will wear a uniform, and a doctor will wear a white lab coat. At a mere glance, these outfits tell people what a person does for a living.

Kinesics in Communication

-Kinesic communication is communicating by body movement and is perhaps the most well-known non-verbal form of communication, although it is not the only way to talk with others without words.

1. Body posture

The way that the body is held can communicate many different messages.
An open body that takes up a lot of space can indicate comfort and domination, whilst a closed-in body that makes itself small can signal inferiority.
Copying of the other person's body shows agreement, trust and liking.

2. Gestures

Gesture is communicating through the movement of body and arms.
Ekman and Friesen (1969) identified five types of gesture:

- Emblems: Direct replacements for words.
- Illustrators: Shaping what is being said.
- Affect displays: shows of emotion.
- Regulators: for controlling the flow of conversation.
- Adaptors: Self-oriented tension relievers and other forms.

3.Facial signals

-When we communicate with others, we look mostly at their face. This is not a coincidence as many signals are sent with the 90-odd muscles in the face. The way the head tilts also changes the message.

4.Occulesics:

-The eyes are particularly important, and when communicating we first seek to make eye contact. We then break and re-establish contact many times during the discussion.
Eyebrows and forehead also add significant signals, from surprise to fear to anger.
The mouth, when not talking can be pursed, downturned or turned up in a smile.

Proxemics is a theory of non-verbal communication that explains how people perceive and use space to achieve communication goals. Introduced by anthropologist Edward T. Hall in the 1960s, the theory emerged from studies of animal behavior conducted in the 19th and early 20th centuries. Just as animals use urine and physical posturing to define their territory, Hall posited, so do humans use personal space and concrete objects to establish theirs. Proximity is communicated, for instance, through the use of space, distance, touching, and body position. The use of space, the physical distance between people, and the options for touch are closely related and culture specific.
These include:

- Intimate distance (0-2 ft.)
- Personal distance (2-4ft.)
- Social distance (4-12 ft.)
- Public distance (>12 ft.)

1.Intimate distance is that which is used for very confidential communications. This zone of distance is characterized by 0 to 2 feet of space between two individuals. An example of intimate distance is two people hugging, holding hands, or standing side-by-side. People in intimate distance share a unique level of comfort with one another. Those who are not comfortable with someone who approaches them in the intimate zone will experience a great deal of social discomfort or awkwardness.

2.Personal distance is used for talking with family and close friends. Although it gives a person a little more space than intimate distance, it is still very close in proximity to that of intimacy, and may involve touching. Personal distance can range from 2 to 4 feet. Like intimate distance, if a stranger approaches someone in the personal zone, he or she is likely to feel uncomfortable being in such close proximity with the stranger.

3.Social distance is used in business transactions, meeting new people and interacting with groups of people. Social distance has a large range in the distance that it can incorporate. From 4 to 12 feet, it is clear that social distance depends on the situation. Social distance may be used among students, co-workers, or acquaintances. Generally, people within social distance do not engage in physical contact with one another.
People may be very particular about the amount of social distance that is preferred. Some people may require much more physical distance than others. Many times, if a person comes too close to another individual, the individual is likely to back up and give himself the amount of space that he feels more comfortable in.

4. **Public distance** is measured at 12 or more feet between persons. An example of this is when two men sit far apart on a park bench, in order to preserve their public distance.

Language of Signs and Symbols (Audio Sign and Visual Sign in everyday life with merits and demerits)

Non verbal communication refers to the communication that makes use of sign language and body language understood by both the parties to communicate a message. Sign Language can be further divided into Visual Signals and Audio Signals. However, apart from body and sign language, the voice of the communicator, the environment, surroundings, colours,timing of the message communicated plays a crucial role in making nonverbal communication an effective one.

Sign Language

Visual Signals

Signs do not belong to any particular language but are common to almost all regions in the world. As goes the cliché, ‘A picture is worth a thousand words’. Sign language expressed through body movements is highly effective in many types of communication. Signs and symbols have greater reach to people of all ages than words, as education is not required for understanding visual signals. Some common examples for signs and symbols are the traffic lights and indications, symbols used in public toilets and roads etc.

Advantages of Visual symbols and signals

1. Visual representation of brands has more reach to the targeted audience than words. They make good tools for advertising products and services
2. Visual representation of ideas minimize the cost since they occupy minimal space in the area planned for advertising
3. Visual symbols and signs attract the interest of the users and motivate customers to go in for the brand
4. Visual representation brings out the background and principles of the communicator in a perfect manner

Audio Signals:

Audio Signals and signs play a crucial role in Non Verbal Communication. Audio Signals communicate the intended emotions in the form of sounds that are different for varying emotions. Some common examples for Audio signals are the Alarm clock which sets time for waking up and many other activities. Drumbeats, Fire Alarms, Work Shift Alarms, VIP Vehicle Alarms are some more examples for Audio signals that are commonly understood by people.

Key advantages of Sound signals

1. Sound signals convey the intended message to all concerned within short span of time
2. Sound Signals help people manage their time in an effective manner during different kinds of occasions
3. Sound Signals used in a typical factory or Industry setup acts as work initiators
4. Sound Signals used in vehicles like Ambulance helps the medical industry save lives at the appropriate times.

**********END OF UNIT-5**********



GOVERNMENT POLYTECHNIC
28/04/2020
SAMBALPUR (RENGALI), ODISHA

1. Computer Organisation :—
   → Introduction to computer education of computers. generation of computer.
   → classification of computer
   → Basic Organisation of computer (functionally block diagram.
   → Input and Output devices
   → computer memory and classification of memory

2. Computer software :—
   → Application software overview of operating system objectives and functions of O.S. Types of operating system.
   → software concept
   → system software
   → Batch processing.
   → Multiprogramming type
   → Features of Dos, windows and unix
   → Programming language computer interpreter computer virus.
   → Detection and prevention of virus.
   → Application of computer's in different domain.

3. Computer Network and Internet :—
   Networking concept.
   → Profectionaly communicating media
   → Data transmission mode

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Introduction of computer :—

(i) Computer is an electronic device which takes input process it and gives output to the user.

(ii) Desktop, personal computer, laptop and general purpose computers.

(iii) The home appliences, electronic gadgets are also computers if it is circuit containing programe is embarded into them.

Ex - Washing machine, digital camera
digital watch, Refrigerator
Microwave

Sealing fan is not a computer as it's not an electronic device but it an electrical device.
Mobile is also a computere

Hardware :—

Hardware is a comprehestive term for all the physical part of a computer as distinguished from the data it contains or operates on and the software that provides instruction for the device for the hardware to accomplish task.

Hardware is anything which is tengible in the computer system.

Software :—

Software are two types.

(i) Application software
(ii) System software

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System Software :—
It is for computer system, they might be software responsible to control hardware Or any back ground task.

Evolution of Computer :—

↳ Developement of the present day computer is the result of a advancement of technologies and the need of quantify calculation.

↳ Abacus was one of first counting device use for simple operation like addition, substraction, multiplication, division.

↳ In 1600 John nabier invented a calculating device called Napier's bone.

↳ Blase pascale invented pascaline in 1645 and it is used for only addition and substraction Lebinitz in 1671 improved the pascal's addition machine and invented the leibniz calculator.

↳ Charless babbage invented the ~~leibniz calculator~~ difference engine 1822. He was first person to design a fully programmable computer.

↳ Adanasoff - berry computer (ABC) was first purpose electronic computer was invented by Jb Adenasoff and C berry. It use a binary system of Arithmatic, parallel processing, regenerative memory and electronic circuit.

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Generation of Computers :—

1st generation (1942 - 1956) :—

↳ It is used vaccum tubes for circuitatory and magnetic drum for memory.

↳ They were very much expensive and anourmorous/ large.

↳ Input was based on punchcards and output was displayed on print-outs.

Ex :— ENIAC

(Electronic numerical integrator and calculator

UNIAC

Universal automatic Computer

IBM 701.

2nd generation Computers (1956-1964) :—

↳ Here Transistors replaced vaccum tubes and inplace of magnetic drum core technology was used, it is still relayed on punchcards for input and printout for Outputs.

Ex :— UNIAC — III

CDC 1604

Honeywell

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3rd generation (1964 - 1975) :-

↳ Here transistors we shrinked and placed on silicon chip called semiconductor which amazingly increased the speed and efficiency of computers.

↳ Here instead of punchcards and printouts, user interacted through keyboards and monitors and used operating system.

↳ For the first time computers became accessible a mass of audiance because they were smaller and cheap then their previous one.

Ex :- IBM360
PDP8
CDC6600

4th generation (1975 - 1989)

↳ Here ICs with VLSI technology were used. Here microprocessors are also used.

↳ Thousands of integrated circuits were onto a single silicon chip.

↳ In this generation Computers also shop the developemer of GUIs. (graphical user interface)

Ex - mouse and handhold devices.

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5th generation :— (1989 - present)

↳ ICs with ULSI technology are used here.

↳ This generation computing device based on artificial intelligence are still in development process.

Ex - PARAM 10000
IBM NOTEBOOK
PANTIUM PCs.

Classification of computer :—

The moderndays computers are broadly classified into

(a) Analog
(b) digital
(c) Hybrid

Analog :—

Analog computers operates on mathematical variable in the form of physical quantities that are continously varying.

These computers are mostly used in industries, in process control activity.

These computers works on Analog data such as variables in temprature, speed, voltage etc.

Advantages :—

The shows the solution in a simple and graphical in less time.

Disadvantages :—

They are not versatile or much accurate.

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Digital computer :—
They are the general purpose computer that works on digital or Binary field.

Advantages :—
Speed and accuracy of this computers are very high.

Disadvantages :—
The real time change required complex programming and graphical programmes.

Hybrid computer :—
These are computer that have features of both Analog and digital computer

These computer are used to control the entire process.

Based on processing capability :—
Computers are available in different shapes, sizes and weight due to this they performs different slots of job.

Supercomputer :—
These are most powerful computer. Super Computers play an important role in field of computational science and are used for a wide range of computationally intensive tasks or jobs in various fields including quantum mechanics, climate research weather forcasting

Mainframe Computer :—

These Computers can also process millions of instructions per seconds and capable of accessing billions of data

These computers have large primary memory and have substantial processing capabilities.

These computers are generally too expensive and are used in companies.

Mini Computers :—

These are the computers which are mostly used by the small types of business or universities.

They have fairly large primary memory that supports wide range of application area.

Workstation :—

It is a powerful desktop computer designed to meet the computing needs to engineers architectures and other proffessionals, generally unit Operating System or variation of it.

Operating system is generally designed to support multiuser environment.

Micro Computer :—

↳ It is the smallest & cheapest available for mass.

↳ These are portables and required minimum power.

↳ It processing power is appropriate for handeling most of the task.

Storage units :—

1 nibble = 4 bits

1 byte = 8 bits.

1 kilobyte = 1024 bytes.

1 megabyte = 1024 kilobytes

1 Gigabyte = 1024 megabytes.

1 terabyte = 1024 Gigabytes.

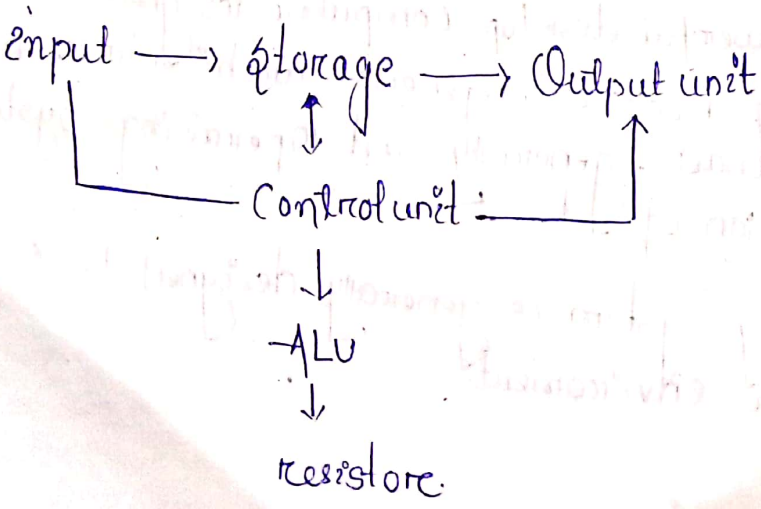
1 pitabyte = 1024 terabytes.

1 Exabyte = 1024 pitabytes

1 Zettabyte = 1024 exabytes.

1 yottabyte = 1024 Zettabytes.

Basic Organizations of Computer :—



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Input unit :-

↳ Computers need to receive data and instruction in Order to exicuit data and instruction any problems.

↳ The input unit consists of One Or more input device.

↳ The input device accept data and instruction and converts it to computer understandable form and then supply the converted data to the computer system for further processing.

Ex - mouse, Keyboard, punchcard, Cpu

Central processing unit (Control unit + ALU)

↳ The mainunit of inside the computer is Cpu.

↳ This unit is responsible for all events inside the computer

↳ It performs all calculations, takes all decisions and controls all units of the computer.

↳ Cpu contains Cu (control unit) which is responsible for all the activities like transfer of data, instructions etc between various subunit.

↳ Alu is the part where actual computation takes place.

↳ Resistors are small in size and are capable of storing few bits at a time

Output unit :—

↳ After the computer process data it needs to represent the result in a human understandable form.

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Input device :—

Input device is any hardware component that allows you to enter data programme.

There are various input devices.

Keyboard :—

The most common input device used by the computer are the keyboard.

The keyboard is a way to input letters, numbers, or special characters into programme.

It mainly contains 4 types of key.

The four types of keys are given below.

- Alphabet keys
- Function keys
- Control keys
- Numerical keys

(b) Mouse :—

It is an input device that is used to control the movement of pointer on the screen and to make selection from the screen.

(c) Optical mark reader :—

It is a special type of input device or scanning device which is used to read carefully placed pen or pencil marks on a OMR sheet.

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Scanner :—

It is an input device that Optically Scan image Or printed text and convert it to a digital image.

Magnetic ink character recognization :— (MICR)
It is a special type of input device that enables special character printed in magnetic ink to be read an input rapidly to a computer.

Output Device :—

In Order to communicate with computer and get the result we need computer devices like —

Monitor :—

The computer monitor (visual display unit) is the most common Output device. images are represented On monitor by individual dots. called pixel.

A pixel is the smallest unit On the Screen that can be turned On and off Or made different Shade.

Printer :—

A printer is an Output devices that produces hardcopy of a data. The resolution of a printer is expressed as DpI (dot per inch).

Micro computer uses five kinds of printer.

i) Dot matrix printer
ii) Deisywheel printer
iii) chain printer
iv) Ink-jet printer
v) Lasser printer

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Plotters :—
It is a special purpose Output devices that draws image with ink pen.

Computer memory :—
The computer memory is the part of the system use to store data and programme which may be permanently or temporarily depending on the requirement and type of memory.

Classification of computer memory :—
According to the purpose memory can be devided into 5 types.

i) Resistor memory (ii) Cache, primary or ~~secondary~~ memory, ~~Auxiliary~~ memory, Back up memory.

Resistor memory :—
It is integrated inside the C.P.U. Its memory capacity is small which is use for storing data temporarily during the exicution of a problem.

Cache :—
It is the smallest memory between CPU and main memory. It's purpose is to hold frequently needed data from the main memory dividing the execution.

Primary memory :—
It is the ~~primary~~ memory ~~between~~ in a computer which is use to store data and instruction during executing Programme.

The

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ROM – Read only Memory

ROM can be further divided (read only memory) 4 types.

P-ROM (programable ROM)

Ep-ROM (Erase programable ROM)

EEp- Electrically Erasable programmable ROM.

UVEPROM – Ultra Violet Erasable Programmable ROM

↳ ROM is mainly used to store small programmes permanently.

↳ This is non-volatile in nature

Auxillary memory Or Secondary memory :–

It is a memory where data Or programme are stored permanently this type of memory hold data until they are erased, hence this memories are none-volatile in nature. Generally magnetic materials Or Optical materials are used as Secondary memory.

For ex – Floppy disk

Hard disk

CD-ROM

Back up memory :—

This memory is used by the user for keeping backup of important data for future use

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Software Concept :—

A computer system mainly compraised of two catagory i.e,

i) computer hardware

ii) Computer software

↳ The tengible component of computers are refered as Computer hardware.

↳ Computer software refers to the set of programes which makes the hardware Operational. The computer software can be classified into 2 types. i.e,

(a) System software

(b) Application software

System Software :—

Software programes that are designed to control the Operation of computer hardware is known as System software.

↳ It provides a platform for installation and developement of application software.

↳ It facilited the exicution of a programme returnin high level language and also provides error free communication between the main computer system and attached peri-ferral device e.t.c.

↳ System software consists of low level and highlevel software that intract with the computer at a very basic level.

↳ Some common system software are Operating system
device drivers
utility programs
language processors

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↳ Operating system is responsible for managing the various computer software.

↳ language processor are the catagory of the system software which are responsible for translating and interploting the programe written by using programming level.

Ex - Compiler, Interpreter.

↳ Device driver are the system software which usually comes along with a perifferal device which is used to establish communication between the devices and computer.

↳ Utility programe is the programe that is directly capable of directly interact with computer hardware for various purpose.

Application software :—

↳ An application software is many programme or groups of programme that is use for the end user

↳ It includes such thing as data base programme, word processer and browser with spread sheet.

Overview of operating system :—

↳ An Operating system is an interface between a computer user and computer hardware.

↳ An Operating system is a software which performs all basic function like —

i) memory management
ii) processor management
iii) Device "
iv) File "
v) Error detecting
vi) Controlonere
System performance

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(viii) Co-ordination between other software or user.

Memory management :—

↳ It refers to management of primary memory or main memory. A main memory is a large array of words or bytes. Where each word or byte has its own address. For a programme to be execute it must me in the main memory. An operating system does some activities for memory management.

↳ Keeps tracks of primary memory i.e what part of it are in use by whom, what parts are not in use.

↳ Allocates the memory when a process requests it to do so.

↳ Deallocates the memory when a process no longer needs it or has been terminated etc.

Processor ~~mange~~ management :—

In multiprogramming enviroment the operating system decides which process gets the processer when and for how much time. This function is called as process ~~scheduling~~ scheduling.

An operating system does few activities for processor management

(i) Tracks of processor and status of process. The programe responsible for task is known as traffic Controller.

(ii) Allocates the processor to approches

(iii) Deallocates the processer when no longer required.

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Device management :—

↳ An Operating system manage device communication via their respective drivers.

↳ Operating system does like few activities for device-management like -

(i) Keeps tracks of all device programme responsible for ~~desktask~~ the tasks is known as input - Output Controller.

(ii) Decides which process gets the device when and for how much time.

(iii) ~~Thereby~~ Allocates the device in the efficient way

(iv) Deallocates the device.

File management :—

A filesystem is normally Organized into directries for easy navigation and uses.

This directories may contains files and other directories.

An Operating system does the few activities like keeps track of information, location, status etc.

This collective facility is often known as file system.

Decides who gets the resources.

Allocates the resources Or deallocates the resources.

Security :—

By means of password Or similar other ~~topics~~ techniques it prevents unauthorized access programmes and datas.

Production of dumps error message, and other debugging and errors

Control over system performance :—
Recording delays between request for a service and response from the system.

Co-ordination between other software, and users.

Co-ordination and assignment of compilers, interpreters, assemblers and other software to the various users of the computer system.

Objectives of Operating system :—
To make the computer system convenient to use in an efficient way.
It hides in an efficient way the detail of the hardware resources from the user.
To manage the resource of a computer system.

Types of Operating system :—
Real time Operating Operating
It was designed to respond to an event with in a pre-determined time.
It aims to execute real time application such as autopilot mechanism used in aircrafts.
It has very little user interphase capability and no end user

Ex - WinCE.

Single user Operating system :—
It is designed for one user two effectively use a computer in time.

Ex - Window95 2000

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Multi user Operating system :—

It allows many user to take advantage of the computer resources simultaneously.

It ensures the problem with one user doesnot affect the entire community of the user.

Ex – Unics Operating system
Linox etc.

Single tasking Operating System :—

It allows only a single programme to run at a time.

Ex :– Palm Operating system.

Multy tasking Operating system :—

It allows the execution of multiple tasks or application at one time.

Ex - Apple's mac Operating system.
Microsoft Windows.

Time sharing Operating system :—

It allows many user to share the computer resources simultaneously.

It provides advantages of quick response.

It reduces CPU idle time.

Distributed Operating System :—

It uses multiple central processers to serves multiple real-time applications.

It manages a group of independent Computers and makes them appear to a single computer.

Data processing jobs are distributed among the processors according to their efficiency.

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BIOS :—

It is a built in software that determines what a computer can do without accessing programme from a disk.

Time saving Operating system :—

Time sharing Operating system is a technic which enables many people located at various terminal to use a particular computer system simultaniously.

Time sharing Or multitasking is logical ~~expression~~ extension of multi-programming Operating system.

Processor's time which is said among multiple users simultaniously is termed as time sharing Operating System.

The main difference between multi-programe batch system and time sharing system is that incase of multi programme batch system the objective is to maximize Processor use where as in time sharing system the objective is to minimize response time.

Advantages :—

- It provide advantage of quick response.
- It avoids duplication of software.
- It reduces Cpu idle time.

Disadvantages :—

- Problem of reliability.
- questions of security and integrity of users programe data.
- Problem of data communication.

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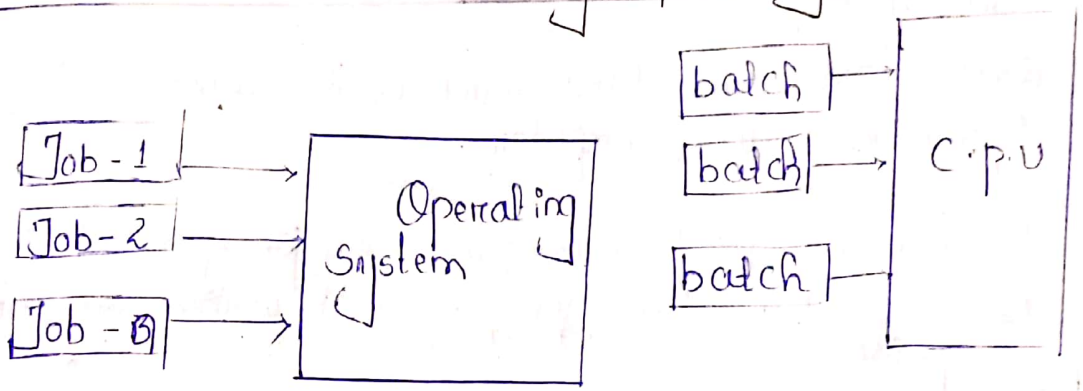
Batch Processing Operating system:-



Batch processing is a technic in which an Operating System collects the data and programe together in a batch.

Before processing starts. An Operating system does few activities related to batch processing like

(i) The Operating system defines a job which has pre-defined sequence of commands Programes and data as a single unit.

(ii) The Operating System keeps a no. of jobs in the memory and exicute them without any manual information.

(iii) Jobs are process as in the Order of Submission i.e 1st come 1st serve fashion.
when a job completes its exicution its memory is released and the Output for the job gets copied into an Output spool. for later Printing Or processing.

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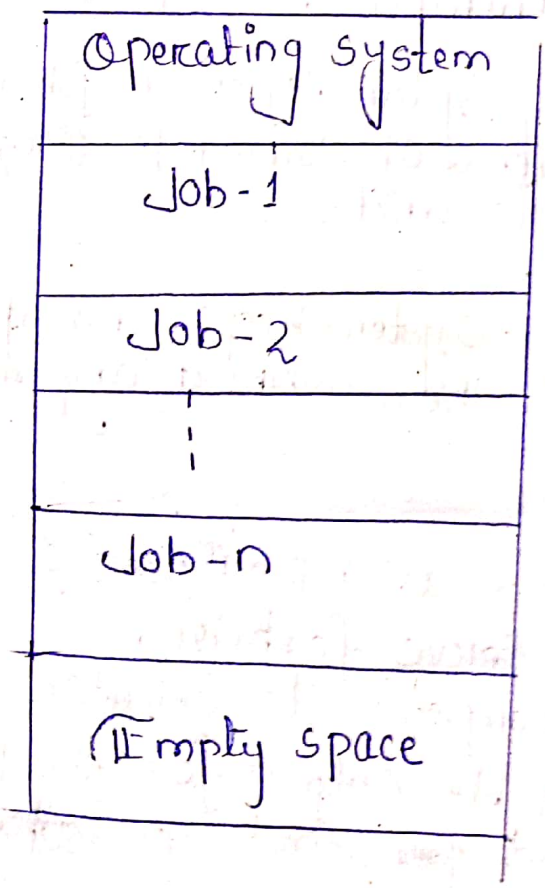
Advantages :-

- Batch processing takes much of the work of the Operator to the computer.
- It increased performance as a new job gets started as soon as previous job finished without any interruption.

Disadvantages :-

- Difficult to debug programme.
- A job could enter an infinite loop.
- Due to lack of protection scheme one batch job can effect pending job.

Multiprogramming



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sharing the processor when two or more programe resides the programe are the same time then it is referred as multi-programming.

Multi programming increases Cpu utilization by Organizing jobs so that Cpu always have one-two exhtcute

An Operating system does few activities related to multiprogramming.

(i) The Operating system keeps several job in memory at a time.

(ii) This set of job is a subset of jobs kept in the job pool.

(iii) The Operating system picks and begins to exhtcute one of the jobs in the memory.

(iv) Multiprograming Operating system monitors the state of all active programes and system resources using memory management programe to ensure that the Cpu is never idle unless there are no jobs to process.

Advantages :-

↳ High and efficient Cpu utilisation.

↳ Users feels that many programes are alloted Cpu almost simultaneously at the same time.

Disadvantages :-

↳ Cpu scheduling is required to accomodate many jobs in memory management is required.

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Features of DOS :- (Disk Operating System)

↳ It is the primary system where the user gets an environment about the input and Output device.
Ex - Monitor, Keyboard, printers etc.

↳ It is helpful in performing file management, like Creating, editing, deleting file etc.

↳ It is a single user Operating system. One user can Operate at one time.

↳ It is a characterbased interphase system.

↳ (Here we can type only letters and characters in this Operating system)

↳ It is a 16bit Operating system.

↳ It is an assembly language.

Feauture of UNIX Operating system :-

↳ It is written in 'C' and assembly language

↳ It is multi tasking with protected memory.

↳ Multiple users can run multiple programmes (Each at same time without interfacing with each other Or Crashing the system.

↳ Very efficient Virtual memory can run so many Progra with a modest amount of physical memory.

↳ Portability (It uses high level language that is easy comprehend, modified and transfer to other machines. We can change language Code according to the requirement of new hardware On your Computers.

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Disadvantages :-

↳ It is not very user friendly Operating system.

↳ It basic interface is command language. Even experienced user can make this mistake using the interface.

↳ It is machine independent means it hides the machine architecture from the user, making it easier to write application that can run on micro, mini and mainframe computers.

↳ The hubs of unix operating system. The kernel manages the application and peripheral on a system. together the kernel and shell carry out are requests and commands.

↳ We communicate without Our system through the unix shell which translate to the kernel.

Kernel :-

It is the centerpart of an Operating system. It manges the Operation of the Computers - (most portably memory and Cpu type)

Shell :-

↳ It is an environment in which we can run Our command programes and shell scripts.

↳ It provides us with an interface to the unix system.

↳ It gathers input from us an exicute programes based On the input.

Features of Windows :-

↳ It is speed Or fast.

↳ Compartable.

↳ hardware requirement.

↳ Search and Organisation.

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↳ Safe and Security
↳ Interface and desktop.
↳ task Or taskmenu

Advantages –
↳ It provides redimade solution. that can be implemented just about anyone whoever used a computer

↳ Using window in the working place is over 95% of all virus and mallicious software are written for the windows Operating system.

Feauture of linux :–
↳ Multitasking and Multiuser.
↳ Portable
↳ ~~Support~~ Virtual memory.

Compiler :–
↳ A programe that converts instructions (highlevel) into a machine Code Or lower level form so that they can be read and exicute by a computer.

Ex - MS. ~~Vid~~ Visual Studio.

Interpreter :–
Interprinter is a computer programme which exicutes a statement directly.

Ex - python, lisp.

Ocam - Objective Catagorical ~~obs~~ abstract machine language.

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2) Differenciate between compiler and Interpreter :—

Compiler	Interpreter
↳ It is a special type of programe that process statements written in a particular programming language and turns them into machine language.	↳ It is a special type of computer programe that directly exicutes instructions written in a programming language.
↳ It usually generates intermediate code in the form of object file.	↳ It doesn't creat an intermediate object file./code.
↳ Faster exicution of control statement as compared to the interprinter.	↳ Slower exicution of control statement as compared to compliere
↳ Detects error in the programe get displayed after the entire programe is read by compliere.	↳ Detected error in the programe get displayed after each instruction read by the interpriter.
↳ Ex – Ms-Visual studio, C++.	↳ Ex - python, lisp.

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Programming language :—

→ It is a vocabulary or a set of grammatical rules for instructing a computer device to perform specific task.

→ The term programming language usually refers to high level language such as basic, C, C++, Java, COBOL etc.

→ In programming language has the unix set of keyboard and a specific syntax for organising computer programme instruct.

Computer Virus :—

→ A computer virus is a mellicious software programme loaded unto a useres a knowledge and performs mellicious actions.

→ Computer virus replicate itself and spread from one computer to another by attaching itself to an existing programme.

⇒ There are various types of virus are —

(1) Resident Virus

Resident Virus :—

→ It fixes themselves into the system memory and get activated whenever the operating system run and infects all the files that are then open.

Ex – Vienna Virus.

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* Direct action Virus
It comes into action when the file containing the virus executed once it infects the file into the folder that once specify.

Ex:- polyboot B.
Anti EXE

* Boot sector Virus:-
This type of virus effect the boot sectors of the harddisk. this also known as master boot sector. Or master boot record virus.

Ex - Elkern

* Macro Virus:-
It infects file that are created using certain application and programe that contains extensions like .doxe, .ppt etc.

* File system Virus:-
It infect the directory of your computer by changing the path that indicate the location of the file. It is also known as Clustere Virus. Of directry.

Ex - Dir - 2.

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Application of computer in different domain / field :-

In different domain computer have become an essential part of modern human life. There are many computer users in different fields like -

↳ Computers acts at educational institution.

↳ Computer have its dominion use in educational field which can make learning better which can make distance learning make easy.

↳ Researchers have massive uses of these computers in that work from the starting to till the end of their scholarly of theirs.

↳ Computers acts in health center. Most of the medical information can now be digitized quick.

↳ From the prescription, different types of therapy to the patient are also possible, because of the computer.

↳ ECGs, MRI, Citiscan, Xerox is not possible without Computer.

↳ Computers acts financial institution.

↳ The four most important thing is to store information about different account holders in a database to be available at any time in banks.

↳ For keeping the records of the cash flow and keeping information regarding your account.

↳ Computers act in different sectors.

↳ Computers are the main help in development.

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↳ Design & the maintainance are possible only through computers.

↳ Computers builts the links between the soilders and commanders through the satelite.

↳ Computers for enterdainment - computers are now measure entertainers and primary time pass machine. We can use computers for playing games, watching movie, listening movie. We can use computers for drawing picture.

↳ Computers acts in e-commerce :—
Electronic shopping, Online shopping added favour to purchasers and merchants. Electronic banking is now on our hand where every bank has Online supports for transaction of monitory issue.

Malware :—

↳ It is a programe designed to gain access to computer system normally for the benifit of some third party without the users permission.

↳ Malware includes Virus, worm, trogen horse, ransomward, spyware and other malicious programe.

Virus :—

↳ A virus is a malicious exicutable code attached to another exicutable file.

↳ Viruses can be harmless or they can be modified or delete data.

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Worm :—

↳ Worms replicates themselves. On the system attaching themselves to different files and looking for pathways between computers.

↳ Worm usually slowdown networks of computer system system.

↳ After a worm affects a host it is able to spread very quickly over the network.

Spyware :—

↳ It's purpose is to steal private information from a computer system for a third party.

↳ Spyware collects information and sends it to the hacker.

Trogen Horse :—

↳ It's a malware that carried out malicious operations under the appearance of a desired operation such as playing an online game.

↳ A trogan horse vary from a virus because the trogan binds itself to non-executable files. such as image, audio, file.

Ransomware :—

↳ Ransom ware grasp a computer system or data it contains until the victim makes a payment.

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Ransomware encrypts data in the computer with a key which unknown to the user. The user has to pay a ransom to the criminals to retrieve the data.

Once the amount is paid the victim can resume using his/her system.

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COMPUTER NETWORKING AND INTERNET :—

↳ A network is a set of devices connected by communication link.

↳ A network must be able to meet a certain number of criteria

↳ The most important of this are performance, reliability and security.

LAN (local area networking) :—

↳ It is usually privately owned and links devices in a single office, building, campus.

↳ It's side is limited to a few kilometer.

MAN

It is designed to extend over an entire city. It may be a single network such as a cable television network.

WAN (Wide area network) :—

It provides long distance transmission of data voice, image and video information over large geographic areas that may comprises it country, continent or even the whole world.

Data transmission mode :—

i) Simplex
ii) Half duplex
iii) full duplex

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Defination :—

Data transmission mode defines the signal flow between to connected device. It is divided into three types.

① Simplex :—

(i) Here communication is unidirectional as on a one way stream.

(ii) Only one of two devices on a link can transmit & the other can only receive.

(iii) Here performing mode of transmission is lowest.

Ex - Keyboard, Monitor.

Half deplex :—

(i) Here each station can both transmit and recieve but not at same time.

(ii) When one device is sending the other can only receive.

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Full duplex :—

Here both station can transmit and received simultaneously. The full duplex mode is like two way street with traffic flowing in both directions at the same time.

Ex - telephone

Protocol :—

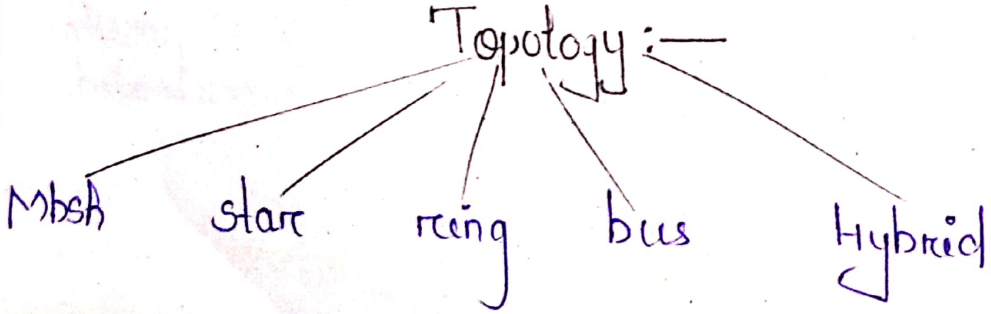
It is a digital language through which we communicate with other on the internet.

Protocol means that it is a set of mutually accepted and implemented rules at both ends of the communication channel.

There are different types of protocol's use in internet. like Tcp, ARP

Tcp – transmission control protocol
Ip – Internet protocol
ARP – average resolution protocol
DHcp – dynamic host configuration protocol
DNS – domain name system.
FTP – file transfer protocol

Topology :—



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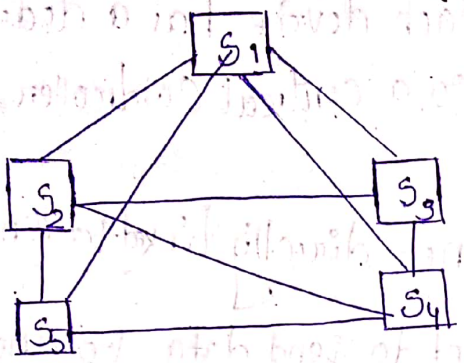
Two or more devices to a link forms a topology. The topology of a network is a geometric representation of relationship of all the links and linking devices to another.

There are basically five types of topology.

Mesh topology –



→ In the mess topology every device has a dedicated point to point link to every other device.

→ A mess topology offers several advantages over other network topology. like the uses of dedicated links, guarantees that each connection can carry its own data load. by eleminating the traffic problem.

→ Fault ~~detection~~ can be detected easily. It is robust in nature and reliable.

Disadvantages :—

→ Installation and reconnection are difficult.

→ The bulk of wiring can be greater than the available space.

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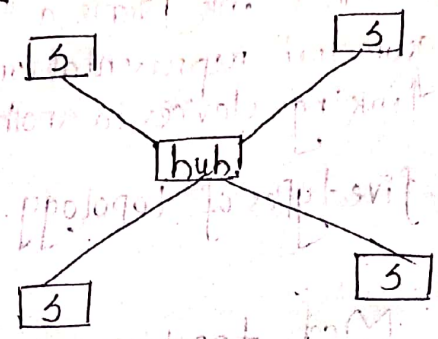
Star topology :—



↳ In star topology each device has a dedicated point to point link. Only two a central controller usually called as a hub.

↳ Here the devices are not directly linked to one another

↳ If one device want to send data to another it sends the data to the controller (hub), which then relay the data to the other connected device. and has less cabling needed.

↳ It is easier to install and fault detection is also easy.

Disadvantages :—

↳ If hub goes down then everything will go down!

↳ The device can work without hub

Bus topology :—

Bus topology on the other hand is multipoint. One long cable act as backbone to link as all the devices in a network.

Advantages —

↳ It is easy installation.

↳ less cabling star and mesh topology.

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Ring topology:-

In ring topology each devices has a delicated point to point connection only with the two devices on either side of it.

A signal is passed along the link. One direction from device to device until it reaches it destination. ~~Each device in~~

Advantanges:-

↳ Easy to install.

↳ Easy managing is easier as to add or remove a device from the topology only two links are required to be change.

Disadvantages:-

A link failure can fail the entire network as the single will not travel forward due to failure.

Hybrid topology:-

↳ Data traffic issue since all the data is circulating in a ring.

↳ A combination two or more topology is known as hybrid topology.

↳ For ex - a combination of star topology and ring topology

Advantages -

We can choose the topology based on requirement.

Disadvantages -

~~1st~~ Installation is difficult

Design is complex so maintainance is high.

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Repeater :—

↳ It operates at physical layer. Its job is to recreat the signal over the same network before the signal become too weak or corrupt. so as to extend the length to which the signal can be transmitted over the same network.

Bridge :—

It is used to devide a large network into smaller segment. It connects different type of media as a network becomes more complex bridges make sure your network speed doesnot drop drastically.

Switch :—

↳ It contains many ports to connect different network segment. They are similar to hub but offers greater performance.

↳ When a network contains a large no. of devices switches are needed instead of hub to make sure communication between devices doesnot slow down.

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INTERNET

↳ Internet is a global wide area networks that connects computer system across the world.

↳ It carries many network services most prominently the world wide wave including social media from electronic mail social media.

↳ Isp is an acronim that stands for internet service provider.

↳ An Isp is a company that provides a internet acess Orgnazination and home users.

↳ Internet service provider in India are like jio, airtel, Vodafone, Idea, Bsnl.

Different types of internet connectivity :—

↳ There are various options available to connect the internet to set up and internet connection we must have an internet service provider.

↳ Dial up connection require users to link there phone line to a computer in order to access the internet.

↳ It doesn't permit user to make or receive phone calls through their home phone service while using the internet.

Dsl :-

↳ Digital Suscriber line.

↳ It uses to copper wire telephone line connected to one's home so service is delivered at the same time as

↳ Customer can still place calls. while suffering internet.

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Satelite :—

↳ In certain area where broadband connection is not yet offered a satelite internet option may be available.

Cable :—

↳ Through use of a cabel modem user can excess the internet over cabel T.V. line.

↳ Cabel modem can provide extremly fast excess to the internet.

Ispn :— (Integrated service digital network)

↳ It allows user to send data voice and video contained over digital telephone line.

↳ The installation of an ISDN adaptor is required at both ends of the transmission means On the part of the user as well as the internet axis provider.

Broadband :—

↳ This highspeed internet connection provided through either ~~either~~ cable Or telephone Company.

It is One of the fastest option available, broadband internet uses multiple data channels to send large quantity of information.

E-mail :—

↳ E-mail is a paperless method of sending messages, notes Or letters from One person to another even many people simultaneously via the internet.

↳ E-mail is very fast compared to the normal post.

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The features of E-mail includes -

↳ One to One communication
↳ One to many communication.
↳ Instant communication.

Physical presence of receipient is not required.

↳ Most inexpensive mail service, 24 hours a day and 7 days in a week

WWW :- (World Wide wave)

↳ It is a way of exchanging information between the computers on the internet, tying them together into a vast collection of interactive multimedia resources.

↳ It is a system based on hypertext and HTTP (hypertext transfer protocol) for providing, organising and accessing a wide i.e variety of resources available via the internet.

File transfer Protocol (FTP) :-

↳ FTP is a protocol used for transfering files from one computer to another typically from your computer to a web server.

↳ FTP is the prefered method of exchanging files because it's faster than other protocol like HTTP.

The basic steps to use FTP are -

(a) Connect the FTP server.
(b) Navigate the file structure to find the file you want.
(c) Transfer the file.

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Chatting :-
Instant messaging is usually between two people or may be more

Ex- Whatsapp
Facebook
Instagram
Twitter
Hike
We chat

Internet relay chat :- (IRS)
It requires software or find many chat rooms.

Internet conferencing :- (Wave conferencing)
It refers to a service that allows conferencing events to be held with remote location.

These are sometime referred as online workshop.

Application of waves conferencing include meeting transfer events, lectures or share presentation of any computer

E-paper :- (Electronic newspaper)
An e-paper is electronic newspaper. is the online version of a newspaper.

Either as a stand alone publication or as online version of printed one.

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↳ going Online creats more Opportunities for newspapers such as competing with broadcast journalism in presenting breaking news in a more timely manner.

↳ E-shopping :-

↳ It is a form of E-commerce which allows consumers to directly buy goods or services from a seller over the internet using a way browsers.

↳ It is also known as E-wave store, E-shop, wave shop, virtual store etc.

↳ An Online shop evokes the physical analogy of buying Produc or services at a bricks and mortor retailers or shopping centre.

↳ The process is called business to consumer. (b to c Online shop)

↳ In the case where the business buys from another business the process is called business-to business Online shopping.

Ex. of some Online retailing Corporation are -

(i) Amazon
(ii) Myntra
(iii) Shein

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Types of connection :—

There are two types of connection.

(i) point to point connection.

(ii) Multipoint connection.

i) It provide a delicated link between ~~the~~ two device. The entire capacity of link is transmission those two devices.

ii) A multipoint connection is one in which more than specific device shares a single link.
In a multipoint envircoment the capacity of the Channel is share.

Networking device :—

A networking devices ~~who~~ holds the key to generate a network to which communication occur. These device is responsible for smooth data transmission among different notes of some network and notes of different netwo

Networking device :—

A networking device holds the key to generate a network to which communication

Hub :—

It is a centralized device that connect multiple devices. when hub receieves the data signal from a connected devices of any of it ~~export~~ accept that export it forwa those signal to all other connected devices from the remaining ports.

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④ File Management & data processing

→ File:

- File is nothing but an electronic document.
- It's contents can be ordinary text or it can be an executable program.
- Each file is given a file name to identify it. The file name is in the form:

File name . Extension

- Filename can be consist of Alphabets or combinations of alphabets, numerals & special characters. Extension indicates the type of file
- Example:

xy.Doc , abc.wav , ~~pqr.mp3~~

Here file name is xy.
Extension name is .Doc which indicates document file.

→ Folder:

→ Folder contains a group of files. Folder is otherwise called as directory. Folder may have a set of files under it. It may have other folders under it also. These files & folders can be arranged in hierarchal manner.

→ File organization:

- It refers to the way data is stored in a file. File organization is very important because it determines the methods of access, efficiency, flexibility & storage devices to use. There are 4 methods of organizing files on a storage media

i) Sequential file organization.
ii) Random or direct file organization.
iii) Serial file organization.
iv) Indexed sequential file organization.

i) Sequential file organization –

- Records are stored & accessed in a particular order stored using a key field.
- Retrieval requires searching sequentially through the entire file record by record to end.
- Here, the record in a file are sorted in a particular order, better file searching method like the binary search technique can be used to reduce the time used for searching a file.
- Since the records are sorted, it is possible to know in which half of the file a particular record being searched is located. Hence this method repeatedly divides the set of records in the file into two halves & searches only the half on which the record is found.
- Ex:

Let a file has records with keyfield 10, 20, 30, 40, 50, 60 & the computer is searching for a record with keyfield 50, it starts at 40 upwards in its search ignoring the first half of the set.

Advantages -
- Sorting makes it easy to access records.
- The binary chop technique can be used to reduce record search time as half time is taken.

Disadvantages -
- The sorting does not remove the need to access other records as the search looks for particular records.
- The requirement that all records be of the same size is sometimes difficult to enforce.
- Sequential records cannot support modern technologies.

ii) Random or direct file organisation -
- Here records are stored randomly but accessed directly.
- To access a file stored randomly, a record key is used to determine where a record is stored on the storage media.
- Magnetic & optical disks allow data to be stored & accessed randomly.

Advantages -
- Quick retrieval of records.
- The records can be of different sizes.

iii) Serial file organisation -
- Records in a file are stored & accessed one after another.
- The records are not stored in any way on the storage medium this type of organisation is mainly used on magnetic tapes.

- It is simple.
- It is cheap.

Disadvantages -
- It cannot support modern high speed requirements for quick record access.
- It is difficult to access because system have to access all preceeding records before retrieving the one being searched.

iv) Indexed sequential file organisation -
- Almost similar to sequential method only that an index is used to enable the computer to locate individual records on the storage media
- Ex: On a magnetic drum, records are stored sequential on the tracks. However each record is assigned an index that can be used to access it directly.

* Data file - it contains records in sequential scheme.
* Index file - it contains the primary key & its address in the data file.

Deciding of a file organisation :-
- The major factors to be considered while file organisation should be chosen are the following:
* percentage of actual records processed in a day. If large number of records are accessed at a time, direct access file organisation

If very few records are accessed, sequential file organization will be more suitable & cheaper.
- files that are frequently updated must be stored on a direct access storage devices such as disk.

Data processing :-
- Data processing means processing the input data to produce some meaningful & purposeful information. Computer has the capability of processing high-volume of data in less time with higher accuracy. Data processing involves 5 distinct steps.
a) data capturing
b) data validation
c) processing / execution
d) data storage.
e) data retrieval.

→ Data capturing encompasses the activities of inputing data to the computer. Before giving input to the system the required data have to be first identified & put in the defined formart called source data layout. The aim of this layout is to have faster data entry. To reduce the volume of data & also have better organisation & easy access to data those can suitably be coded. After data are ready they can be entered to the computer through keyboard. This is sometimes called data capture through intelligent terminal. The other form of data capture is through scanners or optical devices. In this type of data capturing data are not entered rather data are captured from the the source document or paper.

→ After data capturing the data is validated. Data validation involves checking of input data to fit to requirements or specifications. For example price of a book can be numeric only. If by mistake Alphabetic data are entered then it is checked & error is shown to revalidate the data. This prevents unwanted & unspecified data to enter into the system & causing errors.

→ The valid input data are stored in file or database & processed as per the instructions. The instructions are put in programs or software. This software or program, when executed does the processing of input data & produces the output. Again outputs are stored in files in memory.

After processing of data, the outputs are produced. The outputs may be formed in different ways depending on the requirements & specifications. The same set of data can be printed in tabular form or in form of graphs. There are variety of ways for presenting data. The printed output is sometimes called hardcopy. There can be provision of answering to queries of user, where the answer is displayed on the monitor screen itself. So it depends on the requirements of users.

→ An important step of data processing is maintaining database. Database is nothing but collection of data which is controlled centrally with many provisions of data security. This is where, normally data are stored for reference.

(5) problem solving Methodology:

Algorithm -

→ Algorithm is defined as the step by step solution of problem in user's language.

→ It is considered as an effective procedure for solving a problem in finite number of steps.

The characteristics of algorithm are

(i) precise i.e. clear & accurate / particular, exact.

ii) unambiguous i.e. not open to more than one interpretation / definite / specific

iii) Finite termination i.e. fixed or limited end.

iv) Unique solution.

Once algorithm is written, it can be coded into program using any programming language.

Algorithm uses 3 different constructs.

i) Sequence

ii) Branching or decision making

iii) Repetition.

Here sequence says that instructions are to be executed in what order or sequence. Branching involves testing of condition & based on the outcome of the condition testing different instruct are executed. Repetition means one or more instruct shall be repeated for a number of times. This is otherw called as loop. There are different types of loops such as ~~while do~~, do-while for etc.

Example:

1) Algorithm to find out sum of two numbers to be taken as input.

Step 1 - Read the 1st number x

Step 2 - Read the 2nd number y.

Step 3 - Sum = x + y.

step 4 - print sum

This is an example where only sequence is exhibited.

② Algorithm to find out larger between numbers to be taken as input.

step 1 - Read the 1st number x.
step 2 - Read the 2nd number y.
step 3 - If $x > y$
Then print x
Else if $x < y$
Then print y
Else print "Both are equal"

This is an example where branching is exhibited.

③ Algorithm to find out sum of first 10 natural number

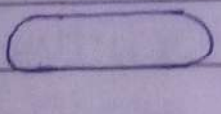
step 1 - $i = 1$, sum = 0
step 2 - Repeat step 3 & 4 while $i <> 10$
step 3 - sum = sum + i
step 4 - $i = i + 1$
step 5 - print sum

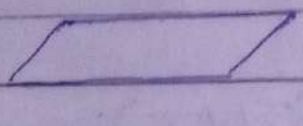
This is an example where repetition is exhibited.

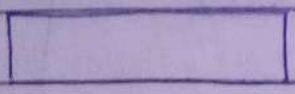
Flowchart ⇒

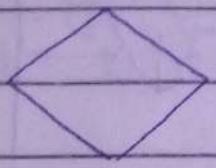
Flowchart is a graphical or symbolic representation of the process of solution to a problem or algorithm. It helps to visualise the complex logic of the solution of the problem in a simplified manner through diagrammatic representation.

Each step of the algorithm is presented using a symbol & a short step description. The different symbols used for the flowchart are.


start or stop


input or output


process

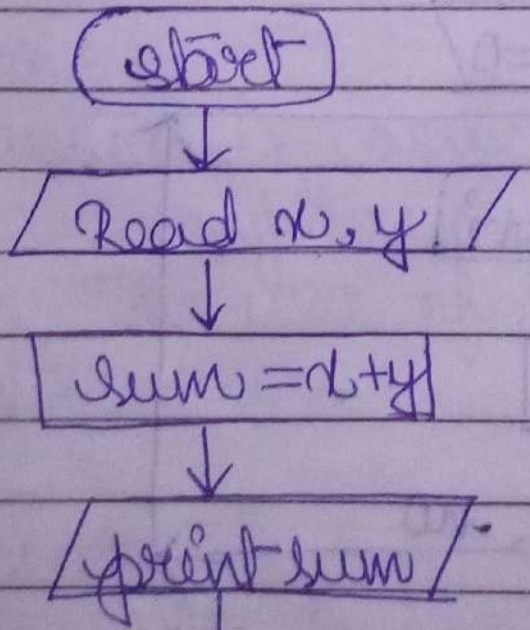

Decision symbol.

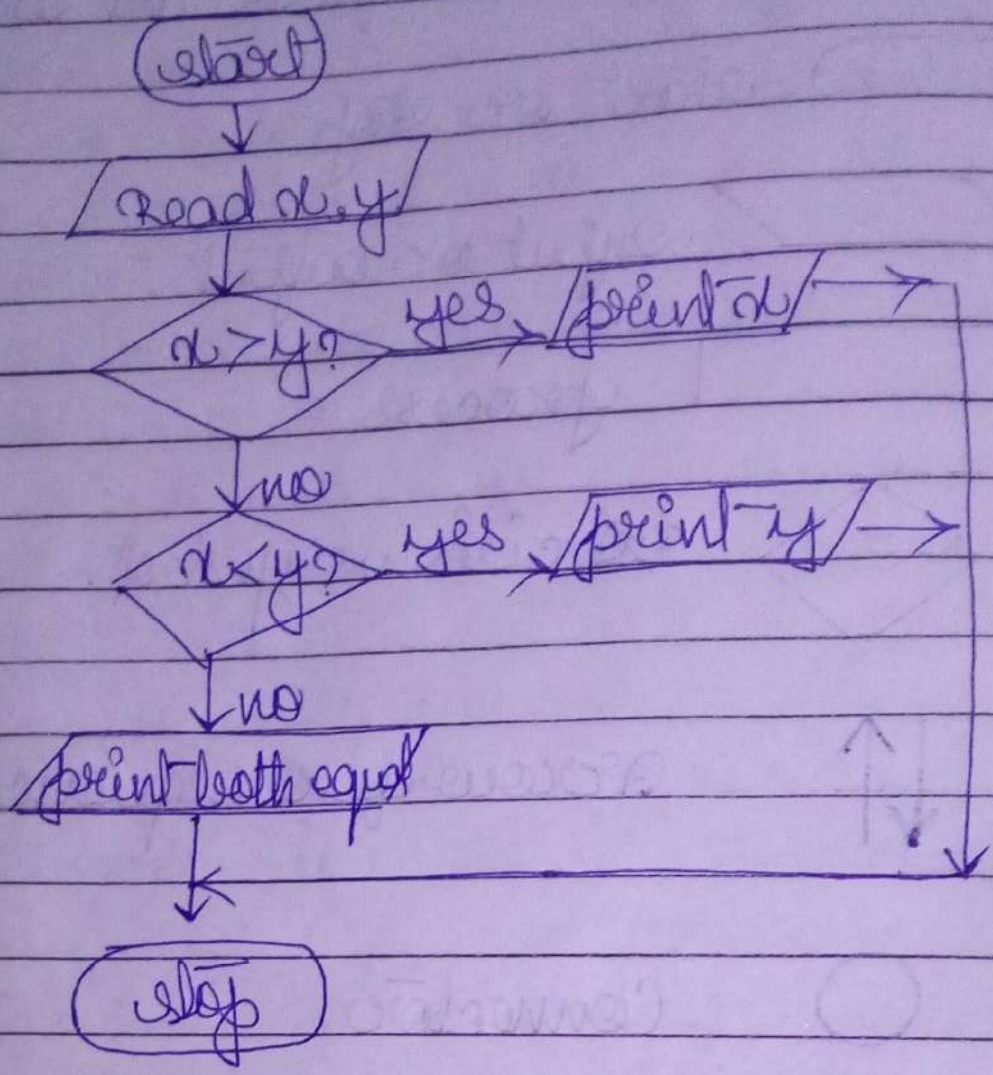

Arrow for sequence


Connector

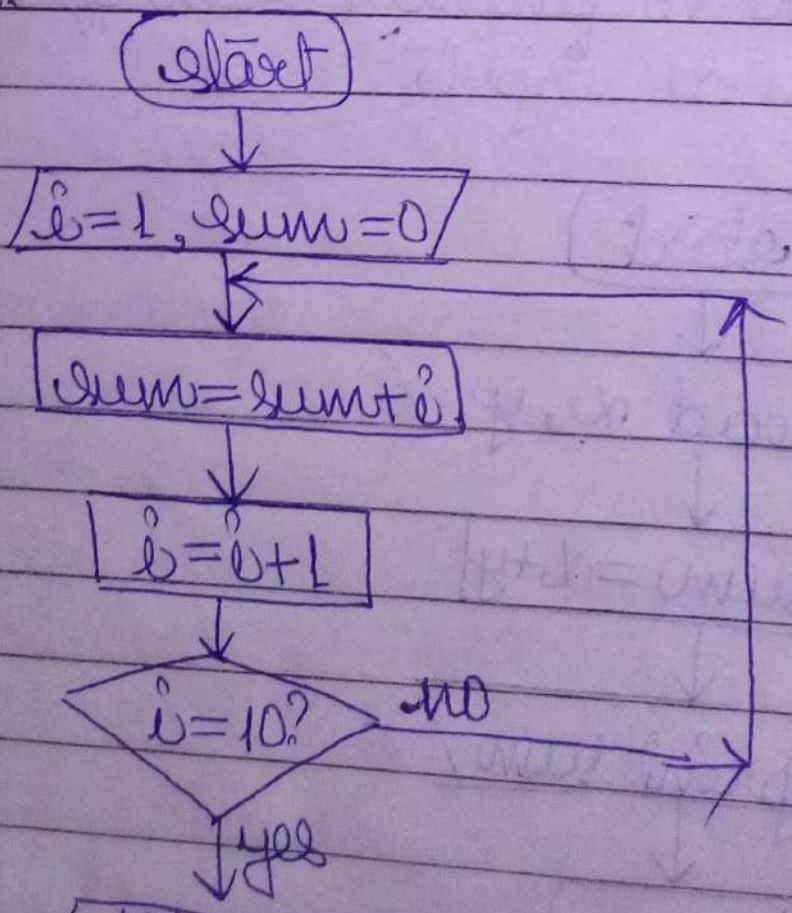
Example:

① Flowchart to find out sum of two numbers to be taken as input.





③ Flowchart to find out sum of first 10 natural numbers.



→ pseudocode

- It is a concise description algorithm in English language that uses programming language constructs. It contains outlines of the program that can be easily converted to program. It focuses on the logic of the algorithm without giving stress on the syntax of programming language. This is meant for understanding the logic of the program easily. Flowchart can be considered as an alternative to pseudocode.

programming language :-

- programming language is a tool to express the logic or instructions for understanding of the computer.
- Any programming language has two compone
  - Syntax
  - Semantics

→ Syntax refers to the rules to be followed for writing valid program statements compiler can detect errors in the syntax while compiling the program.

→ Semantics is associated with logic of the program. Compiler can not detect the semantic error. The user of programmer can diagnose semantic error.

pseudocode -

pseudocode has no syntax like any of the programming language & thus can't be compile or interpreted by the computer.

- pseudocode is detailed yet readable description of what a computer program or algorithm must do, expressed in a formally-styled natural language, rather than in a programming lang. It is sometime used as a detailed step in the process of developing a program.

Structured programming language →

Structured programming is also known as modular programming. In this type of programm technique, the program shall be broken into several modules. This helps in managing memory efficiently as the required module of the pro will be loaded into the memory only & not the entire program. This will also enhance code re writting, understanding, debugging & modifying th individual module of the program.

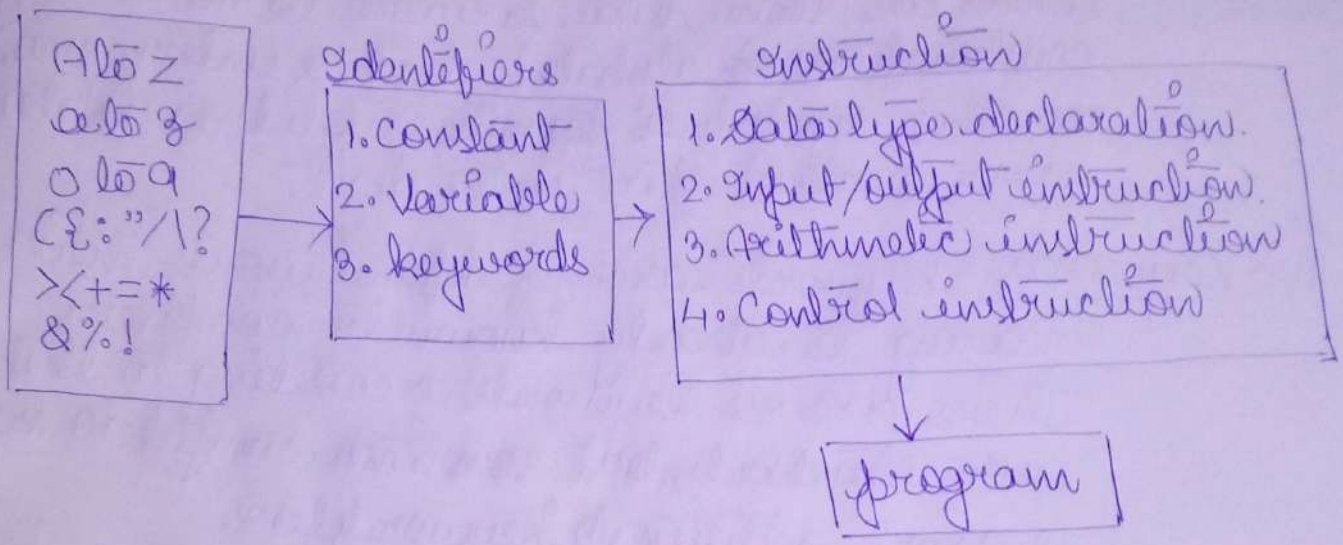
Mnemonics - The study & development of systems for improving & assisting the memory.

C programming language:-

→ History of C language - C is the 3rd generation language developed by Dennis Ritchie in 1972 at BELL laboratories by USA.

→ Why C is important - Oracle, MySQL are written in C.
- Core libraries of android are written in C.
- Unix OS is developed in C.
- Almost every device driver is written in C.

→



Identifiers - Smallest identifying unit in the program is known as identifier. It can be categorized as constants, variables, keywords, function etc.

i) Constant - Any information or data is constant. Every program we make is to process data. For example, program to add two numbers or two to calculate simple interest. We need some data to process. In addition of two numbers prog we need two numbers. Similarly in SI prog we need p, t & r and then only we can process it. So

Data = information = constant

Constants

- primary constant
  - (i) Integer [-55, 25, 0]
  - (ii) Real [2.4, 3.55, -1.3]
  - (iii) character ['a', 'b', '+', ' ']
- Secondary constant
  - (i) Array
  - (ii) string
  - (iii) pointer
  - (iv) structure
  - (v) Enumerator.

ii) Variables - variables are the names of memory location where we store data. Variable name is any combination of alphabet, digit & underscore, No other symbol is permitted. Valid variable name cannot start with digit.

iii) Keywords - keywords are predefined words, their meaning is already known to compiler. There are 32 keywords according to the ANSI standard, but sometime compiler may support additional keywords too.

List of keywords

auto	double	goto	signed	unsigned
break	default	if	sizeof	void
case	enum	int	static	volatile
char	else	long	struct	while.
continue	extern	register	switch	
const	for	return	typedef	
do	float	short	union	

terminated with a semicolon.

a) Datatypes - Datatypes are keywords can be used on various occasions to specify the kind of data. One use of datatypes is the declare variables

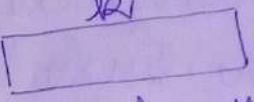
int
char
float
double
void

Declaration statements -

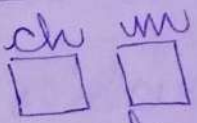
int a, b = 5 ;



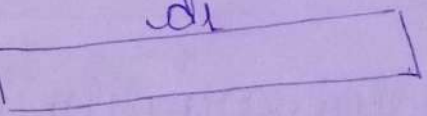
float k ;



char ch, m ;



double d1 ;



- Here variables a & b are of type int, k is of float, ch & m are of type char and d1 is of double.

Header files:

- # is called preprocessor directive, the word after is called preprocessor command. One of the most popular preprocessor command is "include".
- "include" tells the compiler to insert the contents of "stdio" & "conio" at a particular place.

"stdio" standard input output

printf() is a standard output function.
scanf() is a standard input function.
These functions are already defined inside the language library. These functions are not defined by the programmer hence are known as predefined function.
- If we want to use printf() in a program then we need to include "stdio" header file & similarly if we want to use getch(), clrscr() then we need to include "conio" in a header file. If we want to use squareroot func which is sqrt() then we have to include "math" in header file.

Escape sequences -
\n → new line character
\b → same as backspace key
\t → same as tab key
\r → carriage return, it moves cursor at the starting place of the current line
\\ → To print backslash single time.

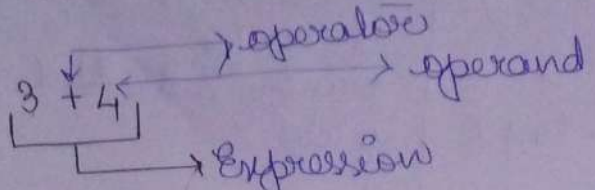
printing values of the variables & expressions -

- To print values of the variable we have to use format specifiers.

%d for int.
%c for char.
%f for float.
%lf for double.

%d, %c, %f, %lf are called format specifiers. They are special symbols used to tell printf about the format in which data should be.

Arithmetic instructions:



i) Unary operators. (one operand)
ii) Binary operators (two operands)
iii) Ternary operators (three operands).

Note: There is no BODMAS rule in c language.
→ According to the behaviour & priority rule
i) Unary
ii) Arithmetic
iii) Bitwise
iv) Relational
v) Logical
vi) Conditional
vii) Assignment.

i) Unary: (+, -, ++, --, sizeof)
Ex: -5, +8
→ ++ (increment operators)

```
void main()
{
int x = 3;
x++;
printf("%d", x);
getch();
}
```

O/P 4

```
→ void main()
{
int x = 3;
++x;
printf("%d", x);
getch();
}
```

O/P 4

x++ is post increment
++x is pre increment

→ main( )
{
int x=3, y;
y=x++;
printf("%d %d", x, y);
getch( );
}

O/P 4, 3

{
int x=3, y;
y=++x;
printf("%d %d", x, y);
getch( );
}

O/P 4,4

→ x-- is post decrement
--x is pre decrement

void main( )
{
int x=3, y;
y=x--;
printf("%d %d", x, y);
getch( );
}

O/P 2,3

void main( )
{
int x=3, y;
printf("%d %d", x, y);
getch( );
}

O/P 2,2

→ void main( )
{
int x;
float k;
char m;
double d;
printf("\n%d", sizeof(int));
printf("\n%f", sizeof(float));
printf("\n%c", sizeof(char));
printf("\n%lf", sizeof(double));
getch( );
}

O/P
4
4
1
8

```
void main()
{
int a, b, c, d;
a = 3+4;
b = 3-4;
c = 3*4;
d = 3/4;
printf("%d %d %d %d", a, b, c, d);
getch();
}
```

o/p 7 -1 12 0

iii) Bitwise operators (&, |, ^, ~, >>, <<);

→ Bitwise AND (&)	→ Bitwise OR (|)	→ Bitwise XOR (^)
0 & 0 → 0	0 | 0 → 0	0 ^ 0 → 0
0 & 1 → 0	1 | 0 → 1	0 ^ 1 → 1
1 & 0 → 0	1 | 1 → 1	1 ^ 0 → 1
1 & 1 → 1	0 | 1 → 1	1 ^ 1 → 0

→ Bitwise NOT (~)

~0 → 1

~1 → 0

-
```
void main()
{
int x;
x = 5&12;
printf("%d", x);
getch();
}
```

5 = 00000000 00000000 00000000 00000101

12 = 00000000 00000000 00000000 00001100

& ——————————————————

4 = 00000000 00000000 00000000 00000100

o/p = 4

-
```
void main()
{
int x;
x = 12>>2;
printf("%d", x);
getch();
}
```

12 = 00000000 00000000 00000000 00001100

>> ——————————————————

3 = 00000000 00000000 00000000 00000011

>> → right shift operation

<< → left shift operation.

```
{
int x;
x=12<<2;
printf("%d",x);
getch();
}
```

12 = 00000000 00000000 00000000 00001100
<< 2
48 = 00000000 00000000 00000000 00110000

o/p = 48

iv) Relational operators (<, >, <=, >=, ==, !=):

Result of these operators are either 1 (for true) or 0 (false)

5>4 is 1

4<4 is 0

3!=4 is 1

5>4>3 is 0

v) Logical operators (!, &&, ||):

! → Logical NOT

&& → Logical AND

|| → Logical OR

o/p x=0

! True = False

! False = True

```
- void main()
  {
  int x;
  x=!(5>4);
  printf("x=%d",x);
  }
```

```
- void main()
  {
  int x;
  x=!4;
  printf("x=%d",x);
  getch();
  }
```

o/p x=0

```
int main()
{
int x;
x=5>3&&4<0
printf("%d",x);
```

o/p 0

Exp1	Exp2	result
True	True	True
True	False	False
False	True	False
False	False	False

```
int x, y=5;
x = y>10 || y<7;
printf("%d", x);
getch();
}
```

True	True	True
True	False	True
False	True	True
False	False	False

o/p 1

v) Conditional operator:

Expression1 ? expression2 : expression3;

vi) Assignment operator (=, +=, -=, *=, /=, %=, &=, \=, ^=):

x=4; → valid expression, here value 4 is assigned to the variable x.

4=x; } These are invalid expression.
3=4; }

- Compound Assignment operator (+=, -=, *=, /=, %=, &=, \=, ^=)

```
void main()
{
int x=5;
x+=4;
printf("x=%d", x);
getch();
}
```

o/p x=9

x+=4; → x=x+4;

x-=3; → x=x-3;

x*=5; → x=x*5;

x/=7; → x=x/7;

x%=3; → x=x%3;

Decision control instructions:-

Control instructions -

program is a set of instructions. Each instruction of the program is executed by the processor. It executes instructions one by one. processor's control moves from one line to another. This movement of control is known as flow of the program.

Sometimes, it is required that the program's flow should be sequential. For example, we want to execute first line of our program, then second & the 3rd line but after executing 3rd line, we may want to skip fourth line & jump to the 7th line. In such situations, we use control instructions.

- Control instruction gives power to the programmer to decide the flow of the program.

There are four types of control instructions.

i) Decision control instructions.
ii) Iterative control instruction.
iii) Switch case control instruction.
iv) Go to jump instruction.

i) Decision control instruction -

Decision control instruction is also known as selection control instruction.

a) if
b) if-else
c) nested if statement
d) if else if / Multicondition if statement
e) conditional operator.

a) if statement :-

Syntax -

```
if( some condition )
{
```

statement 1;
statement 2;
+ - - - -
:
:
}

Here 'if' is a keyword which let compiler know the decision control statement begins.

- Immediately after if keyword some condition is there in the parenthesis.
- Condition can be any valid expression in C language
- condition is always evaluated as true or false.
- If the result of expression is non-zero it is considered as "true" otherwise "false".
- Immediately after this condition there is a block of code. This block is known as if block. whatever we write in if block will be executed only when condition is "true".
- When condition is "false" control skip if block & executed statements written after if block.

Ex:- program to check whether pass or fail

```
void main()
{
int marks;
clrscr();
printf("Enter marks");
scanf("%d", &marks);
if (marks >= 33)
{
printf("you are pass");
}
```

```
if(marks<33)
{
printf("you are fail");
}
getch();
}
```

→ if else statement

Syntax = if(same condition)
{
statement-1;
statement-2;
:
:
}
else
{
sl-1;
sl-2;
:
}

- This is similar to if but the else block is not only added.
- If the condition of if is true if block is executed and if the condition of if is false else block is executed. We can use if statement without else blocked but else must be in conjunction with if blocked.
- else block should appear immediately after

if blocks otherwise an error occured during compilation.

Ex - program to check whether pass or fail using if-else.

```
void main()
{
int marks;
clrscr();
printf("Enter marks");
scanf("%d", &marks);
if(marks >= 33)
{
printf("you are pass");
}
else
{
printf("you are fail");
}
getch();
}
```

c) Nested if statement -

- Syntax.

```
if(condition-1)
{
if(condition-2)
{
st-1;
}
else
```

```
{
sf 1;
} }
else
{
if(condition 3)
{
st-2;
}
else
{
sf 2;
}
}
st x;
```

When an if statement occurs within another if statement, then such type of statement is called nested if statement. This statement is little complex then the simple if or if-else statement but it is very useful to solve real problems.

Ex: WAP to find out biggest no. among 3 nos

```
void main()
{
int a, b, c;
clrscr();
printf("Enter three nos");
scanf("%d %d %d", &a, &b, &c);
if(a>b && a>c)
printf("%d is biggest", a);
else if (b>a && b>c)
printf("%d is biggest", b);
else
printf("%d is biggest", c);
getch();
}
```

→d) if else if / multicondition if statement –

When in a complex problem conditions arise in a sequence, then we can use multicondition if statements to solve the problem in a simple manner.

syntax –

```
if (con-1)
{
st-1;
}
else if (con-2)
{
st 2;
}
else if (con-3)
{
st 3;
}
;
else if (cond-n)
{
st n;
}
else
{
default st;
}
statement x;
```

Eg: C++ to display the color according to its codes.

```
void main()
{
int code;
clrscr();
printf("Enter the color code");
scanf("%d", &code);
if(code==1)
{
printf("\n color is red");
}
else if(code==2)
{
printf("\n color is green");
}
else if(code==3)
{
printf("\n color is white");
}
else
{
printf("\n no color code defined");
}
printf("\n End of the program");
getch();
}
```

→ e) Conditional operator

Conditional operator is the only operator in C language which requires three operands, hence known as ternary operator.

Syntax -

Expression1 ? expression2 : expression3 ;

- Expression1 is condition, evaluated as true or false. When expression1 is true expression2 is selected other wise expression3 is selected.

Ex

C++ to find greater between two numbers :

```
void main()
{
int x, y;
clrscr();
printf("Enter two numbers");
scanf("%d%d", &x, &y);
x>y ? printf("%d is greater", x) : printf("%d is greater
getch();
}
```

- Occasionally we have to write more than one statement in expression2 or expression3, in that case use comma to separate statements. ~~for example~~. Conditional operator provides an ease of writing selective assignment.

Another conditional operator can be use in a conditional operator as an expression2 or expression3, this is called nesting.

Ex:
(a) AP to find greatest among three numbers using nested if else.

```
void main()
{
int a, b, c;
clrscr();
printf("Enter three numbers:");
scanf("%d%d%d", &a, &b, &c);
if(a>b)
{
if(a>c)
printf("%d is greatest", a);
else
printf("%d is greatest", c);
}
else
{
if(b>c)
printf("%d is greatest", b);
else
printf("%d is greatest", c);
}
getch();
}
```

- Since, if else statement is considered as a single statement, thus we can remove curly braces used in the body of if blocks and else blocks.

ii) Iterative con...

a) for loop.

b) while loop

c) do while loop.

a) for loop -

Syntax:
```
for(initialization ; condition; flow)
{
st 1;
st 2;
 |
 |
}
```

Ex WAP to print 'learning C' six times on the screen using for loop.

```
void main()
{
int i=1;
for(i=1; i<=6 ; i++)
{
printf('learning C\n');
}
```

b) while loop -

Syntax:
```
while(some condition)
{
block of statements;
}
statement x;
```

Ex WAP to print 'learning C' five time on the screen.

```
void main()
{
int i=1;
```

```
printf("learning c \n");
i++;
}
```

c) do-while loop-

Syntax:

```
do
{
block of statements;
}
while(some condition);
statement x;
```

Ex: WAP to print 'learning c' five times.

```
void main()
{
int i=1;
do
{
printf("learning c \n");
i++;
}
while(i<=5);
}
```

when number of conditions ... it is difficult to solve such type of complex problem with the help of ladder if statement, then there is need of such type of statement which should have different alternatives or different cases to solve this problem in simple & easy way. For this purpose switch statement is used.

Syntax:

```
switch(expression)
{
case values1;
 block1;
 break;
case values2;
block2;
break;
 .
 .
 .
case valuesn;
 blockn;
 break;
default;
default block;
}
```

Ex: WAP to print the color according to the code.

```
void main()
{
int code;
printf("\n Main menu");
printf("\n1. for color red");
printf("\n2. for color green");
printf("\n Enter the color code");
scanf("%d", &code);
```

```
case 1;
printf("\n color is Red");
break;
case 2;
printf("\n color is Green");
break;
default;
printf("\n color does not found");
}
getch();
}
```

break statement:

- This statement is always used with a decision making statement like if & switch statement. The statement ~~statement~~ will quit from the loop when the condition is true.
- The purpose of break is to terminate loop's execution immediately as it encounters.

Syntax:

```
while(condition 1)
{
if (condition 2)
{
break;
}
statement x;
}
```

Ex:

```
void main()
{
int i=1,x;
```

```
printf("Enter a number");
scanf("%d",&x);
if(x>0)
break;
i++;
}
i==6?printf("Ends normally"):printf("applied break");
getch();
}
```

Goto:

continue:

- The keyword continue is used only in the body of loop. It is used to move control at termination condition in the case of while & do-while loop & also in for loop.

syntax:

```
while(condition1)
{
st1;
st2;
if(condition2)
{
continue;
}
st3;
st4;
}
st5;
```

```
void main()
{
int x;
while(1)
{
printf("Enter an even number");
scanf("%d",&x);
if(x%2==1
continue;
else
{
printf("This is the correct value");
break;
}
}
getch();
}
```

goto:

The goto moves the controls on the specified address called label name.

syntax:

```
goto label_name;
- - - -
- - - - -
label_name:
```

Ex

```
main()
{
int sum=0;
for(int i=0;i<=0;i++)
{
sum=sum+i;
```

```
goto addition;
}
}
addition:
printf("%d", sum);
return 0;
}
```

Type conversion:

- To convert one datatype to another datatype is known as conversion.

Ex

```
main()
{
int a=5;
float b;
b=a;
printf("b=%f", b);
return 0;
}
```

O/p

b=5.000000

pressions:

- It is a combination of variables, constants & operators written according to the syntax.

algebraic expression	C expression
$a+b-c$	$a+b-c$
$a \times b+c-d$	$a*b+c-d$
ab/c	$a*b/c$
$3x^2+3x$	$3*x*x+3*x$

Date: 15.04.20

⑦ Advanced features of C:-

Functions

- Function is more about the arrangement of the code. It has some name for identification.
- The format of function is

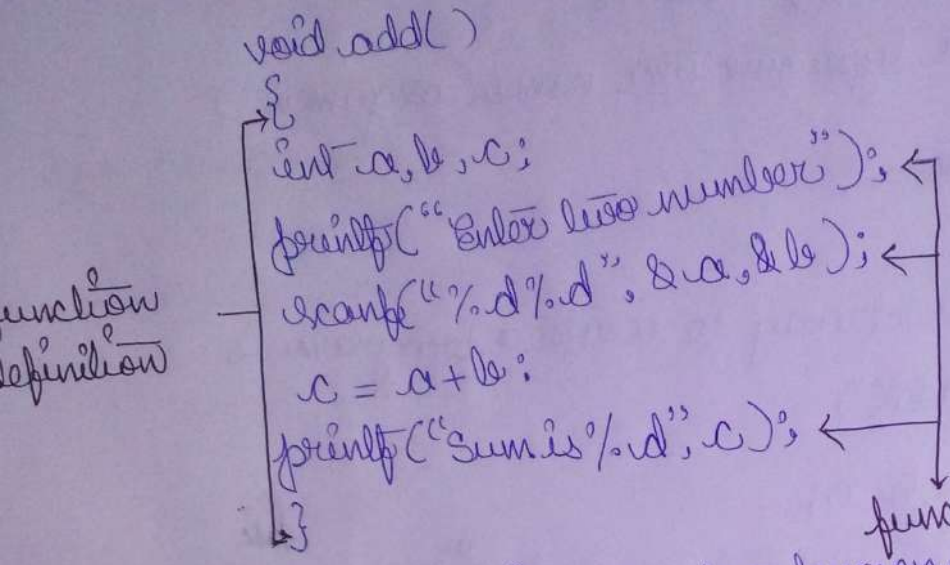
```
return_type function_name (argument)
{
statements;
}
```

- The correct way to write a program is

```
void add()
{
int a, b, c;
printf("Enter two numbers");
scanf("%d %d", &a, &b);
c = a + b;
printf("sum is %d", c);
}
```

- Function names must be unique we can have any numbers of function in a C program. We can define function in any order, main() is also a function we cannot define a function inside a function.
- Function definition is different from function declaration & function call.
- There are two types of functions
  i) predefined functions.
  ii) User-defined functions.

- add(), main() are user defined function where as printf, scanf are prime examples of predefined functions.
- Function call is a representative of function code



- Function declaration is also known as function prototype. It is a single line statement written for the compiler to process. The general format of function prototype is:

return_type function_name(argument);

- void main(); ← function declaration (global declaration)

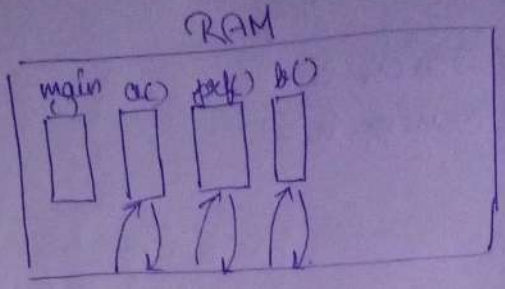
```
main()
{
add(); ← function call
}
void add()
{
int a, b, c;
printf("Enter two numbers");
scanf("%d%d", &a, &b);
c = a+b;
printf("Sum is %d", c);
}
```

function definition

Date: 18.04.20

→
```
#include<stdio.h>
#include<conio.h>
main()
{
clrscr();
add();
iseven();
add();
add();
}
add()
{
int a,b,c;
printf("Enter two numbers");
scanf("%d%d",&a,&b);
c=a+b;
printf("sum is %d",c);
}
iseven()
{
int a;
printf("Enter a number");
scanf("%d",&a);
if(a%2==0)
printf("even");
else
printf("odd");
}
```

```
main()
{
a();
b();
a();
}
a()
{
printf("\n India");
}
b()
{
a();
}
```



o/p screen

India
India
India

~~ways of defining~~

ways to define a function

```
i) /* Takes nothing, Returns nothing */
#include<stdio.h>
#include<conio.h>
main()
{
void add(void);
clrscr();
add();
getch();
}
void add()
{
int a, b, c;
printf("Enter two numbers");
scanf("%d %d", &a, &b);
c = a+b;
printf("sum is %d", c);
}
```

ii) /* Takes something, return nothing */

```
#include<stdio.h>
#include<conio.h>
void main()
{
int x, y;
void add(int, int);
clrscr();
printf("Enter two numbers");
scanf("%d%d", &x, &y);
add(x,y);
getch();
}
void add(int a, int b)
{
int c;
c = a+b;
printf("sum is %d", c);
}
```

iii) /* Takes nothing, Return something */

```
#include<stdio.h>
#include<conio.h>
int add(void);
void main()
{
int s;
clrscr();
s = add();
printf("sum is %d", s);
getch();
}
```

```
int add()
{
int a, b, c;
printf("Enter two nos");
scanf("%d%d", &a, &b);
c = a+b;
return(c);
}
```

iv) /* Takes something, Return something */

```
#include<stdio.h>
#include<conio.h>
int add (int, int);
void main()
{
int s, x, y;
clrscr();
printf ("Enter two nos");
scanf ("%d%d", &x, &y);
s = add(x, y);
printf("sum is %d", s);
getch();
}
int add(int a, int b)
{
int c;
c = a + b;
return(c);
}
```

Benefits of function:

i) Easy to read, debug & modify.
ii) Better memory utilization.
iii) Achieve modularization.

Recursion:

- When a function call itself, then it is called recursion.

```
main()
{
int k;
k = sum(3);
printf("%d", k);
}
int sum(int a)
{
int s;
if(a==1)
return(a);
s = a + sum(a-1);
return(s);
}
```

main()
k → k = sum(3);
printf("%d", k);

sum(int a)
a → if(a==1)
return(a);
s → s = a + sum(a-1);
return(s);

sum(int a)
a → if(a==1)
return(a);
s → s = a + sum(a-1);
return(s);

sum(int a)
a → if(a==1)
return(a);
s → s = a + sum(a-1);
return(s);

- Not every problem can be solved using recursion.
- If a problem can be solved using recursion, then it must have an iterative solution too.
- We can think of a function which is calling itself, like:

```
int fun()
{
----
fun();
----
}
```

→ There are several types of recursion.

i) Linear recursion - A linear recursive function is a function that only makes a single call to itself each time the function runs.

ii) Tail recursion - A function call is said to be tail recursive if there is nothing to do after the function returns except return its value.

iii) Binary recursion - Some recursive functions don't have just one call to themself. They have two or more. Functions with two recursive calls are referred as binary recursive functions.

iv) Indirect recursion - A recursive function doesn't necessarily need to call itself. Some recursive functions work in pairs. Function A calls B & B calls A.

Arrays:

- Array is a linear collection of similar elements.
- Array is also known as subscript variable.
- Creating array is creating a group of variables & all its elements are accessed via single name & different subscript values.

Array declaration -

- To declare an array in C, a programmer specifies the type of the elements & the numer of elements required by an array.

  <datatype> arrayName[arraysize];

- This is called single dimension array. The arraysize must be an integer constant greater than zero & type can be any valid C datatype.

For example:

```
int a[5];
float k[4];
```

Initializing array -

```
int a[5] = {34,56,72,93,12};
int a[5]= {34,56};
int a[ ] ={34,56,72,93,12};
int a[5];
```

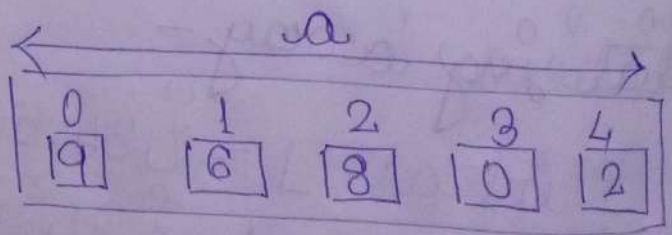
- Initializing an array with lesser values than its size is allowed & the remaining array blocks will contains zero. Array can also be initialized during declaration when its size is not mentioned. Declaration 5 is the size of an array we can say an array is a collection of 5 variables here.

Program to calculate average of 10 nos.

```
#include<stdio.h>
#include<conio.h>
int main()
{
 int i, marks[10], sum=0;
 float avg;
printf("Enter 10 nos");
for(i=0; i<=9; i++)
 scanf("%d", &marks[i]);
for(i=0; i<=9; i++)
sum = sum + marks[i];
avg = sum/10.0;
printf("Average is %f", avg);
getch();
return(0);
}
```

Declaration of arrays -

```
int a[ ]; error
int a[5];
int a[5]={9,6,8,0,2};
int a[ ]={9,6,8,0,2}
int a[5] = {9,6,8,0,2,4,7}; error
int a[5] = {9,6};
```



Two dimensional arrays:

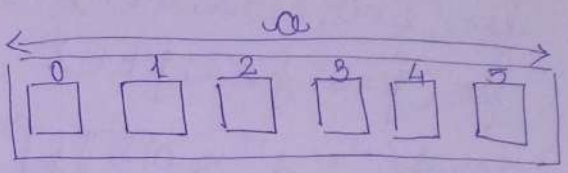
→ C programming language allows multidimensional arrays. The general form of a multidimensional array declaration is -

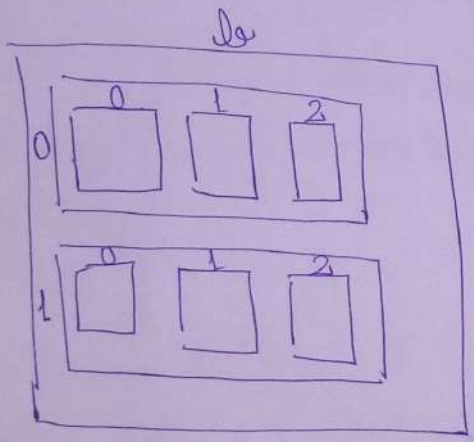
<datatype> arrayname [size1][size2]---[sizen];

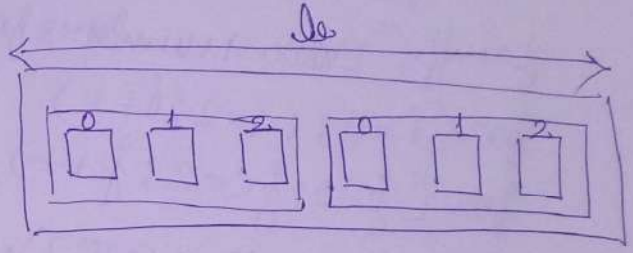
→ The simplest form of the multidimensional array is the two dimensional array.

int a[6];

int b[2][3];







Initialization of two dimensional arrays:

int b[2][3] = {12,65,78,45,33,21};

int b[ ][ ] = {12,65,78,45,33,21};

int b[2][ ] = {12,65,78,45,33,21};

int b[ ][ ] = {12,65,78,45,33,21};

→ Last two styles are invalid & lead to compile time error.

```
#include<stdio.h>
#include<conio.h>
main()
{
int a[3][3],b[3][3],c[3][3],i,j;
clrscr();
printf("Enter 9 numbers for 1st matrix");
for(i=0;i<=2;i++)
for(j=0;j<=2;j++)
scanf("%d",&a[i][j]);
printf("Enter 9 numbers for 2nd matrix");
for(i=0;i<=2;i++)
for(j=0;j<=2;j++)
scanf("%d",&b[i][j]);
for(i=0;i<=2;i++)
for(j=0;j<=2;j++)
{
c[i][j]=a[i][j]+b[i][j];
printf("%d",c[i][j]);
}
printf("\n");
}
getch();
}
```

Strings in C -

→ The string in C programming language is managed in a one-dimensional array of characters. String is a sequence of characters terminated by a null character '\0'. Null character is a non-printing symbol with ASCII code 0.

Ex

```
char city[8] = {'R','O','U','R','K','E','L','A','\0'};
```

or

```
char city[8] = "Rourkela";
```

```
#include<stdio.h>
#include<conio.h>
main()
{
char s[8] = {'I','N','D','I','A','\0'};
int i;
clrscr();
for(i=0; s[i]!='\0'; i++)
printf("%c",s[i]);

getch();
}
```

→ can be written as "INDIA";

→ can be written as

```
printf("%s",s);
```

or

```
puts(s);
```

```
#include<stdio.h>
#include<conio.h>
main()
{
char s[20];
int i;
clrscr();
printf("Enter your name");
scanf("%s", s); //&s[0]
for(i=0; s[i]!='\0'; i++)
printf("%c", s[i]);
getch();
}
```

or

```
printf("%s", &s[0]);
or
puts(s);
or
puts(&s[0]);
```

→ we have remember space is a delimiter in string and if we want to enter space then we have to write gets(s);

```
gets(s);
```

```
#include<conio.h>
int main()
{
char text[20];
clrscr();
printf("Enter your name");
scanf("%s",&text[0]);
printf("%s",&text[0]);
return(0);
}
```

O/p:
Enter your name Amit
Amit

→
```
#include<stdio.h>
#include<conio.h>
int main()
{
char text[20];
clrscr();
printf("Enter your name");
gets(&text[0]);
printf("%s",&text[0]);
return(0);
}
```

O/p:
Enter your name Amit Gupta
Amit Gupta

→ There are several predefined functions declared in string.h header file.

- strlen() ⇒ prototype: int strlen(char);
  It calculates the length of the given string.
- strrev() ⇒ prototype: char* strrev(char);
  It is used to reverse the given string
- strlwr() ⇒ prototype: char strlwr(char);
  It converts the given string into its corresponding lower case

- strupr() ⇒ prototype: char strupr(char);
  It converts the given string into its corresponding upper case.
- strcpy() ⇒ prototype: char strcpy(char, char);
  It copies the second string into first.
- strcmp() ⇒ prototype: int strcmp(char, char);
  It used to compare two strings & it returns '0' then string is correct otherwise not.

  Ex:- strcmp("AMAR", "AMIT");
- strcat() ⇒ prototype: char strcat(char, char);
  It simply concatenates two strings.

  Ex: strcat(s, "student");

Structure:

- It is a collection of heterogeneous data. Just like an array it is also a group of variables but can be of dissimilar types. Using structure we can create datatype known as user defined datatype. Such datatypes are also known as non-primitive datatypes.

Defining a structure:-

Syntax:

```
struct <tag>
{
Type variablename;
Type variablename;
-----
};
```

- struct is a keyword. <tag> is any choice. It becomes the name of user defined data types. variables declaring inside structure body are called member variables. Remember to put semicolon at the end of structure body.

union:

- union is a keyword in C language. The syntax of union is very similar to structure. It is also used to create custom data type. A union is a special data type available in C that allows storing different data types in the same memory location.

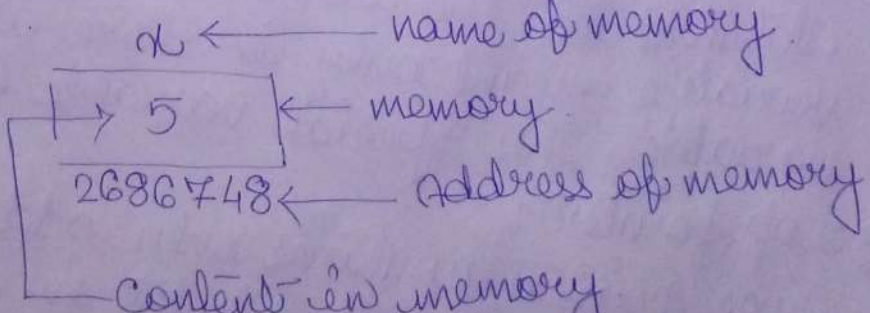
Syntax:

```
union <tag>
{
Type variablename;
Type variablename;
- - - -
};
```

pointers:

- pointer is a variable which is used to hold address of another variable. For example

int x=5;



- Here the above declaration statement tells compiler about the name of memory block(variable x), amount of memory occupied by the block & type of content.

- Every byte has a logical reference number, known as address of variable. In above example address of x is 2686748. Though this address number could be anything & unpredictable to us, it is always in the range 0 to 4294967295.
- Addresses are also known as references. Address number is always an integer, even if the variable is not of type int.

Address operator:

& is called address of operator, also known as referencing operator. It is a unary operator, thus requires only one operand. & returns the reference number of variable specified as the operand.

Declaration of pointer variable

However we cannot assign anything to &x, we can assign address of x (&x) into some other variable. For example: j is a variable then we can write

```
j = &x; // valid statement
```

- This is the correct way as variable is in the left side of assignment operator.

```
int *j;
```

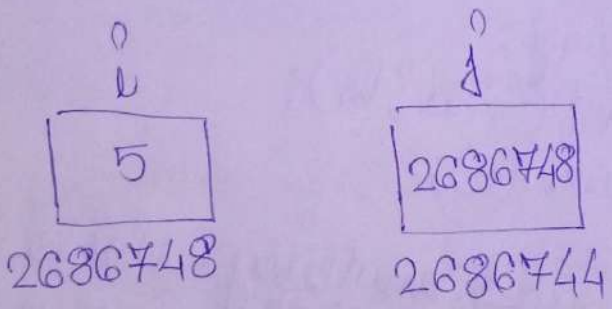
- Asterisk symbol before j in the declaration statement tells the compiler that this a special variable meant only to store address of another variable. This special variable is called pointer.

Size of pointer:

Since pointer contains only address of another variable, they consume 4 bytes in memory.

Example

```
#include<stdio.h>
#include<conio.h>
int main()
{
int i=5, *j; clrscr();
j=&i;
clrscr();
printf("\n%u", &i);
printf("\n%u", j);
printf("\n%u", &j);
printf("\n%d", *&j);
printf("\n%d", i);
printf("\n%d", *(&i));
printf("\n%d", *j);
return(0);
}
```



O/P

```
2686748
2686748
2686744
2686748

5
5
5
```

process returned 0 <0x0> execution time : 0.034
press any key to continue.

Pointer's arithmetic:

Rule 1 - Take care for the compatibility.

Example -

```
int main()
{
int i=3; int k, i=3, *j;
char *j; j = &i;
j = &i;  k = *j + *j;
        printf("%d", k);
        return(0);
        }
```

O/P 6

Rule 2 - We cannot add two addresses.

Example -

```
int main()
{
int *k, i=3, *j;
j = &i;
k = j + j;
printf("%d", k);
return(0);
}
```

We cannot add, multiply, divide two addresses

Rule 3 - We cannot multiply, divide scalar value to an address.

```
int main()
{
int *k, i=3, *j;
j = &i;
k = j * 5;
printf("%d", k);
return(0);
}
```

iv) Rule 4 - Adding 1 to the pointer gives address of the immediately next block of the same type.

```
int main()
{
int *k, i=3, *j;
j = &i
k = j+1
printf("%d", k); return(0);
}
```

Call by reference:

When a function is called by passing addresses of variables, it is known as call by reference. Function can only access its own memory & cannot access variables of other functions but if we pass address of variables during function call, we actually give power to the called func to access variables of calling function via addresses of variables.

Scope of variables in C:-

- Scope generally refers to the visibility of variables, which parts of a program can be seen or use it. There are mainly two types of scope of variable
a) Local variables: It can be accessed from that part of a program where it is declared.
b) Global variables: It can be accessed from any part of the program.

Storage classes in C

There are four storage classes in C i.e.

a) Auto - It is used for a local variable defined within a block.

b) register - It is used to store the variable in CPU registers.

c) static - It is a local variable which is capable of returning a value even when control is transferred to the function call.

d) extern - It is a global variable.

- Storage class represents the visibility & location of a variable.

*

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Physical Chemistry

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Chapter - 1

Atomic Structure

Fundamental Particles

(1) Electron – An electron is defined as sub atomic particle having a unit negative charge & mass equal to $1/1835^{th}$ the mass of the hydrogen atom.

Mass of electron – $(9.1 \times 10^{-31} kg)$

Charge on electron – $(-1.6 \times 10^{-19} Coulomb)$

(2) Proton – A proton is defined as sub atomic particle having a unit positive charge & mass equal to that of hydrogen atom.

Mass of proton – $(1.67 \times 10^{-27} kg)$

Charge on proton – $(+1.6 \times 10^{-19} Coulomb)$

(3) Neutron – It is defined as the neutral sub atomic particle having a mass $1.67 \times 10^{-}$

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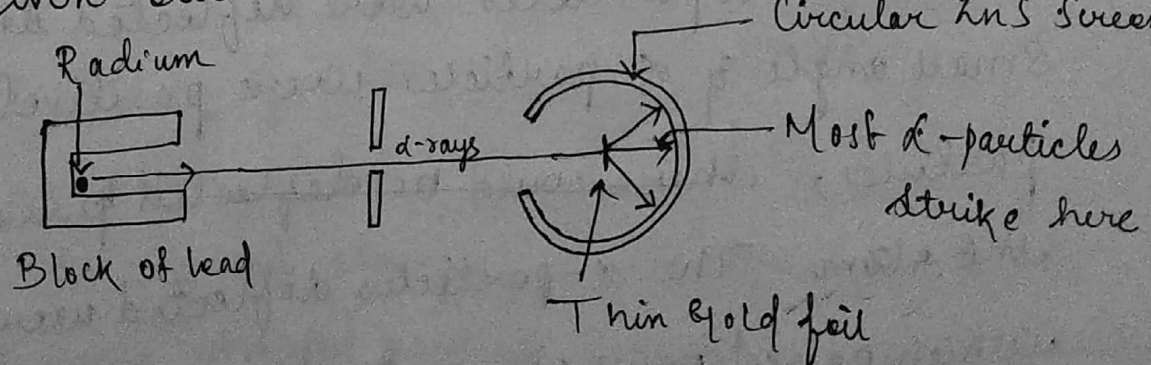
Rutherford's Atomic Model
or
Rutherford Gold Foil Experiment.

In 1911, Rutherford performed the famous Gold foil experiment. He bombarded thin Gold foil (100 nm thick) with a beam of fast moving α-particles. The source of this α particles (or positively charged particles) was radium, a radioactive substance, placed in a block of lead. Slits were used to get a fine beam. The presence of α-particle at any point was detected with the help of a circular zinc sulphide screen. When an α particle strikes this screen, a flash of light is given out.



Rutherford Scattering Experiment

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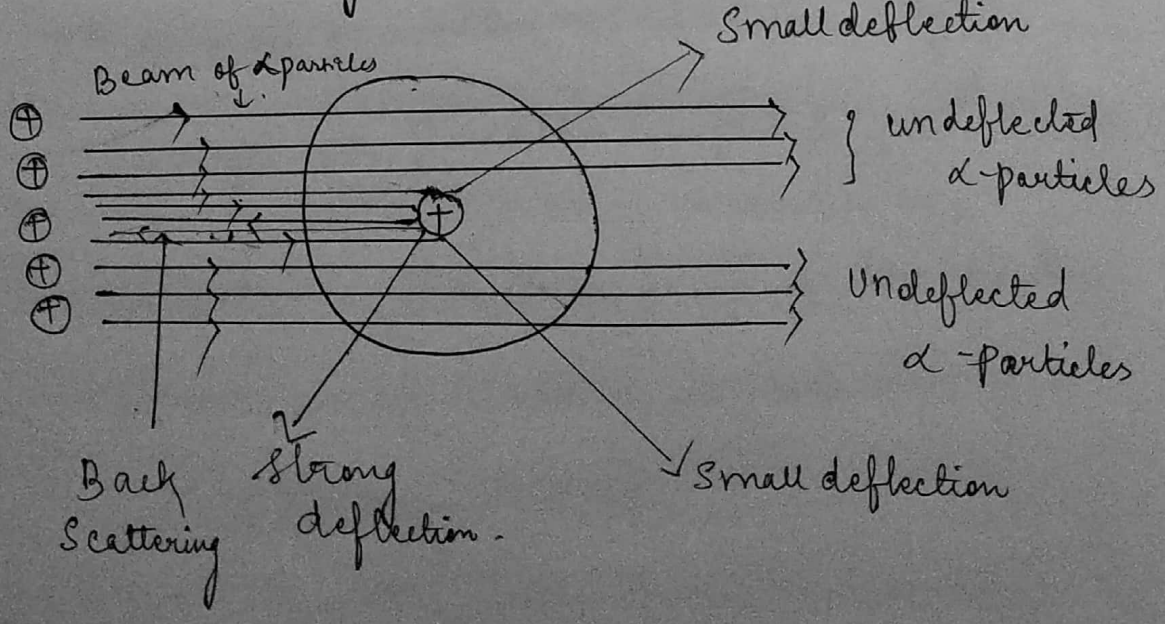
Observations & Conclusions

From Rutherford Scattering Experiment following are the observations & conclusions ——

1. Most of the α-particles were undeflected i.e. they passed straight through the Gold foil without any deviation. This clearly indicates the most of the parts of an atom are empty.
2. A few α-particles were found to be deflected strongly from their normal paths. This indicates the presence of a massive (heavy) positively charged body inside the atom. This massive positively charged body is called nucleus.
3. A very few (0.01%) α particles were found to be retraced their original paths (deflected through almost 180°). This indicates that the size of nucleus is very small.



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Postulates of Rutherford Atomic Model.

(1) An atom consists of two parts; they are i) Nucleus ii) Extra-Nuclear Part.

(2) Every atom consists of a very small but heavy positively charged body, called nucleus.

(3) The whole mass of an atom is concentrated at the nucleus.

(4) The electrostatic force of attraction (acting inward) between the nucleus & electrons is balanced by the centrifugal force (acting outward) arising due to the motion of electrons. This is why the electron do not fall into the nucleus.

Drawbacks or Failure of Rutherford's Atomic Model

(1) Stability of atom — The theory fails to explain about the stability of atoms.

As to ~~base~~ of classical electrodynamics, if an electrically charged particle revolves around circular path, then it always radiates out energy.

Thus, when electron moves around the nucleus, it continuously radiate out energy & hence, gradually move towards the nucleus in spiral path, till it collides with the nucleus.

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(2) Rutherford Atomic Model failed to explain the structure of atom i.e. the distribution of electrons around the nucleus & their energies.

(3) Rutherford's model failed to explain the existence of certain definite lines in the hydrogen spectrum.

Bohr's Atomic Model

In 1913, Neils Bohr put forward the new model of atomic structure. This atomic model is based upon the quantum theory of energy.

Postulates

1. An atom consists of a massive positively charged nucleus.
2. Electrons revolve around the nucleus in certain fixed circular paths called orbits or shells.
3. Each orbit has a definite energy & therefore known as stationary energy level or shell. These orbits are numbered as 1, 2, 3, 4 or designated as K, L, M, N.

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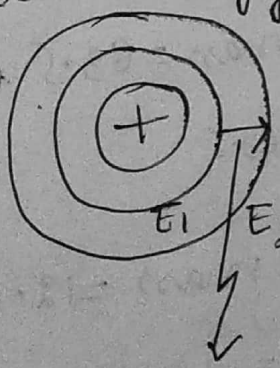
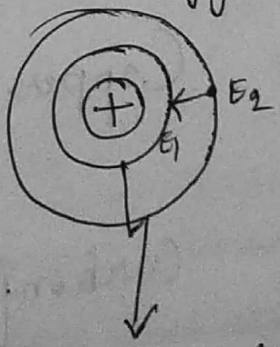
4. As long as an electron remains in a particular shell, it neither emits nor absorbs any energy. i.e. the energy of an electron in a given orbit is fixed (or quantized). Such orbits are called stationary energy states.

5. An electron can make a transition from a stationary state of higher energy E_2 to a stationary state of lower energy E_1 by emitting energy. Similarly, on absorbing energy, the electron makes transition from lower energy E_1 to higher energy E_2.



Energy absorbed
$= E_2 - E_1$



Energy emitted
$= E_2 - E_1$.

6. Only those orbits are allowed for which the angular momentum (mvr) of the electron is integral multiple of $h/2\pi$.

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Mass Number – The mass number of an element is defined as the total number of protons & neutrons in an atom.

Mass no. of an element = No. of protons (p) + No. of neutrons (n)

$$A = p + n$$

Atomic mass – The atomic mass of an element is relative mass of an atom of that element as compared to 1/12 the mass of an atom of carbon (C^{12})

→ The mass number of an element is nearly equal to the atomic mass of that element.

. Eg :- Copper → Atomic mass = 63.5
→ Mass no = 63.5

Carbon → Atomic mass = 12.01
→ Mass no = 12

Hydrogen → Atomic mass = 1.008
→ Mass no = 1

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Isotopes – The atoms of the same element which have the same atomic number but different mass numbers are called isotopes.

Eg – $_{1}^{1}H$, $_{1}^{2}H$, $_{1}^{3}H$ — Isotopes of Hydrogen.

$_{17}^{35}Cl$, $_{17}^{37}Cl$ — Isotopes of Chlorine.

$_{6}^{12}C$, $_{6}^{14}C$ — Isotopes of Carbon.

Isobars – The atoms of different elements having the same mass number but different atomic numbers are called Isobars.

Examples :– $_{18}^{40}Ar$, $_{19}^{40}K$, $_{20}^{40}Ca$

$_{26}^{58}Fe$, $_{27}^{58}Ni$.

Isotones – Atoms of different elements having same number of neutrons but different mass numbers as well as atomic numbers are called isotones.

Eg – $_{14}^{30}Si$, $_{15}^{31}P$ (neutrons = 16).

$_{6}^{14}C$, $_{7}^{15}N$, $_{8}^{16}O$ (neutrons = 8).

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Bohr - Bury Scheme

Bohr - Bury Scheme deals with the arrangement of electrons in various shells.

Postulates of the scheme are :-

1. A shell can contain a maximum $2n^2$ electrons, where n = number of the shell.

Shell	Maximum no. of electrons ($2n^2$)
K - Shell	$n = 1, 2 \times 1^2 = 2$
L - Shell	$n = 2, 2 \times 2^2 = 8$
M - Shell	$n = 3, 2 \times 3^2 = 18$
N - Shell	$n = 4, 2 \times 4^2 = 32$ & so on.

2. The outermost shell of an element cannot hold more than 8 electrons.

3. The penultimate shell (the shell just before the outermost shell) cannot hold more than 18 electrons.

4. A higher orbit may start filling before the lower orbit is completely filled.

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Arrangements of electrons in different shells of some elements according to Bohr-Bury scheme

Element	Number of electrons			
	K-Shell	L-Shell	M-shell	N-Shell
Hydrogen, $_1^1H$	1			
Helium, $_2^4He$	2			
Lithium, $_3^7Li$	2	1		
Fluorine, $_9^{19}F$	2	7		
Aluminium, $_{13}^{27}Al$	2	8	3	
Calcium, $_{20}^{40}Ca$	2	8	8	2
Zinc, $_{30}^{65}Zn$	2	8	18	2

Aufbau's Principle (n+l rule)

→ The word "aufbau" means "building up". The building up of orbitals means filling up of orbitals with electrons.

→ Aufbau's principle may be stated as "electrons are filled in different sub-shells in order of their increasing energies."

→ The subshell with lowest energy is filled first & those with higher energy are filled later.

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The (n+l) Rule.

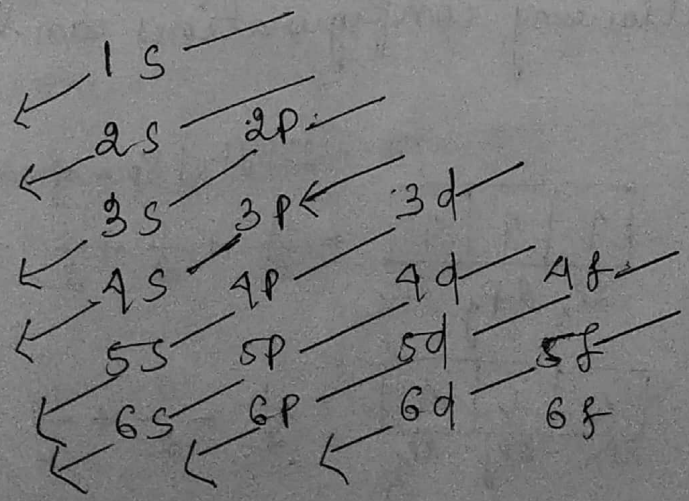
i) The subshell having lower (n+l) value possesses lower energy & is filled first.

ii) If the (n+l) value for two given sub-shells are equal, then the one with lower value of 'n' possesses lower energy & is filled first.

Following the (n+l) rule, let us compare the energy possessed by various sub-shells.

Sub shell	1S	2S	2P	3S	3P	3d	4S	4P
(n+l)	1+0 =1	2+0 =2	2+1 =3	3+0 =3	3+1 =4	3+2 = 5	4+0 =4	4+1 =5

Thus, the increasing order of energy content of sub-shells is 1S < 2S < 2P < 3S < 3P < 4S < 3d < 4P <-



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Hund's Rule of Maximum Multiplicity

Electrons in a subshell are paired only when all the orbit

Hund's Rule of Maximum Multiplicity

Electron pairing in p, d & f orbitals cannot occur until each orbital of a given subshell contains one electron each or is singly occupied.

→ Hund's Rule is also known as Maximum multiplicity Rule

→ Consider, for example, the following illustration:

For the element, nitrogen, which contains 7 electrons, the following configurations can be written:

Total Spin of unpaired e

a) ↑↓ (1s) ↑↓ (2s) ↑ | ↑ | ↑ ($2p_x$ $2p_y$ $2p_z$) $= \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 1\frac{1}{2}$

b) ↑↓ (1s) ↑↓ (2s) ↑ | ↓ | ↑ ($2p_x$ $2p_y$ $2p_z$) $= \frac{1}{2} - \frac{1}{2} + \frac{1}{2} = \frac{1}{2}$

c) ↑↓ (1s) ↑↓ (2s) ↑↓ | ↑ | ($2p_x$ $2p_y$ $2p_z$) $= \frac{1}{2}$

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In accordance with Hund's rule, the configuration 'a' in which the three unpaired electrons occupying $2p_x$, $2p_y$ & $2p_z$ orbitals have parallel spins (either all clockwise or anticlockwise) is correct while the configuration (b) in which the unpaired electrons don't have parallel spins is incorrect.

The configuration (c) in which the pairing of the electrons has shown in the $2p_x$ orbital without putting the third electron in $2p_z$ orbital is also not consistent with the Hund's rule of maximum multiplicity

Thus, in accordance with Hund's Rule configuration (a) with maximum multiplicity of $1\frac{1}{2}$ is correct.

Electronic Configuration

Electronic Configuration is the arrangement of an atom in different sub-shells in the increasing order of their energy.

Elements	Electronic Configuration
$_1H$	$1s^1$
$_2He$	$1s^2$
$_8O$	$1s^2 2s^2 2p^4$
$_{17}Cl$	$1s^2 2s^2 2p^6 3s^2 3p^5$
$_{20}Ca$	$1s^2 2s^2 2p^6 3s^2 3p^6$
$_{30}Zn$	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$

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Exceptional Electronic Configuration.

$_{24}Cr - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

$_{29}Cu - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$.

The above electronic configuration is due to the fact that half-filled & completely filled orbitals are more stable.

Electronic Configuration of some ions

N^{3-} — $1s^2 2s^2 2p^6$

Al^{3+} — $1s^2 2s^2 2p^6$

Fe^{3+} — $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

Fe^{2+} — $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

Cu^{2+} — $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$

Cr^{3+} — $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

O^{2-} — $1s^2 2s^2 2p^6$

Cl^- — $1s^2 2s^2 2p^6 3s^2 3p^6$

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2: Chemical Bonding

Definition – Chemical bond is the force of attraction between the constituent atom.

Types of covalent bond

- Electrovalent / Ionic Bond
- Covalent Bond.
- Co-ordinate Bond.

Why do atoms combine?

The atoms of different elements combine with each other in order to complete their respective octets (ie 8 electrons in their outermost shell) or duplets (ie outermost shell having 2 electrons) in case of H, Li & Be to attain stable nearest gas configuration.

Electrovalent or Ionic Bond

Definition :- An electrovalent or ionic bond formed by complete transfer of electron or electrons from one atom to the other.

Electrovalency – The no. of electrons that an atom gains or loses during the formation of an ionic bond is called its electrovalency.

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Examples of compound having Ionic Bond

Formation of NaCl (Sodium chloride)

- Sodium (atomic no = 11) has electronic configuration 2, 8, 1. By losing one electron of its outermost shell, it acquires the inert gas configuration of Neon & changes into Na^+ ion.

$$Na(2,8,1) \longrightarrow Na^+(2,8) + e^-$$

- On the other hand, chlorine (atomic no = 17) having electronic configuration (2,8,7) accepts one electron released by sodium to complete its octet by attaining stable configuration of argon. In this process, chlorine is converted into chloride ion.

$$:\ddot{Cl}\cdot\ (2,8,7) + e^{\ominus} \longrightarrow \left[:\ddot{Cl}:\right]^-_{2,8,8}$$

$$Na^+ + \left[:\ddot{Cl}:\right]^- \longrightarrow [Na]^+ \left[:\ddot{Cl}:\right]^-$$

or

$$NaCl.$$

→ The above steps may be represented as follows.

$$Na\cdot\ (2,8,1) + :\ddot{Cl}:\ (2,8,7) \longrightarrow Na^+\ (2,8) + \left[:\ddot{Cl}:\right]^-\ (2,8,8) \rightarrow NaCl.$$

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Formation of $MgCl_2$ (Magnesium Chloride)

- Magnesium (atomic number = 12) has electronic configuration 2, 8, 2. By losing 2 electron of its outermost shell, it acquires the inert gas configuration of neon & changes into Mg^{2+} ion.

$$Mg: (2,8,2) \longrightarrow Mg^{2+}(2,8) + 2e^-$$

- On the other hand, Chlorine (atm no = 17; elect. conf = 2,8,7) on gaining one electron forms Chloride ion & acquires the stable configuration of Argon.
- Here, Magnesium atom loses two electrons & forms Mg^{2+} ion & the two electrons are transferred to two Chlorine atoms, which are converted into chloride ions.

$$Mg\ (2,8,2) \longrightarrow Mg^{2+}\ (2,8) + 2e^-$$

$$:\ddot{Cl}: (2,7) + e^- \longrightarrow [:\ddot{Cl}:]^-$$

$$Mg^{2+} + 2[:\ddot{Cl}:]^- \longrightarrow Mg^{2+} + 2Cl^-$$

or

$$MgCl_2$$

The above steps may be represented as

$$:\ddot{Cl}: + Mg + :\ddot{Cl}: \rightarrow Mg^{2+} \cdot\cdot\ 2[:\ddot{Cl}:]^-$$

or

$$MgCl_2$$

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Covalent Bond

The bond formed between the two atoms by mutual sharing of electrons between them do as to complete their octets or duplets in case of elements having only one shell is called covalent bond or covalent linkage.

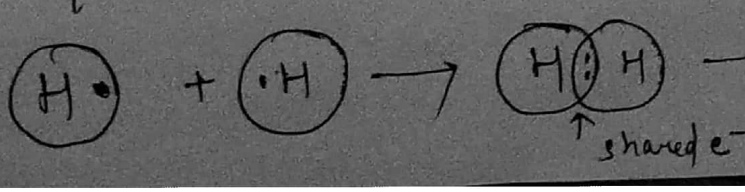
Covalency – The number of electrons contributed by each atom is known as covalency.

Examples of compounds having covalent bond

(1) Formation of H_2 molecule:

- The electronic configuration of H atom is $1s^1$.
- It needs one more electron to complete its valence shell.
- When two hydrogen atom approach each other, at a certain inter nuclear distance, they share their Valence electrons & form a shared pair.
- The shared pair belongs equally to both the atoms.
- The two atoms are said to be linked by a single covalent bond.

$$H\cdot + \cdot H \longrightarrow H:H \text{ or } H-H$$



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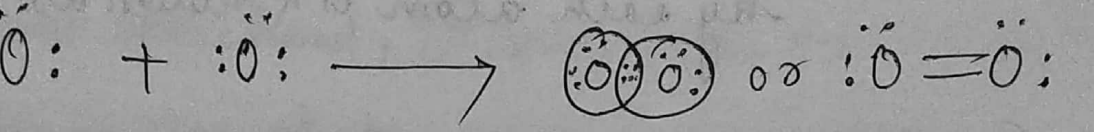
(2) Formation of O_2 molecule —

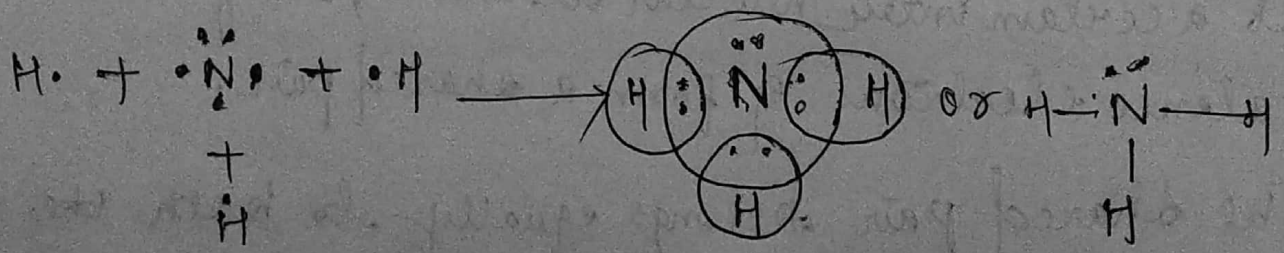
- An oxygen atom (2,6) contains 6 valence electrons & needs two more electrons to achieve the octet.
- When two oxygen atoms approach each other, they can achieve the octets by contributing two electrons each & thus forming two bond pairs.



- The O_2 molecule contains two bond pairs & each oxygen atom in it contains two unshared pairs.

(3) Formation of NH_3

- Nitrogen atom (2,5) has 5 valence electrons & can achieve the octet by sharing three electrons, one with each of the three hydrogen atom.



- Thus NH_3 molecule contains 3 covalent bond pairs

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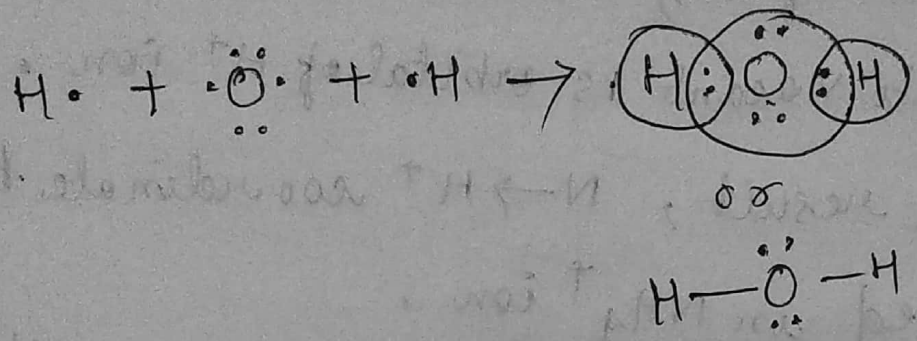
(4) Formation of H_2O molecule.

- Oxygen atom (2,6) can achieve the octet by sharing two electrons, one with each of the two hydrogen atoms, leading to the formation of H_2O molecule as follows:



or

Coordinate Bond — A coordinate bond (also called dative bond) is formed between two atoms when one atom having complete octet (after mutual sharing) donates an electron pair to the other atom, the donated electron is shared by both the atoms so as to complete their octets or duplets.

- The atom which contributes the electrons is called the donor while the other which only shares the electron pair is known as acceptor.
- This bond is usually represented by an arrow.

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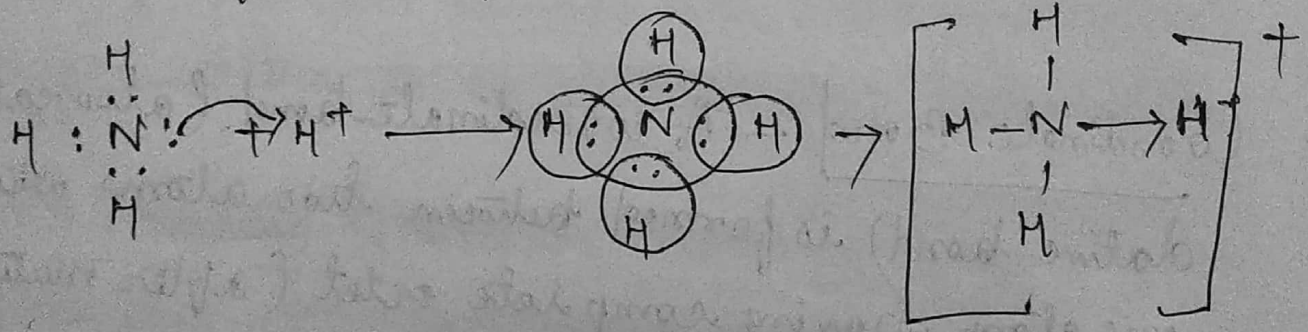
Examples of molecules/ions having coordinate bond

(1) Ammonium ion (NH_4^+) – The ion is formed by combination of NH_3 molecule with H^+ ion.

- N-atom of NH_3 molecule donates an electron pair to vacant 1s orbital of H^+ ion.
- As a result, $N \rightarrow H^+$ coordinate bond is formed in NH_4^+ ion.



Formation of NH_4^+.

(2) Hydronium ion (H_3O^+) – The molecule is formed by combination of water molecule with H^+ ion.

- Oxygen atom of H_2O molecule donates an electron pair to vacant 1s orbital of H^+ ion.
- As a result, $O \rightarrow H^+$ coordinate bond is formed in H_3O^+ ion.

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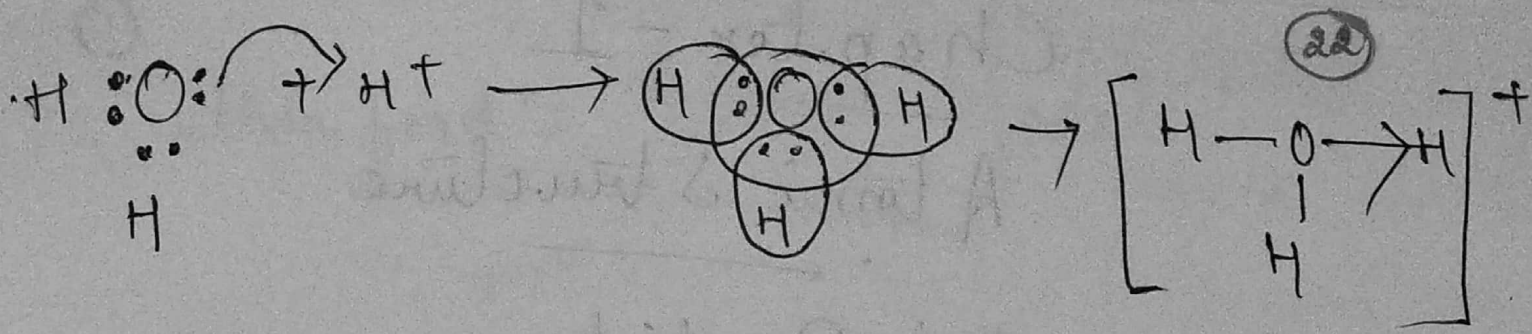

Formation of Hydronium Ion.

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Chapter-3

Acid-Base Theory

Arrhenius Theory

POSTULATES

i) A/c to Arrhenius theory, "Acids are the substances which produce H^+ ions (protons) in aqueous solution while bases are the substances which produce OH^- ion in aqueous solution."

Acids:

$$HCl(g) + aq \rightleftharpoons H^+(aq) + Cl^-(aq)$$
$$HNO_3(l) + (aq) \rightleftharpoons H^+(aq) + NO_3^-(aq).$$
$$CH_3COOH(l) + aq \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$$

Base:

$$NaOH(s) + aq \rightleftharpoons Na^+(aq) + OH^-(aq)$$
$$NH_4OH + aq \rightleftharpoons NH_4^+(aq) + OH^-(aq).$$

ii) Neutralisation of an acid & base is based on the key reaction between H^+ ion & OH^- ion to form water molecules.

$$H^+(aq) + OH^-(aq) \longrightarrow H_2O(l).$$

iii) During electrolysis of an aqueous solution of an acid, H^+ ions proceed to the cathode & negative ions to the anode. Thus,

$$HCl(g) \xrightarrow{water} H^+(aq) + Cl^-(aq).$$

At cathode: $2H^+(aq) + 2e \longrightarrow H_2(g)$.

At anode: $2Cl^- - 2e \longrightarrow Cl_2(g)$.

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limitations

i) Nature of hydrogen ion & hydroxyl ion —
A/c to Arrhenius, an acid releases H^+ ions in aqueous medium. However, it has been found that H^+ ion is a proton which cannot exist ~~fundamentally~~ independently.

ii) It fails the explain the acidic & the basic properties of substances in solvents other than water.

iii) It fails to explain the acidic properties of substances like CO_2, SO_2, P_2O_5 etc which do not contain hydrogen. Also it does not explain the basic nature of substances like NH_3, CaO, etc which do not contain OH group.

iv) It fails to explain neutralisation reactions in absence of water. We know that the following neutralisation reaction take place even in the absence of water.

$$\underset{\text{Base}}{CaO(s)} + \underset{\text{Acid}}{SO_2(g)} \longrightarrow \underset{\text{salt}}{CaSO_3(s)}$$

$$NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s).$$

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Such reactions do not involve the combination of H^+ ions & OH^- ions to produce water which should occur as per Arrhenius theory.

Bronsted-Lowry Concept of Acid & Base

A/c to Lowry-Bronsted theory "Acids are the substances (molecules/ion) which donate a proton (H^+ ion) to any other substance, while bases are the substances (molecules/ions) which accept a proton (H^+ ion) from any other substance".

Postulates

- Acids are proton donors whereas base are proton acceptors.

Acids: $HCl \rightleftharpoons H^+ + Cl^-$

$H_3O^+ \rightleftharpoons H^+ + H_2O$

Bases: $NH_3 + H^+ \rightleftharpoons NH_4^+$

$CO_3^{2-} + H^+ \rightleftharpoons HCO_3^-$

$H_2O + H^+ \rightleftharpoons H_3O^+$.

- Whenever an acid reacts with a base, we get another pair of acid & base. For eg, HCl reacts with water (base) to form H_3O^+ (acid) & Cl^- (base).

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$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

(acid)$_1$ · base$_2$ · Acid$_2$ base$_1$

⇒ Neutralisation process is simply the transfer of proton between an acid & a base.

$$HCl + NH_3 \rightleftharpoons NH_4^+ + Cl^-$$

⇒ All Arrhenius acids are Bronsted acids but all Bronsted base are not Arrhenius bases.

⇒ A/c to this theory an acid reacts with a base to form another pair of acid & base, this pair of acid & base differ by a proton (H^+ ion) is called a conjugate acid-base pair.

Acid $- H^+ \longrightarrow$ conjugate base

Base $+ H^+ \longrightarrow$ conjugate acid.

∴ Some Acid-Base pairs

Acid	Conjugate Base	Base	Conjugate Acid
H_3O^+	H_2O	NH_2^-	NH_3
NH_4^+	NH_3	OH^-	H_2O
CH_3COOH	CH_3COO^-	$H_2PO_4^-$	H_3PO_4
H_2SO_4	HSO_4^-	HS^-	H_2S

⇒ The substance which act both as acid as well as an base is known as Amphoteric Substance.

Eg ⇒ H_2O, HS^-, HCO_3^-, HPO_4^{2-}, HSO_4^-

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Limitations of Bronsted Theory

- It fails to explain the acidic nature of the substances such as SiO_2, CO_2, SO_2, BF_3, etc which cannot donate H^+ ion.
- It fails to explain the basic nature of the substances, such as Na_2O, K_2O, CaO, etc which cannot except H^+ ion.
- It fails to explain the reaction between some acids & bases which do not give another pair of acid & base. Eg - $HCl + NaOH \rightarrow NaCl + H_2O$.

Lewis Theory

A/c to lewis theory, "Acids are the substance (molecules / ions) which can accept a pair of electrons from any other substance, while bases are the substances (molecules / ions) which can donate a pair of electrons to any other substance."

Postulates

- In other words, acids are electron acceptors while bases are electron donors.

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Examples of Acids

i) All cations are lewis Acids. Eg — Na^+, K^+, Al^{3+} etc.

ii) Neutral molecules containing electron deficient atoms are lewis acids. For eg — $AlCl_3$, $FeCl_3$, $ZnCl_2$.

iii) Neutral molecules containing vacant -d orbitals in the central atom for the accomodation of incoming electrons act as lewis acids. For eg- $SiCl_4$, SiF_4, etc.

iv) The molecules having multiple bonding (= or ≡) between the atoms of different elements are acidic in nature. For eg - CO_2 (O=C=O), SO_2, etc.

Examples of Bases.

i) All anions are lewis bases :- F^-, Cl^-, CO_3^{2-} etc.

ii) Neutral molecules containing, at least one lone pair of electrons are lewis bases

- A/c to this theory, an acid reacts with a base to form an acid-base complex which involves a coordinate bond or dative bond.

For eg- $H_2\ddot{O}: \rightarrow H^+ \longrightarrow H_3O^+$ or $[H_2O \rightarrow H]^+$

base acid

- All Bronsted lowry bases are lewis bases while the reverse is not true.

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Limitations

i) According to this theory, the reaction between an acid & base results in the formation of a dative bond. Formation of a coordinate bond is a slow process. While the reactions between the acids such as HCl, HNO_3, H_2SO_4 & the bases such as NaOH, KOH, etc. are instantaneous or fast.

ii) Catalytic activity of lewis acid cannot be explained.

iii) The theory fails to explain the relative strengths of different acids & bases.

Neutralisation Reaction

A neutralization reaction is when an acid & a base react to form water & salt.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

Salt – A salt is an crystalline / amorphous compound which is formed by the complete neutralisation of aqueous strong acid with an aqueous solution of a strong base.

or

Salt is regarded as ionic compounds made up of positive & negative ions. The positive part comes from a base while negative part comes from an acid.

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Types of Salts

1. Normal Salts – These are the salts which are formed by the complete neutralisation of aqueous

Types of Salts

a) Normal Salts – These are the salts which are formed from strong acids (HCl, H_2SO_4, HNO_3) & strong bases ($NaOH$, KOH etc).

Example – $NaCl$, K_2SO_4, Na_2SO_4.

ii) Acidic Salts – These salts are formed by incomplete neutralisation of polybasic acids. Such salts are $NaHCO_3$, $NaHSO_4$, NaH_2PO_4

iii) Basic Salts – These salts are formed by incomplete neutralisation of poly acid bases.
Eg – $Mg(OH)Cl$, $Zn(OH)Cl$, $Fe(OH)Cl$.

iv) Double Salts – These are the addition compounds formed by combination of two simple salts.
Eg – $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ & $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$

v) Complex Salts – These are the compounds formed by the combination of simple salts or molecular compounds.

Eg – $K_4[Fe(CN)_6]$, $[Cu(NH_3)_4]SO_4$

vi) Mixed Salts – These are the salts which furnish more than one cation or more than one anion which dissolved in water. Eg – $CaOCl_2$, $NaKSO_4$.

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4: Solutions

Solution — Homogeneous mixture of two or more chemically non reacting substances in single phase is called solution.

Concentration of solution — The amount of solute in a given solvent or solution is called concentration of solution.

Methods to express Concentration of solution: There are different modes of expressing of solution. Some of these are:—

(1) Molarity (M): The number of moles of solute present in one litre or per litre of solution is called molarity.

It is represented as 'M' or 'mol/L'.

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in litre (ml)}} \times 1000$$

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Numericals

1) 4g of NaOH are dissolved in 200 cm^3 of water. Find the molarity of solution.

Soln: Molarity of NaOH = $\frac{\text{no. of moles of solute}}{\text{vol. of solution (ml)}} \times 1000$

$$\text{no. of moles of solute} = \frac{\text{weight of solute}}{\text{molecular mass of solute}} = \frac{4}{40}$$

$$\text{molarity of NaOH} = \frac{4 \times 1000}{40 \times 200} = 0.5\,M \text{ or } 0.5 \text{ mol/ltr}$$

2) Calc molarity when 73 gm of HCl is dissolved in water to make 1500 ml solution.

$$\text{Molarity of HCl(M) soln} = \frac{73 \times 1000}{36.5 \times 1500} = 1.33\,M.$$

(3) Molality (m) — Molality of a solution is defined as the no. of moles of solute present in 1kg of the solvent.

$$\text{Molality (m)} = \frac{\text{No. of moles of solute}}{\text{Weight of solvent in kg}}$$

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Q What is the molality of a solution containing 0.25 mole of solute in 250 gm of the solvent?

$$\text{molality} = \frac{\text{no of moles of solute}}{\text{wt of solvent in (gm)}} \times 1000$$

$$= \frac{0.25 \text{ mol}}{250} \times 1000$$

$$= 1 \text{ m or } 1 \text{ mole/kg}.$$

Q 29.25 gm of NaCl is present in 529.25 gm of the solution. Find out the molality.

$$\text{molality} = \frac{\text{no. of moles of solute}}{\text{wt of solvent in (gm)}} \times 1000$$

$$= \frac{29.25}{58.5} \times \frac{1000}{529.25} = 0.945 \text{ mol/kg}$$

or

0.945 m.

Normality (N) — The number of gram equivalents of solute present in one litre of solution.

$$\text{Normality} = \frac{\text{No. of gram equivalent of solute}}{\text{Volume of solution (in ml)}} \times 1000$$

$$\text{No. of gram equivalents of solute} = \frac{\text{Mass of solute in grams}}{\text{Equiv. wt of Solute}}$$

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① Find out the weight of NaOH required to prepare 2 litres of N/10 solution.

$$\text{Normality} = \frac{\text{no. of gm. equiv of solute}}{\text{vol. of solution (ml)}} \times 1000$$

$$\Rightarrow \frac{1}{10} = \frac{x}{2} \Rightarrow x = 0.2 \text{ gram equiv}$$

$$\text{No. of gram equivalent} = \frac{\text{Mass of Solute in gm}}{\text{molecular mass}}$$

$$\Rightarrow 0.2 \text{ gram equiv} = \frac{x}{40}$$

$$\Rightarrow x = 0.2 \times 40$$
$$= 8 \text{ gm}$$

Relationship between molarity & Normality.

molarity × molecular mass of solute
= Normality × Equivalent Mass of Solute

② Calc the molarity of Seminormal Na_2CO_3 solution.

Soln: · Seminormal = 0.5 N.

$$\text{molarity} = \frac{\text{normality} \times \text{Equivalent mass of solute}}{\text{molecular mass of solute}}$$

$$= \frac{0.5 \times 53}{106} = 0.25 \text{ M}$$

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Commonly used molarity & Normality terms.

$\frac{M}{10}$ — Decimolar Solution — $\frac{1}{10}$ mole/litre = 0.1M

$\frac{N}{10}$ — Decinormal Solution — $\frac{1}{10}$ gmequiv/litre = 0.1N

$\frac{M}{100}$ — Centimolar Solution — $\frac{1}{100}$ mole/litre = 0.01M

$\frac{N}{100}$ — Centinormal Solution — $\frac{1}{100}$ gmequiv/litre = 0.01N

$\frac{M}{2}$ — Semimolar Solution — $\frac{1}{2}$ mole/litre = 0.5M.

Definition of PH

PH of the solution is defined as the negative logarithm of H^+ ion concentration.

$$PH = -\log [H^+]$$

① Calculate PH of 0.001 M HCl ?

molarity of HCl solution $= [H^+]$

$= 0.001$

$= 1 \times 10^{-3}$

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$$pH = -\log[10^{-3}]$$

$$= -(-3)\log 10$$

$$= 3.$$

② How many grams of KOH are required to prepare 2 litre of its solution having pH = 12.

$$pH = 12.$$

$$[H^+] = 10^{-12}.$$

$$[H^+] = \frac{K_w}{[OH^-]}$$

$$\Rightarrow 10^{-12} = \frac{10^{-14}}{[OH^-]}$$

$$\Rightarrow [OH^-] = \frac{10^{-14}}{10^{-12}} = 10^{-2}$$

We required to find concentration of $[OH^-]$ as a base i.e. KOH is given.

$[OH^-]$ = molarity of KOH solution

$= 10^{-2}$ M.

$$\text{Molarity} = \frac{\text{Amt of Solute}}{\text{molecular mass of solute}} \times \frac{1000}{\text{Volume of solution (ml)}}$$

$$10^{-2} = \frac{x}{56} \times \frac{1000}{2}$$

$$\Rightarrow x = 2 \times 56 \times 10^{-2}$$

$$= \frac{2 \times 56}{100} = 1.12 \text{ gms}$$

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(2) Calculate PH of a solution contain 4.0 gm of NaOH present in 1 litre of its solution.

$$\text{molarity} = \frac{\text{No. of grams of solute}}{\text{mol. mass of solute} \times \text{vol. of sol}^n(l)}$$

$$= \frac{4}{40 \times 1} = 0.1\ M$$

Here, molarity = $[OH^-]$ as NaOH is base.

$$[H^+] = \frac{k_w}{[OH^-]}$$

$$= \frac{10^{-14}}{10^{-1}} = 10^{-13}\ M.$$

$$PH = -\log [H^+]$$

$$= -\log [10^{-13}] = -(13)\log 10$$

$$= 13.$$

Importance of PH in Industries

① PH play very important role in crystallization of sugar in sugar industries.

② PH is very important for paper industries

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5: Electrochemistry

What is electrochemistry?

The branch of chemistry which deals with the study of relationship between electrical energy, chemical energy & interconversion of one form into another is called electrochemistry.

What is electrolysis?

The process of chemical decomposition of an electrolyte in solution or in the fused state by passage of electric current is known as electrolysis.

What is electrolyte?

The substances which conduct electricity in their fused or in aqueous solution are called electrolysis.

Eg:- NaCl, $CaCl_2$, etc.

Electrolytic Cell

It is a device in which electrical energy is converted in to chemical energy.

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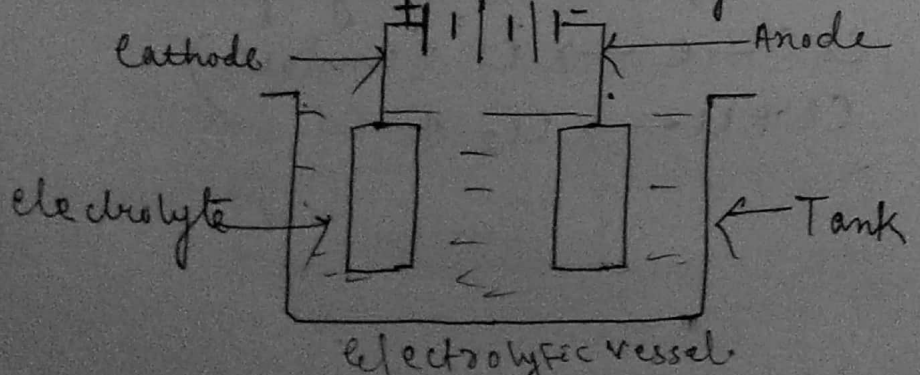
Process of Electrolysis

- The process of electrolysis is carried out in a vessel known as **electrolytic tank**.
- It is made up of some insulating material such as glass, stone, cement, etc.
- Fused electrolyte or an aqueous solution of the electrolyte is taken in an electrolytic tank & two metallic plates are dipped in the electrolyte. The plates are known as **electrodes**.
- The electrodes are connected to external source of battery. The electrode connected with positive end of the battery is called **anode** & the electrode which is connected to the negative end is called **cathode**.
- When an electric current is passed through the solution, cations move towards the cathode, whereas anions move towards the anode.
- This movement of ions towards oppositely charged electrodes is called electrolytic conduction.



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Strong Electrolytes – The electrolytes which dissociate or ionize completely into ions in either molten or aqueous state are called strong electrolyte.

Eg:- HCl, H_2SO_4, HNO_3, KOH, $NaOH$, $NaCl$, KCl, etc.

Weak Electrolytes – The electrolytes which dissociate partially into ions in their molten or aqueous state is called weak electrolytes.

Eg:- CH_3COOH, H_2CO_3, NH_4OH, $AgCl$, etc.

Electrolysis of Aqueous Sodium Chloride (Platinum electrode)

$$NaCl \longrightarrow Na^+ + Cl^-$$
$$H_2O \longrightarrow H^+ + OH^-$$

At cathode H^+ will be discharged because of low discharge Potential.

$$H^+ + e \longrightarrow H \text{ (unstable)}$$
$$H + H \longrightarrow H_2 \uparrow$$

At anode Cl^- ions are discharged readily than OH^- ions because of low discharge potential

$$Cl^- - e \longrightarrow Cl \text{ (unstable)}$$
$$Cl + Cl \longrightarrow Cl_2 \uparrow.$$

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Electrolysis of fused NaCl, (Platinum electrode)

In fused NaCl,

$$NaCl \longrightarrow Na^+ + Cl^-$$

At cathode : $Na^+ + e^- \longrightarrow Na$ (metal)

At anode : $Cl^- - e^- \longrightarrow Cl$ unstable

$$Cl + Cl \longrightarrow Cl_2 \uparrow$$

Therefore, at cathode sodium metal is deposited & at anode chlorine gas is liberated.

Faraday's 1st laws of Electrolysis :

According to Faraday's first law of electrolysis,

" The amount of the substance deposited or liberated at electrodes is directly proportional to the quantity of electricity passed through electrolyte."

'W' is the mass of substance deposited or liberated at electrode.

Then, $W \propto Q$

We know $Q = C \cdot t$

where c = current in amperes

t = time in seconds

Thus $W \propto CT$

or $\boxed{W = ZCT}$

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Where Z is a constant called Electrochemical Equivalent.

In the above relationship, if c = 1 ampere & t = 1 second then $\boxed{W = Z}$

Thus, electrochemical equivalent of the substance is the amount of the substance deposited or liberated on electrode, when 1A current is passed through its electrolytic solution for 1 sec.

Quantity of electric charge (Q) = 1 Amp × 1 sec
= 1 Coulomb.

$\boxed{1 \text{ Faraday} = 96500 \text{ Coulomb}}$

Faraday's Second law of Electrolysis:

A/c to Faraday's second law of electrolysis, "The amount of substances deposited or liberated at the electrodes by passing the same quantity of electricity through solutions of different electrolytes is directly proportional to their equivalent weights or their electrochemical equivalents.

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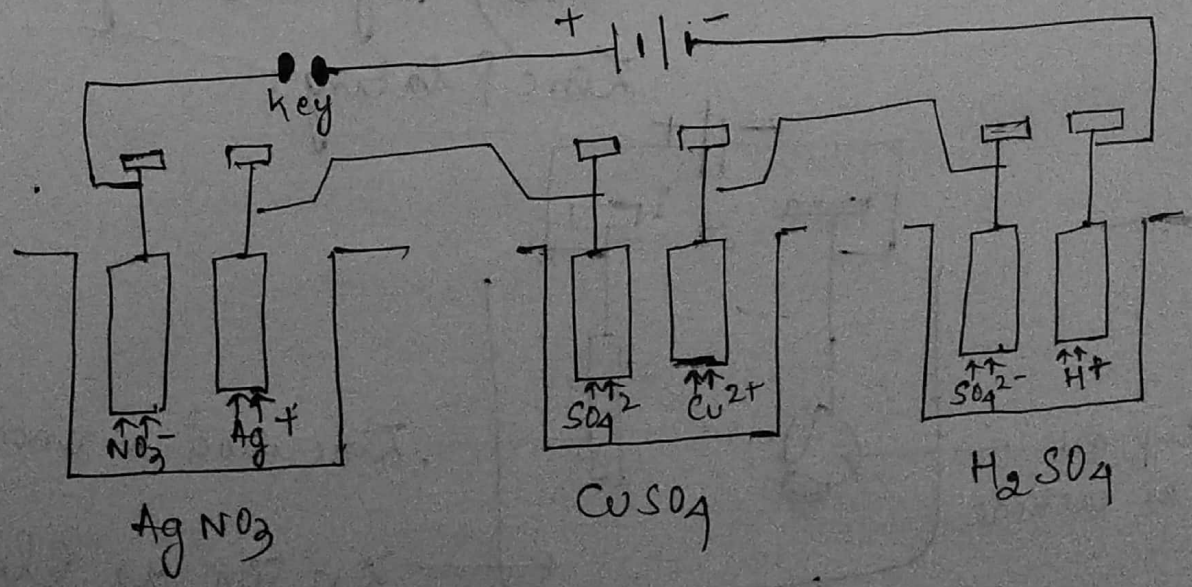
Explanation :-

- Consider three electrolytic cells containing Copper Sulphate, Silver Nitrate & Sulphuric Acid respectively.
- They are connected in series as shown in diagram
- On passing the current through the three cells for some time, the three cells receive the same amount of electricity.
- The weights of Copper, Silver & Hydrogen are in the ratio of their equivalent weights.

$$\frac{\text{Weight of Copper deposited}}{\text{Weight of Silver deposited}} = \frac{\text{Equiv mass of Copper}}{\text{Equivalent mass of Silver}}$$

&

$$\frac{\text{Weight of Hydrogen}}{\text{Weight of copper deposited}} = \frac{\text{Equivalent mass of Hydrogen}}{\text{Equivalent mass of Copper.}}$$



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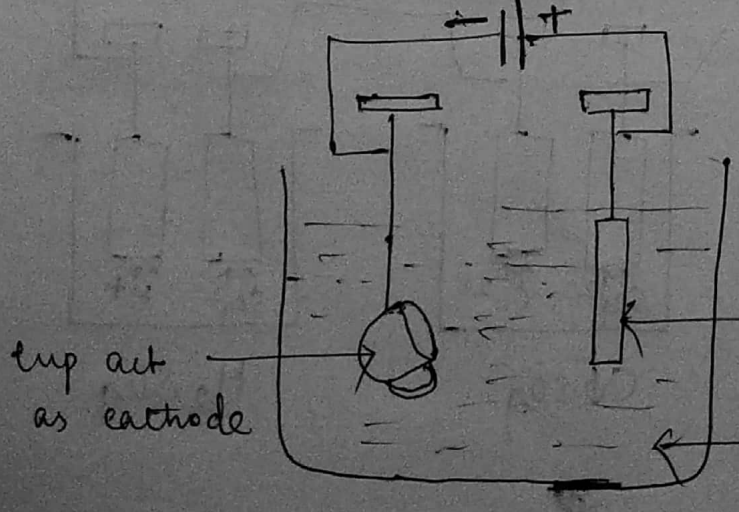
Industrial Application of Electrolysis

Electroplating :- The process of coating a layer of superior metal on inferior metals surface by electrolysis is called electroplating. The electroplating is done —

1. To protect the metal or alloy from corrosion.
2. To improve the surface & provide aesthetic look to metal.

Zinc Plating :- The process of coating a layer of zinc metal (superior metal) on inferior metal (Iron, ~~steel~~) by electrolysis is called Zinc Plating.



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- The metal to be electroplated or inferior metal (say Fe) is made Cathode.
- The rod of superior metal (Zinc) is made the anode.
- $ZnSO_4$ (Zinc Sulphate soln) is taken as electrolyte.
- On passing current (electricity) the Zinc anode dissolve & pass into the solution in the form of ions & same no. of ions from solution deposit on cathode.

Electrode reactions :—

Anode : $Zn \longrightarrow Zn^{2+} + 2e^-$

Cathode : $Zn^{2+} + 2e^- \longrightarrow Zn$

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6: Corrosion

What is Corrosion?

- Corrosion may be defined as gradual deterioration & consequent loss of solid metal by chemical or electrochemical reaction with its environment.

[OR]

- Corrosion is a process which involves the conversion of metal into an undesirable compound (usually oxide) on exposure to atmospheric conditions ie moisture & oxygen.

What are the examples of Corrosion?

- (1) Rusting of Iron
- (2) Tarnishing of Silver
- (3) Development of green coating on copper & Bronze.

Types of Corrosion

— Atmospheric Corrosion
— Waterline Corrosion.

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What is Atmospheric Corrosion?

Atmospheric Corrosion is the deterioration & destruction of a material & its vital properties due to electrochemical as well as the other reactions of its surface with the constituents of the atmosphere surrounding the materials such as water, gases like CO_2 & SO_2, etc.

Mechanism of Atmospheric Corrosion

- Atmospheric Corrosion can be explained by electro-chemical theory.
- Commercial form of iron behaves like small electric cells in presence of water containing dissolved O_2, CO_2 or SO_2.

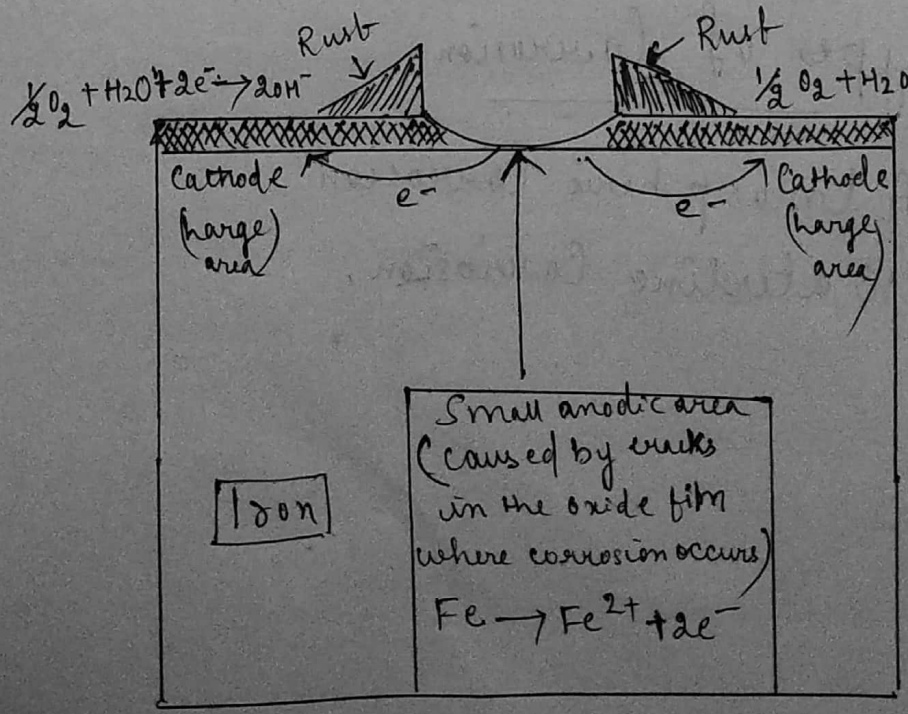

Fig: Rusting of Iron

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- The surface of iron is usually coated with a thin film of iron oxide.
- However, if this iron oxide film develops some cracks, anodic areas are created on the surface; while the well-metal parts act as cathodes.
- Anodic areas are small while the rest of the surface of metal forms large cathodes
- At Anode

The metal (iron) dissolves as ferrous ions with liberation of electrons (oxidation)

$$2Fe \longrightarrow 2Fe^{2+} + 2e^-$$

- The liberated electrons flows from anode to cathode through iron metal, where electrons are intercepted by dissolved oxygen

$$O + H_2O + 2e^- \longrightarrow 2OH^-$$ Reduction

- The Fe^{2+} ions at (anode) & OH^- ions at cathode diffuse & when they meet, ferrous hydroxide is precipitated.

$$2Fe^{2+} + 4OH^- + H_2O + O \longrightarrow 2Fe(OH)_3$$

or

$$Fe_2O_3 \cdot 3H_2O$$

(Rust)

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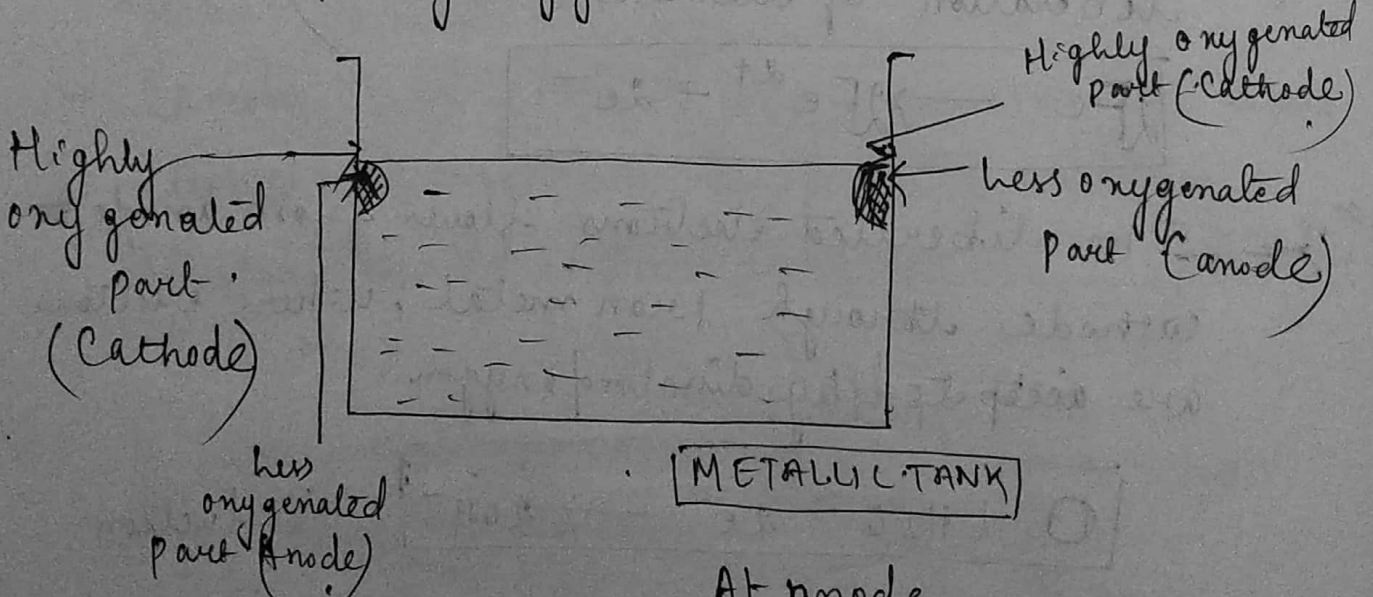
Waterline Corrosion

— Waterline corrosion occurs due to differential oxygen concentration

— When water is stored in steel tank, considerable corrosion takes place along a line just below the level of meniscus.

— The area above the waterline is cathode as it is highly oxygenated.

— The area below the waterline is anode as it is poorly oxygenated.



At anode

$$2Fe \longrightarrow 2Fe^{2+} + 2e^- \quad \text{(Oxidation)}$$

At cathode

$$O + H_2O + 2e^- \longrightarrow 2OH^- \quad \text{(Reduction)}$$

Overall Reaction

$$2Fe^{2+} + 4OH^- + H_2O + O \rightarrow 2Fe(OH)_3$$

or

$$\text{Rust} \longrightarrow Fe_2O_3 \cdot 3H_2O$$

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Occurence :

This type of corrosion occurs in ships, water tanks, pipelines, etc.

Prevention :

- We can use Antifouling paints to marine ships to prevent waterline corrosion.

Protection from Corrosion :

We can protect the metal from corrosion in various methods ——

a) Alloying — Corrosion resistance of most metals is ~~based~~ best increased by alloying them with suitable elements, but for maximum corrosion resistance, alloy should be completely homogeneous.
— Alloys resist corrosion in 2 ways
i) Homogenity
ii) Oxide film.

b) Galvanisation — The process of covering iron or steel with a thin coat of zinc to prevent it from rusting.
— Zinc protects the iron sacrificially, since it is more electropositive than iron.
— Zinc loses electrons in preference to iron & is consumed in course of time.

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Inorganic Chemistry

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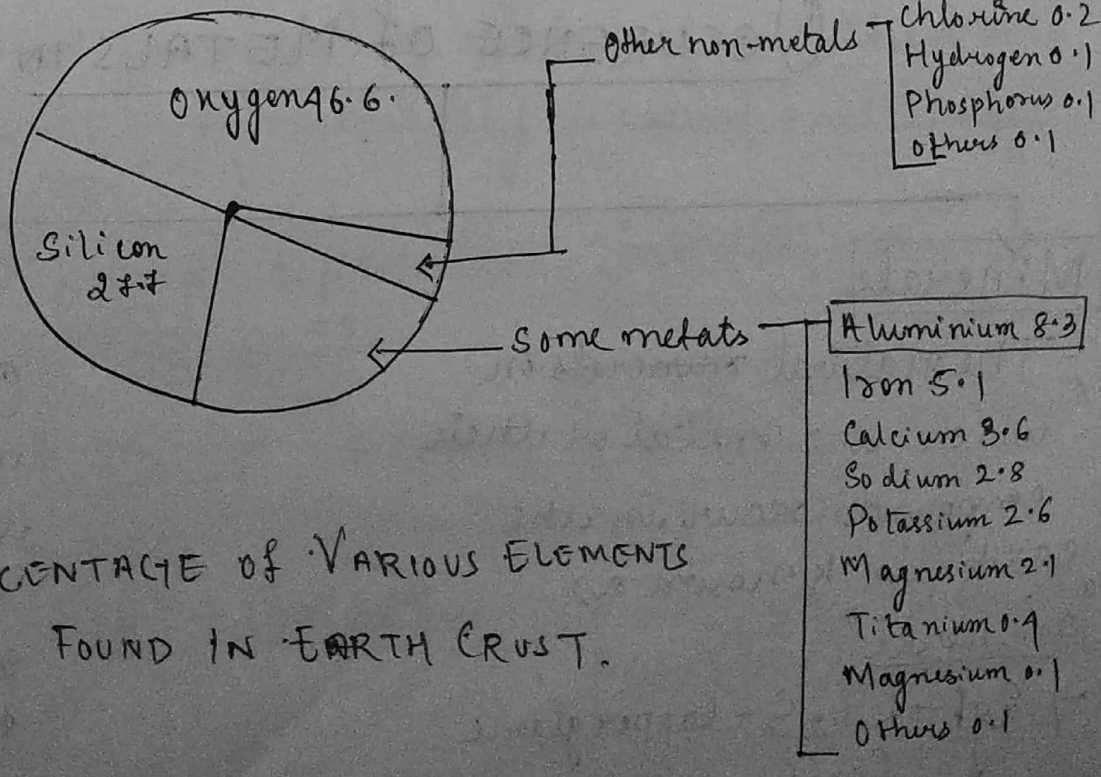
Chapter-7: Metallurgy.

Metals & Non-metals

Metals: The elements which are hard, dense, malleable, ductile, good conductor of electricity, electropositive in character & have bright lustre & have high melting point & boiling point are called metals.
Examples — Copper, Silver, Iron etc.

Non-metals: The elements which are generally not malleable, not ductile, bad conductor of electricity, electronegative in character are called non-metals.
Examples — Hydrogen, oxygen, carbon, etc.



PERCENTAGE OF VARIOUS ELEMENTS FOUND IN EARTH CRUST.

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OCCURRENCE OF ELEMENTS IN NATURE

Native (free) state

→ Elements which are not attacked by moisture, oxygen & carbon dioxide of the air occur in native state.

Eg:- Gold, Platinum, etc. noble gases

Combined State

→ Elements which are readily attacked by moisture, oxygen & carbon dioxide of the air occur in the combined state in form of their compounds.

Eg:- Oxides, Sulphides, carbonates, etc of Cu, Al, Fe, Ca, etc

OCCURENCE OF METALS IN NATURE

Minerals

→ The natural ~~minerals~~ on which the metal or their compounds occur in the earth is known as "mineral"

→ Eg:- Cu_2S - Copper glance
$CuCO_3$ - Malachite
$CuFeS_2$ - Copper Pyrites
(Minerals of Copper)

ORes

ORes are the minerals from which the concerned metal can be extracted conveniently & economically.

→ Eg:- Copper Pyrite ($CuFeS_2$) is ore of copper

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Minerals

Eg1- Fe_2O_3 - Haematite
Fe_3O_4 - Magnetite
(Minerals of Iron)

Eg3- $Al_2O_3 \cdot 2H_2O$ (Bauxite)
Al_2O_3 Corundum
(Minerals of Aluminium)

ORES

Eg2- Fe_2O_3 & Fe_3O_4 Haematite & magnetite are ores of Iron

Eg3- Bauxite ($Al_2O_3 \cdot 2H_2O$) is ore of Aluminium

GANGUE – The earthly or undesired or unwanted impurities present in the ore is called Gangue.

What is Metallurgy?

The Process of extracting metals from their ores conveniently & economically is called metallurgy.

Metallurgical Operation involves the following steps :–

Step 1– Crushing & Grinding of ore

Step 2 – Concentration or Dressing of ore

Step 3 – Oxidation : Conversion of ore into an oxide form (metal oxide)

Step 4 – Reduction : Conversion of metallic oxide into Crude Metal

Step 5 – Refining

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I. **Crushing of ore** – The process of converting big piece (lumps) of ore into smaller pieces is called Crushing of ore.

– It is done with help of Jaw crusher.

Pulverization of Ore – The process of converting crushed ore into powder form is called pulverization of ore.

– It is done with help of ball mill or stamp mill.

II Concentration of Ore / Dressing of Ore

⇒ The process of removing unwanted, earthy impurities (gangue or matrix) from the ore is called Ore-dressing or concentration of ores.

Depending on the type of impurities present in ore & nature of ore following methods are used for concentration of ore.

1) Gravity Separation
2) Magnetic Separation
3) Froth-Floatation
4) Leaching.

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(8)

1- **Gravity Separation** — Gravity separation also called hydraulic washing.

- It is based on the differences in gravities or densities of the ore & the gangue.
- Impure crushed ore is washed with stream of running water.
- The lighter gangue particles are washed away & heavier ores are left behind.
- This can be done in specially designed tables called Wilfley tables.
- It is used for ores of tin & iron (SnO_2, Fe_2O_3)

2- **Froth Floatation Method**

→ This method is based on the difference in the wettability of the ore & the gangue particles.

→ This method is used for: concentration of sulphide ores. (ZnS, $CuFeS_2$) etc

→ A powdered ore is mixed with water, pine oil & the mixture is agitated by air.

→ Pine oil called collector enhances the wettability of the ore & Froth-stabilisers (eg- cresols, aniline) stabilize the froth.

→ Froth contains ore particles & is light, collected at the top & can be removed.

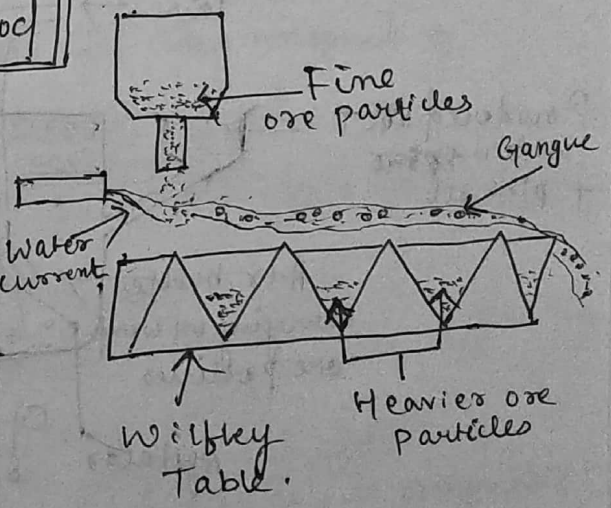

FIG: Gravity Separation

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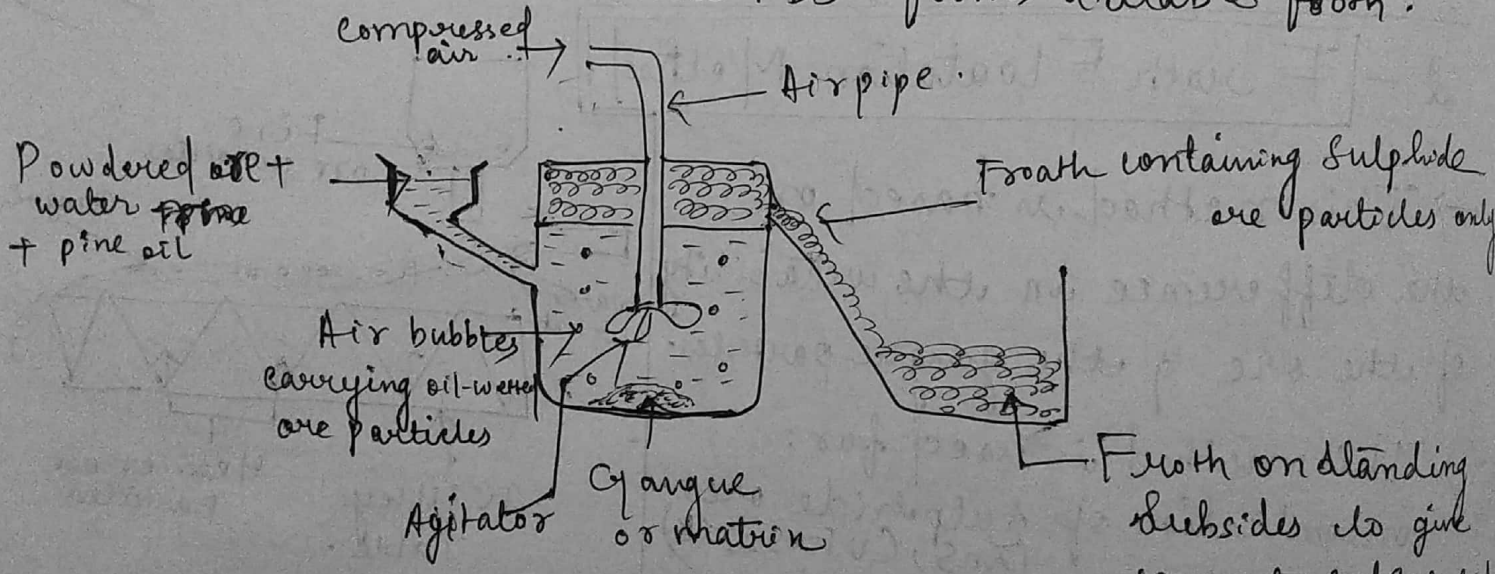
→ If the minerals to be concentrated consists of sulphides of two metals, then depressants are added.

→ The sole purpose of depressant is to speed up the formation of froth by one sulphide ore & depress the froth formation by second sulphide ore.

Eg – NaCN which combines with ZnS & forms a ~~stable~~ complex which remains in solution while PbS forms a stable froth.



FROTH FLOATATION PROCESS.

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3) Magnetic Separation Method.

~~→ If the impurity partic~~

→ This method is used if the impurity particles are magnetic & the ore particles are non-magnetic or vice-versa.

→ In this method, an electromagnetic separator is used.

→ The separator consists of a rubber belt which moves over two rollers, one of which encloses a magnet in it.

→ The crushed ore is dropped over the belt, the magnet particles are attracted by magnet & hence fall just below the magnet.
While the non-magnetic particles fall away from it.

Eg:- Tinstone ore, SnO_2 is non magnetic. The impurities it contains — $FeWO_4$ (magnetic),
— ~~$FeCr_2O_4$~~ (chromite ore), $FeO \cdot Cr_2O_3$, is magnetic.
The impurities it contains — Silicious impurities (non magnetic)

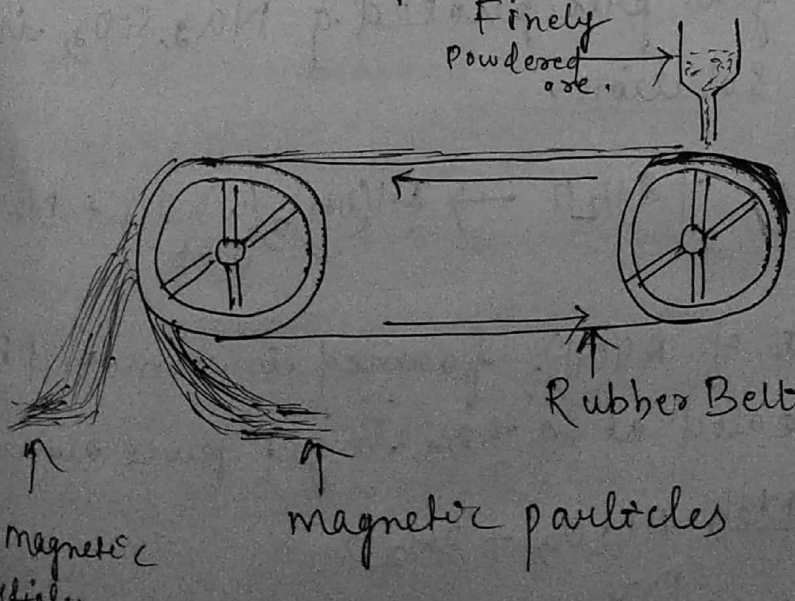

FIG: Electromagnetic Separator

A. Leaching Process.

→ LE is a chemical treatment of the ore.
→ Leaching is used if the ore is soluble in some suitable solvent.

Leaching of Bauxite Ore (Bayer's Process)

→ Bauxite ($Al_2O_3 \cdot 2H_2O$), an ore of Aluminium.
→ Bauxite contains SiO_2 as impurity.
→ The impure bauxite ore is treated with conc. NaOH

$$Al_2O_3 \cdot 2H_2O(s) + 2NaOH(aq) \rightarrow \underbrace{2NaAlO_2(aq) + 3H_2O(l)}_{\text{Solution}}$$

$$\underset{\text{(impurity)}}{SiO_2(s)} + 2NaOH(aq) \rightarrow \underbrace{Na_2SiO_3(aq)}_{\text{Solution}}$$

→ The solution containing $NaAlO_2$ & Na_2SiO_3 is diluted with water, as a result of which a white ppt. of $Al(OH)_3$ gets precipitated & Na_2SiO_3 is left behind in solution.

$$NaAlO_2(aq) + 2H_2O \rightarrow \underbrace{Al(OH)_3}_{\text{white ppt}} + NaOH(aq)$$

→ The precipitate of $Al(OH)_3$ formed is removed by filtration & heated at 1470 K to get pure alumina.

$$2Al(OH)_3 \xrightarrow{1470\,K} \underset{\text{Pure alumina.}}{Al_2O_3} + 3H_2O$$

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III: Conversion of the Concentrated Ore into Metal Oxide.

→ The conversion of ore into metal oxide can be done by any of the following methods :—

Calcination

- It is the process of converting an ore into its oxide by heating strongly below its melting point either in absence or limited supply of air.
- This method is commonly used to convert metal carbonates ($CaCO_3$, $MgCO_3$) & hydroxides to their respective oxides.
- Chemical changes / functions occur during Calcination :—
  1) Moisture is removed.
  2) Volatile impurities such as S, As & P are removed.
  3) Carbonate ores are converted into metal oxide.

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$$

$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2\uparrow$$

$$CuCO_3 \cdot Cu(OH)_2 \xrightarrow{\Delta} 2CuO + H_2O + CO_2$$

  4) Ore become Porous / soft

Roasting.

- It is the process of converting an ore into its metallic oxide by heating strongly at high temperature below its melting point in excess of air.
- This method is use to convert to convert Sulphide ores (PbS, ZnS) to their respective oxides.
- Chemical changes / functions occur during roasting :
  1) Moisture is removed
  2) Volatile impurities such as Sulphur, P & As are removed.
  3) Sulphide ores are converted into metallic oxides.

$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$$

$$2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$$

  4) Ore becomes Porous / soft.

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Difference

Calcination	Roasting
i) The ore is strongly heated in the absence of air.	i) The ore is strongly heated in presence of air
ii) The process is used for hydrated ~~or~~ & carbonate ores.	ii) The process is used for sulphide ores.
iii) Calcination converts the hydrated oxide or carbonates into metallic oxide.	iii) Roasting converts the sulphide ores into metallic oxide.

IV. **Reduction :** Conversion of Metallic oxide into Free crude Metal.

Smelting :- The process of extracting the metal by reduction of its oxide ore with carbon (in form of coal, coke, charcoal & co) is called Smelting.

- In this process, the roasted or calcined ore is ~~heated~~ mixed with required quantity of carbon (coke or coal) & heated to a high temp above melting point in a reverberatory furnace.

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$ZnO + C \xrightarrow{\Delta} Zn + CO\uparrow$

$PbO + C \xrightarrow{\Delta} Pb + CO\uparrow$

(PbO: metallic oxide; Pb: free metal)

$ZnO + CO \xrightarrow{\Delta} Zn + CO_2\uparrow$

$FeO + CO \xrightarrow{\Delta} Fe + CO_2\uparrow$

The metal thus produced is in molten state.

→ During the process of smelting, an additional substance called **flux** is added which combines with the impurities to form fusible slag.

$$\text{Flux} + \underset{\text{(Gangue or matrix)}}{\text{Impurity}} \longrightarrow \underset{\text{Fusible.}}{\text{Slag.}}$$

Flux — A substance added during the process of smelting to convert the gangue or matrix (impurities) into fusible mass called slag.

Slag — A fusible mass obtained during the process of smelting when flux combines with impurities.

Depending upon the nature of the impurities present in the ore, fluxes are of two types — **Acidic Flux** & **Basic Flux**

⇒ Acidic Flux is used to remove basic impurities during smelting.

Basic Impurity. Acidic Flux → Slag.

CaO + SiO_2 → $CaSiO_3$

MgO + SiO_2 → $MgSiO_3$

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→ Basic Flux is used to remove acidic impurities from the ore during smelting.

Acidic Impurity	Basic Flux	Slag
SiO_2	$CaCO_3$	$CaSiO_3 + CO_2$
SiO_2	$MgCO_3$	$MgSiO_3 + CO_2$

V. Refining Of Crude Metal

The metal extracted by any of the operations above is still impure & is called crude metal.

" The process of purifying crude metals is called refining. "

Some Methods are :—

① Distillation – It is used for ~~low boiling~~ volatile metals like Mercury, Zinc, etc which contain non-volatile impurities.

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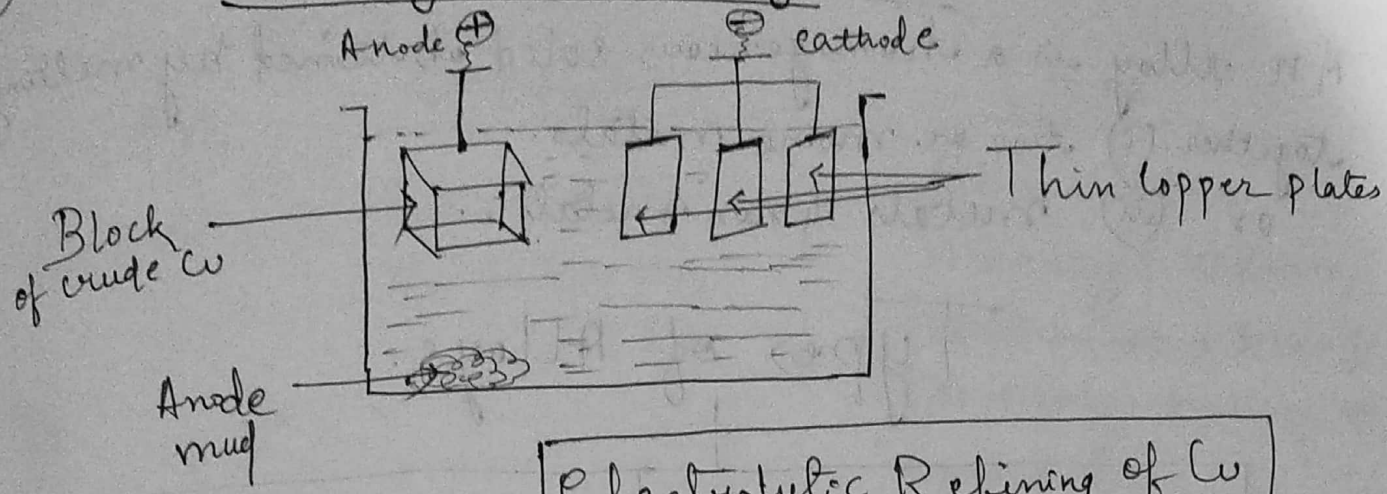
(2) Electrolytic Refining



Electrolytic Refining of Cu

→ Anode – Impure Copper block
→ Cathode – Pure Thin copper plates
→ Electrolyte – $CuSO_4$ soln + H_2SO_4.
→ Anode reaction – $Cu \rightarrow Cu^{2+} + 2e^-$
→ Cathode " – $Cu^{2+} + 2e^- \rightarrow Cu$ (pure metal)

Copper (of impure anode) forms copper ions, these go into solution of electrolyte
Cu^{2+} ions go to the cathode, where they are reduced to copper & gets deposited on cathode.

→ Impurities of Sb, Ag, Au & Pb are obtained at bottom anode called Anode mud.

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8: Alloys.

An alloy is a homogeneous solid obtained by melting together (i) two or more metals.
or (ii) metals & non metals.

Types of Alloys.

Ferro-Alloys.

The alloy containing iron as main constituent is called a ferroalloy.
Eg - Stainless steel
Magn Manganese steel.

Non-Ferro Alloys

The alloy which does not contain iron as main constituent is called non-ferro alloy.
Eg - Brass, Bronze.

Amalgams

Alloy contain Mercury as one of the constituent are called Amalgams.
Eg :- ① Copper amalgams
② Tin amalgams

Comm. Features of Alloy.

① Alloys are homogeneous in molten state but they may be either homogeneous or heterogeneous in solid state.
② Alloy must contain a metal.
③ In alloys, chemical properties of the component elements are retained, but certain physical properties are improved.

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Composition & Uses of Important Alloys.

Alloys	Composition	Uses
1. Brass	Cu: 60%-90% Zn: 40%-10%	It is used in making: Utensils, hardwares, screws, jewellery, battery caps, nameplates.
2. Bronze	Cu: 80%-95% Sn: 20%-5%	Making jewellery, water fittings, statues, medals, blades, pumpvalves, coins.
3. Alnico	Steel - 50% Ni - 21% Al - 20% Co - 9%	Used in making Permanent magnets.
4. Dwalmin	Al - 95% Cu - 4% Mn - 0.5% Mg - 0.5%	It is used in making airships.

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Organic Chemistry

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Hydrocarbon and Nomenclature

Hydrocarbons :- The compounds containing carbon and Hydrogen are called Hydrocarbons.

→ They ~~ben~~ are bonded through covalent bonds.

Classification of Hydrocarbons :-

Hydrocarbons

- Open chain Compound (Aliphatic Compound)
  - Saturated — Eg- Alkane (C_nH_{2n+2})
  - Unsaturated — Eg- Alkene (C_nH_{2n}), Alkyne (C_nH_{2n-2})
- Cyclic Compounds
  - Aromatic
  - Alicyclic (Non aromatic)

Aliphatic Compounds :-

→ Organic Compound containing C & H joined together in straight chains, branched chains

(a) Saturated Hydrocarbons :-

→ These are the Hydrocarbons containing C–C Single bonds only.

Example :- Alkane (C_nH_{2n+2})

CH_4 (Methane) C_3H_8 (Propane)

C_2H_6 (Ethane) C_4H_8 (Butane)

$CH_3-\underset{CH_3}{\underset{|}{CH}}-CH_3$ (Isobutane) $CH_3-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CH_3$ (neopentane)

(b) Unsaturated Hydrocarbons :-

→ These are the Hydrocarbons containing carbon-carbon multiple bond C=C (double bonds), C≡C (triple bond)

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Example (i)- Alkene (C_nH_{2n}). n = number of 'C'

→ General formula = C_nH_{2n}

→ Contain C=C double bond

Ex:- $CH_2=CH_2$ (Ethene)

$CH_2=CH-CH_3$ (propene)

$CH_2=CH-CH_2-CH_3$ (Butene)

Example (ii) - Alkyne (C_nH_{2n-2})

→ General formula = C_nH_{2n-2}

→ Contain C≡C triple bond

Ex:- $CH\equiv CH$ Ethyne

$CH\equiv C-CH_3$ propyne

Aromatic Hydrocarbons:-

→ The Hydrocarbons which obey Huckel's rule of aromaticity are called Aromatic Hydrocarbons.

Imp

Huckel's rule of Aromaticity:-

→ It state that a Hydrocarbon is said to be aromatic if it satisfy

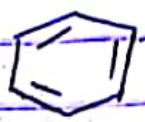
(i) Cyclic

(ii) planner (each 'C' undergo sp^2 Hybridised)

(iii) contain conjugated double bond

(iv) contain $(4n+2)\pi$ electrons, where n = 0, 1, 2, 3 ---
(Whole no.)

Example (i)-



(Benzene)

(i) It is cyclic

(ii) planner

(iii) contain conjugated double bond

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(iv) $(4n+2)\pi = 6\pi$

$\Rightarrow 4n\pi = 6\pi - 2\pi$

$\Rightarrow 4n = 4$

$\Rightarrow n = \frac{4}{4} = 1$ (whole no.)

* Since Benzene obey all four factors, It is aromatic compound.

Example - 2.



(Napthalein)

(i) It is cyclic

(ii) It is planner

(iii) Contain conjugated double bond

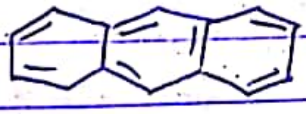
(iv) $(4n+2)\pi = 10\pi$

$\Rightarrow 4n = 8$

$\Rightarrow n = 8/4 = 2$ (whole no)

So, It is Aromatic Compound.

Example - 3



(Anthracene)

(i) It is cyclic

(ii) It is planner.

(iii) Contain conjugated double bond

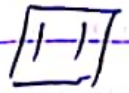
(iv) $(4n+2)\pi = 14\pi$

$\Rightarrow 4n = 12$

$\Rightarrow n = \frac{12}{4} = 3$ (whole no)

So, It is Aromatic Compound.

Qsn:- check whether these compounds are Aromatic or Not.

(a) 

(b) 

(c) 

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Ans:- (a) 

(i) cyclic (iii) contain conjugated
(ii) planner double bonds
(iv) $(4n+2)\pi = 4\pi$
$\Rightarrow 4n\pi = 4\pi - 2\pi$
$\Rightarrow 4n = 2$
$\Rightarrow n = 2/4 = \frac{1}{2}$ (fractional number)

∴ It is not aromatic as fourth factor i.e $(4n+2)\pi$ electrons is not satisfied.

(b) Not aromatic, Explain as (a)

(c) Aromatic, As It satisfy all factors of Aromaticity

Imp. Qsn:-

State and Explain Huckel's rule of Aromaticity with example.

Difference between Aliphatic and Aromatic Compounds.

Aliphatic	Aromatic
(i) In aliphatic Hydrocarbon, 'C's & 'H's are arranged in straight chain, branched manner.	(i) Carbons and Hydrogens are arranged in ring structure
(ii) Do not have pleasant odour	(ii) Have a pleasant odour.
(iii) They may be saturated and Unsaturated	(iii) All are unsaturated
(iv) Carbon to Hydrogen ratio is high.	(iv) Carbon to Hydrogen ratio is low.
(v) Have not delocalised π-electrons	(v) Have Delocalised π-electrons

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(vi) Example: methane, Butene. (vi) Eg: Benzene, Anthracene.

IUPAC System of Nomenclature :-

IUPAC (International Union of pure and applied Chemistry)

According to IUPAC System of Nomenclature an Organic Compound may contain the following four parts

(1) Root word (3) primary Suffix
(2) Prefix (4) Secondary Suffix

General Scheme of Naming :-

[prefix + Root word + primary Suffix + Secondary Suffix]

1. Root word :-

It refers to the number of Carbon atoms present in the parent chain of Organic Compound.

No. of 'C'-atom		Root word
01	-	Meth
02	-	Eth
03	-	Prop
04	-	But
05	-	Pent
06	-	Hex
07	-	Hept
08	-	Oct.
09	-	Non
10	-	Dec

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2. Prefix :-

It refers to the presence of Substituent or Side chain in the parent chain of organic Compound

	Group	Prefix
(R-)	$-CH_3$	Methyl
	$-CH_2-CH_3$	Ethyl
	$-F$	Fluoro
	$-Cl$	Chloro
	$-Br$	Bromo
	$-I$	Iodo
	$-NO_2$	Nitro
	$-OCH_3$	Methoxy
	$-OC_2H_5$	Ethoxy

3. Primary Suffix :-

It refers to the (C-C) single bond, (C=C) double bond and (C≡C) triple bond in compound

Nature of the bond		primary Suffix
All	C-C	-ane
one	C=C	-ene
Two	C=C	-Diene
one	C≡C	-yne
Two	C≡C	-Diyne

4. Secondary Suffix :-

It refers to the presence of functional group. It gives the identity of an organic Compound

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Compound	Functional group	2nd degree Suffix
$-OH$	Alcohol	-ol
$-CHO$	Aldehyde	-al
$>CO$	Ketone	-one
$-COOH$	Carboxylic acid	-oic acid
$-NH_2$	Amine	-amine
$-CONH_2$	Amide	-amide
$-COCl$	Acid chloride	-oyl chloride

Rules for IUPAC System of Nomenclature :-

1. Expansion of chain :- Sometimes condensed group are present in Organic Compounds. These condensed groups are to be separated.

Ex :- $CH_3-CH_2-(CH_2)_2-CH_3 \rightarrow CH_3-CH_2-CH_2-CH_2-CH_3$

$(CH_3)_2-CH-CH_3 \rightarrow CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3$

$CH_3-\underset{\underset{C_2H_5}{|}}{CH}-CH_2-CH_2-CH_3 \rightarrow CH_3-\underset{\underset{\underset{CH_3}{|}}{CH_2}}{\underset{|}{CH}}-CH_2-CH_2-CH_3$

2. Selection of Longest Carbon chain :-

$CH_3-CH_2-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$ → longest C-skeleton

$CH_3-\underset{\underset{CH_2-CH_3}{|}}{CH}-CH_3$

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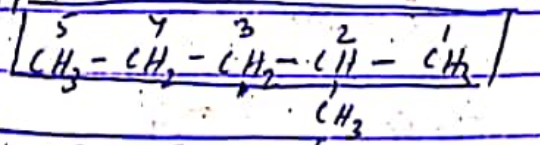
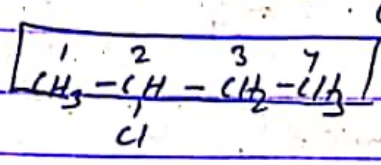
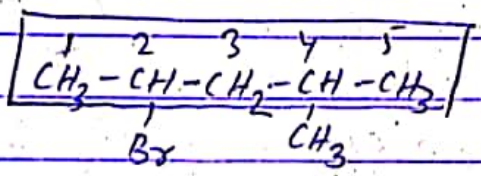
3. Numbering of Carbon-chain ~~from lowest~~ is done in such a way, that gives lowest number to the substituent.

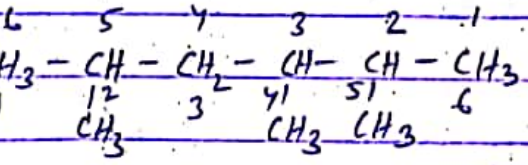




4. presence of 1 substituent and 1 side chain at the same position from either end. In this case lower numbering is given alphabatically which ~~have~~ appear 1st.



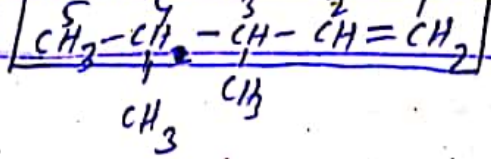
5. If same substituents are present either at the end. Numbering is done in such a way that gives lowest set of locants.



2+3+5 = 10 (Correct)

2+4+5 = 11 (Wrong)

6. presence of double bond/triple bond, minimum number is given to the carbon containing multiple bond



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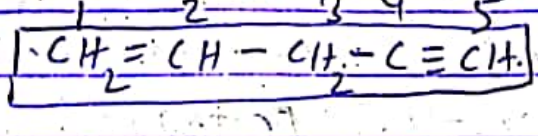
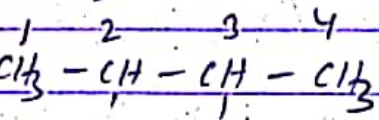
Note :- (1) If a compound containing (=) bond & (≡) bond then (C=C) is given higher priority & given lowest numbering.



Name end with : en-yne

(7) If compound contain more then one substituent Then naming will be alphabetical order.



2-Bromo-3-chloro Butane

Prefix +	Root word +	Primary Suffix +	Secondary Suffix
Side chain or Substituent	No. of 'C'-atoms	(-) ane (=) ene (≡) yne	functional group.

Class of Compounds :-

Alkane :-

→ General formula C_nH_{2n+2} n = no. of C-atom.

→ Representation $-\overset{|}{\underset{|}{C}}-$ (C has tetravalent)

→ Name ends with -ane.

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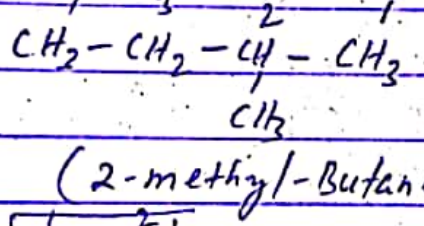
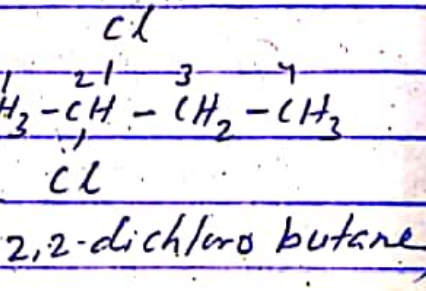
IUPAC Name of Alkane :-

Compound	Name
CH_4	Methane
CH_3-CH_3	Ethane
$CH_3-CH_2-CH_2-CH_3$	~~Propane~~ Butane
$CH_3-CH_2-CH_2-CH_2-CH_3$	~~pentane~~
$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$	Hexane

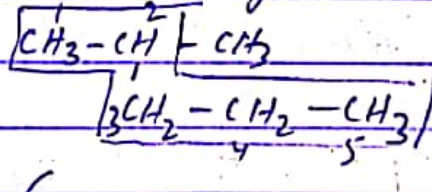
Practice



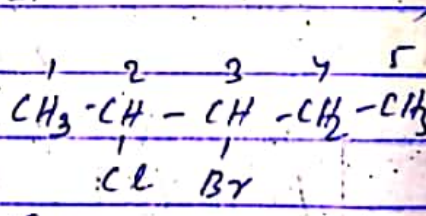
(2-methyl-Butane)



(2,2-dichloro butane)



(2-methyl-pentane.)



(3-bromo, 2-chloro pentane)

Alkene :-

→ General formula C_nH_{2n} n = no. of 'C'-atom.

→ Representation $CH_2=CH_2$

$>C=C<$

→ Name ending with -ene

Compound	IUPAC Name
$CH_2=CH_2$	Ethene
$CH_2=CH-CH_3$	Propene
$CH_2=CH-CH_2-CH_3$	Butene

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$CH_3-CH=CH-CH_3$ But-2-ene

$CH_2=CH-CH=CH_2$ But-1,3-diene.

$CH_3-CH(CH_3)-CH=CH_2$ 3-methyl-But-ene.

Practice :-

$CH_3-CH=CH-C(Cl)(Br)-CH_3$ 4-Bromo,4-chloro pent-2-ene.

$CH_3-CH(I)-CH=CH-CH_3$ 4-iodo-pent-2-ene.

Alkyne :-

- General formula C_nH_{2n-2}
- Representation $-C\equiv C-$
- Name ends with -yne

Compound	IUPAC name
$CH\equiv CH$	Ethyne
$CH\equiv C-CH_3$	Propyne
$CH-C\equiv C-CH_2-CH_3$	Pent-2-yne

practice :-

$CH_3-C\equiv C-CH(CH_3)-CH_3$ 4-Methyl pent-2-yne.

$CH_2=CH-CH_2-C\equiv CH$ pent-1-en-4-yne

Halo alkane :- (Alkyl halide)

→ General formula - RX

where R = alkyl group. ($-CH_3$, $-CH_2-CH_3$ etc)

X = Halogen (F, Cl, Br)

→ General name - Halo alkane

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Compound	IUPAC Name
CH_3-Cl	Chloro-methane
CH_3-CH_2-Br	Bromo ethane
$CH_3-CH_2-CH_2-Cl$	Chloro propane
$CH_3-\underset{Cl}{CH}-\underset{Cl}{CH}-CH_3$	2,3-dichloro-butane

Alcohol :-

→ General formula - R-OH

R - alkyl group

→ functional group is -OH

→ Name ends with - ol.

→ General name - alkanol.

Compound	IUPAC Name
CH_3-OH	Methanol
CH_3-CH_2-OH	Ethanol
$CH_3-CH_2-CH_2-OH$	propanol
$CH_3-CH_2-CH_2-OH$	Butanol

Practice :-

$CH_3-\underset{OH}{CH}-CH-CH_3$

Butan-2-ol

$\overset{1}{CH_3}-\overset{2}{CH}-\overset{3}{CH}-\overset{4}{CH_2}-\overset{5}{CH_3}$
$\quad\quad\quad

Uses of some Common aromatic Compounds :-

(01) Benzene :- (Uses)

→ It is used to make plastics, resins, Synthetic fibres, rubber lubricants.

→ Used to make Dye, detergent, drugs & pesticides.



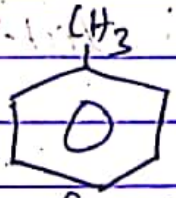
(Benzene)

(02) Toluene :-

→ It is used as solvent in paints, thinners, glues.

→ It is used as Correction fluid and nail polish remover.

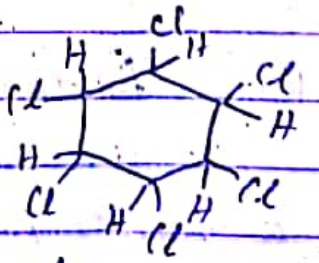
→ Used in the printing and leather tanning process.



(Toluene)

(03) BHC (Benzene Hexachloride) $C_6H_6Cl_6$

→ It is used as an important agriculture pesticide used for exterminating white ants, leaf hopper



→ It is used in Pharmaceuticals

→ It is used to treat Scabies.

→ It is used in shampoo.

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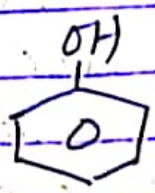
(04) Phenol

→ It is used in plastic manufacturing industries.
→ It is used to commercially prepare phenolic resins.
→ It is used in the study and extraction of bio-molecules.
→ It is used in Cosmetic industry in the manufacturing of sun screen, skin lightening cream, hair colouring solution

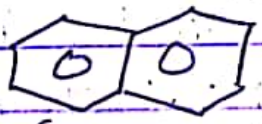


(Phenol)

or

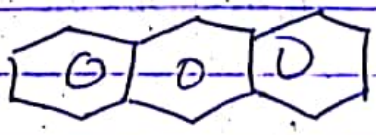
(05) Naphthalene

→ It is used to make moth balls, PVC, insecticides,
→ used to make dyes, Toilet deodorant blocs
→ It is used to make pharmaceutical & resin.


(Naphthalene)

(06) Anthracene :-

→ It is cesed to in the artificial production of the red dye Alizarin.
→ It is used in wood preservatives, insecticides and coating materials.


Anthracene

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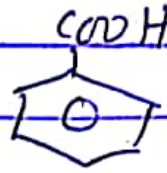
(07) Benzoic acid.



(Benzoic acid)

→ It is used in perfumes, dyes, insect repellents.
→ It is used as pH adjuster and preservative in food.
→ Preventing the growth of microbes to keep food safe

Important Questions:-

(01) State and Explain the Huckel's rule of Aromaticity with example
or.
Define Aromatic Compound and explain with example.

(02). IUPAC Nomenclature ?
Write

(03) Uses of Aromatic Compound
(a) Benzene (d) Benzoic acid.
(b) Toluene (e) Naphthalene
(c) phenol (f) Anthracene.

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Industrial Chemistry

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WATER

Water is one of the most important compounds of hydrogen and oxygen. It is a colourless liquid and possesses a high dielectric constant (80) and therefore, salts are highly ionised when dissolved in water, but not so in other solvents. It is the most convenient universal solvent. In general, water is a good solvent for ionic compounds but a poor one for co-valent compounds.

Classification of water

All the source of water can broadly be classified in to two categories.

A. Surface Water

B. Underground Water

Classification of Surface Water

- Rain Water
- River Water
- Sea Water
- Lake Water

Classification of Under Ground Water

- Spring Water
- Well Water

A. Surface water:

1. Rain water:

i. Rain is formed by the continuous evaporation and condensation of surface water.

ii. Rain water is considered to be purest form of natural water.

iii. It does not contain any dissolved minerals.

iv. However during its downward movement, it comes across a number of industrial gases like CO_2, SO_2, SO_3, NO_x etc. which dissolves them to form acid rain.

$CO_2 + H_2O \rightarrow H_2CO_3$

$SO_2 + H_2O \rightarrow H_2SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

v. All the water obtained as a result of rain fall is not available for further use, because some of it is lost by evaporation, percolation and transpiration.

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2. River water:

i. The over flown surface water (surface run off), which is seen in the form of various streams join together to form river.

ii. It is also formed due to the melting of glaciers.

iii. It contains a high percentage of dissolved minerals like NaCl, KCl, $NaNO_3$, $CaCO_3$, $NaHCO_3$ etc.

iv. More is the contact of the water with the soil more is the amount of mineral deposit in the river.

3. Lake water:

i. A lake is formed due to the collection of water in a natural basin or depression in a mountainous area or in planes, whereas natural lake is a large body of water within land with impervious bed.

ii. Lake water contains a less percentage of dissolved minerals but a very high percentage of organic matters. Presence of high percentage of organic matters is due to the decomposition of vegetable matters and dead bodies of animals during natural calamities like flood, tsunami etc.

4. Sea water:

Sea is formed when a number of rivers meet together.

i. Sea water is considered to be the most impure form of natural water.

ii. Sea water contains about 3.5% dissolved minerals of which about 2.6% is only NaCl.

iii. The percentage of minerals is gradually increasing day by day due to the continuous evaporation of sea water.

iv. Besides NaCl, it also contains other minerals such as Na_2SO_4, $KHCO_3$, $Mg(HCO_3)_2$, $Ca(HCO_3)_2$, KBr, $MgBr_2$ etc.

B. Underground water:

The sources of water which supply water from below the earth's surface are known as **underground water**. In this type of source, the water that has percolated into the ground is brought on the surface. Underground water is of two types:

a. Spring water **b. Well water**

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a. Spring water:

i. Spring is formed due to the melting of glaciers. It is also formed in the mountainous area. During rainy season a part of rain water percolates into the surface of earth. It dissolves many minerals which are in the way of this water. During its downward journey when it meets hard rock, it retards back and emerges out as spring in some weak areas.

ii. It is a clearer form of natural water.

iii. It contains high percentage of dissolved minerals and thus its hardness is very high.

b. Well water:

i. It is a clearer from of natural water.

ii. It is obtained by digging the surface of earth to a high depth.

iii. It contains many dissolved minerals

iv. It also contains some organic matters.

CLASSIFICATION OF WATER

i. Soft water: Water which produces enough foam or lathers with soap solution is called **soft water.**

ii. Hard water: Water which does not produce much foam or which does not lathers with soap solution is called **hard water.**

Hardness of water: The characteristic of water by virtue of which it prevents the formation of foam with soap solution is called **hardness**. The hardness of water is due to the presence of certain dissolved minerals like **$Ca(HCO_3)_2$, $Mg(HCO_3)_2$, $CaCl_2$, $MgCl_2$, $FeSO_4$**, etc in water.

The unit of Hardness: Parts per million (PPM).

Hardness of water is of two types:

A. Temporary or Carbonate hardness

B. Permanent or Non-carbonate hardness

A. Temporary hardness: The temporary hardness of water arises due to the presence of bicarbonates of **Ca and Mg, [$Ca(HCO_3)_2$, $Mg(HCO_3)_2$]**. Temporary hardness is also called carbonate hardness.

B. Permanent of hardness: The permanent hardness of water arises due to the presence of chlorides of Ca, Mg ($CaCl_2$, $MgCl_2$) and sulphates of certain heavy metals like Fe ($FeSO_4$).

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REMOVAL OF HARDNESS OR SOFTENING OF WATER

The process of decreasing the hardness of water is called **softening**. It involves decreasing the concentration of calcium and magnesium salts in water.

REMOVAL OF HARDNESS

A. Removal of Temporary Hardness:

The temporary hardness of water can easily be removed just by boiling the water. When hard water is boiled, the soluble $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ are decomposed in to insoluble carbonates, which are removed by filtration.

$$\underset{\text{Hard Water (soluble)}}{Ca(HCO_3)_2} \xrightarrow{\text{Boil}} \underset{\text{(insoluble)}}{CaCO_3} + H_2O + CO_2 \uparrow$$

$$\underset{\text{Hard Water (Soluble)}}{Mg(HCO_3)_2} \xrightarrow{\text{Boil}} \underset{\text{(insoluble)}}{MgCO_3} + H_2O + CO_2 \uparrow$$

B. Removal of Permanent Hardness:

Removal of permanent hardness requires chemical treatment. Various methods used for the removal of permanent hardness are described below.

1. LIME SODA PROCESS (L – S PROCESS)

Principle:

In this process hard water is treated with a calculated quantity of lime and soda. Lime and soda convert the soluble hardness causing chemicals present in hard water in to insoluble substances.

$$\underset{\text{(soluble)}}{CaCl_2} + \underset{\text{soda}}{Na_2CO_3} \rightarrow \underset{\text{(insoluble)}}{CaCO_3\downarrow} + 2NaCl$$

$$\underset{\text{(soluble)}}{MgCl_2} + Ca(OH)_2 \rightarrow \underset{\text{(Insoluble)}}{Mg(OH)_2\downarrow} + CaCl_2$$

The precipitate or sludge formed is then removed by filtration to get soft water.

Lime-Soda process is of two types.

a. COLD L – S PROCESS:

Principle:

A calculated quantity of lime and soda is treated with hard water at room tem

Lime and soda react with the hardness causing chemicals present in ha

precipitates or sludge formed are removed by filtration.

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Construction of Apparatus:

The apparatus consists of a conical shaped steel tank, containing a rotating shaft at the middle. Also it contains a wood fibre filter.

Working Process:

Hard water and a calculated quantity of lime, soda along with a little quantity of coagulant are introduced into the apparatus. When the shaft rotates water is properly mixed with lime and soda. The soluble hardness causing chemicals present in hard water react with lime and soda to form insoluble sludge.

$$\underset{\text{hard water}}{CaCl_2} + \underset{\text{soda}}{Na_2CO_3} \rightarrow \underset{\text{ppt}}{CaCO_3\downarrow} + 2NaCl$$

$$\underset{\text{hard water}}{MgCl_2} + \underset{\text{lime}}{Ca(OH)_2} \rightarrow \underset{\text{ppt}}{Mg(OH)_2\downarrow} + CaCl_2$$

Coagulant aggregates the finely divided sludge particles which settle down in the conical sedimentation tank. The sludge is then removed from time to time through its outlet. Water is now allowed to pass through the wood-fibre filter to get soft water. The residual hardness left in this process is about 50 – 60 ppm.

b. Hot lime Soda Process:

Priniciple: This process involves treatment of hard water with a calculated quantity of lime and soda in presence of super-heated steam (at 80 ℃ to 150 ℃).

Apparatus: The apparatus consists of three main parts:

1. Reaction tank: Here the reaction of lime and soda with the hard water takes places.

2. Conical sedimentation tank: Here the precipitates (sludge) are formed and deposited.

3. Filtering unit: It consists of a number of layers of gravels which is used to filter water.

Working Process:

Hard water along with a calculated quantity of lime and soda are introduced into the reaction tank. Also super-heated steam at 80 ℃ to 150 ℃ is passed in to it. The soluble hardness causing chemicals present in the hard water react with lime and soda to form insoluble sludge which settles down in the conical sedimentation tank. The sludge formed is removed periodically through its outlet. Water is then allowed to pass thorough the filtering unit to get soft water. The residual hardness left in this process is only about 15 – 30 ppm.

Advantages of hot L-S process over Cold L-S Process

i. It is much economical.

ii. The reaction is completed within a short period.

iii. The reaction proceeds faster. Hence the softening capacity in increased.

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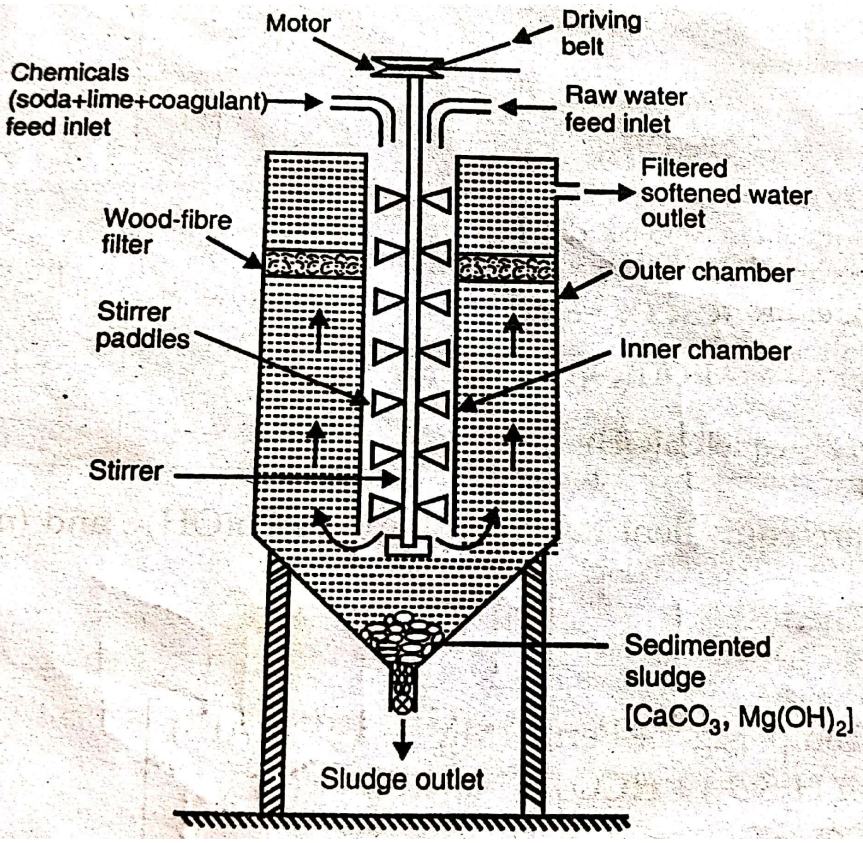

Fig. 3. Continuous cold lime-soda softener.

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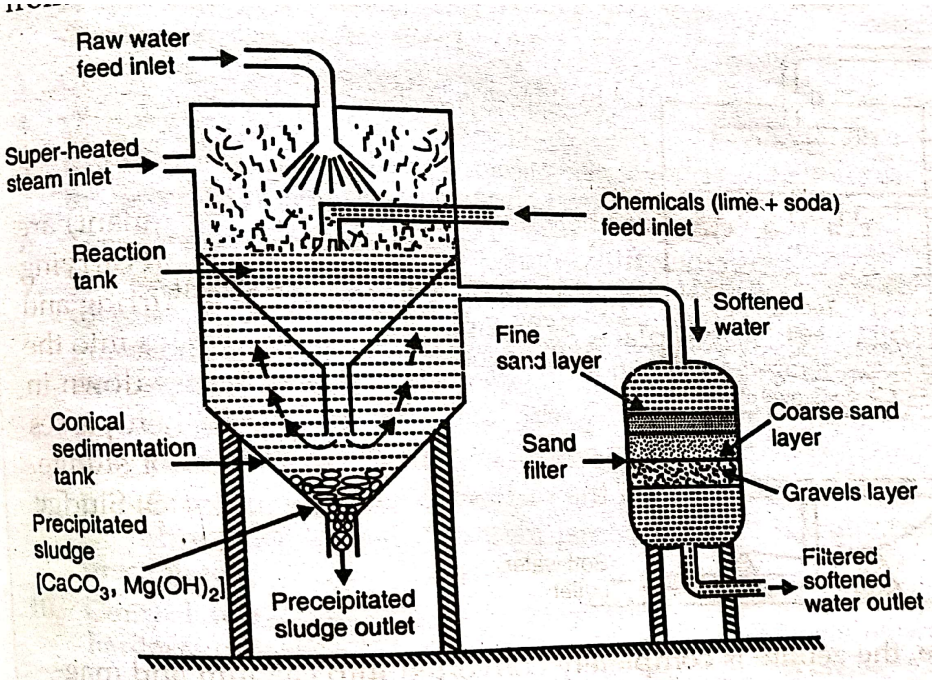

Fig. 4. Continuous hot lime-soda softener.

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iv. No coagulant is required, as the sludge settles down easily.

v. Dissolved gasses like CO_2, air etc. are removed.

vi. Under hot condition viscosity of water is lowered. Thus filtration becomes easier.

vii. Pathogenic bacteria are destroyed.

viii. The residual hardness left in this process is much lower (15-30 ppm) as compared to that in the cold L-S process (50-60 ppm).

2. ION EXCHANGE PROCESS:

[Deionization process or De-mineralization process]

In this method ion-exchange resins are used. These are insoluble long chained organic copolymers having micro-porous structure. These resins contain either acidic or basic functional groups capable of exchanging their H^+ or OH^- ion with the ions present in hard water.

Ion-exchange resins are of two types:-

1) Cation-exchange resins (RH)

These resins contain acidic functional groups like – COOH, $-SO_3H$ etc. which can exchange their H^+ ions with the cations of the hardness causing chemicals present in hard water.

2) Anion-exchange resins (ROH)

These resins contain basic functional groups like – $N^+Me_3OH^-$ which can exchange their OH^- ions with the anions of hardness causing chemicals.

Process: Hard water is first passed through the cation-exchange resin. The resin exchange its H^+ ions with the cations (Ca^{2+}, Mg^{2+} etc.) of hard water.

$$\underset{\text{(Cation-Exchange Resin)}}{2RH} + \underset{\text{hard water}}{Ca^{2+}} \rightarrow \underset{\text{Exhausted Resin}}{R_2Ca} + 2H^+$$

$$\underset{\text{(Cation-Exchange Resin)}}{2RH} + \underset{\text{hard water}}{Mg^{2+}} \rightarrow \underset{\text{Exhausted Resin}}{R_2Mg} + 2H^+$$

Then it is passed through the anion-exchange resin which exchange its OH^- ions with the anioins (Cl^-, SO_4^{2-} etc) present in the hard water.

$$\underset{\text{(Anion-Exchange Resin)}}{ROH} + \underset{\text{hard water}}{Cl^-} \rightarrow \underset{\text{Exhausted Resin}}{RCl} + OH^-$$

Regeneration of resins:

When all the H^+ and OH^- ions of the resins are exchanged by the ions of hard water, then the resins are said to be exhausted. The cation-exchange resin can be regenerated by the treatment of dil. HCl with the exhausted cation-exchange resin.

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$$\underset{\text{(Exhausted resin)}}{R_2Ca} + 2HCl \rightarrow \underset{\text{(Regenerated resin)}}{2RH} + CaCl_2$$

Similarly, the anion-exchange resin can be regenerated by the treatment of dil NaOH solution with the exhausted anion-exchange resin.

$$\underset{\text{(Exhausted resin)}}{RCl} + NaOH \rightarrow \underset{\text{(Regenerated resin)}}{ROH} + NaCl$$

Note: The residual hardness left in this process in only about 2 ppm.

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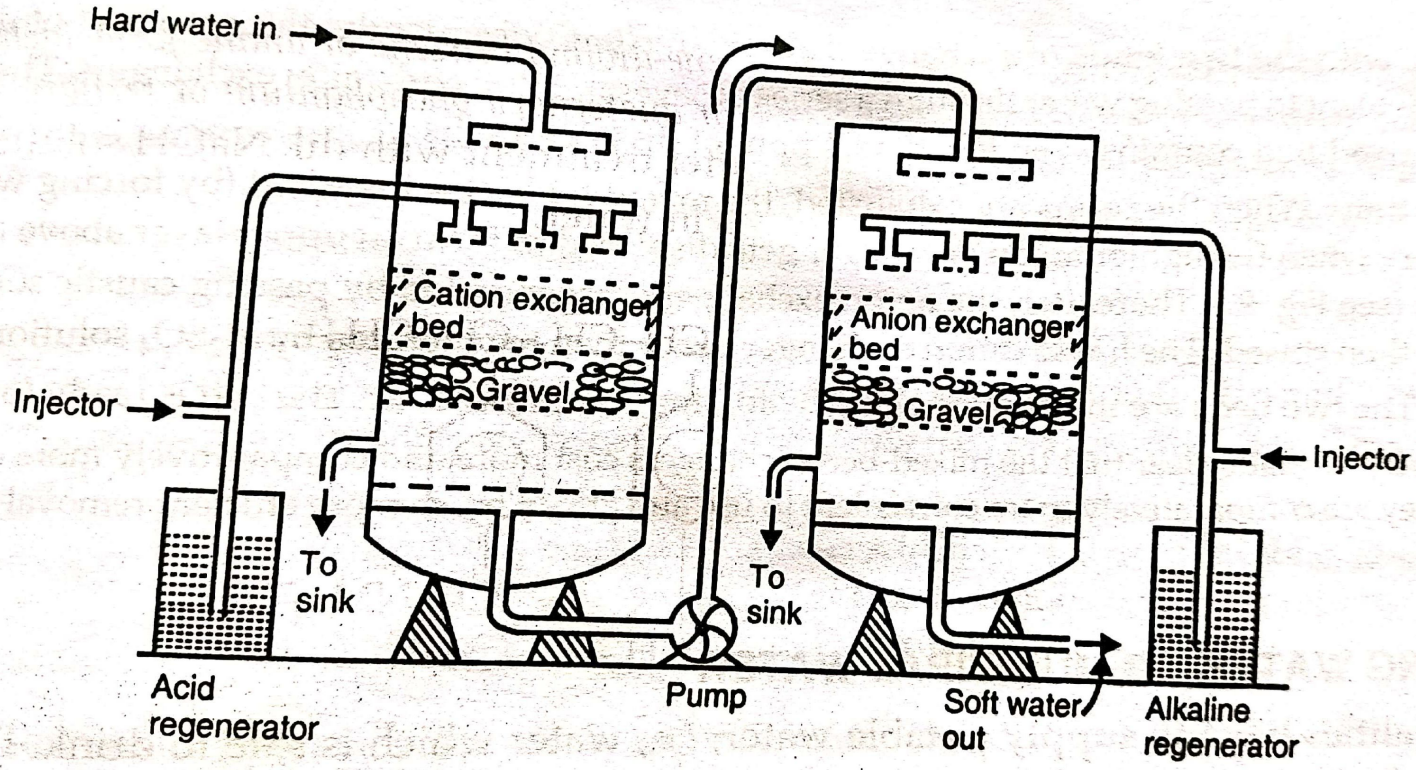

Fig. 8. Demineralization of water.

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S.No	Cold-lime soda process	Hot lime soda process
1.	This process is conducted at room temperature (at 25°C).	This process is conducted at high temperature (80-150°C).
2.	Co-agulant like alum is needed in it.	No co-agulant is required in it.
3.	It takes about 24 hours to complete.	This process is completed within 15 minutes.
4.	Hardness left in the water is about 60 ppm.	Hardness left in this process is 30 ppm to the maximum.

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Chapter 11 : LUBRICANTS

Lubricants

definition

The substance introduced between two moving/sliding surfaces with a view to reduce the frictional resistance between the two, is called a lubricant

Lubrication

definition

The process of reducing frictional resistance between moving/sliding surfaces, by introduction of lubricants in-between them, is called lubrications.

Types of lubricants

SOLID LUBRICANTS

It is used where:-

i) the working temperature is very high.

ii) Contamination (by entry of dust or grit particles) of lubricating oil or grease is unacceptable.

iii) Combustible lubricants must be avoided.

Eg- Graphite
Molybdenum disulphide (MoS_2)

LIQUID LUBRICANTS

It is used where:-

i) the working temperature is high.

ii) the speed of the roller is very high.

iii) the sealing arrangement is perfect to prevent the loss of oil.

Eg: Petroleum oil
Animal oil (whale oil, lard oil)
Blended oil (Animal oil + Petroleum oil)

SEMI-SOLID LUBRICANTS

It is used where:-

i) the working load is high & the machine is working at low speed.

ii) For sealing bearings against dirt & dust particles

iii) In places where dripping & spurting of oil is undesirable.

Eg:- Grease

FUNCTIONS OF LUBRICANTS

- It reduces the frictional resistance between the sliding surfaces.
- It reduces wearing & tearing of machinery parts.
- It reduces loss in energy.
- It increases the efficiency of engines.
- It acts as a cooling medium.
- It reduces expansion of metals.
- It enhances the durability of machinery parts.

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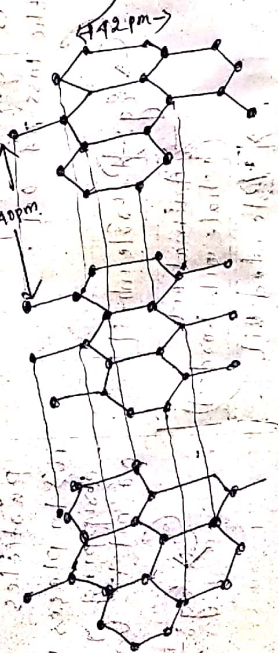
Grease (Semisolid)

A semisolid lubricant, consisting of a soap dispered throughout a lubricating oil.

- Major Components of greases are;-
  - i) Oil component – mineral oil, waxes,
  - ii) Thickening component – Na, K soaps
  - iii) Modifiers – antioxidant.

Graphite (Solid lubricant)

- Graphite is used in powder form or as suspension in oil or water.
- The suspension of graphite in water is aquadag
- The suspension of graphite in oil is called Oildag.



Structure of Graphite

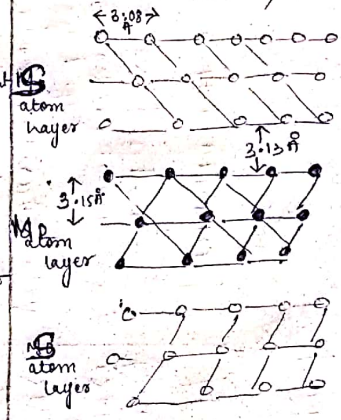
Uses

- As a lubricant in heavy machinery.
- In making electrodes for the electric furnaces.
- In making lead pencil
- In paints & varnishes.
- In nuclear reactors to slow down high energy neutrons.

Molybdenum Disulphide (MoS_2) (Solid lubricant)

Uses

- It is used as ~~lubricant~~ lubricant in form of powder along with solvent.
- It is better lubricant than Graphite.
- It is stability upto 400°C. (low coefficient of friction



Structure of Molybdenum disulphide

Liquid lubricants or lubricating Oil

1. Mineral Oil
2. Vegetable Oil
   - ↳ Olive oil (lubrication of bearings)
   - ↳ Palm oil (lubrication of watches & clocks)
   - ↳ Castor oil (")
3. Synthetic oil ⇒ Used in jet engines, rocket motors.
4. Animal Oil
   - ↳ Whale oil (Light Machinery)
   - ↳ Lard oil (used in various machines)

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CH-12 Fuels

Occurrence based

- **Primary or Natural Fuels** → State of aggregation
  - **Solid** → Wood, Peat, Coal, Lignite
  - **Liquid** → Crude oil or petroleum
  - **Gaseous** → Natural gas
- **Secondary or Derived Fuels** → State of aggregation
  - **Solid** → Coke, Charcoal, Briquette (wood chips, sawdust)
  - **Liquid** → Tar, Kerosene, Diesel, Petrol, L.P.G
  - **Gaseous** → Water gas, Coal gas, Biogas

Fuel + O_2 → Product + Heat energy

Calorific Value of Fuel

→ The calorific value of a fuel is defined as the amount of heat obtained by the complete combustion of unit mass of the Fuel.

Units of Calorific Value :-

Solid & liquid fuels :→ calories per gram (cal/g)
→ kilo calories per kilogram (K cals/kg)

Gaseous fuels – k·cal/m^3 or B·Th·U/ft^3
British Thermal unit per feet-3 → British Thermal Units Per Pound (B·Th·U/lb)

Choice of Good Fuel

→ Fuel should have high calorific value.
→ Low moisture content
→ Moderate ignition temperature.
→ Low cost
→ Should burn in air with efficiency without much smoke.
→ Low moisture content.
→ Easy to transport & handle.
→ Products of combustion should not be harmful.

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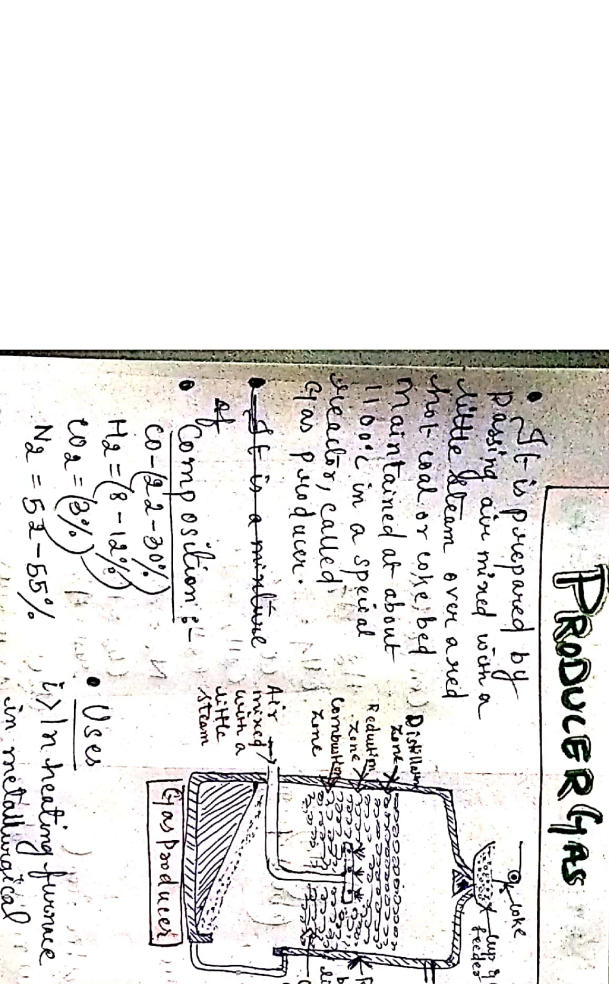
LIQUID FUELS

PETROL OR GASOLINE	KEROSENE	DIESEL
⇒ It consist of hydrocarbons between pentane to octane (C_5H_{12} to C_8H_{18})	⇒ It consists of hydrocarbons between decane to hexadecane ($C_{10}H_{22}$ to $C_{16}H_{34}$)	⇒ It consists of hydrocarbons between pentadecane to octadecane ($C_{15}H_{32}$ to $C_{18}H_{38}$)
⇒ Composition C = 84% H = 15% O+S+N = 1%	⇒ Composition C = 84% H = 16% S < 0.1%	⇒ Composition C = 85% H = 12% O+S+N = 3%
⇒ Calorific Value 11,250 kcal/kg	Calorific Value 11,100 kcal/kg	Calorific Value 11,000 kcal/kg
USES:	USES:	USES:
⇒ It is used as a fuel in the Petrol engine.	⇒ It is used as a fuel in the kitchen for domestic	⇒ It is used as a fuel in diesel engine
⇒ It is used as a dry cleaning agent.	⇒ It is used as a fuel in jet planes	
	⇒ It is used in making oil gas	

PRODUCER GAS

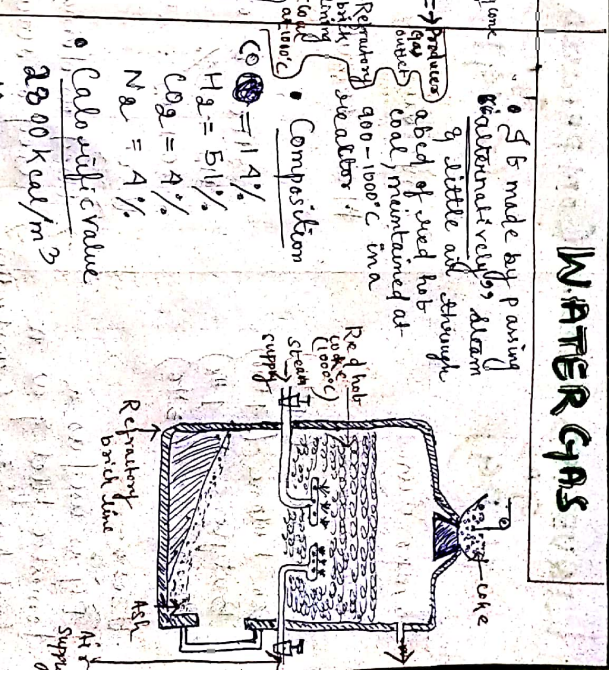
- It is prepared by passing air mixed with a little steam over a red hot coal or coke bed maintained at about 1100°C in a special reactor, called Gas producer.
- It is a mixture of
- Composition:-
  CO - (22-30%)
  H_2 = (8-12%)
  CO_2 = (3%)
  N_2 = 52-55%
- Calorific Value
  1300 kcal/m^3.



- Uses
  i) In heating furnace in metallurgical operation.
  ii) As a reducing agent.

WATER GAS

- It made by passing alternatively steam & little air through red hot coal, maintained at 900-1000°C in a reactor.
- Composition
  CO = 41%
  H_2 = 51%
  CO_2 = 4%
  N_2 = 4%
- Calorific value
  2800 kcal/m^3
- Uses
  i) used as an illuminating gas
  ii) a fuel (iii) a source of H_2 gas.



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LIQUEFIED NATURAL GAS (LPG)

Composition :

- Propane - (C_3H_8)
- n-butane - (C_4H_{10})
- iso-butane - (C_4H_{10})
- Butylene - (C_4H_8)
- Propylene - (C_3H_6)

Uses :-

→ LPG is used as a domestic fuel & as a fuel for internal combustion engines.

→ It is used as feedstock for the manufacture of various chemicals.

Calorific Value

27,800 Kcal/m³

COMPRESSED NATURAL GAS (CNG)

Composition :-

Main constituent Methane (CH_4) (about 70-90%)

- C_2H_6 = 5-10%
- H_2 = 3%
- $CO + CO_2$ = rest

Uses :-

→ Used as domestic fuel

→ Used as raw material for the manufacture of carbon black (a filler for rubber).

→ It is used in manufacture of number of chemicals.

Calorific Value

13000 Kcal/m³

COAL GAS

Composition

- H_2 = 47%
- CH_4 = 32%
- CO = 7%
- C_2H_2 = 2%
- C_2H_4 = 3%
- N_2 = 1%
- CO_2 = 1%
- rest = 4%

Uses

→ As a fuel

→ As a reducing agent in metallurgical process

→ As an illuminant

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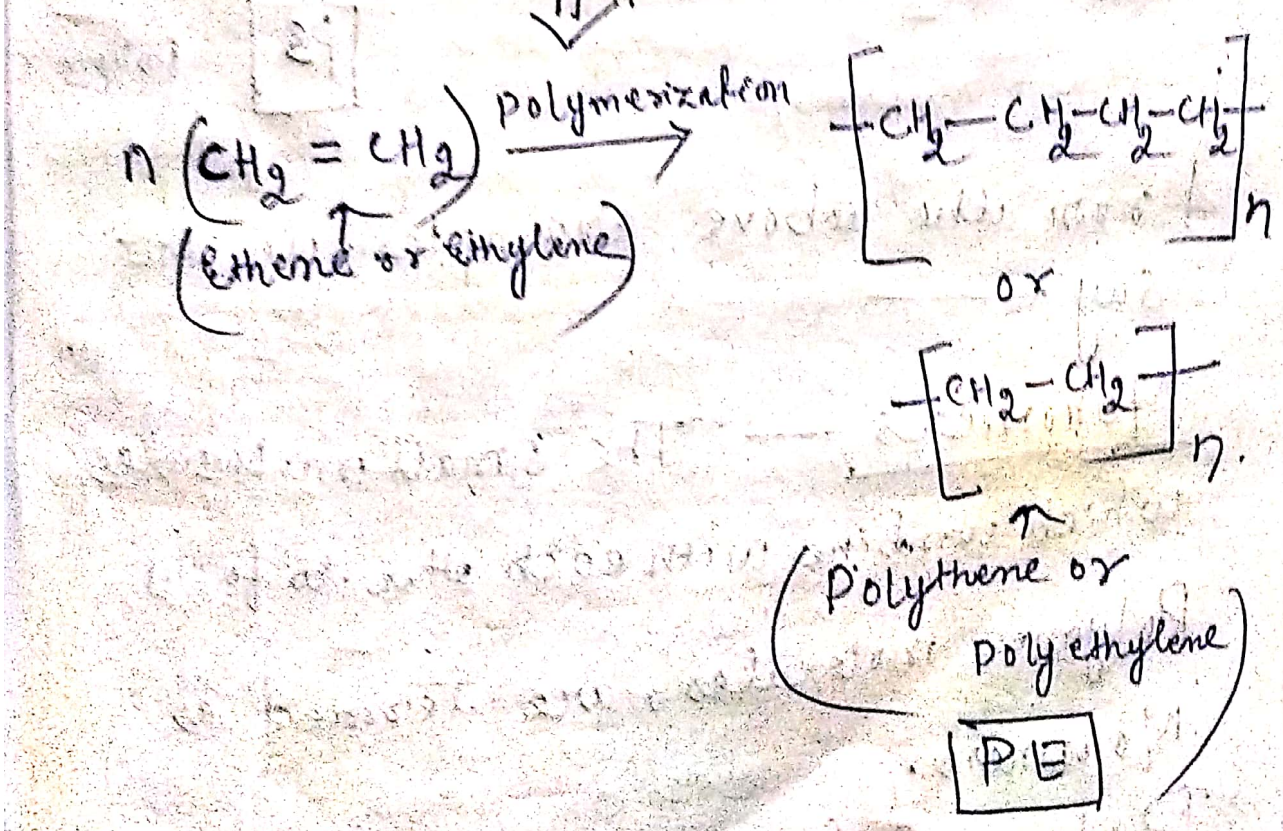
Polymers

Poly + Mere
(Many) (Parts or Units).

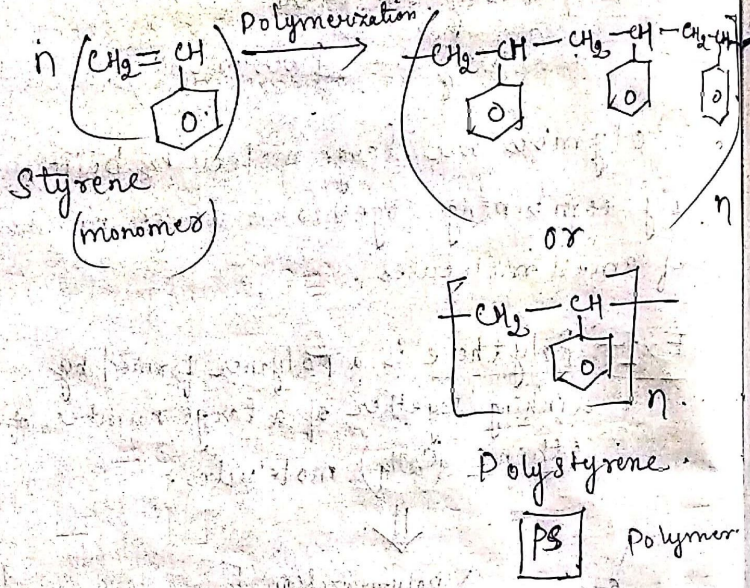
- Polymers are large molecules built up by combining together a large number of small molecules.

Ex1- Polythene is a polymer formed by linking together of a large number of ethene (C_2H_4) molecules.



Polystyrene is a polymer formed

Ex 2 - by linking together a large number of styrene monomer.



From the above examples, we can say —

Monomers — The small molecules which combine with each other to form Polymer molecules, are termed as Monomers.

Polymerisation — The process by which the monomer molecule are linked to form big polymer molecule is called Polymerisation

A polymer may consist of identical monomers or monomers of different chemical structure & accordingly they are, called Homopolymers & Copolymers respectively.

—M—M—M—M—M— —M1—M2—M1—M2—M1—M2—

Homopolymer Co-polymer.

- Homopolymer — Polymer is made from all identical monomer molecules/units.
  Eg:- Polyethylene, Polystyrene, Poly vinyl chloride.
- Copolymers — Polymer made from different monomer units/molecules.
  Eg:- Styrene Butadiene rubber.
- Degree of polymerization — The number of repeating units (or monomer) that combine to form polymer is called degree of polymerisation.
  → Polymers usually fall into the 5000 - 200,000 molecular range.

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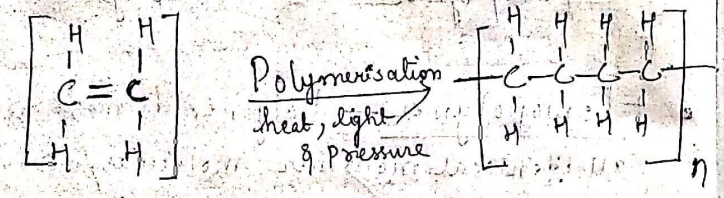
• Natural rubber is a mixture of polymer molecules having as many as 50,000 units per molecule, therefore its degree of polymerisation is 50,000.

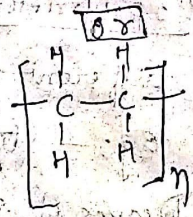
Examples of Homopolymer

① Polythene (PE)



Ethene (Monomer) → Polythene (PE) polymer

OR

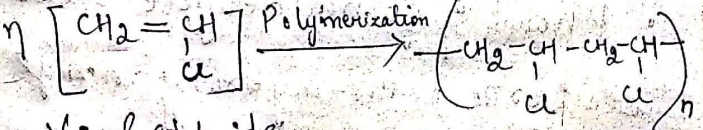


(P.E) Polythene

Uses: ① low Density polyethene.
- → It is used as packaging material
- → It is used in insulating wires
- → It is used in manufacture of pipes, toys, bottles.

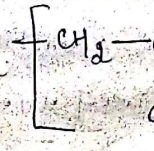
② High Density polyethene.
- → It is used in the manufacture of containers (buckets, tubes etc) & for making house wares, pipes, bottles, toys, etc.

② Polyvinyl Chloride (P.V.C)



Vinyl Chloride → Polyvinyl chloride

OR



Polyvinyl chloride (PVC)

Uses:-
1) It is used for making electrical insulators.
2) It is used in manufacture of gramophone, records, raincoats, PVC pipes, hand bags.

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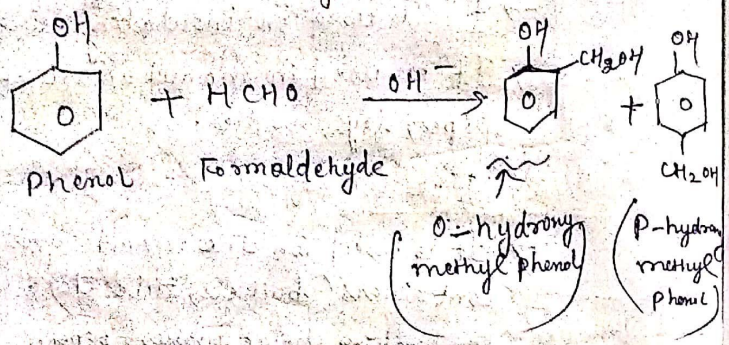
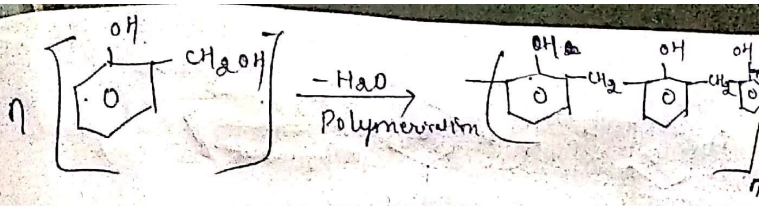
Bakelite (Phenol-Formaldehyde Resin)

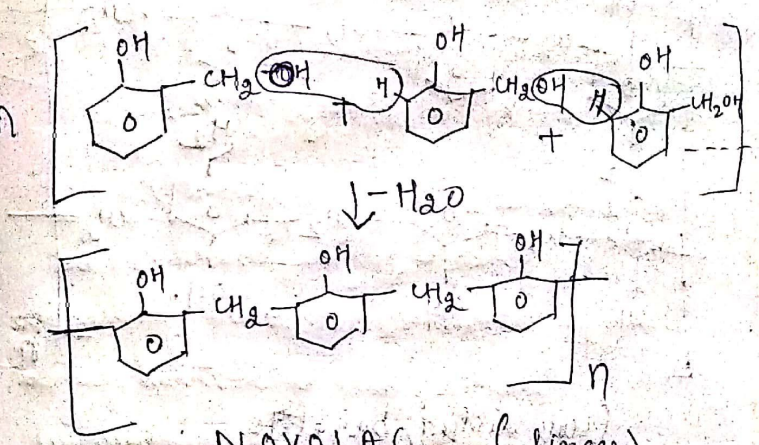
≈ Copolymer



- It is a co-polymer of phenol & formaldehyde.
- Phenol & formaldehyde react to form ortho-hydroxy methyl Phenol & para-hydroxy methyl phenol.
- The orthohydroxy methyl phenol thus formed undergoes polymerisation with another ortho-hydroxy methyl phenol to form linear polymer compound called NOVOLAC.



Mechanism



NOVOLAC (linear)

- Cross linked polymer (bakelite) can also be formed by polymerisation of O-hydroxy methyl phenol & P-hydroxy-methyl phenol.

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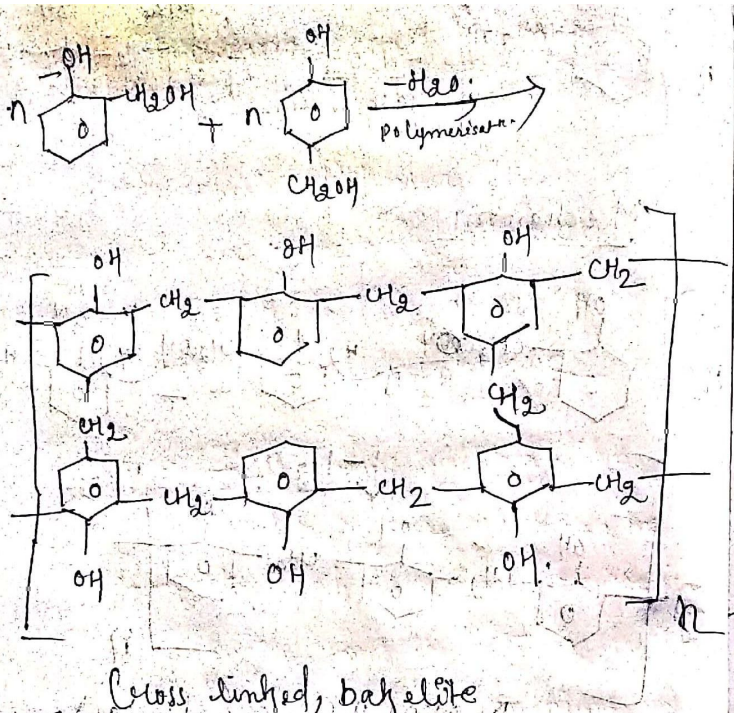
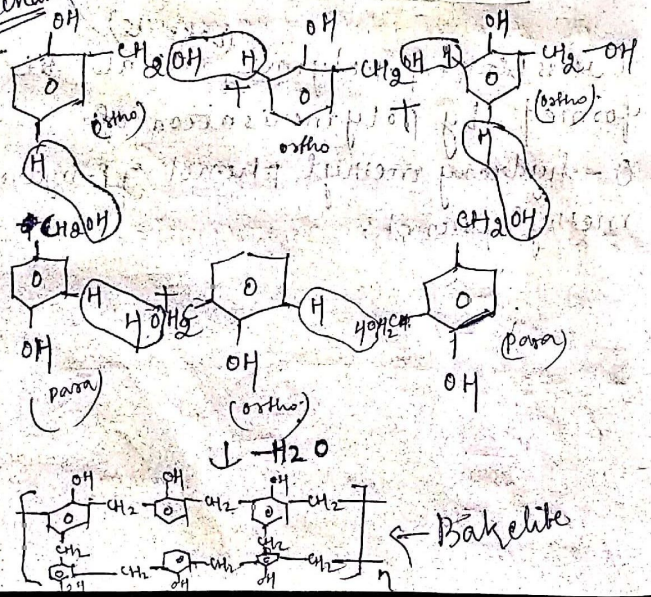


Cross linked, bakelite

Mechanism



Uses

- It is used in manufacture of insulation parts like switches, plugs, heated handles.
- As an ion-exchange resin in softening of water.
- Used in Radio & TV cabinets.
- Used in Paints & Varnishes.
- Telephone parts.

Thermosetting Polymers Eg:- Bakelite, Polyester	Thermoplastic Polymer. Eg:- Polyethene, PVC, PS
1. They do not soften on heating.	1. They soften on heating readily.
2. Their ~~poly~~ molecules have 3-D network structure.	2. Their molecules have linear chain structure.
3. They are formed by condensation polymerisation.	3. They are formed by addition polymerisation.
4. They cannot be reshaped & reused.	4. They can be reshaped, softened & thus reused.
5. They are hard, strong & more brittle.	5. They are usually soft, weak & less brittle.
6. Due to strong bonds & cross-linking, they are insoluble in almost all solvents.	6. They are usually soluble in organic solvents.

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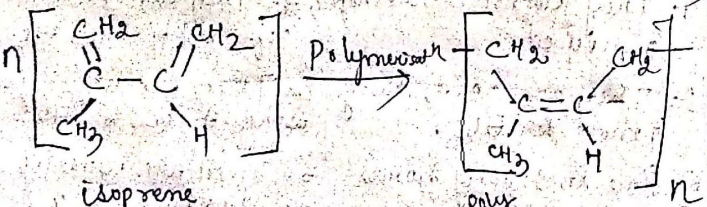
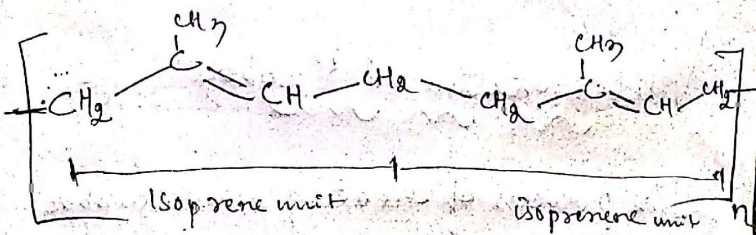
Eg of Thermosetting Polymer
— Bakelite, Polyester

Thermoplastic Polymer
— Polythene,
Polyvinylchloride
Polystyrene

Elastomers — It is any rubber like elastic polymer which can be stretched to atleast thrice its length, but it returns to its original shape & dimensions as soon as stretching force is released.

Natural Rubber :— It is a polymer of isoprene (2-Methyl buta-1,3-diene)





Structure of Natural Rubber
or
Cis-Polyisoprene

Drawbacks of Natural Rubber

- It has little durability.
- When stretch to a great extent, it suffers permanent deformation.
- It is plastic in nature
- It can be used between temperature (10°C to 60°C). In other words, it become brittle at low temp. & soft at high temp.
- It is weak, its tensile strength is only 200 kg/cm².
- It is attacked by oxidizing agents like nitric Acid, Sulphuric acid etc.
- It has large water absorption capacity.

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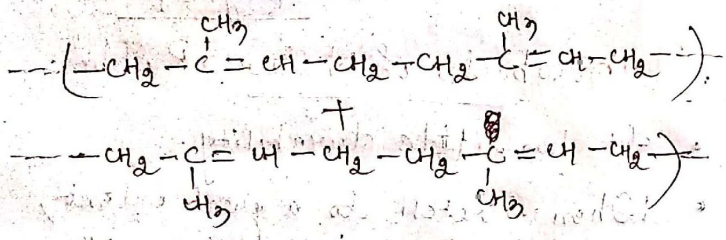
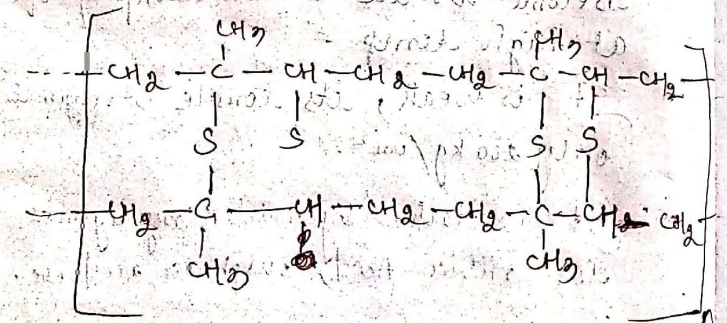
Vulcanization of Rubber Imp.

The process of heating raw rubber with sulphur upto 140°C in order to improve properties of rubber, is called vulcanization of Rubber.



(Raw or unvulcanized Rubber)

↓ Sulphur vulcanization



Vulcanized Rubber

Advantages of Vulcanisation

1. It has high durability
2. It has useful temperature range −40°C to 100°C.
3. It has good tensile strength, can bear a load of 2000 kg/cm².
4. It is not attacked by oxidising agents like HNO_3, H_2SO_4.
5. It has excellent resilience, ie article made from it returns to original shape, when the deforming load is removed.
6. It has better electrical insulation power.
7. It has high resistance to oxidation, abrasion, etc.

What is main purpose of vulcanisation?

The main purpose is to make the product stiff by adding sulphur which chemically at the double bonds of different rubber chains.

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Chapter - 14
Chemicals in Agriculture

What are Pesticides?

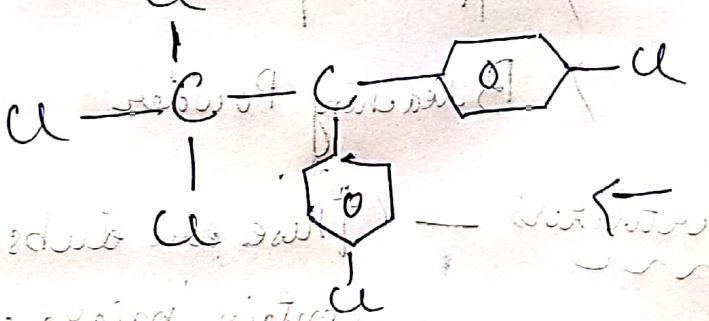
Pesticides are chemical substances that are meant to kill pests such as insects, ~~herbs~~ unwanted, fungi, etc.

~~Pesticides are classified as~~ —

a) Insecticides b) ~~herbicides~~ c) Fungicides.

a) Insecticides – The chemicals used to kill/control insects are called insecticides.

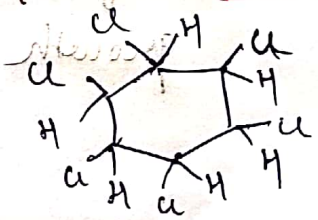
Example – ① DDT (Dichlorodiphenyl trichloroethane)



← DDT.

Uses – It is used to kill pest.

② Gammaxane (Benzene Hexachloride) (BHC).



← BHC

Uses :- It is used in insect control.

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Herbicides - Chemicals used to kill unwanted herbs such as grass & weeds, that may compromise the growth & yield of desired crops.

Examples:- → Atrazine - Used for control of broad leaf weeds & grasses.

→ Glyphosate based herbicides - It is a non-selective herbicide.

Fungicides - Chemicals used to kill moulds & fungi, are called fungicides.

Examples:- → Copper Sulphate solution

→ Bleaching Powder

Bio fertilizers — These are substances that contain micro organisms, which when added to the soil increases its fertility & promotes plant growth

Types of Bio-fertilizers

a) Symbiotic Nitrogen Fixing Bacteria

→ Rhizobium
→ Cynobacteria (or Blue Green Algae)

} These bacteria seek shelter in plants & help in providing nitrogen to the plants.

b) Free-living Nitrogen Fixing Bacteria

→ Azotobacter — These are free living soil bacteria which helps in nitrogen fixation.

c) Phosphate Solubilizing bacteria

— These bacteria helps to convert insoluble phosphorous in soil into soluble phosphorous compounds making them available to plants.

Importance of Bio fertilizers

→ B.f improves soil fertility & yield of plants.

→ B.f are eco-friendly & cost-effective.

→ B.f protects the environment from pollutants since they are natural fertilizers.

→ B.f donot allow pathogens to flourish.

GOVERNMENT POLYTECHNIC
28/04/2020
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Vector

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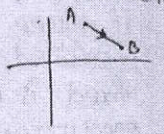
Any directed line segment is called vector. Here direction is from A to B. A = Initial point = IP, B = final / Terminal point = TP



$\overline{AB}$ = magnitude of $\overline{AB}$

Magnitude: Distance between Initial point & Terminal points.

Direction: - From IP → TP

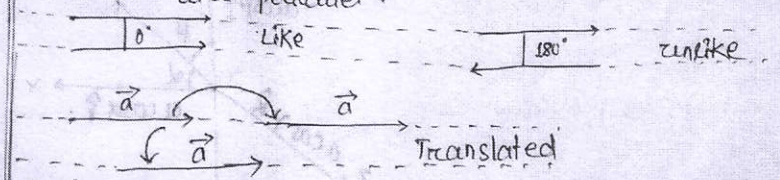
Sense (Line of Action) The straight line along which vectors acts.

Types of vectors: The vector having magnitude '1' is called unit vector

1) Unit vector: The vector having magnitude '1' is called unit vector. $\frac{\overline{AB}}{|\overline{AB}|} = \hat{AB}$ Direction of unit vector is along given vector.

2) Null vector: - The vector which IP & TP are co-inside. It has arbitrary direction. Hence, it's direction is undefined.
$\vec{0} + \vec{A} = \vec{A}$
$\vec{A} + \vec{0} = \vec{A}$

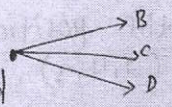
3) Parallel vector: - Two vectors are parallel, if their lines of action are parallel.



Collinear: - When two vectors are parallel, they are said to be collinear. parallel vectors are said to collinear. Two vectors A & B are parallel, if $a = mb$ or $b = na$.

CO-INITIAL: - Two or more vectors are said to be co-initial if they ~~lie on~~ same plane have same initial point.
~~$\vec{a}$ $\vec{b}$ $\vec{c}$~~ are coplanar volume of.
$\overline{AB}$, $\overline{AC}$, $\overline{AD}$

Angle between two vectors is measured when they are co-initial.



Co-planar: - 3 or more vectors are said to co-planar if they lie on same plane.

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$\vec{a}\ \vec{b}\ \vec{c}$ are coplanar volume of solid generated by them $=0$ $[\vec{a}\ \vec{b}\ \vec{c}] = 0$

If three vectors $\vec{a}, \vec{b}\ \vec{c}$ are coplanar if $\lambda\vec{a} + \mu\vec{b} = \vec{c}$

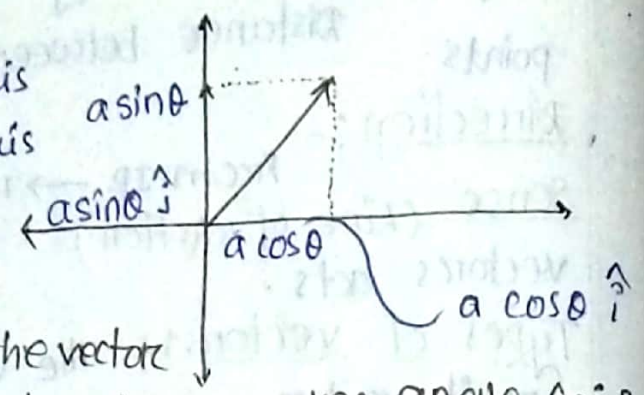
Localised / fixed vector: The vector whose initial point is fixed is called localised vector.

RESOLUTION OF A VECTOR:

$\hat{i}$ = unit vector along +ve X axis

$\hat{j}$ = " " " +ve y axis

$\vec{a} = a\cos\theta\,\hat{i} + a\sin\theta\,\hat{j}$



Q-1 Find X and y component of the vector whose magnitude is 10 and which makes angle 60° with +ve X-axis?

$|\vec{a}| = 10$

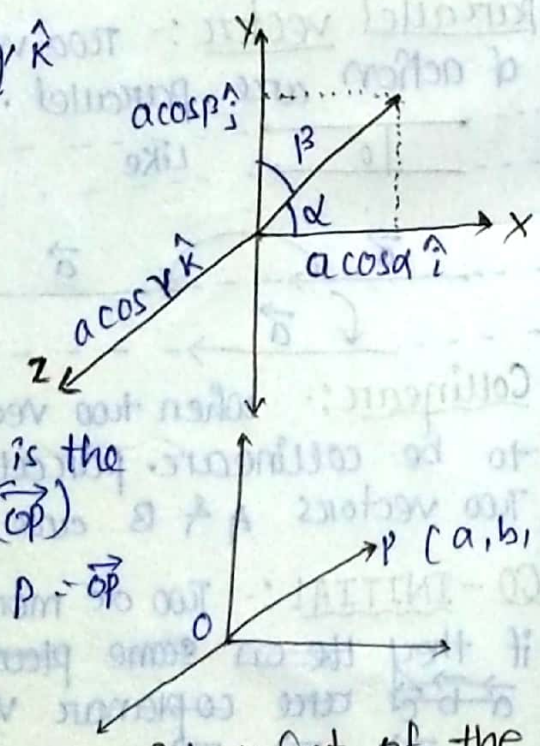
$\theta = 60°$

X - component $= 10\cos\theta\,\hat{i} = 10 \times \frac{1}{2}\hat{i} = 5\hat{i}$

Y - component $= 10\sin\theta\,\hat{j} = 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3}\,\hat{j}$

$\therefore \vec{a} = 5\hat{i} + 5\sqrt{3}\hat{j}$

$\Rightarrow \vec{a} = a\cos\alpha\,\hat{i} + a\cos\beta\,\hat{j} + a\cos\gamma\,\hat{k}$



POSITION VECTOR:

position vector of a point 'P' is the vector from origin that point ($\vec{OP}$)

position vector of P = $\vec{OP}$

$= a\hat{i} + b\hat{j} + c\hat{k}$

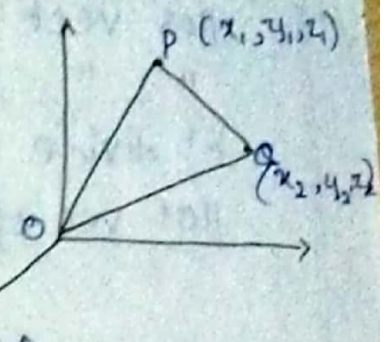
Q-2 Find the position vector of the mid point of the line joining (2,4,3), (-1,6,8)

co-ordinate of M: $\left(\frac{-1+2}{2}, \frac{6+4}{2}, \frac{8+3}{2}\right)$

$= \left(\frac{1}{2}, 5, \frac{11}{2}\right)$

position vector of M = $\vec{OM}$

$= \frac{1}{2}\hat{i} + 5\hat{j} + \frac{11}{2}\hat{k}$ (Ans)



position vector of P = $\vec{OP} = x_1\hat{i} + y_1\hat{j} + z_1\hat{k}$

$Q = \vec{OQ} = x_2\hat{i} + y_2\hat{j} + z_2\hat{k}$

In $\triangle OPQ$ $\vec{OP} + \vec{PQ} = \vec{OQ}$

$\Rightarrow \vec{PQ} = \vec{OQ} - \vec{OP}$

$= pos(Q) - pos(P)$

$= (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$

Q-3 Find $\vec{PQ}$ and its scalar & vector components where P = (3,-4,6) and Q = (8,7,11)

$\vec{PQ} = (8-7)\hat{i} + \{7-(-4)\}\hat{j} + (11-6)\hat{k}$

$= 5\hat{i} + 11\hat{j} + 5\hat{k}$

$\therefore$ Scalar components are (5, 11, 5)

vector " " $(5\hat{i}, 11\hat{j} + 5\hat{k})$

Q-4 $\vec{AB} = (5-3)\hat{i} + (2-7)\hat{j} + \{0-(-1)\}\hat{k}$

$= 2\hat{i} - 5\hat{j} + \hat{k}$

$\vec{BC} = (1-5)\hat{i} + (8-2)\hat{j} + (3-0)\hat{k}$

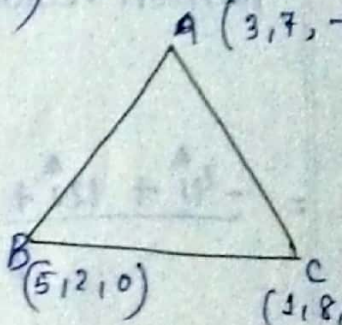
$= -4\hat{i} + 6\hat{j} + 3\hat{k}$

$\vec{AC} = (1-3)\hat{i} + (8-7)\hat{j} + \{3-(-1)\}\hat{k}$

$= -2\hat{i} + \hat{j} + 4\hat{k}$

$\vec{CA} = (3-1)\hat{i} + (7-8)\hat{j} + (-1-3)\hat{k}$

$= 2\hat{i} - \hat{j} - 4\hat{k}$



Q-5 In $\triangle PQR$, S is the Mid point of QR prove that $\vec{PQ} + \vec{PR} = 2\vec{PS}$

Sol^n $\vec{QS} = \vec{SR}$

$\vec{SQ} + \vec{SR} = 0$

In $\triangle PQS$ $\vec{PS} + \vec{QS} = \vec{PQ}$

In $\triangle PRS$ $\vec{PS} + \vec{SR} = \vec{PR}$

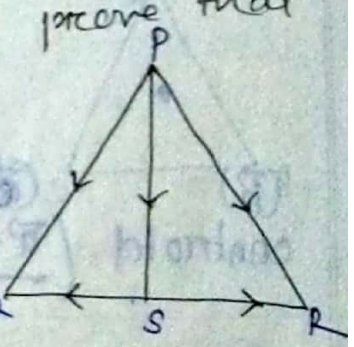
Adding the equation

$\vec{PS} + \vec{QS} = \vec{PQ}$

$+\ \vec{PS} + \vec{SR} = \vec{PR}$

$2\vec{PS} + (\vec{QS} + \vec{SR}) = \vec{PQ} + \vec{PR}$

$\Rightarrow 2\vec{PS} + 0 = \vec{PQ} + \vec{PR} \Rightarrow \vec{PQ} + \vec{PR} = 2\vec{PS}$ (proved)



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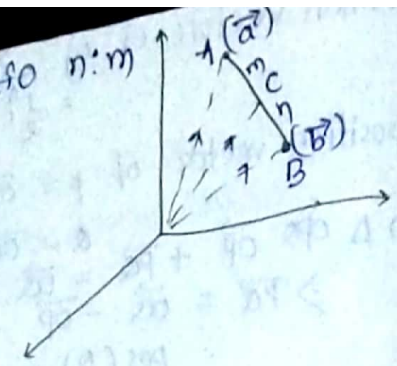
Note (i) C divides AB in the ratio m:n

pos vect of A = $\vec{a}$

" " B = $\vec{b}$

C divide AB in m:n

pos vec of C =



Find the vector from origin to the point the line joining (3,4,1) & (-2,6,8) in the ratio 2:5?

position vector of A = $\vec{a} = 3\hat{i} + 4\hat{j} + \hat{k}$

" " B = $\vec{b} = -2\hat{i} + 6\hat{j} + 8\hat{k}$

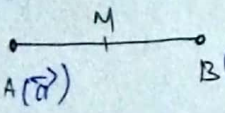
'C' divides AB in 2:5

position vector of C = $\overrightarrow{OC} = \frac{2\vec{b} + 5\vec{a}}{2+5}$

$= \frac{2(-2\hat{i}+6\hat{j}+8\hat{k}) + 5(3\hat{i}+4\hat{j}+\hat{k})}{7}$

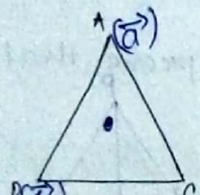
$= \frac{-4\hat{i} + 12\hat{j} + 16\hat{k} + 15\hat{i} + 20\hat{j} + 5\hat{k}}{7} = \frac{11\hat{i} + 32\hat{j} + 21\hat{k}}{7}$

(i)



mid point = $\frac{\vec{a}+\vec{b}}{2}$

(ii)



centroid $\left(\frac{\vec{a}+\vec{b}+\vec{c}}{3}\right)$

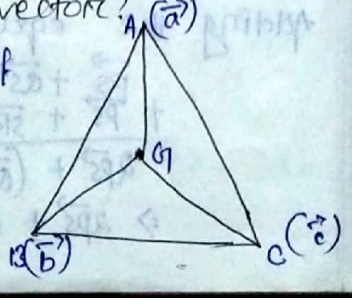
Q prove that the sum of the vectors from centroid to the vertices of a triangle is a null vector?

Sol^n

Let ABC be a Δ with position vector of A, B, C as $\vec{a}$, $\vec{b}$, $\vec{c}$ respective

Let 'G' be the centroid of Δ.

claim: $\overrightarrow{GA} + \overrightarrow{GB} + \overrightarrow{GC} = \vec{0}$



As 'G' is the centroid position vector of G = $\frac{\vec{a}+\vec{b}+\vec{c}}{3}$

$\overrightarrow{GA}$ = position vector of A − position vector of G

$= \vec{a} - \frac{\vec{a}+\vec{b}+\vec{c}}{3}$

$\overrightarrow{GB}$ = position vector of B − position vector of G

$= \vec{b} - \frac{\vec{a}+\vec{b}+\vec{c}}{3} = \frac{3\vec{b} - \vec{a} - \vec{b} - \vec{c}}{3}$

$\overrightarrow{GC}$ = position vector of C − position vector of G

$= \vec{c} - \frac{\vec{a}+\vec{b}+\vec{c}}{3} = \frac{3\vec{c} - \vec{a} - \vec{b} - \vec{c}}{3}$

$\therefore \overrightarrow{GA} + \overrightarrow{GB} + \overrightarrow{GC}$

$= \vec{a} - \frac{\vec{a}+\vec{b}+\vec{c}}{3} + \vec{b} - \frac{\vec{a}+\vec{b}+\vec{c}}{3} + \vec{c} - \frac{\vec{a}+\vec{b}+\vec{c}}{3}$

$= \vec{a} + \vec{b} + \vec{c} - 3\left(\frac{\vec{a}+\vec{b}+\vec{c}}{3}\right)$

$= \vec{0}$

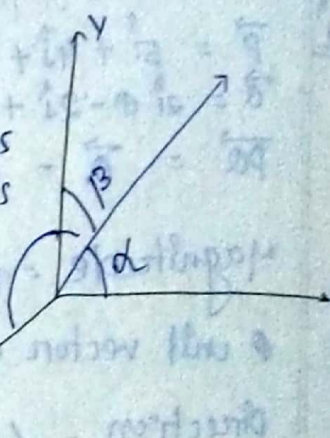
Direction of a vector :-

α, β, γ → direction angles

α - angle between vector and x-axis

β - " " " " y-axis

γ - " " " " z-axis



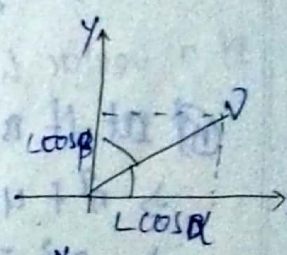
$\langle \cos\alpha, \cos\beta, \cos\gamma \rangle$

direction cosines (dcs) of vector

In 2D $(L\cos\alpha)^2 + (L\cos\beta)^2 = L^2$

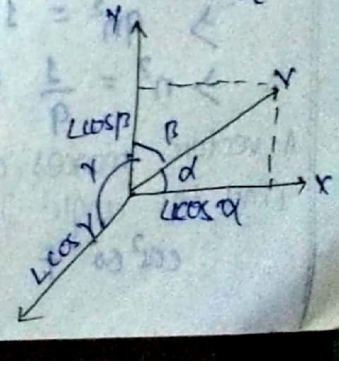
$\Rightarrow L^2\cos^2\alpha + L^2\cos^2\beta = L^2$

$\Rightarrow \cos^2\alpha + \cos^2\beta = 1$



In 3D $(L\cos\alpha)^2 + (L\cos\beta)^2 + (L\cos\gamma)^2 = L^2$

$\Rightarrow \cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$



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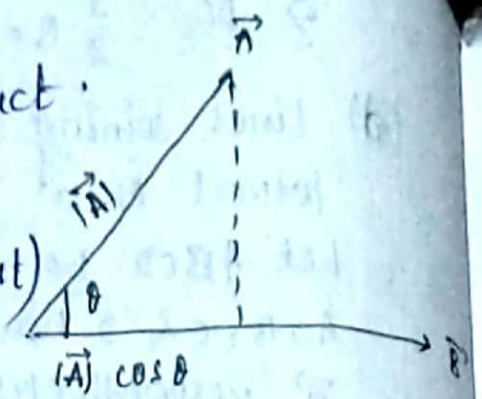
Dot Product :-

- It is called SCALAR product.

dot product = (magnitude of first) · (projection of sec on first)



$\Rightarrow \vec{A} \cdot \vec{B} = |\vec{B}| \cdot |\vec{A}| \cos\theta$

(1) $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$

(2) $\vec{A} \cdot \vec{B} = 0$ $(\Rightarrow \vec{A} = \vec{0}$ or $\vec{B} = \vec{0}$ or $\theta = 90^\circ)$

(3) $\hat{i} \cdot \hat{j} = 0$

(4) $\hat{j} \cdot \hat{k} = 0$

$\hat{i} \cdot \hat{k} = 0$

(4) $|\vec{A}| \cdot |\vec{A}| = |\vec{A}| |\vec{A}| \cos 0 = |\vec{A}|^2$

(5) $\hat{i} \cdot \hat{i} = |\hat{i}|^2 = 1^2 = 1$

$\hat{j} \cdot \hat{j} = 1$, $\hat{k} \cdot \hat{k} = 1$

(6) $\vec{A}$, $\vec{B}$, how to find $\vec{A} \cdot \vec{B}$

$|\vec{A}| = m$

$|\vec{B}| = n$

angle betⁿ $\vec{A}$ & $\vec{B} = \theta$

$\boxed{\vec{A} \cdot \vec{B} = mn\cos\theta}$

$\vec{A} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$

$\vec{B} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$

$\boxed{\vec{A} \cdot \vec{B} = a_1b_1 + a_2b_2 + a_3b_3}$

$\Rightarrow \vec{A} \cdot \vec{B} = (a_1\hat{i} + a_2\hat{j} + a_3\hat{k}) \cdot (b_1\hat{i} + b_2\hat{j} + b_3\hat{k})$

$= a_1b_1 + a_2b_2 + a_3b_3$

Q-1 $\vec{A} = 3\hat{i} - 2\hat{j} + 6\hat{k}$

$\vec{B} = 4\hat{i} + 7\hat{k}$

$\vec{A} \cdot \vec{B} = 3 \cdot 4 + (-2)(0) + (6)(7)$

$= 12 + 42 = 54$

Q-2 If $|\vec{a}| = 3$, $|\vec{b}| = 5$, find max & min value of $\vec{a} \cdot \vec{b}$

$\vec{a} \cdot \vec{b} = |\vec{a}| \cdot |\vec{b}| \cos\theta = 3 \times 5 \cos\theta = 15\cos\theta$

$\vec{a} \cdot \vec{b}]_{max} = 15$ $(\because \cos\theta = 1)$

$\vec{a} \cdot \vec{b}]_{min} = -15$ $(\because \cos\theta = -1)$

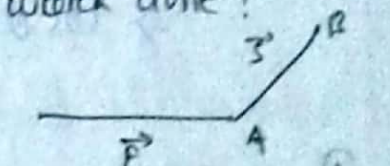
Q-3 for what value of λ, the vector $2\hat{i} - 3\hat{j} + \lambda\hat{k}$ & $4\hat{i} + 7\hat{j} + 2\hat{k}$ are perpendicular?

If the vectors are $\perp$, dot product = 0

$\Rightarrow 8 + (-21) + 2\lambda = 0$

$\Rightarrow 8 - 21 + 2\lambda = 0 \Rightarrow -13 + 2\lambda \Rightarrow \lambda = \frac{13}{2} = 6.5$

Q-4 A body under a force $\vec{F} = 3\hat{i} - 5\hat{j} - 2\hat{k}$ moves from A $(-2, 3, 1)$ to B $(6, 1, 9)$ Find the work done!



$S = \vec{AB} = \vec{B} - \vec{A}$

$= (6+2)\hat{i} + (1-3)\hat{j} + (9-1)\hat{k}$

$= 8\hat{i} - 2\hat{j} + 8\hat{k}$

$W = \vec{F} \cdot \vec{S}$

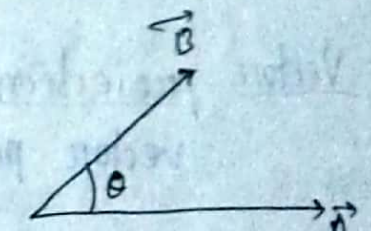
$= (3 \times 8) + (-5)(-2) + (-2)8$

$= 24 + 10 - 16 = 18$ unit

(7) Maximum value of $\vec{a} \cdot \vec{b} = |\vec{a}| \cdot |\vec{b}|$

Minimum value of $\vec{a} \cdot \vec{b} = -|\vec{a}| |\vec{b}|$

Angle between two Vectors :-



$\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos\theta$

$\boxed{\Rightarrow \cos\theta = \frac{\vec{A} \cdot \vec{B}}{|\vec{A}| |\vec{B}|}}$

$\Rightarrow \cos\theta = \frac{a_1b_1 + a_2b_2 + a_3b_3}{\sqrt{a_1^2 + a_2^2 + a_3^2}\sqrt{b_1^2 + b_2^2 + b_3^2}}$

Q-5 Find the angle between the vector.

(i) $3\hat{i} + 4\hat{j} - \hat{k}$, $2\hat{i} + 2\hat{j} + \hat{k}$

(ii) $\hat{i} + \hat{j}$, $\hat{j} - \hat{k}$

let $\vec{a} = 3\hat{i} + 4\hat{j} - \hat{k}$

$\vec{b} = 2\hat{i} + 2\hat{j} + \hat{k}$

Let 'θ' be the angle between $\vec{a}$ & $\vec{b}$

we know that $\cos\theta = \frac{\vec{a} \cdot \vec{b}}{|\vec{a}| |\vec{b}|}$

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$$= \frac{(3\times2)+(4\times2)+(-1)(1)}{\sqrt{3^2+4^2+(-1)^2}\sqrt{2^2+2^2+1^2}}$$

$$= \frac{6+8-1}{\sqrt{26}\sqrt{9}} = \frac{13}{3\sqrt{26}}$$

$$\Rightarrow \theta = \cos^{-1}\left(\frac{13}{3\sqrt{26}}\right)$$

(ii) $\cos\theta = \dfrac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|} = \dfrac{(1\times0)+(1\times1)+(0\times1)}{\sqrt{1^2+(1)^2+0^2}\sqrt{0^2+(1)^2+(-1)^2}}$

$$\Rightarrow \cos\theta = \frac{1}{2} \qquad \Rightarrow \theta = \cos^{-1}\left(\frac{1}{2}\right)$$

$$\Rightarrow \theta = 60^\circ$$

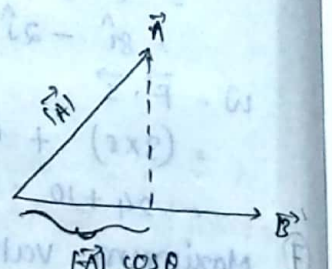
Projection :-

Scalar projection :-

projection of $\vec{A}$ on $\vec{B}$ $= |\vec{A}|\cos\theta$

$$= \frac{|\vec{B}||\vec{A}|\cos\theta}{|\vec{B}|}$$

$$= \frac{\vec{A}\cdot\vec{B}}{|\vec{B}|} = \vec{A}\cdot\hat{B}$$



Vector projection :-

vector projection of $\vec{A}$ on $\vec{B}$

$$= \left(\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|}\right)\cdot\hat{B} = \frac{\vec{A}\cdot\vec{B}}{|\vec{B}|}\cdot\frac{\vec{B}}{|\vec{B}|}$$

$$= \frac{(\vec{A}\cdot\vec{B})\,\vec{B}}{|\vec{B}|^2}$$

Q-6 Find scalar & vector projection of $\vec{a} = 6\hat{i}+3\hat{j}+\hat{k}$ on $\vec{b} = 3\hat{i}+2\hat{j}-6\hat{k}$

scalar projection of $\vec{a}$ on $\vec{b} = \dfrac{\vec{a}\cdot\vec{b}}{|\vec{b}|}$

$$= \frac{(6\times3)+(3\times2)+(1\times-6)}{\sqrt{3^2+2^2+(-6)^2}}$$

$$= \frac{18+6-6}{\sqrt{49}} = \frac{18}{7}$$

vector projection of $\vec{a}$ on $\vec{b} = \dfrac{\vec{a}\cdot\vec{b}}{|\vec{b}|}\cdot\hat{b}$

$$= \frac{18}{7}\cdot\frac{3\hat{i}+2\hat{j}-6\hat{k}}{\sqrt{(3)^2+(2)^2+(-6)^2}}$$

$$= \frac{18}{7}\cdot\frac{3\hat{i}+2\hat{j}-6\hat{k}}{7}$$

$$= \frac{18}{49}\cdot(3\hat{i}+2\hat{j}-6\hat{k})$$

Cross product $(\vec{A}\times\vec{B})$

It is denoted by $\vec{A}\times\vec{B}$

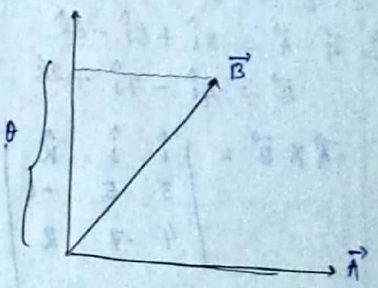
It is called vector product

Magnitude of $\vec{A}\times\vec{B}$ is defined as magnitude of 1 vector. projection of second vector perpendicular to 1st vector.

$$\boxed{\vec{A}\times\vec{B} = |A||B|\sin\theta}$$

Direction of $\vec{A}\times\vec{B}$ is perpendicular to both $\vec{A}$ & $\vec{B}$ (According to clockwise or anticlock wise)

$B\sin\theta$



$\vec{A}\times\vec{B} = |\vec{A}||\vec{B}|\sin\theta\,\hat{n}$

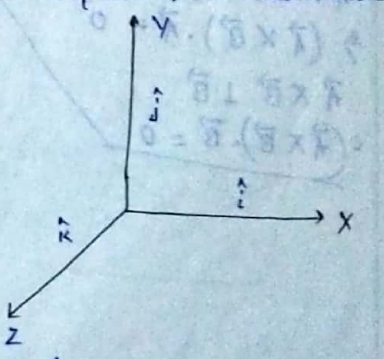
$\vec{A}\times\vec{B}$ maximum value is $|\vec{A}||\vec{B}|$

$\vec{A}\times\vec{B} = \vec{0}$ when

(i) $\vec{A} \parallel \vec{B}$ $(\theta = 0^\circ, \theta = 180^\circ)$

(ii) If atleast 1 of $\vec{A}$, $\vec{B}$ is a ~~small~~ ~~line~~ 'null vector'.





* $\vec{A}\times\vec{B} \neq \vec{B}\times\vec{A}$ (direction are opposite)

$|\vec{A}\times\vec{B}| = |\vec{B}\times\vec{A}|$

$\vec{A}\times\vec{B} = -\vec{B}\times\vec{A}$ $[\vec{A}\times\vec{A} = 0]$

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Evaluation of cross product

$\vec{A} = (a_1\hat{i} + a_2\hat{j} + a_3\hat{k})$

$\vec{B} = (b_1\hat{i} + b_2\hat{j} + b_3\hat{k})$

$\vec{A} \times \vec{B} = (a_1\hat{i} + a_2\hat{j} + a_3\hat{k}) \times (b_1\hat{i} + b_2\hat{j} + b_3\hat{k})$

$= \vec{0} + a_1b_2\hat{k} - a_1b_3\hat{j} - a_2b_1\hat{k} + \vec{0} + a_2b_3\hat{i} + a_3b_1\hat{j} - a_3b_2\hat{i} + \vec{0}$

$= (a_2b_3 - a_3b_2)\hat{i} + (a_3b_1 - a_1b_3)\hat{j} + (a_1b_2 - a_2b_1)\hat{k}$

$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$

If $\vec{A} = 3\hat{i} + 5\hat{j} - 6\hat{k}$

$\vec{B} = 4\hat{i} - 7\hat{j} + 2\hat{k}$

$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 5 & -6 \\ 4 & -7 & 2 \end{vmatrix} = \hat{i}\begin{vmatrix} 5 & -6 \\ -7 & 2 \end{vmatrix} - \hat{j}\begin{vmatrix} 3 & -6 \\ 4 & 2 \end{vmatrix} + \hat{k}\begin{vmatrix} 3 & 5 \\ 4 & -7 \end{vmatrix}$

$= \hat{i}(10 - 42) - \hat{j}(6 + 24) + \hat{k}(-21 + (-20))$

$= -32\hat{i} - 30\hat{j} - 41\hat{k}$

$\vec{A} \times \vec{B} \perp \vec{A}$

$\Rightarrow (\vec{A} \times \vec{B}) \cdot \vec{A} = 0$

$\vec{A} \times \vec{B} \perp \vec{B}$

$\Rightarrow (\vec{A} \times \vec{B}) \cdot \vec{B} = 0$

$[\vec{a} \cdot (\vec{b} \times \vec{c})]^2$

$= [\vec{a} \cdot |\vec{b}||\vec{c}| \sin 90^\circ \cdot \hat{a}]^2$

$= [\vec{a} \cdot bc \cdot 1\,\hat{a}]^2$

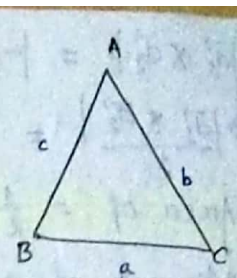
$= b^2c^2[\vec{a} \cdot \hat{a}]^2$

$= b^2c^2[|\vec{a}||\hat{a}| \cos 0]^2$

$= b^2c^2[a \cdot 1 \cdot 1]^2$

$= b^2c^2a^2$

Area of Δ



Area of $\Delta = \frac{1}{2}|\vec{AB} \times \vec{BC}| = \frac{1}{2}|\vec{BC} \times \vec{AC}|$

$= \frac{1}{2}|\vec{AC} \times \vec{AB}|$

Q. Find area of the triangle whose vertices are $(1,2,3)A$, $(3,4,6)B$, $(2,7,8)C$

Soln

$\vec{BA} = -2\hat{i} - 2\hat{j} - 3\hat{k}$

$\vec{BC} = 3\hat{i} + 3\hat{j} + 2\hat{k}$

$\vec{BA} \times \vec{BC} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -2 & -3 \\ 3 & 3 & 2 \end{vmatrix}$

$= \hat{i}\begin{vmatrix} -2 & -3 \\ 3 & 2 \end{vmatrix} + \hat{j}\begin{vmatrix} -2 & -3 \\ 3 & 2 \end{vmatrix} + \hat{k}\begin{vmatrix} 2 & -2 \\ 3 & 3 \end{vmatrix}$

$= 5\hat{i} - 13\hat{j} + 12\hat{k}$

$|\vec{AB} \times \vec{BC}| = \sqrt{(5)^2 + (13)^2 + (12)^2}$

$= \sqrt{(13)^2 + (13)^2} = 2\sqrt{13}$

$\frac{1}{2}\sqrt{b^2a^2 + b^2c^2 + c^2a^2}$

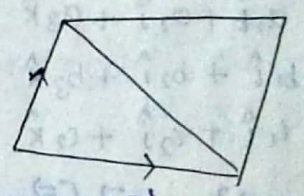
Area of $\Delta = \frac{1}{2} \times 2\sqrt{13} = \sqrt{13}$

Area of Parallelogram

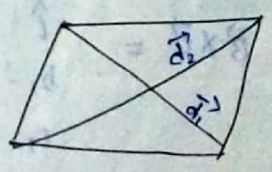
(i) Area of parallelogram

$= 2 \times \frac{1}{2}|\vec{a} \times \vec{b}|$

$= |\vec{a} \times \vec{b}|$



(ii) $\Rightarrow$ formula $= \frac{1}{2}|\vec{d_1} \times \vec{d_2}|$



Proof Area $= |\vec{a} \times \vec{b}|$

$\vec{d_1} = \vec{a} + \vec{b}$

$\vec{d_2} = \vec{a} - \vec{b}$

$\vec{d_1} \times \vec{d_2} = (\vec{a} + \vec{b}) \cdot (\vec{a} - \vec{b})$

$\vec{d_1} \times \vec{d_2} = \vec{0} - \vec{a} \times \vec{b} + \vec{b} \times \vec{a} - \vec{0}$

$\vec{d_1} \times \vec{d_2} = -\vec{a} \times \vec{b} - \vec{a} \times \vec{b}$

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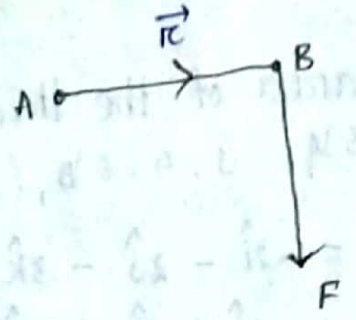
$|\vec{a_1} \times \vec{a_2}| = |-2\vec{a} \times \vec{b}|$

$\Rightarrow \frac{|\vec{a_1} \times \vec{a_2}|}{2} = \vec{a} \times \vec{b}$

Area of $= \frac{1}{2}|\vec{a_1} \times \vec{a_2}|$

Moment of a force :-

Moment of $F = \vec{r} \times \vec{F}$ at O



F is applied at B

moment of f at A $= \overrightarrow{AB} \times \vec{F}$

Scalar Triple product (STP)

- Triple product is a scalar
- $\vec{a}, \vec{b}, \vec{c}$ scalar triple product is denoted by $[\vec{a}\ \vec{b}\ \vec{c}]$
- $[\vec{a}\ \vec{b}\ \vec{c}] = \vec{a} \cdot (\vec{b} \times \vec{c})$

volume of parallelopiped whose edges are $\vec{a}, b, c$ is

$[\vec{a}\ \vec{b}\ \vec{c}] = \vec{a} \cdot (\vec{b} \times \vec{c}) = (\vec{a} \times \vec{b}) \cdot \vec{c}$

- $\cdot$ & $\times$ canbe interchange in $\vec{a}\ \vec{b}\ \vec{c}$ scalar triple product
- $[\vec{a}\ \vec{b}\ \vec{c}] = [\vec{b}\ \vec{c}\ \vec{a}] = [\vec{c}\ \vec{a}\ \vec{b}] = -[\vec{a}\ \vec{c}\ \vec{b}]$

Q-

$\vec{A} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$

$\vec{B} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$

$\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$

$[\vec{A}\ \vec{B}\ \vec{c}] = \vec{A} \cdot (\vec{B} \times \vec{c})$

$$\vec{B} \times \vec{c} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = (b_2c_3 - b_3c_2)\hat{i} - (b_1c_3 - b_3c_1)\hat{j} + \hat{k}(b_1c_2 - b_2c_1)$$

$\vec{A} \cdot (\vec{B} \times \vec{c}) = a_1(b_2c_3 - b_3c_2)$

Q-1 Find $[\vec{A}\ \vec{B}\ \vec{c}]$ where $\vec{a} = 2\hat{i} + \hat{j}$, $\vec{b} = 2\hat{j} + \hat{k}$, $\vec{c} = \hat{i} + 2\hat{k}$

$$[\vec{a}\ \vec{b}\ \vec{c}] = \begin{vmatrix} 2 & 1 & 0 \\ 0 & 2 & 1 \\ 1 & 0 & 2 \end{vmatrix} = 2\begin{vmatrix} 2 & 1 \\ 0 & 2 \end{vmatrix} - 1\begin{vmatrix} 0 & 1 \\ 1 & 2 \end{vmatrix}$$

$= 2(4-0) - 1(0-1)$

$= 8 + 1 = 9$ (unit cubic)

Q-2 Find volume of parallelopiped whose 3 coterminous edg

$\vec{a} = 2\hat{i} + 3\hat{j} + 6\hat{k}$

$\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$

$c = 3\hat{j}$

$$[\vec{a}\ \vec{b}\ \vec{c}] = \begin{vmatrix} 2 & 3 & 6 \\ 1 & 2 & -1 \\ 0 & 3 & 0 \end{vmatrix} = \begin{vmatrix} 2 & 6 \\ 1 & -1 \end{vmatrix}$$

$= -3(-2-6)$

$= -3(-8)$

$= 24$ cubic unit

$\Rightarrow [\vec{a}\ \vec{b}\ \vec{c}] = 0$

(i) $\vec{a}, \vec{b}, \vec{c}$ are coplanar

(ii) At least one of the vectors $\vec{a}, \vec{b}, \vec{c}$ is a null vecto

(iii) $[\vec{0}\ \vec{b}\ \vec{c}] = 0$, $[\vec{a}\ \vec{0}\ \vec{0}] = 0$

(iv) If any two are parallel (equal)

Q-3 Find value of λ if the vectors, $\vec{a} = 3\hat{i} - 2\hat{j} + \lambda\hat{k}$, $\vec{b} = 4\hat{i} + \hat{j} + \hat{k}$, $\vec{c} = 2\hat{i} + 2\hat{j} + \hat{k}$

If $\vec{a}, \vec{b}, \vec{c}$ are coplanar, $(\vec{a}\ \vec{b}\ \vec{c}) = 0$

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$$\Rightarrow \begin{vmatrix} 3 & -2 & \lambda \\ 4 & 1 & 1 \\ 2 & 2 & 1 \end{vmatrix} = 0$$

$\Rightarrow 3(-1) + 2(2) + \lambda(6) = 0$

$\Rightarrow -3 + 4 + 6\lambda = 0$

$\Rightarrow +1 + 6\lambda \Rightarrow \lambda = \frac{-1}{6}$

Q-4 prove that scalar triple product of $[\vec{a}+\vec{b} \quad \vec{b}+\vec{c} \quad \vec{c}+\vec{a}]$ $= 2[\vec{a}\ \vec{b}\ \vec{c}]$

Sol: L.H.S. $[\vec{a}+\vec{b} \quad \vec{b}+\vec{c} \quad \vec{c}+\vec{a}]$

$= (\vec{a}+\vec{b}) \cdot \{(\vec{b}+\vec{c}) \times (\vec{c}+\vec{a})\}$

$= (\vec{a}+\vec{b}) \cdot \{\vec{b}\times\vec{c} + \vec{b}\times\vec{a} + \vec{c}\times\vec{c} + \vec{c}\times\vec{a}\} \quad [\because \vec{c}\times\vec{c} = 0]$

$= (\vec{a}+\vec{b}) \cdot \{\vec{b}\times\vec{c} + \vec{b}\times\vec{a} + \vec{c}\times\vec{a}\}$

$= \vec{a}\cdot(\vec{b}\times\vec{c}) + \vec{a}\cdot(\vec{b}\times\vec{a}) + \vec{a}\cdot(\vec{b}\times\vec{a}) + \vec{b}\cdot(\vec{b}\times\vec{c}) +$
$\vec{b}\cdot(\vec{b}\times\vec{a}) + \vec{b}\cdot(\vec{c}\times\vec{a})$

$= \vec{a}\cdot(\vec{b}\times\vec{c}) + 0+0+0+0 + \vec{b}\cdot(\vec{c}\times\vec{a}) \quad [\because \vec{p}\times\vec{q} \perp \vec{p}\ \&\ \vec{q}]$

$= [\vec{a}\ \vec{b}\ \vec{c}] + [\vec{b}\ \vec{c}\ \vec{a}] = [\vec{a}\ \vec{b}\ \vec{c}] + [\vec{a}\ \vec{b}\ \vec{c}]$

$= 2[\vec{a}\ \vec{b}\ \vec{c}]$ (proved)

Q prove that the following vector are coplanere? where the vectors are $\hat{i} - 2\hat{j} + 2\hat{k}$, $3\hat{i} + 4\hat{j} + 5\hat{k}$, $-2\hat{i} + 4\hat{j} - 4\hat{k}$

$\vec{A} = \hat{i} - 2\hat{j} + 2\hat{k}$

$\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$

$\vec{C} = -2\hat{i} + 4\hat{j} - 4\hat{k}$

$$\Rightarrow \begin{vmatrix} 1 & -2 & 2 \\ 3 & 4 & 5 \\ -2 & 4 & -4 \end{vmatrix} = 0$$

$\Rightarrow 1[4\times-4 - 20] - (-2)[-12 - (-10)] +$
$2[-8 - 12] = 0$

$\Rightarrow [-16 - 20] + 2[-10 + 12] + 2[-20] = 0$

$\Rightarrow -36 + (-4) + 40 = 0$

$\Rightarrow -40 + 40 = 0$ (proved)

$\Rightarrow [\vec{a}\ \vec{b}\ \vec{c}]$ are coplanere.

Continuity

A function $f(x)$ is said to be continious at $x = c$, if

LHL at $x=c$ = RHL at $x=c$ = function Value at $x=c$

i.e, $\lim_{x\to c^-} f(x) = \lim_{x\to c^+} f(x) = f(c)$

But we know that,

when $\lim_{x\to c^-} f(x) = \lim_{x\to c^+} f(x) = \lambda$

$\Rightarrow \lim_{x\to c} f(x) = \lambda$

So, continuity at $x=c$ may be defined as $\lim_{x\to c} f(x) = f(c)$

Q check continuity of $f(x) = \begin{cases} \frac{x^3-8}{x-2}, & x \neq 2 \\ 12, & x = 2 \end{cases}$ at $x = 2$,

LHL of $f(x)$ at $x = 2$

$\lim_{x\to 2^-} f(x)$

$= \lim_{h\to 0} f(2-h)$

$= \lim_{h\to 0} \frac{(2-h)^3 - 8}{2-h-2}$

$= \lim_{h\to 0} \frac{2^3 - 3\cdot 2^2 h + 3\cdot 2h^2 - h^3 - 8}{-h}$

$= \lim_{h\to 0} \frac{-12h + 6h^3 - h^3}{-h}$

$= \lim_{h\to 0} \frac{-h(12 - 6h + h^2)}{h}$

$= 12 - 6\times 0 + 0^2$

$= 12$

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LIMIT & CONTINUITY

Notation

$\forall$ → For all

$\exists$ → There Exist

$\exists!$ → There Exist Uniquely

$\in$ → Belongs to

$\subset$ → Super Subset

$\subseteq$ → Subset

s.t. → Such that

$f(x)$ → function of x

$f: X \to Y$ → A mapping or function from X to Y

D_f → Domain of function

R/R_f → Range of function

$\mathbb{R}$ → Set of real numbers.

$\mathbb{Z}$ → Set of integers

$\mathbb{N}$ → Set of natural numbers

$\mathbb{Q}$ → Set of rational numbers

$\mathbb{Q}^c$ → Set of irrational numbers

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Function

A function is a special case of relation.
A function f from X to Y i.e. $f: X \to Y$ s.t. for each $x \in X$ $\exists!$ $y \in Y$ which is related to x by the relation f.

We write $y = f(x)$ & call it image of x. under f & call x is the preimage of y under f.

Onto or Surjective fn

A function $f: X \to Y$ is said to be an onto or surjective fn if $R_f = f(x) = Y$ i.e. every element of Y is the image of some element of X.

Into function

A function $f: X \to Y$ is said to be an into function if $R_f = f(x) \subset Y$ i.e. if $\exists$ at least one element $y \in Y$ which has no preimage in X.

One-One or injective fn

A function $f: X \to Y$ is said to be 1-1 or one-one or injective function if for every $x_1, x_2 \in X$

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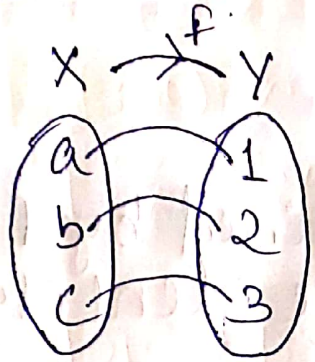
$f(x_1) = f(x_2) \Rightarrow x_1 = x_2$

$f(x_1) \neq f(x_2) \Rightarrow x_1 \neq x_2$

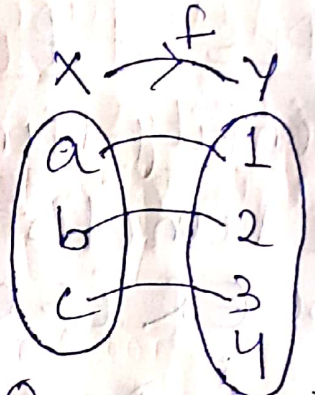
Many one f^n

A function $f: X \to Y$ is said to be many-one f^n if $\exists\, x_1, x_2 \in X$ with $x_1 \neq x_2$ s.t. $f(x_1) = f(x_2)$

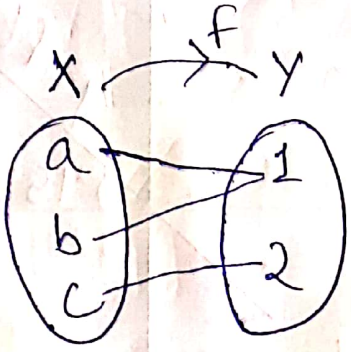
Examples



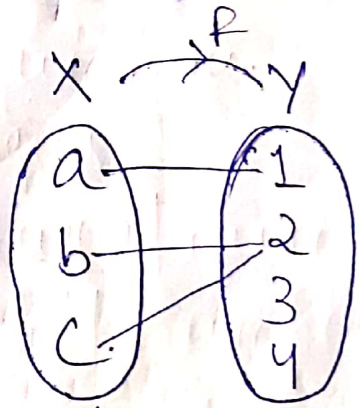
(i) one-one & onto



(ii) One-one & into



(iii) Many-one & onto



(iv) Many one & into

Domain

The set X is known as Domain of the function.

Co-Domain

The set Y is called the co-domain of the function.

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Range

The set of all images of the elements of X under the mapping or function f is called the range of f & denoted by f(x).

Real valued function

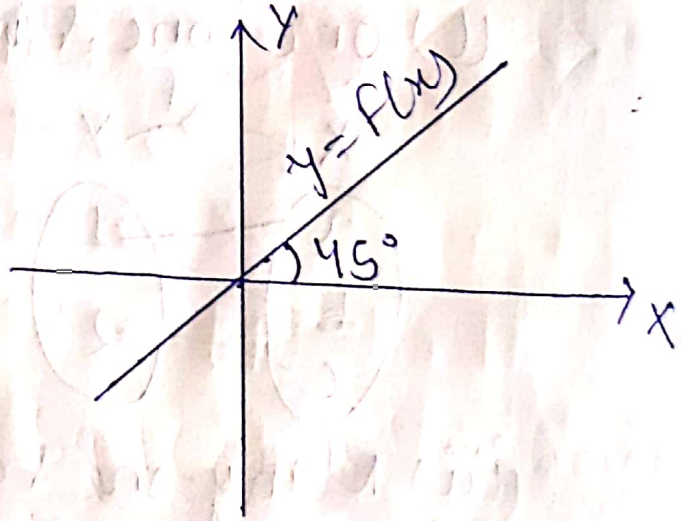
A function $f: X \to Y$ is said to be real valued f^n if $X, Y \in \mathbb{R}$.

TYPES of FUNCTION

(i) Identity function

The function f is defined by $f(x) = x$. $\forall x \in \mathbb{R}$ is called the identity function.

Here, $D_f = R_f = \mathbb{R}$



(ii) Constant function

The function f defined $f(x) = c \; \forall x \in D_f$ where c is any real constant number.

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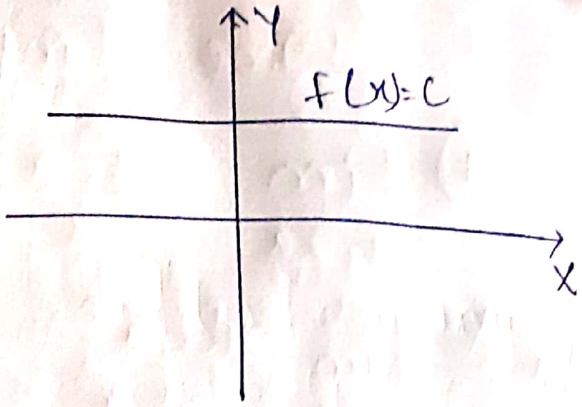

Modulus function

The function f defined by $f(x) = |x|$

$$f(x) = |x| = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$$ is called the modulus function or absolute value function $D_f = \mathbb{R}$, $R_f = [0, \infty)$

Greatest integer fuction

For every $x \in \mathbb{R}$, $[x]$ is greatest integer function $\leq x$.

Let n be an integer. Then

$$[x] = \begin{cases} n, & \text{if } x = n \\ n-1, & \text{if } n-1 \leq x \leq n \end{cases}$$

Eg- $[3] = 3$, $[-4] = -4$, $\left[\frac{19}{3}\right] = 6$, $[\sqrt{2}] = 1$

x	...	$-2 \leq x < -1$	$-1 \leq x < 0$	$0 \leq x < 1$	$1 \leq x < 2$	$2 \leq x < 3$
y	...	-2	-1	0	1	2

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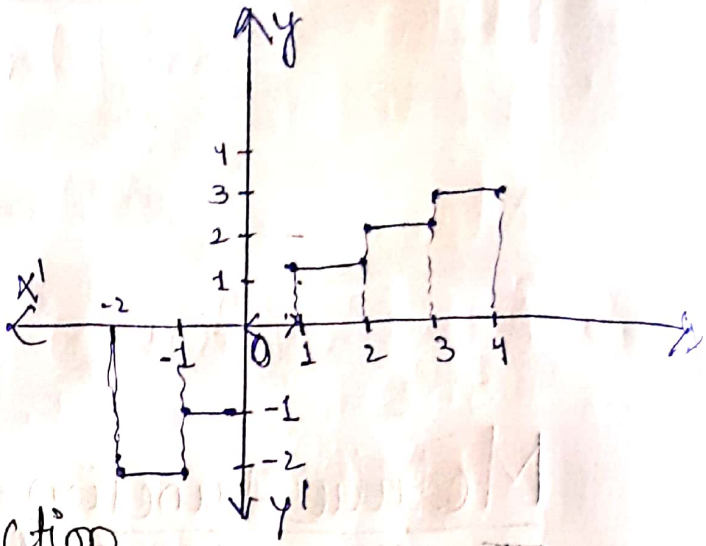
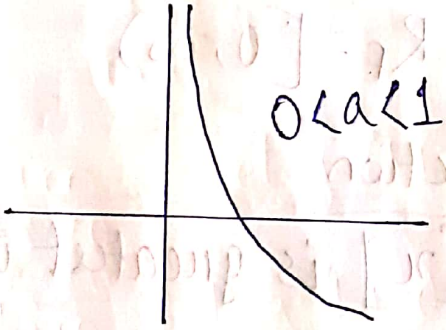
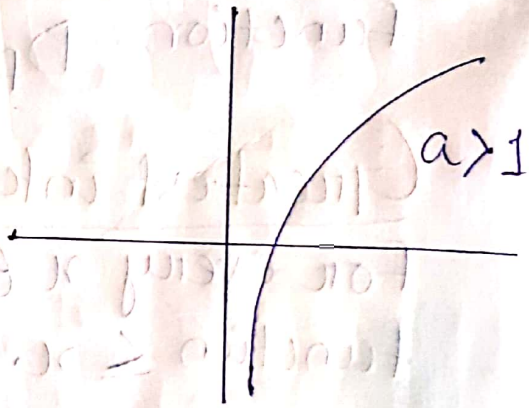


Logarithmic function

The function f defined by $f(x) = \log_a x$, where $x > 0$, $a > 0$ & $a \neq 1$, $a \in \mathbb{R}$ is called logarithmic function.

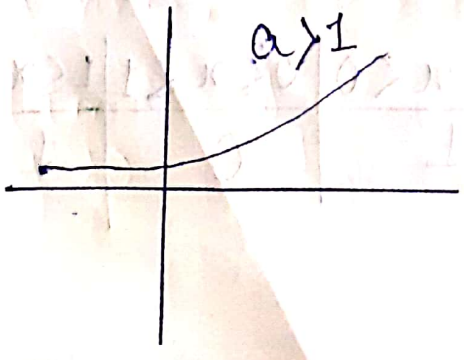


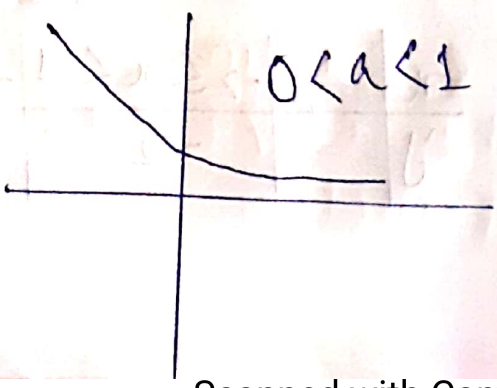


Exponential function

The function f defined by $f(x) = a^x$ where $a > 0$ & $x \in \mathbb{R}$ is called exponential function.

$D_f = \mathbb{R}$, $R_f = (0, \infty)$





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Trigonometric Function

Function	Domain	Range
$\sin x$	$\mathbb{R}$	$[-1, 1]$
$\cos x$	$\mathbb{R}$	$[-1, 1]$
$\tan x$	$\mathbb{R} - \{(2n+1)\pi/2, n \in \mathbb{Z}\}$	$\mathbb{R}$
$\cot x$	$\mathbb{R} - \{n\pi, n \in \mathbb{Z}\}$	$\mathbb{R}$
$\sec x$	$\mathbb{R} - \{(2n+1)\pi/2, n \in \mathbb{Z}\}$	$\mathbb{R} - (-1, 1)$
$\operatorname{cosec} x$	$\mathbb{R} - \{n\pi/2, n \in \mathbb{Z}\}$	$\mathbb{R} - (-1, 1)$

Expansion of Formula

① $e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots\cdots$

② $\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \cdots\cdots$

③ $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots\cdots$

④ $a^x = 1 + x(\log_e a) + \frac{x^2}{2!}(\log_e a)^2 + \cdots\cdots$

⑤ $(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \cdots$

⑥ $\sin^{-1} x = x + \frac{1}{2} \cdot \frac{x^3}{3} + \frac{1}{2} \cdot \frac{3}{4} \cdot x^5 + \cdots$

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Some Important Limit

① $\lim_{x \to a} \frac{x^n - a^n}{x - a} = n a^{n-1}$

Proof $= \lim_{x \to a} \left(\frac{x^n - a^n}{x - a} \right) = \lim_{x \to a} \frac{(x-a)(x^{n-1} + x^{n-2}a + x^{n-3}a^2 + \cdots + a^{n-1})}{(x-a)}$

$= \lim_{x \to a} (x^{n-1} + x^{n-2}a + x^{n-3}a^2 + \cdots + a^{n-1})$

$= a^{n-1} + a^{n-2} \cdot a + a^{n-3}a^2 + \cdots + a^{n-1}$

$= a^{n-1} + a^{n-2} + a^{n-1} + \cdots + a^{n-1}$

$= n a^{n-1}$

② $\lim_{x \to 0} \frac{\log(1+x)}{x} = 1$

Proof $\lim_{x \to 0} \frac{\log(1+x)}{x}$

Putting $\log(1+x) = y$

$\Rightarrow 1 + x = e^y$

$\Rightarrow x = e^y - 1$

When, $x \to 0$, $y \to 0$

$\lim_{y \to 0} \frac{y}{e^y - 1}$

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$$= \lim_{y\to 0} \frac{1}{\frac{e^y - 1}{y}} = 1 \qquad \left(\because \lim_{y\to 0} \frac{e^y - 1}{y} = 1\right)$$

③ $\lim_{x\to 0} (1+x)^{1/x} = e$

Proof. $LHS = \lim_{x\to 0} (1+x)^{1/x}$

$$= \lim_{x\to 0} \left(1 + \frac{1}{x}\cdot x + \frac{1/x\left(\frac{1}{x}-1\right)}{2!}x^2 + \frac{\frac{1}{x}\left(\frac{1}{x}-1\right)\left(\frac{1}{x}-2\right)}{3!}x^3 + \cdots\right)$$

$$= \lim_{x\to 0} \left(1 + 1 + \frac{1-x}{2!} + \frac{(1-x)(1-2x)}{3!} + \cdots\right)$$

$$= 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \cdots = e^1$$

④ $\lim_{x\to 0} \frac{a^x - 1}{x} = \log a$

Proof. Let us assume $a^x - 1 = y$

$$\Rightarrow a^x = y+1$$
$$\Rightarrow \log a^x = \log(y+1)$$
$$\Rightarrow x \log a = \log(y+1)$$
$$\Rightarrow x = \frac{\log(y+1)}{\log a}$$

as, $x \to 0$, $y \to 0$

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$$\lim_{y\to 0} \frac{y}{\frac{\log(y+1)}{\log a}}$$

$$= \lim_{y\to 0} \frac{y \log a}{\log(y+1)}$$

$$= \lim_{y\to 0} \frac{\log a}{\frac{\log(y+1)}{y}}$$

$$= \lim_{y\to 0} \frac{\log a}{\frac{\log(y+1)}{y}}$$

$$= \frac{\log a}{1}$$

$$\left[\because \lim_{y\to 0} \frac{\log(1+y)}{y} = 1\right]$$

(5) $$\lim_{x\to 0} \frac{e^x - 1}{x} = 1$$

$$= \lim_{x\to 0} \left[\frac{\left(1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots\right) - 1}{x}\right]$$

$$= \lim_{x\to 0} \frac{x\left(1 + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots\right)}{x}$$

$$= \lim_{x\to 0} \frac{x\left(1 + \frac{x}{2!} + \frac{x^2}{3!} + \cdots\right)}{x}$$

$$= 1 + 0 + 0 + 0 + \cdots$$

$$= 1$$

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(6) $\lim_{x \to 0} \frac{\sin x}{x} = 1$

Proof. $\lim_{x \to 0} \frac{\left(x - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots\right)}{x}$

$= \lim_{x \to 0} \frac{x\left(1 - \frac{x^2}{3!} + \frac{x^4}{5!} - \cdots\right)}{x}$

$= \lim_{x \to 0} \left(1 - \frac{x^2}{3!} + \frac{x^4}{5!} - \cdots\right)$

$= 1 - 0 + 0 - \cdots$

$= 1$

(7) $\lim_{x \to 0} \cos x = 1$

Proof. We know that $\cos x = 1 - 2\sin^2 \frac{x}{2}$

$\therefore \lim_{x \to 0} \cos x = \lim_{x \to 0} \left[1 - 2\sin^2 \frac{x}{2}\right]$

$= 1 - 2\left[\lim_{x \to 0} \left(\sin \frac{x}{2}\right)^2\right]$

$= 1 - 2(0)^2 \quad \left[\because \lim_{x \to 0} \sin \frac{x}{2} = 0\right]$

$= 1$

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(7) $\lim_{x \to 0} \frac{\tan x}{x} = 1$

Proof $\lim_{x \to 0} \frac{\tan x}{x}$

$= \lim_{x \to 0} \left[\frac{\sin x}{x} \cdot \frac{1}{\cos x} \right]$

$= \left(\lim_{x \to 0} \frac{\sin x}{x} \right) \cdot \lim_{x \to 0} \frac{1}{\cos x}$

$= (1 \times 1)$

$= 1$

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CONTINUITY

⇒ A function $f(x)$ is said to be continuous at $x = a$ if

(i) $\lim_{x \to a} f(x)$ exist

(ii) $f(a)$ exist

(iii) $\lim_{x \to a} f(x) = f(a)$

Eg. $f(x) = \begin{cases} \frac{x^2 - 4x + 3}{x - 1}, & x \neq 1 \\ -2, & x = 1 \end{cases}$

at $x = 1$ test continuity

Sol. $\lim_{x \to 1^-} \frac{x^2 - 4x + 3}{x - 1}$

$= \lim_{x \to 1^-} \frac{x^2 - 3x - x + 3}{x - 1}$

$= \lim_{x \to 1^-} \frac{x(x-3) - 1(x-3)}{(x-1)}$

$= \lim_{x \to 1^-} \frac{(x-3)(x-1)}{(x-1)}$

$= \lim_{h \to 0} (1 - h - 3) = -2$

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RHL

$$\lim_{x \to 1^+} \frac{x^2 - 4x + 3}{x - 1}$$

$$= \lim_{x \to 1^+} \frac{x^2 - 3x - x + 3}{x - 1}$$

$$= \lim_{x \to 1^+} \frac{x(x-3) - 1(x-3)}{x - 1}$$

$$= \lim_{x \to 1^+} \frac{(x-3)(x-1)}{(x-1)}$$

$$= \lim_{h \to 0} (1 + h - 3) = -2$$

$$\lim_{x \to 1} f(x) = -2 = f(a)$$

∴, Hence the f^n. f(x) is continuous at $x = 1$

Q. $$f(x) = \begin{cases} 2x + 1 & \text{if } x \leq 0 \\ x & \text{if } 0 < x \leq 1 \\ 2x - 1 & \text{if } x > 1 \end{cases}$$ at $x = 0$

Sol: Here $a = 0$

LHL

$$\lim_{x \to 0^-} 2x + 1 = \lim_{h \to 0} 2(0 - h) + 1$$

$$= 1$$

RHL

$$\lim_{x \to 0^+} x = \lim_{h \to 0} 0 + h$$

$$= 0$$

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∴, Hence LHL ≠ RHL

So, the given f? is no continuous at $x = 0$

at $x = 1$

Sol? - Here, $a = 1$

LHL

$$\lim_{x \to 1^-} x = \lim_{h \to 0} 1 - h$$

$$= 1$$

RHL

$$\lim_{x \to 1^+} 2x - 1 = \lim_{h \to 0} 2(1+h) - 1$$

$$= 1$$

$$\lim_{x \to 1} f(x) = 1 = f(a)$$

∴, Hence LHL = RHL

So, the given f? is continuous at $x = 1$

Q - $f(x) = \begin{cases} -\cos x, & x \geq 0 \\ \cos x, & x < 0 \end{cases}$ at $x = 0$ test continuity

Q - $f(x) = \begin{cases} \frac{x}{|x|} & \text{when } x \neq 0 \\ 1 & x = 0 \end{cases}$ at $x = 0$ test continuity

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DIFFERENTIAL CALCULUS

Differentiation = process

Derivative = Result of the process

Let,

$y = f(x)$

x = Variable changing

Changing y to $y + \delta y$ or $f(x + \delta y)$

Now finding the rate of change in 'y' with respect to 'x'

$$\frac{f(x+\delta x) - f(x)}{x + \delta y - x}$$

$$= \frac{f(x+\delta x) - f(x)}{\delta x}$$

$$= \frac{y + \delta y - y}{\delta x}$$

$$= \frac{\delta y}{\delta x}$$

$$\lim \frac{\delta y}{\delta x} = \frac{f(x+\delta x) - f(x)}{\delta x}$$

$$\lim_{\delta x \to 0} \frac{\delta x}{\delta y}$$

$$\Rightarrow \frac{f(x+\delta x) - f(x)}{\delta x}$$

Now the changing in rate

$$\Rightarrow \frac{\delta y}{\delta x}$$

Now $\frac{\delta y}{\delta x} = \frac{f(x+\delta x) - f(x)}{\delta x}$

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Derivative :—

Derivative is the result of the process called as the differentiation of a function.

$$\frac{dy}{dx} = y = f(x)$$

Formulae :—

$$\frac{d}{dx}(x^n) = nx^{n-1}$$

$$\frac{d}{dx} e^x = e^x$$

$$\frac{d}{dx} a^x = a^x \ln a$$

$$\frac{d}{dx} \sin x = \cos x$$

$$\frac{d}{dx} \cos x = -\sin x$$

$$\frac{d}{dx} \tan x = \sec^2 x$$

$$\frac{d}{dx} \cot x = \operatorname{cosec}^2 x$$

$$\frac{d}{dx} \sec x = \sec x \cdot \tan x$$

$$\frac{d}{dx} \operatorname{cosec} x = -\operatorname{cosec} x \cdot \cot x$$

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Q1. Find the derivatives of the following

1. $y = 2x^3 - 3x^2 + 4x - 5$
2. $y = x^3 + e^x + 3^x + \cot x$
3. $y = 9x^2 + 3/x + 5\sin x$
4. $y = x^2 + \frac{4}{x^2} - 2/3\tan x + 7\log e^x + 6e^x$
5. $y = \log e^x$

Answer -

1) $y = 2x^3 - 3x^2 + 4x - 5$

$\frac{dy}{dx} = 6x^2 - 6x + 4$

2) $y = x^3 + e^x + 3^x + \cot x$

$\frac{dy}{dx} = 3x^2 + e^x + 3^x \ln 3 - \operatorname{cosec}^2 x.$

3) $y = 9x^2 + 3/x + 5\sin x$

$\frac{dy}{dx} = 18x - 3/x^2 + 5\cos x$

4) $y = x^2 + 4/x^2 - 2/3\tan x + 7\log e^x + 6e^x$

$dy/dx = 2x - 8/x^3 - 2/3\sec^2 x + 7/x + 6e^x$

5) $y = \log e^x$

$dy/dx = \frac{1}{x}$

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Find the derivatives :—

1) $y = \frac{1-\tan x}{1+\tan x}$

2) $y = \sqrt{\frac{1-\cos 2x}{1+\cos 2x}}$

3) $y = \sqrt{1+\sin 2x}$

4) $y = x \sin x \left(\frac{e^x}{1+x^2}\right) - \frac{e^x}{1+x^2}$

1) $y = \frac{1-\tan x}{1+\tan x}$

$\frac{d}{dx}(y) = \frac{d}{dx}\left(\frac{1-\tan x}{1+\tan x}\right)$

$\Rightarrow \frac{dy}{dx} = \frac{(1+\tan x)\frac{d}{dx}(1-\tan x) - (1-\tan x)\frac{d}{dx}(1+\tan x)}{(1+\tan x)^2}$

$= \frac{(1+\tan x)(-\sec^2 x) - (1-\tan x)(\sec^2 x)}{(1+\tan x)^2}$

$= \frac{-\sec^2 x - \tan x \cdot \sec^2 x - (\sec^2 x - \sec^2 x \tan x)}{(1+\tan x)^2}$

$= \frac{-\sec^2 x - \tan x \cdot \sec^2 x - \sec^2 x + \sec^2 x \tan x}{(1+\tan x)^2}$

$= \frac{-2\sec^2 x}{(1+\tan x)^2}$

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2) $y = \sqrt{\frac{1-\cos 2x}{1+\cos 2x}}$

$\frac{dy}{dx} = \frac{d}{dx}\sqrt{\left(\frac{1-\cos 2x}{1+\cos 2x}\right)}$

$= \sqrt{\frac{2\sin^2 x}{2\cos^2 x}}$

$= \sqrt{\tan^2 x}$

$\frac{dy}{dx} = \tan x$

$dy/dx = \sec^2 x$ (Ans)

3) $y = \sqrt{1+\sin 2x}$

$= \sqrt{(\sin x + \cos x)^2}$

$= \sin x + \cos x$

$\frac{dy}{dx} = \frac{d}{dx}(\sin x + \cos x)$

$= \cos x - \sin x$ (Ans)

4) $y = x\sin x - \frac{e^x}{1+x^2}$

$\frac{dy}{dx} = x\cdot\frac{d}{dx}\sin x + \sin x \frac{d}{dx}x - \left[(1+x^2)\frac{d}{dx}e^x - e^x\frac{d}{dx}(1+x^2)\right]$

$(1+x^2)^2$

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$$\frac{dy}{dx} = x\cos x + 2\sin x - \frac{[e^x(1+x^2) - 2e^x \cdot 2x}{(1+x^2)^2}$$

$$= x\cos x + 2\sin x - \frac{e^x(1+x^2) - 2xe^x}{(1+x^2)^2}$$

5) (a) $\frac{3x^2}{5}$

Let,

$$y = \frac{3x^2}{5}$$

$$\frac{dy}{dx} = \frac{5\frac{d}{dx}3x^2 - 3x\, d/dx\, 5}{(5)^2}$$

$$= \frac{5 \times 6x}{25}$$

$$= \frac{30x}{25}$$

2) Let,

$$y = 3x^3 + 9x + 9$$

$$\frac{dy}{dx} = 9x^2 + 9$$

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3) $y = \frac{x^4}{4} + 5x + 2/9$

$$\frac{dy}{dx} = \frac{4 \times 4x^3}{16} + 5$$

$$= \frac{16x^3}{16} + 5$$

$$= x^3 + 5$$

CHAIN RULE :-

If y is a function of f(x) and also f(x) is a function of g(x) then $y = f[g(x)]$ and the process to solve this type of question is taken by chain rule.

Example :-

$$y = \sqrt{x^3+4}$$

$$\frac{dy}{dx} = \frac{d}{dx}\left(\sqrt{x^3+4}\right)$$

$$= (x^3+4)^{1/2}$$

$$= 1/2 (x^3+4)^{-1/2} \frac{d}{dx}(x^3+4)$$

$$= \frac{3x^2}{2\sqrt{x^3+4}}$$

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2) $y = \frac{1}{(x^3+4x)^2}$

$$\frac{dy}{dx} = \frac{d}{dx}\left(\frac{1}{[x^3+4x]^2}\right)$$

$$= (x^3+4x)^{-2}$$

$$= -2(x^3+4x)^{-3}\frac{d}{dx}(x^3+4x)$$

$$= \left[-2(x^3+4x)^{-3}\right](3x^2+4)$$

$$= (3x^2+4)\left[-2(x^3+4x)^{-3}\right]$$

$$= \frac{-2(3x+4)}{(x^3+4x)^3}$$

3) $y = \log(\sin x)$

$$\frac{dy}{dx} = \frac{1}{\sin x}\frac{d}{dx}\sin x$$

$$= \frac{\cos x}{\sin x}$$

$$= \cot x$$

4) $y = \log \sin\sqrt{x}$

$$\frac{dy}{dx} = \frac{1}{\sin\sqrt{x}} \cdot \frac{d}{dx}\sin\sqrt{x}$$

$$= \frac{1}{\sin\sqrt{x}} \cdot \cos\sqrt{x}\,\frac{d}{dx}\sqrt{x}$$

$$= \frac{\cot\sqrt{x}}{2\sqrt{x}}$$

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1) $\frac{d}{dx}(\sin x + 2x^3 - 6x) = \cos x + 6x^2 - 6$

2) $\frac{d}{dx}(2x^4 - x^3/4) = 8x^3 - \frac{4 \times 3x^2}{16} = 8x^3 - \frac{12x^2}{16}$

3) $\frac{d}{dx}(\operatorname{cosec} x) = -\operatorname{cosec} x \cdot \cot x$

4) $\frac{d}{dx}(x^3/2x+3) = \frac{(2x+3) \times 3x^2 - 2x^3}{(2x+3)^2}$

5) $\frac{d}{dt}(t^{5/2} - 5/2t + t^{-9}) = 5/2t^{3/2} - 5/2 - 9t^{-10}$

6) $\frac{d}{dx}\left(\frac{t^{2/9}}{2t^6}\right) = \frac{2t^6 \times 2/9 t^{-7/9} - t^{2/9} \times 12t^5}{(2t^6)^2}$

7) $\frac{d}{dt}(\sec t \times e^t) = e^t \sec t + e^t \cdot \sec t \cdot \tan t$

8) $\frac{d}{dx}(e^t \sin t) = e^t \sin t \cdot \cos t$

4) $\frac{d}{dx}\left(\frac{x^3}{2x+3}\right)$

$= \frac{(2x+3)\, d/dx\, x^3 - x^3 \frac{d}{dx}(2x+3)}{2x+3}$

$= \frac{3x^2(2x+3) - 2x^3}{2x+3}$

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$y = e^{\sin x^3 + 3x}$

$\frac{dy}{dx} = e^{\sin x^3 + 3x} \cdot \frac{d}{dx}(\sin x^3 + 3x)$

$= e^{\sin x^3 + 3x} \cdot 3x^2 \cos x^3 + 3$

1) $y = \left(\frac{7x}{x^2+11}\right)^3$

2) $y = \sin^2 x$

3) $y = \log(\sin x)$

4) $y = \sqrt{\sin\sqrt{x}}$

5) $y = e^{\tan\sqrt{x}}$

6) $y = \cos^2\sqrt{x}$

7) $y = \sin\sqrt{x}$

8) $y = \sqrt{\sin x}$

9) $y = 2e^{\sin x}$

10) $y = \log(\log(\log x))$

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(1) $y = \left(\frac{7x}{x^2+1}\right)^3$

$$\frac{dy}{dx} = 3\left(\frac{7x}{x^2+1}\right)^2 \frac{d}{dx}\left(\frac{7x}{x^2+1}\right)$$

$$= 3\left(\frac{7x}{x^2+1}\right)^2 \left[\frac{7(x^2+1) - 7x \times 2x}{(x^2+1)2}\right]$$

$$= 3\left(\frac{7x}{x^2+1}\right)^2 \left[\frac{7(x^2+1) - 14x^2}{(x^2+1)^2}\right]$$

(2) $y = \sin^2 x$

$= (\sin x)^2$

$$\frac{dy}{dx} = 2\sin x \cdot \cos x$$

$= \sin 2x$

(3) $y = \log(\sin x)$

$$\frac{dy}{dx} = \frac{1}{\sin x} \frac{d}{dx} \sin x$$

$$= \frac{\cos x}{\sin x}$$

$= \cot x$

(4) $y = \sqrt{\sin\sqrt{x}}$

$$= \frac{1}{2}(\sin\sqrt{x})^{-1/2} \frac{d}{dx} \sin\sqrt{x}$$

$$= \frac{1}{2\sqrt{\sin\sqrt{x}}} \times \frac{\cos\sqrt{x}}{2\sqrt{x}}$$

$$= \frac{\cos\sqrt{x}}{4\sqrt{\sin\sqrt{x}}\sqrt{x}}$$

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6) $y = \cos^2\sqrt{x}$

$= (\cos\sqrt{x})^2$

$= 2\cos\sqrt{x} \cdot \frac{d}{dx}\cos\sqrt{x}$

$= -2\cos\sqrt{x}\sin\sqrt{x} \cdot \frac{1}{2\sqrt{x}}$

7) $y = \sin\sqrt{x}$

$\frac{dy}{dx} = \frac{\cos\sqrt{x}}{2\sqrt{x}}$

8) $y = \sqrt{\sin x}$

$\frac{dy}{dx} = \frac{\cos x}{2\sqrt{\sin x}}$

9) $y = e^{\sin x}$

$\frac{dy}{dx} = e^{\sin x} \cdot \cos x$

$\log x$

$e^{\log x}$ (2)

$= e^{\log x}$

x^2

10) $y = \log(\log x(\log x))$

$\frac{1}{x}$

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$y = \log(\log(\log x))$

$$\frac{dy}{dx} = \frac{1}{\log(\log x)} \cdot \frac{d}{dx}\log(\log x)$$

$$= \frac{1}{\log(\log x)} \times \frac{1}{\log x} \frac{d}{dx}\log x$$

$$= \frac{1}{\log(\log x)} \cdot \frac{1}{\log x} \cdot \frac{1}{x}$$

Differentiate w.r.t 'x'

1. $\log x \cdot e^{\sin x + x^3}$
2. $\sin[\cos(\tan x)]$
3. $\log(\sin x)^{\cos x}$
4. $e^{2x}\sin 3x$
5. $\frac{e^x \log x}{x^2}$

(1) Let,

$$y = \log x \cdot e^{\sin x + x^3}$$

$$\frac{dy}{dx} = \log x \frac{d}{dx} e^{\sin x + x^3} + e^{\sin x + x^3} \frac{d}{dx}\log x$$

$$= \log x \left[e^{\sin x + x^3} \cdot (\cos x + 3x^2)\right] \frac{e^{\sin x + x^3}}{x}$$

$$= e^{\sin x + x^3}\left[\{\log x(\cos x + 3x^2)\} + \frac{1}{x}\right]$$

(2) let,

$$y = \log(\sin x)^{\cos x}$$

$$\frac{dy}{dx} = \frac{1}{(\sin x)^{\cos x}} \cdot (\cos x)^{\cos x} \times (-\sin x)$$

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(3) let,

$$y = \sin[\cos(\tan x)]$$

$$\frac{dy}{dx} = \cos[\cos(\tan x)]$$

$$= \cos[-\sin(\tan x)]$$

$$= \cos[-\sin(\tan x)] \cdot \sec^2 x$$

(4) let,

$$y = e^{2x} \sin 3x$$

$$\frac{dy}{dx} = e^{2x} \frac{d}{dx} \sin 3x + \sin 3x \frac{d}{dx} e^{2x}$$

$$= 3\cos 3x \cdot e^{2x} + 2e^{2x} \cdot \sin 3x$$

(5) let,

$$y = \frac{e^x \log x}{x^2}$$

$$\frac{dy}{dx} = \frac{x^2 \frac{d}{dx}(e^x \cdot \log x) - e^x \log x \frac{d}{dx} x^2}{x^4}$$

$$= \frac{x^2 \left(\frac{e^x}{x} \times \log x \cdot e^x\right) - 2x \cdot e^x}{x^4}$$

(2) let,

$$y = \sin[\cos(\tan x)]$$

$$\frac{dy}{dx} = \cos[\cos(\tan x)] \times [-\sin(\tan x) \cdot \sec^2 x]$$

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③ Let,

$$y = \log(\sin x)^{\cos x}$$

$$= \cos x \log \sin x$$

$$\frac{dy}{dx} = \cos x \frac{d}{dx} \log \sin x + \log \sin x \frac{d}{dx} \cos x$$

$$= \frac{\cos x}{\sin x} \times \cos x + (-\sin x) \log \sin x$$

$$= \cot x \cdot \cos x + (-\sin x) \log \sin x$$

Exercise :-

① let,

$$y = x^2 - 7x + 3$$

$$\frac{dy}{dx} = \frac{d}{dx}(x^2 - 7x + 3)$$

$$= 2x - 7$$

② let,

$$y = \frac{1}{x^2}$$

$$\frac{dy}{dx} = -\frac{1}{x^3}$$

③ let,

$$y = \sqrt{\cos x}$$

$$\frac{dy}{dx} = \frac{\sin x}{2\sqrt{\cos x}}$$

④ let,

$$y = x \sin x$$

$$\frac{dy}{dx} = x \frac{d}{dx} \sin x + \sin x \frac{d}{dx} x$$

$$= x \cos x + \sin x$$

⑤ let,

$$y = ax^2 + bx + c$$

$$\frac{dy}{dx} = 2ax + b$$

⑥ let,

$$y = x(x+2)(x+3)$$

$$= (x^2 + 2x)(x+3)$$

$$= x^3 + 3x^2 + 2x^2 + 6x$$

$$= x^3 + 5x^2 + 6x$$

$$\frac{dy}{dx} = 3x^2 + 10x + 6$$

⑦ $y = x^4 - 2x^2 + 7$

$$\frac{dy}{dx} = 4x^3 - 4x$$

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8) $y = \frac{(x+2)(x^2+5)}{x}$

$= \frac{x^3+5x+2x^2+10}{x}$

$\frac{dy}{dx} = \frac{x\frac{d}{dx}(x^3+5x+2x^2+10) - (x^3+5x+2x^2+10)\frac{d}{dx}x}{x^2}$

$= \frac{x(3x^2+4x+5) - (x^3+2x^2+5x+10)}{x^2}$

9) $y = 2x - \frac{1}{x}$

$\frac{dy}{dx} = 1 + \frac{1}{x^2}$

10) $y = 5\tan x + b\cot x$

$\frac{dy}{dx} = 5\sec^2 x + -b\operatorname{cosec}^2 x$

11) $y = \frac{x^2-1}{x^2+x+1}$

$\frac{dy}{dx} = \frac{(x^2+x+1)\frac{d}{dx}(x^2-1) - (x^2-1)\frac{d}{dx}(x^2+x+1)}{(x^2+x+1)^2}$

$= \frac{2x(x^2+x+1) - (2x+1)(x^2-1)}{(x^2+x+1)^2}$

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(12) $y = \frac{1-\sin x}{1+\sin x}$

$$\frac{dy}{dx} = \frac{(1+\sin x)\frac{d}{dx}(1-\sin x) - (1-\sin x)\frac{d}{dx}(1+\sin x)}{(1+\sin x)^2}$$

$$= \frac{(-\cos x)(1+\sin x) - \cos x(1-\sin x)}{(1+\sin x)^2}$$

$$= \frac{-\cos x - \cancel{\cos x \sin x} - \cos x + \cancel{\sin x \cos x}}{(1+\sin x)^2}$$

$$= \frac{-2\cos x}{(1+\sin x)^2}$$

(13) $y = x^2 \cos x$

$$\frac{dy}{dx} = -x^2 \sin x + 2x\cos x$$

(14) $y = \frac{1-\tan x}{1+\tan x}$

$$\frac{dy}{dx} = \frac{(1+\tan x)(-\sec^2 x) - \sec^2 x(1-\tan x)}{(1+\tan x)^2}$$

$$= \frac{-\sec^2 x - \sec^2 x \cdot \tan x - \sec^2 x + \sec^2 x \cdot \tan x}{(1+\tan x)^2}$$

$$= \frac{-2\sec^2 x}{(1+\tan x)^2}$$

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(15) $y = \sqrt{\frac{1-\cos 2x}{1+\cos 2x}}$

$= \sqrt{\frac{2\sin^2 x}{2\cos^2 x}}$

$= \sqrt{\tan^2 x}$

$= \tan x$

$\frac{dy}{dx} = \sec^2 x$

(16) $y = \sqrt{\frac{1-\sin 2x}{1+\sin 2x}}$

$= \sqrt{\frac{\sin^2 x + \cos^2 x - 2\sin x \cdot \cos x}{\sin^2 x + \cos^2 x + 2\sin x \cdot \cos x}}$

$= \sqrt{\frac{(\sin x - \cos x)^2}{(\sin x + \cos x)^2}}$

$= \frac{\sin x - \cos x}{\sin x + \cos x}$

$\frac{dy}{dx} = \frac{(\sin x + \cos x)(\cos x + \sin x) - (\sin x - \cos x)(\sin$

(16) $y = \frac{a^x - b^x}{x}$

$\frac{dy}{dx} = \frac{x \frac{d}{dx}(a^x - b^x) - (a^x - b^x)\frac{d}{dx}x}{x^2}$

$= \frac{x(a^x \ln a - b^x \ln b) - (a^x - b^x)}{x^2}$

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(17) $y = \dfrac{(x^{3/5} - ae^{2\ln x} + \ln x^{2/3})}{x+1}$

(18) $y = (2x^3 - 1)^4$

$$\frac{dy}{dx} = 4(2x^3-1)\frac{d}{dx}(2x^3-1)$$

$$= 4(2x^3-1)(6x^2)$$

(19) $y = (3x^2 + 2x + 1)^8$

$$\frac{dy}{dx} = 8(3x^2+2x+1)^7 \frac{d}{dx}(3x^2+2x+1)$$

$$= 8(3x^2+2x+1)^7(6x+2)$$

(20) $y = \left(2x^2 + \frac{3}{4}x + 7\right)^8$

$$\frac{dy}{dx} = 8\left(2x^2 + \frac{3}{4}x + 7\right)^7 \frac{d}{dx}\left(2x^2 + \frac{3}{4}x + 7\right)$$

$$= 8\left(2x^2 + \frac{3}{4}x + 7\right)^7 \left(4x + \frac{3}{4}\right)$$

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(21) $y = \left(\frac{2x^3+1}{3x^2+1}\right)^2$

$$\frac{dy}{dx} = 2\left(\frac{2x^3+1}{3x^2+1}\right)\frac{d}{dx}\left(\frac{2x^3+1}{3x^2+1}\right)$$

$$= 2\left(\frac{2x^3+1}{3x^2+1}\right)\left[\frac{(3x^2+1)6x^2 - (2x^3+1)6x}{(3x^2+1)^2}\right]$$

(22) $y = (x^2+3)^4(x^2+5)^2$

$$\frac{dy}{dx} = (x^2+3)^4\left[2(x^2+5)(2x)\right] + (x^2+5)^2\left[4(x^2+3)^3 \cdot 2x\right]$$

(23) $y = (2x^4+x^2-x)^{1/3}$

$$\frac{dy}{dx} = \frac{1}{3}(2x^4+x^2-x)^{-1/3}\frac{d}{dx}(2x^4+x^2-x)$$

$$= \frac{1}{3\sqrt[3]{2x^4+x^2-x}}(8x^3+2x-1)$$

(24) $y = [\tan(3x^2+5)]^5$

$$\frac{dy}{dx} = 5[\tan(3x^2+5)]^4\frac{d}{dx}[\tan(3x^2+5)]$$

$$= 5[\tan(3x^2+5)^4]\sec^2(3x^2+5)\cdot 6x$$

(22) $y = \sqrt{\frac{1+\sin x}{1-\sin x}}$

$$\frac{dy}{dx} = \frac{1}{2}\left(\frac{1+\sin x}{1-\sin x}\right)^{-1/2}\frac{d}{dx}\left(\frac{1+\sin x}{1-\sin x}\right)$$

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$$= \frac{1}{2}\left(\frac{1+\sin x}{1-\sin x}\right)^{-1/2}\left[\frac{(1-\sin x)\cos x + (1+\sin x)\cos x}{(1-\sin)^2}\right]$$

(23) $y = \sqrt{1+\tan x}$

$$\frac{dy}{dx} = \frac{\sec^2 x}{2\sqrt{1+\tan x}}$$

(24) $y = \sqrt{1+\sin x}$

$$\frac{dy}{dx} = \frac{1}{2}(1+\sin x)^{-1/2}\cdot\cos x$$

(25) $y = \left(\frac{2\tan x}{1+\tan x+\cos x}\right)^2$

$$\frac{dy}{dx} = 2\left(\frac{2\tan x}{1+\tan x+\cos x}\right)\frac{d}{dx}\left(\frac{2\tan x}{\tan x+\cos x}\right)$$

$$= 2\left(\frac{2\tan x}{1+\tan x+\cos x}\right)\left[\frac{(1+\tan x+\cos x)\frac{d}{dx}2\tan x - 2\tan x \frac{d}{dx}(1+\tan x+\cos x)}{(1+\tan x+\cos x)^2}\right]$$

$$= 2\left(\frac{2\tan x}{1+\tan x+\cos x}\right)\left[\frac{2\sec^2 x(1+\tan x+\cos x) - 2\tan x(\sec^2 x - \sin x)}{(\tan x+\cos x)^2}\right]$$

(26) $y = \sqrt{\frac{1+x}{2+x}}$

$$\frac{dy}{dx} = \frac{1}{2}\left(\frac{1+x}{2+x}\right)^{-1/2}\left[\frac{(2+x)-(1+x)}{(2+x)^2}\right]$$

$$= \frac{1}{2\sqrt{\frac{1+x}{2+x}}}\left(\frac{2+x-1-x}{(2+x)^2}\right)$$

not Verified

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(27) $y = \frac{1}{(x^3+\sin x)^2}$

$$\frac{dy}{dx} = -2(x^3+\sin x)^{-3} \frac{d}{dx}(x^3+\sin x)$$

$$= \frac{-2}{\sqrt[3]{x^3+\sin x}} (3x^2+\cos x)$$

(28) $y = \ln(\sqrt{x}+1)$

$$\frac{dy}{dx} = \frac{1}{\sqrt{x}+1} \cdot \frac{d}{dx}\sqrt{x}+1$$

$$= \frac{1}{(\sqrt{x}+1)} \times \frac{1}{2\sqrt{x}}$$

(29) $y = \sin 5x + \cos 7x$

$$\frac{dy}{dx} = 5\cos 5x - 7\sin 7x$$

(30) $y = \left(\frac{x+1}{x^2+3}\right)^{-3}$

$$\frac{dy}{dx} = -3\left(\frac{x+1}{x^2+3}\right)^{-4} \left[\frac{(x^2+3)-(x+1)2x}{(x^2+3)^2}\right]$$

(31) $y = e^{\sin^2 x}$

$$\frac{dy}{dx} = e^{\sin^2 x} \frac{d}{dx} \sin^2 x$$

$$= e^{\sin^2 x} \times 2\sin x \cdot \cos x$$

$$= e^{\sin^2 x} \cdot \sin 2x$$

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32) $y = e^{\sin x^2}$

$$\frac{dy}{dx} = e^{\sin x^2} \frac{d}{dx} \sin x^2$$

$$= e^{\sin x^2} \cdot \cos x^2 \cdot 2x$$

33) $y = \log x^2$

$$\frac{dy}{dx} = \frac{1}{x^2} \times 2x$$

$$= \frac{2}{x}$$

34) $y = e^{2x} \sin 3x$

$$\frac{dy}{dx} = e^{2x} \times 3\cos 3x + \sin 3x \cdot 2e^{2x}$$

35) $y = \log\left(\frac{1-x}{1+x}\right)$

$$\frac{dy}{dx} = \frac{1}{1-x/1+x} \frac{d}{dx}\left(\frac{1-x}{1+x}\right)$$

$$= \frac{1+x}{1-x}\left[\frac{1+x-1+x}{(1+x)^2}\right]$$

$$= \frac{1+x}{1-x} \times \frac{2x}{(1+x)^2}$$

36) $y = \cos(\log x)^2$

$$= 2\cos(\log x) \frac{d}{dx} \cos(\log x)$$

$$= \frac{2\cos(\log x) - \sin(\log x)}{x}$$

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(37) $y = \log(x + \sqrt{x^2+a})$

$$\frac{dy}{dx} = \frac{1}{x+\sqrt{x^2+a}} \frac{d}{dx}(x+\sqrt{x^2+a})$$

$$= \frac{1}{x+\sqrt{x^2+a}} \left[1 + \frac{1}{2\sqrt{x^2+a}}\right] \times 2x$$

(38) $y = \frac{e^x \log x}{x^2}$

$$\frac{dy}{dx} = \frac{\frac{x^2 e^x}{x} - e^x \log x \cdot 2x}{x^4}$$

$$= \frac{xe^x - e^x \log x 2x}{x^4}$$

(39) $y = \sqrt{e^{\sqrt{x}}}$

$$\frac{dy}{dx} = \frac{1}{2\sqrt{e^{\sqrt{x}}}} \frac{d}{dx} e^{\sqrt{x}}$$

$$= \frac{1}{2\sqrt{e^{\sqrt{x}}}} \cdot \frac{e^{\sqrt{x}}}{2\sqrt{x}}$$

(40) $y = \log(\log x)$

$$\frac{dy}{dx} = \frac{1}{\log x} \times \frac{1}{x}$$

(41) $y = \log(\sec x + \tan x)$

$$\frac{dy}{dx} = \frac{1}{\sec x + \tan x} \times \sec x \cdot \tan x + \sec^2 x$$

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42) $y = \log\left(\frac{1+\sqrt{x}}{1-\sqrt{x}}\right)$

$$\frac{dy}{dx} = \frac{1-\sqrt{x}}{1+\sqrt{x}}\left(\frac{\frac{1-\sqrt{x}}{2\sqrt{x}} - \frac{1+\sqrt{x}}{2\sqrt{x}}}{(1-\sqrt{x})^2}\right)$$

$$= \frac{1-\sqrt{x}}{1+\sqrt{x}}\left[\frac{\frac{1-\sqrt{x}-1-\sqrt{x}}{2\sqrt{x}}}{(1-\sqrt{x})^2}\right]$$

$$= \frac{1-\sqrt{x}}{1+\sqrt{x}}\left[\frac{-1}{(1-\sqrt{x})^2}\right]$$

43) $y = \frac{\log x}{1+x\log x}$

$$\frac{dy}{dx} = \frac{1+x\log x}{x} - \log x\left(1+\log x\right)$$

$$\frac{dy}{dx} = \frac{1+x\log x \times \frac{1}{x} - \log x\left(x/x+\log x\right)}{(1+x\log x)^2}$$

$$= \frac{\frac{1+x\log x}{x} - \log x(1+\log x)}{(1+x\log x)^2}$$

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INVERSE TRIGONOMETRY :-

DERIVATIES :-

Formulae:—

1. $\frac{d}{dx}\sin^{-1}x = \frac{1}{\sqrt{1-x^2}}$

2. $\frac{d}{dx}\cos^{-1}x = -\frac{1}{\sqrt{1-x^2}}$

3. $\frac{d}{dx}\tan^{-1}x = \frac{1}{1+x^2}$

4. $\frac{d}{dx}\cot^{-1}x = -\frac{1}{1+x^2}$

5. $\frac{d}{dx}\sec^{-1}x = \frac{1}{x\sqrt{x^2-1}}$

6. $\frac{d}{dx}\operatorname{cosec}^{-1}x = -\frac{1}{x\sqrt{x^2-1}}$

7. $1-\cos x = 2\sin^2\frac{x}{2}$

8. $1+\cos x = 2\cos^2\frac{x}{2}$

Note:—

1) Normal function.

2) Trigonometry with trigonometric function one more than one function.

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Questions—

1. $\sin^{-1}2x$
2. $\tan^{-1}\sqrt{x}$
3. $\sqrt{\cot^{-1}\sqrt{x}}$
4. If $y = \frac{x\sin^{-1}x}{\sqrt{1-x^2}}$ then $\frac{dy}{dx}$.

Answers—

let,

$$y = \sin^{-1}2x$$

$$\Rightarrow \frac{dy}{dx} = \frac{1}{\sqrt{1-4x^2}} \frac{d}{dx} 2x$$

$$= \frac{2}{\sqrt{1-4x^2}}$$

let,

$$y = \tan^{-1}\sqrt{x}$$

$$\Rightarrow \frac{dy}{dx} = \frac{1}{1+x} \frac{d}{dx}\sqrt{x}$$

$$= \frac{1}{2\sqrt{x}(1+x)}$$

let,

$$y = \sqrt{\cot^{-1}\sqrt{x}}$$

$$\Rightarrow \frac{dy}{dx} = \frac{1}{2\sqrt{\cot^{-1}\sqrt{x}}} \frac{d}{dx} \cot^{-1}\sqrt{x}$$

$$= -\frac{1}{2\sqrt{\cot^{-1}\sqrt{x}}} \times \frac{1}{1+x} \times \left(-\frac{1}{2\sqrt{x}}\right)$$

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$$y = \frac{x \sin^{-1} x}{\sqrt{1-x^2}}$$

$$\Rightarrow y\sqrt{1-x^2} = x \sin^{-1} x$$

$$\Rightarrow \frac{dy}{dx} = \frac{d}{dx}\left(\frac{x \sin^{-1} x}{\sqrt{1-x^2}}\right)$$

$$= \frac{\sqrt{1-x^2}\,\frac{d}{dx} x \sin^{-1} x - x \sin^{-1} x \frac{d}{dx}\sqrt{1-x^2}}{1-x^2}$$

$$= \frac{\sqrt{1-x^2}\left(\frac{x}{\sqrt{1-x^2}} + \sin^{-1} x\right) + \frac{2x}{2\sqrt{1-x^2}} \cdot x}{1-x^2}$$

$$= \frac{x + (\sin^{-1} x)(\sqrt{1-x^2}) + \frac{x^2 \sin^{-1} x}{\sqrt{1-x^2}}}{1-x^2}$$

$$= \frac{x + (\sin^{-1} x)(\sqrt{1-x^2}) + x^2 \sin^{-1} x}{(1-x^2)^{3/2}}$$

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Inverse derivative of trigonometric function:-

1. $\sin^2\left[\cot^{-1}\sqrt{\frac{1+x}{1-x}}\right]$

Let,

$$y = \sin^2\left[\cot^{-1}\frac{\sqrt{1+x}}{\sqrt{1-x}}\right]$$

Put, $x = \cos\theta$

$$= \sin^2\left[\cot^{-1}\sqrt{\frac{1+\cos\theta}{1-\cos\theta}}\right]$$

$$= \sin^2\left[\cot^{-1}\left(\frac{\sqrt{2\cos^2\theta/2}}{\sqrt{2\sin^2\theta/2}}\right)\right]$$

$$= \sin^2\left[\cot^{-1}(\cot\theta/2)\right]$$

$$= \sin^2\theta/2$$

$$= \frac{1-\cos\theta}{2}$$

$$= \frac{1}{2} - \frac{x}{2}$$

$$\frac{dy}{dx} = -\frac{1}{2}$$

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2. $\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

let,

$y = \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

Put,

$x = \tan\theta$

$= \cos^{-1}\left(\frac{1-\tan^2\theta}{1+\tan^2\theta}\right)$

$= \cos^{-1}(\cos 2\theta)$

$\frac{dy}{dx} = \frac{d}{dx}\left[\cos^{-1}(\cos 2\theta)\right]$

$= 2 \cdot 2\tan^{-1}x$

$= \frac{2}{1+x^2}$

3. $\sin^{-1}(3x-4x^3)$

let,

$y = \sin^{-1}(3x-4x^3)$

Put $x = \sin\theta$.

$\theta = \sin^{-1}x$

$= \sin^{-1}(3\sin\theta - 4\sin^3\theta)$

$= \sin^{-1}(\sin 3\theta)$

$= 3\theta$ $= 3\times\sin^{-1}x$

$dy/dx = 3\theta$ $= \frac{3}{\sqrt{1-x^2}}$

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5. $\tan^{-1}\left(\frac{4\sqrt{x}}{1-4x}\right)$

let,

$$y = \tan^{-1}\left(\frac{4\sqrt{x}}{1-4x}\right)$$

$$= \tan^{-1}\left(\frac{2\sqrt{x}+2\sqrt{x}}{1-2\sqrt{x}\cdot 2\sqrt{x}}\right)$$

$$= \tan^{-1}2\sqrt{x} + \tan^{-1}2\sqrt{x}$$

$$= \frac{1}{1+4x} + \frac{1}{1+4x}$$

$$= \frac{2}{1+4x}$$

$$= \frac{1}{1+4x}\frac{d}{dx}2\sqrt{x} + \frac{1}{1+4x}\frac{d}{dx}2\sqrt{x}$$

$$= \frac{1}{\sqrt{x}(1+4x)} + \frac{1}{\sqrt{x}(1+4x)}$$

$$= \frac{2}{\sqrt{x}(1+4x)}$$

$$= \frac{2}{\sqrt{x}+4x\sqrt{x}} \text{ (Ans)}$$

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let,

$$y = \tan^{-1}\left(\frac{1-\cos x}{\sin x}\right)$$

$$= \tan^{-1}\left(\frac{2\sin^2 x/2}{2\sin x/2 \cdot \cos x/2}\right)$$

$$= \tan^{-1}\left(\tan x/2\right)$$

$$= x/2$$

$$\frac{dy}{dx} = \frac{1}{2}$$

let,

$$y = \tan^{-1}\left(\frac{\cos x - \sin x}{\cos x + \sin x}\right)$$

$$= \tan^{-1}\left(\frac{\frac{\cos x - \sin x}{\cos x}}{\frac{\cos x + \sin x}{\cos x}}\right)$$

$$= \tan^{-1}\left(\frac{1-\tan x}{1+\tan x}\right)$$

$$= \tan^{-1}\left(\frac{1 - \tan x}{1 - 1.\tan x}\right)$$

$$= \tan^{-1}\left(\frac{\pi/4 - \tan x}{1 - \pi/4 \cdot \tan x}\right)$$

$$= \tan^{-1}\left(\tan(\pi/4 - x)\right)$$

$$= \pi/4 - x$$

$$\frac{dy}{dx} = -1$$

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3) $y = \tan^{-1}\left(\sqrt{\frac{1-\cos x}{1+\cos x}}\right)$

$= \tan^{-1}\left(\sqrt{\frac{2\sin^2 x/2}{2\cos^2 x/2}}\right)$

$= \tan^{-1}(\tan x/2)$

$= \frac{x}{2}$

$= \frac{1}{2}$

4) $y = \tan^{-1}\left(\frac{\cos x}{1+\sin x}\right)$

$= \tan^{-1}\left[\frac{\cos^2 x/2 - \sin^2 x/2}{(\cos x/2 + \sin x/2)^2}\right]$

$= \tan^{-1}\left[\frac{(\cos x/2 + \sin x/2)(\cos x/2 - \sin x/2)}{(\cos x/2 + \sin x/2)^2}\right]$

$= \tan^{-1}\left[\frac{\cos x/2 - \sin x/2}{\cos x/2 + \sin x/2}\right]$

$= \tan^{-1}\left[\frac{1 - \tan x/2}{1 + \tan x/2}\right]$

$= \tan^{-1}\left[\tan(\pi/4 - x/2)\right]$

$= -x/2$

$= -1/2$

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$\{\tan^{-1}(\sec x + \tan x)\}$

let,

$y = \tan^{-1}(\sec x + \tan x)$

$= \tan^{-1}\left(\frac{1}{\cos x} + \frac{\sin x}{\cos x}\right)$

$= \tan^{-1}\left(\frac{1 + \sin x}{\cos x}\right)$

$= \tan^{-1}\left[\frac{(\cos x/2 + \sin x/2)^2}{\cos^2 x/2 - \sin^2 x/2}\right]$

$= \tan^{-1}\left[\frac{(\cos x/2 + \sin x/2)^2}{(\cos x/2 - \sin x/2)(\cos x/2 + \sin x/2)}\right]$

$= \tan^{-1}\left[\frac{1 + \tan x/2}{1 - \tan x/2}\right]$

$= \tan^{-1}(\pi/4 + x/2)$

$= \tan^{-1}$

$= \tan^{-1}[\tan(\pi/4 + x/2)]$

$\frac{dy}{dx} = \frac{1}{2}$

let,

$y = \left\{\cos^{-1}\sqrt{\frac{1 + \cos x}{2}}\right\}$

$= \cos^{-1}\left(\sqrt{\frac{2\sin^2 x/2}{2}}\right)$

$= \cos^{-1}(\cos x/2)$

$= x/2$

$dy/dx = 1/2$

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$= \tan^{-1}\sqrt{\frac{2\sin^2\theta/2}{2\cos^2\theta/2}}$

$= \tan^{-1}(\tan\theta/2)$

$= \theta/2$

$= \frac{\cos^{-1}x}{2}$

$\frac{dy}{dx} = -\frac{1}{2\sqrt{1-x^2}}$

3. $(\tan^{-1}5x)^2$

let, $y = (\tan^{-1}5x)^2$

$\frac{dy}{dx} = \frac{5}{1+25x^2} \cdot 2\tan^{-1}5x \times \frac{5}{1+25x^2}$

4. $\tan^{-1}\left(\frac{\cos x}{1+\sin x}\right)$

let, $y = \tan^{-1}\left(\frac{\cos x}{1+\sin x}\right)$

$= \tan^{-1}\left(\frac{\cos^2 x/2 - \sin^2 x/2}{(\cos x/2 + \sin x/2)^2}\right)$

$= \tan^{-1}\left(\frac{\cos x/2 - \sin x/2}{\cos x/2 + \sin x/2}\right)$

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$$= \tan^{-1}\left(\frac{1 - \tan x/2}{1 + \tan x/2}\right)$$

$$= \tan^{-1}\left[\tan\left(\pi/4 - x/2\right)\right]$$

$$= \pi/4 - x/2$$

$$\frac{dy}{dx} = -\frac{1}{2}$$

5. $\tan^{-1}x - \cot^{-1}x$

let,

$$y = \tan^{-1}x - \cot^{-1}x$$

$$\frac{dy}{dx} = \frac{1}{1+x^2} + \frac{1}{1+x^2}$$

$$= \frac{2}{1+x^2}$$

6. $\sin^{-1}2ax\sqrt{1-a^2x^2}$

let,

$$y = \sin^{-1}2ax\sqrt{1-a^2x^2}$$

Put,

$$x = \sin\theta$$

$$\theta = \sin^{-1}x$$

$$= \sin^{-1}2\times a\sin\theta\sqrt{1-a^2\sin^2\theta}$$

$$= \sin^{-1}(2a\sin\theta\cdot\cos\theta)$$

$$= \sin^{-1}(2\sin 2a\theta)$$

$$= 2a\theta$$

$$= 2a\sin^{-1}x$$

$$\frac{dy}{dx} = \frac{2a}{\sqrt{1-4a^2}}$$

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7. $\sin^{-1}\left(2ax\sqrt{1-a^2x^2}\right)$

Let,

$y = \sin^{-1}\left(2ax\sqrt{1-(ax)^2}\right)$

Put,

$ax = \sin\theta$

$\Rightarrow \theta = \sin^{-1}ax$

$y = \sin^{-1}\left(2\sin\theta\sqrt{1-\sin^2\theta}\right)$

$= \sin^{-1}(2\sin\theta\cdot\cos\theta)$

$= \sin^{-1}(\sin 2\theta)$

$= 2\theta$

$= 2\sin^{-1}ax$

$\frac{dy}{dx} = \frac{2a}{\sqrt{1-a^2x^2}}$

$y = \sec^{-1}\left(\frac{\sqrt{x^2+a^2}}{a}\right)$

Put,

$x = a\tan\theta$

$\Rightarrow \theta = a\tan^{-1}x$

$= \sec^{-1}\left(\frac{\sqrt{a^2\tan^2\theta + a^2}}{a}\right)$

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$$= \sec^{-1}\left(\frac{\sqrt{a^2(\tan^2\theta+1)}}{a}\right)$$

$$= \sec^{-1}\left(\frac{\sqrt{a^2\sec^2\theta}}{a}\right)$$

$$= \sec^{-1}\left(\frac{a\sec\theta}{a}\right)$$

$$= \theta$$

$$= a\tan^{-1}x$$

$$= \frac{a}{1+x^2}$$

Exercise :—

1) $x = \frac{1-t^2}{1+t^2}$ and $y = \frac{2t}{1+t^2}$

differentiate x and y with respect to 't'

$$\frac{dx}{dt} = \frac{d}{dt}\left(\frac{1-t^2}{1+t^2}\right)$$

$$= \frac{(1+t^2)\frac{d}{dt}(1-t^2) - (1-t^2)\frac{d}{dt}(1+t^2)}{(1+t^2)^2}$$

$$= \frac{-2t(1+t^2) - 2t(1-t^2)}{(1+t^2)^2}$$

$$= \frac{-2t[(1+t^2)+(1-t^2)]}{(1+t^2)^2}$$

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$$\frac{dy}{dt} = \frac{d}{dt}\left(\frac{2t}{1+t^2}\right)$$

$$= \frac{2(1+t^2) - 4t^2}{(1+t^2)^2}$$

$$\frac{dy}{dt} = \frac{\frac{2(1+t^2) - 4t^2}{(1+t^2)^2}}{\frac{-2t[(1+t^2) + (1-t^2)]}{(1+t^2)^2}}$$

$$= \frac{2 + 2t^2 - 4t^2}{-2t(1+t^2) + (1-t^2)}$$

$$= \frac{2 - 2t^2}{-2t(1+t^2) + (1-t^2)}$$

$x = a\cos\theta$ and $y = b\sin\theta$

differentiating x and y with respect to 'θ'

$$\frac{dx}{d\theta} = -a\sin\theta$$

$$\frac{dy}{d\theta} = b\cos\theta$$

$$\frac{dy}{dx} = -\frac{b}{a}\cot\theta$$

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3) $x = a\sin^3 t$ and $y = b\cos^3 t$.

differentiating x and y with respect to 't'

$$\frac{dx}{dt} = 3a\sin^2 t \cdot \cos t$$

$$\frac{dy}{dt} = -3b\cos^2 t \cdot \sin t$$

$$\frac{dy}{dt} = \frac{-3b\cos^2 t \cdot \sin t}{3a\sin^2 t \cdot \cos t}$$

$$= -\frac{b}{a}\cot\theta$$

4) $x = a\left(\theta + \frac{1}{\theta}\right)$ and $y = a\left(\theta - \frac{1}{\theta}\right)$

differentiating x and y with respect to 'θ'

$$\frac{dx}{d\theta} = a\left(1 - \frac{1}{\theta^2}\right) = a\left(\frac{\theta^2 - 1}{\theta^2}\right)$$

$$\frac{dy}{d\theta} = a\left(1 + \frac{1}{\theta^2}\right) = a\left(\frac{\theta^2 + 1}{\theta^2}\right)$$

$$\frac{dy}{dx} = \frac{a\left(\frac{\theta^2+1}{\theta^2}\right)}{a\left(\frac{\theta^2-1}{\theta^2}\right)}$$

$$= \frac{a}{a}\left(\frac{\theta^2+1}{\theta^2-1}\right)$$

5) $x = \frac{2at}{1+t^2}$ and $y = \frac{2bt}{1-t^2}$

differentiating x and y with respect to 't'

$$\frac{dx}{dt} = \frac{2a(1+t^2) - 4at^2}{(1+t^2)^2}$$

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$$\frac{dy}{dt} = \frac{2b(1-t^2) + 4bt^2}{(1-t^2)^2}$$

$$\frac{dy}{dx} = \frac{\dfrac{2b(1-t^2) + 4bt}{(1-t^2)^2}}{\dfrac{2a(1+t^2) - 4at}{(1+t^2)^2}}$$

(4) $x = a(\theta + \sin\theta)$ and $y = a(1 - \cos\theta)$

Differentiating x and y with respect to 'θ'

$$\frac{dx}{d\theta} = a(1 + \cos\theta) = 2\cos^2\theta/2$$

$$\frac{dy}{d\theta} = a\sin\theta$$

$$= 2a\sin\theta/2 \cdot \cos\theta/2$$

$$\frac{dy}{dx} = \frac{2a\sin\theta/2 \cdot \cos\theta/2}{2\cos^2\theta/2}$$

$$\frac{dy}{dx} = \tan\theta/2$$

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Q- $\frac{dy}{dx} = ?$

If $\sin x = \frac{2t}{1+t^2}$

$$\tan y = \frac{2t}{1-t^2}$$

$$\sin x = \frac{2t}{1+t^2}$$

$$\Rightarrow x = \sin^{-1}\left(\frac{2t}{1+t^2}\right)$$

- Put,

$$t = \tan\theta$$

$$\Rightarrow \theta = \tan^{-1} t$$

$$= \sin^{-1}\left(\frac{2\tan\theta}{1+\tan^2\theta}\right)$$

$$= \sin^{-1}(\sin 2\theta)$$

$$= 2\theta$$

$$= 2\tan^{-1} t$$

$$\frac{dx}{dt} = \frac{2}{1+t^2}$$

$$\tan y = \frac{2t}{1-t^2}$$

$$\Rightarrow y = \tan^{-1}\left(\frac{2t}{1-t^2}\right)$$

- put

$$t = \tan\theta$$

$$\Rightarrow \theta = \tan^{-1} t$$

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$$= \tan^{-1}\left(\frac{2\tan\theta}{1-\tan^2\theta}\right)$$

$$= \tan^{-1}(\tan 2\theta)$$

$$= 2\theta$$

$$= 2\tan^{-1}t$$

$$\frac{dy}{dt} = \frac{2}{1+t^2}$$

$$\therefore \frac{dy}{dx} = \frac{2}{1+t^2} \Big/ \frac{2}{1+t^2}$$

$$= 1 \text{ (Ans)}$$

7) $x = at^2$ and $y = at^3$

differentiating x and y w.r.t 't'

$$\frac{dx}{dt} = 2at$$

$$\frac{dy}{dt} = 3at^2$$

$$\frac{dy}{dx} = \frac{3at^2}{2at}$$

$$= \frac{3}{2}t$$

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5) $x = \frac{2at}{1+t^2}$ and $y = \frac{2bt}{1-t^2}$

Differentiating x and y w.r.t. 't'

$$\frac{dx}{dt} = \frac{2a(1+t^2) - 4at^2}{(1+t^2)^2} = \frac{2a + 2at^2 - 4at^2}{(1+t^2)^2}$$

$$\frac{dy}{dt} = \frac{2b(1+t^2) - 4bt^2}{(1+t^2)^2} = \frac{2b + 2bt^2 + 4bt^2}{(1-t^2)^2}$$

$$\frac{dy}{dx} = \frac{\frac{2a + 2at^2 - 4at^2}{(1+t^2)^2}}{\frac{2b + 2bt^2 + 4bt^2}{(1+t^2)^2}}$$

$$= \frac{\frac{2a - 2at^2}{(1+t^2)^2}}{\frac{2b + 2bt^2}{(1-t^2)^2}}$$

$$= \frac{2a(1-t^2)}{(1+t^2)^2} \times \frac{(1-t^2)^2}{2b(1+t^2)^2}$$

$$= \frac{a(1-t^2)^3}{b(1+t^2)^3}$$

$$\Rightarrow \frac{dy}{dx} = \frac{b(1+t^2)^3}{a(1-t^2)^3}$$

They are not very accurate.

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8) $x = \frac{at^2}{1+t^2}$ and $y = \frac{at^3}{1+t^2}$

Differentiating x and y w.r.t 't'

$$\frac{dx}{dt} = \frac{2at(1+t^2) - 2at^3}{(1+t^2)^2}$$

$$\frac{dy}{dt} = \frac{3at^2(1+t^2) - 2at^4}{(1+t^2)^2}$$

$$\frac{dy}{dx} = \frac{3at^2 + 3at^4 - 2at^4}{2at + 2at^3 - 2at^3}$$

$$= \frac{2at}{3at^2 + at^4}$$

$$= \frac{2at}{at^2(3+t^2)}$$

$$= \frac{2}{a(t^2/t)}$$

$$= \frac{3at^2 + t^4}{2at}$$

$$= \frac{at^2(3+t^2)}{2at}$$

$$= \frac{a(3+t^2)}{2}$$

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9) $x = \frac{a(1-t)}{1+t^2}$ and $y = at\left(\frac{1-t^2}{1+t^2}\right)$

Differentiating 'x' and 'y' with respect to 't'

$$x = \frac{a(1-t)}{1+t^2}$$

$$= \frac{a-at}{1+t^2}$$

$$\frac{dx}{dt} = \frac{d}{dt}\left(\frac{a-at}{1+t^2}\right)$$

$$= \frac{(1+t^2)\frac{d}{dt}(a-at) - (a-at)\frac{d}{dt}(1+t^2)}{(1+t^2)^2}$$

$$= \frac{-a(1+t^2) - 2t(a-at)}{(1+t^2)^2}$$

$$y = at\left(\frac{1-t^2}{1+t^2}\right)$$

$$= \frac{at - at^3}{1+t^2}$$

$$\frac{dy}{dt} = \frac{(1+t^2)\frac{d}{dt}(at-at^3) - (at-at^3)\frac{d}{dt}(1+t^2)}{(1+t^2)^2}$$

$$= \frac{(1+t^2)(a-3at^2) - 2t(at-at^3)}{(1+t^2)^2}$$

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$$= \frac{(a - 3at^2)(1+t^2) - 2t(at - at^3)}{(1+t^2)^2}$$

$$\frac{dy}{dx} = \frac{(a - 3at^2)(1+t^2) - 2t(at - at^3)}{(1+t^2)^2}$$
$$\frac{}{-a(1+t^2) - 2t(a - at)}$$

$$= \frac{a + at^2 - 3at^2 - 3at^4 - 2t^2 + 2at^4}{-a - at^2 - 2at + 2at^2}$$

$$= \frac{a - at^2 - 2at^2 - at^4}{-(a + 2at + at^2)}$$

$$= \frac{a - 2at^2 - 2t - at^4}{-a(1 + 2t + t^2)}$$

$$= \frac{a(1 - 2t^2) - t(2 - at^3)}{-a(1 + 2t + t^2)}$$

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11. $ax^2 + by^2 = 25$

differentiating both the sides w.r.t 'x'

$\Rightarrow 2ax + 2b\frac{dy}{dx} = 0$

$\Rightarrow 2by\frac{dy}{dx} = -2ax$

$\Rightarrow \frac{dy}{dx} = -\frac{2ax}{2b}$

$= -\frac{ax}{by}$

12. $3x^2 + 3y^2 + 4x - 3y + 12 = 0$

differentiating both the sides w.r.t 'x'

$\Rightarrow 6x + 6y\frac{dy}{dx} + 4 - 3\frac{dy}{dx} = 0$

$\Rightarrow 6x + 4 + 6y\frac{dy}{dx} - 3\frac{dy}{dx} = 0$

$\Rightarrow \frac{dy}{dx}(6y - 3) = -(6x + 4)$

$\Rightarrow \frac{dy}{dx} = -\frac{(6x + 4)}{6y + 3}$

$= -\frac{2(3x + 2)}{3(2y + 1)}$

$=$

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13. $\frac{x^2}{9} + \frac{y^2}{16} = 1$

differentiating both the sides w.r.t 'x'

$\Rightarrow \frac{18x}{9} + \frac{32y}{16} = 0$

$\Rightarrow \frac{18x \times 6 + 32y \times 9}{144} = 0$

14. $x^2 + y^2 + 5xy = 0$

Differentiating b.t.s w.r.t 'x'

$\Rightarrow 2x + 2y\frac{dy}{dx} + 5\left(x\frac{dy}{dx} + y\right) = 0$

$\Rightarrow 2x + 2y\frac{dy}{dx} + 5\frac{dy}{dx} + 5y = 0$

$\Rightarrow \frac{dy}{dx}(2y + 5) = -(2x + 5y)$

$\Rightarrow \frac{dy}{dx} = -\frac{(2x + 5y)}{(2y + 5x)}$

15. $e^{xy} + y\sin x = 1$

Differentiating both the sides w.r.t 'x'

$\Rightarrow e^{xy}\left(x\frac{dy}{dx} + y\right) + y\cos x + \sin x\frac{dy}{dx} = 0$

$\Rightarrow xe^{xy}\frac{dy}{dx} + ye^{xy} + y\cos x + \sin x\frac{dy}{dx} = 0$

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$\Rightarrow (xe^x + \sin x)\frac{dy}{dx} + ye^{xy} + y\cos x = 0$

$\Rightarrow \frac{dy}{dx}(xe^x + \sin x) = -(ye^{xy} + y\cos x)$

$\Rightarrow \frac{dy}{dx} = -\frac{(ye^{xy} + y\cos x)}{xe^{xy} + \sin x}$

16. $\ln\sqrt{x^2+y^2} = \tan^{-1}\left(\frac{y}{x}\right)$

Differentiating both the sides with respect to 'x'

$\Rightarrow \frac{1}{\sqrt{x^2+y^2}} \frac{d}{dx}\sqrt{x^2+y^2} = \frac{x^2}{x^2+y^2} \frac{d}{dx}\left(\frac{y}{x}\right)$

$\Rightarrow \frac{1}{2(x^2+y^2)} \frac{d}{dx}(x^2+y^2) = \frac{x^2}{x^2+y^2}\left[\frac{x\frac{dy}{dx} - y}{x^2}\right]$

$\Rightarrow \frac{1}{2(x^2+y^2)} \times 2x + 2y\frac{dy}{dx} = \frac{x^2}{x^2+y^2} \times \frac{x\frac{dy}{dx} - y}{x^2}$

$\Rightarrow \frac{(x + y\frac{dy}{dx})}{(x^2+y^2)} = \frac{x\frac{dy}{dx} - y}{x^2+y^2}$

$\Rightarrow x + y\frac{dy}{dx} = x\frac{dy}{dx} - y$

$\Rightarrow (y - x)\frac{dy}{dx} = -(x+y)$

$\Rightarrow \frac{dy}{dx} = \frac{-(x+y)}{-(x-y)}$

$= \frac{x+y}{x-y}$

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Differentiation

standard formula

① $\frac{d}{dx}(x)^n = n \cdot x^{n-1}$

② $\frac{d}{dx} a^x = a^x \ln a$, $a > 0$, $a \neq 1$

③ $\frac{d}{dx} e^x = e^x$

④ $\frac{d}{dx} \log_a x = \frac{1}{x \ln a}$, $x > 0$, $a > 0$, $a \neq 1$

⑤ $\frac{d}{dx} \log x = \frac{1}{x}$

⑥ $\frac{d}{dx}(k) = 0$

⑦ $\frac{d}{dx} \sin x = \cos x$

⑧ $\frac{d}{dx} \cos x = -\sin x$

⑨ $\frac{d}{dx} \tan x = \sec^2 x$

⑩ $\frac{d}{dx} \cot x = -\operatorname{cosec}^2 x$

⑪ $\frac{d}{dx} \sec x = \sec x \cdot \tan x$

⑫ $\frac{d}{dx} \operatorname{cosec} x = -\operatorname{cosec} x \cdot \cot x$

① $\frac{d}{dx}\left(\frac{1}{x}\right) = \frac{-1}{x^2}$, $x \neq 0$

② $\frac{d}{dx}\sqrt{x} = \frac{1}{2\sqrt{x}}$, $x > 0$

③ $\frac{d}{dx}(ax+b)^n = n(ax+b)^{n-1} \times a$

④ $\frac{d}{dx} a^{mx} = a^{mx} (\ln a) m$

⑤ $\frac{d}{dx} e^{mx} = e^{mx} \times m$

⑥ $\frac{d}{dx} \sin$ $= (\cos Mx) \times m$

$\frac{d}{dx} e^{2\ln x} = \frac{d}{dx} x^2 = 2x$

$\frac{d}{dx} 3^{\log_3 x} = \frac{d}{dx} x = 1$

$\frac{d}{dx} a^{\log_3 x} = \frac{d}{dx}(3^2)^{\log_3 x}$

$= \frac{d}{dx} 3^{2\log_3 x} = \frac{d}{dx} x^2$

$= 2x$

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$\frac{d}{dx} 3^{\log_a x} = \frac{d}{dx} (a^{1/2})^{\log_a x}$

$= \frac{d}{dx} x^{1/2} = 1/2 x^{-1/2}$

$= \frac{1}{2\sqrt{x}}$

Find $\frac{d}{dx} e^{[x] \ln(1+x)}$ where $3 \le x < 4$

$\frac{d}{dx} e^{[x] \ln(1+x)}$

$= \frac{d}{dx} e^{3 \ln(1+x)}$

$= \frac{d}{dx} (1+x)^3$

$= 3 (1+x)^2$

Find $\frac{d}{dx} e^{\ln|x|}$, where $x < 0$

$\frac{d}{dx} e^{\ln|x|} = \frac{d}{dx}$

$= \frac{d}{dx} |x|$

$= \frac{d}{dx} (-x)$

$= -1$

Find $[x]$ at $x = 2$

Not differentiate

Algebra of derivatives:-

① $\frac{d}{dx} (u+v) = \frac{d}{dx} u \pm \frac{dv}{dx}$

② $\frac{d}{dx} Kf(x) = K \cdot \frac{d}{dx} f(x)$

③ $\frac{d}{dx} (uv) = u \frac{dv}{dx} + v \frac{du}{dx}$

④ $\frac{d}{dx} (uvw) = uv \frac{dw}{dx} + uw \cdot \frac{dv}{dx} + vw \frac{du}{dx}$

If $f(x) = (x-1)(x-2)(x-3) \ldots\ldots (x-107)$ then $f'(1) = ?$

$f'(x) = (x-1)(x-2) \ldots\ldots \frac{d}{dx}(x-107) + (x-1)(x-2) \ldots (x-103)$

$(x-107) \frac{d}{dx} (x-106) + \ldots\ldots + (x-2)(x-3) \ldots (x-107) \frac{d}{dx}(x-1)$

$f'(1) = (-1)(-2) \ldots\ldots (-106) \times 1$

$= 106!$

Q $y = {}^{15}C_0 + {}^{15}C_1 x + {}^{15}C_2 x^2 + \ldots\ldots + {}^{15}C_{15} x^{15}$

$y = {}^{15}C_0 + {}^{15}C_1 x + {}^{15}C_2 x^2 + \ldots\ldots + {}^{15}C_{15} x^{15}$

$= (1+x)^{15}$

$\frac{dy}{dx} = 15 (1+x)^{14}$

Derivative of composite functions

Chain rule

$y = (x+1)^2 \Rightarrow y = t^5 \Rightarrow \frac{d}{dt}(y)$

$\Rightarrow \frac{d}{dt}(t^5) \Rightarrow \frac{dy}{dt} = 5t^4$

$\Rightarrow \frac{dy}{dt} 5(x+1)^4$

Q. $\frac{d}{dx} (x^2+5)^8$

$\frac{d}{dx} (x^2+5)^8 = 8(x^2+5)^7 \cdot \frac{d}{dx}(x^2+5)$

$= 8(x^2+5)^7 \cdot 2x$

Q. $\frac{d}{dx} \frac{1}{(x^3+\sin x)^2}$

$\frac{d}{dx} (x^3+\sin x)^{-2} = -2 (x^3+\sin x)^{-3} \cdot (3x^2 + \cos x)$

Q. $\frac{d}{dx} \ln(\sqrt{x}+1)$

$\frac{1}{\sqrt{x}+1} \cdot \frac{1}{2\sqrt{x}}$

Q. $\frac{d}{dx} \sin 5x + \cos 7x$

$= 5\cos x \cdot 7 \sin 7x$

Q. $\frac{d}{dt} e^{\sin t}$

$e^{\sin t} \cdot \cos t$

Q. $\frac{d}{dx} \sqrt{ax^2+bx+c}$

$= \sqrt{ax^2+bx+c} \cdot \frac{d}{dx}(ax^2+bx+c)$

$= \frac{1}{2\sqrt{ax^2+bx+c}} [a \times 2x + b \times 1 + 0]$

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$= \frac{2ax+b}{2\sqrt{ax^2+bx+c}}$

Q. $\frac{d}{dx}\left(\frac{x+1}{x^2+3}\right)^{-3}$

$\left(\frac{x^2+3}{x+1}\right)^3 = 3\left(\frac{x^2+3}{x+1}\right)^2 \cdot \frac{d}{dx}\left(\frac{x^2+3}{x+1}\right)$

$= \frac{3(x^2+3)^2}{(x+1)^2}\left[\frac{(x+1)\frac{d}{dx}(x^2+3) + (x^2+3)\frac{d}{dx}(x+1)}{(x+1)^2}\right]$

$= \frac{3(x^2+3)^2}{(x+1)^4}\left[(x+1)2x - (x^2+3)\right]$

$= \frac{3(x^2+3)^2}{(x+1)^4}\left[2x^2+2x-x^2-3\right]$

Q. $\frac{d}{d\theta}\sec(\tan\theta)$

$\sec\cdot\tan(\tan\theta)\cdot\sec^2\theta$

Q. $\frac{d}{dx}\sin\left(\frac{1-x^2}{1+x^2}\right)$

$= \cos\left(\frac{1-x^2}{1+x^2}\right)\cdot\left[\frac{(1+x^2)\frac{d}{dx}(1-x^2) - (1-x^2)\frac{d}{dx}(1+x^2)}{(1+x^2)^2}\right]$

$= \cos\left(\frac{1-x^2}{1+x^2}\right)\cdot\left[\frac{(1+x^2)\cdot 2x - (1-x^2)\cdot 2x}{(1+x^2)^2}\right]$

$= \cos\left(\frac{1-x^2}{1+x^2}\right)\left[\frac{-2x(1+x^2+1-x^2)}{(1+x^2)^2}\right]$

$= \cos\left(\frac{1-x^2}{1+x^2}\right)\frac{(-4x)}{(1+x^2)^2}$

Q. $\frac{d}{dz}\sqrt{\tan 3z}$

$= \frac{1}{2\sqrt{\tan 3z}}\cdot\sec^2 3z\cdot 3$

$= 3\sec^2 3z / 2\sqrt{\tan 3z}$

$\frac{d}{dx}\tan^3 x$

Q.30 P.7 $\frac{d}{dx}\left[\frac{1-\tan x}{1+\tan x}\right]^{1/2} = \frac{-1}{\sqrt{\cos 2x}\,[\cos x+\sin x]}$

L.H.S $\frac{d}{dx}\left[\frac{1-\tan x}{1+\tan x}\right]^{1/2} = \frac{1}{2}\left[\frac{1-\tan x}{1+\tan x}\right]^{-1/2}\frac{d}{dx}\left[\frac{1-\tan x}{1+\tan x}\right]$

$= \frac{1}{2}\left[\frac{1+\tan x}{1-\tan x}\right]^{1/2}\left[\frac{(1+\tan x)\frac{d}{dx}(1-\tan x) - (1-\tan x)\frac{d}{dx}(1+\tan x)}{(1+\tan x)^2}\right]$

$= \frac{1}{2}\frac{\sqrt{1+\tan x}}{\sqrt{1-\tan x}}\left[\frac{(1+\tan x)(-\sec^2 x) - (1-\tan x)\sec^2 x}{\sqrt{1+\tan x}\,(1+\tan x)}\right]$

$= \frac{-\sec^2 x\,[1+\tan x+1-\tan x]}{2\sqrt{1-\tan^2 x}\,(1+\tan x)}$

$= \frac{-2\,/\cos^2 x}{2\sqrt{1-\frac{\sin^2 x}{\cos^2 x}}\left(1+\frac{\sin x}{\cos x}\right)} = \frac{-1/\cos x}{\sqrt{\frac{\cos^2 x-\sin^2 x}{\cos x}}\left(\frac{\cos x+\sin x}{\cos x}\right)}$

$= \frac{-1}{\sqrt{\cos 2x}\,(\cos x+\sin x)}$

Derivative of Inverse trigonometric functions:-

① $\frac{d}{dx}\sin^{-1}x = \frac{1}{\sqrt{1-x^2}}$, $-1 < x < 1$

Proof Let $y = \sin^{-1}x \Rightarrow \sin y = x$

$\Rightarrow \frac{d}{dx}(\sin y) = \frac{d}{dx}x \Rightarrow \cos y\frac{dy}{dx} = 1$

$\Rightarrow \frac{dy}{dx} = \frac{1}{\cos y}$

$= \frac{1}{\sqrt{1-\sin^2 y}} = \frac{1}{\sqrt{1-x^2}}$

② $\frac{d}{dx}\cos^{-1}x = \frac{-1}{\sqrt{1-x^2}}$, $-1 < x < 1$

Proof Let $y = \cos^{-1}x \Rightarrow \cos y = x$

$\Rightarrow \frac{d}{dx}\cos y = \frac{d}{dx}x \Rightarrow -\sin y\frac{dy}{dx} = 1$

$\Rightarrow \frac{dy}{dx} = \frac{-1}{\sin y} \Rightarrow \frac{dy}{dx} = \frac{-1}{\sqrt{1-\cos^2 y}} = \frac{-1}{\sqrt{1-x^2}}$

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(3) $\frac{d}{dx}\tan^{-1}x$

proof: let $y = \tan^{-1}x$, $x \in R$

$\tan y = x \Rightarrow \frac{d}{dx}\tan y = \frac{d}{dx}x$

$\Rightarrow \sec^2 y \frac{dy}{dx} = 1 \Rightarrow \frac{dy}{dx} = \frac{1}{\sec^2 y} \Rightarrow \frac{dy}{dx} = \frac{1}{1+\tan^2 y}$

$= \frac{1}{1+x^2}$

(4) $\frac{d}{dx}\cot^{-1}x = \frac{-1}{1+x^2}$, $x \in R$

proof let $y = \cot^{-1}x \Rightarrow x \in R$

$\Rightarrow \cot y = x \Rightarrow \frac{d}{dx}\cot y = \frac{d}{dx}x$

$\Rightarrow -\operatorname{cosec}^2 y \frac{dy}{dx} = 1 \Rightarrow \frac{dy}{dx} = \frac{-1}{\operatorname{cosec}^2 y}$

$\Rightarrow \frac{dy}{dx} = \frac{-1}{1+\cot^2 y} = \frac{-1}{1+x^2}$, $x \in R$

(5) $\frac{d}{dx}\sec^{-1}x = \frac{1}{|x|\sqrt{x^2-1}}$, $x \in R - [-1, 1]$

proof let $y = \sec^{-1}x$, $x \in R$

$\Rightarrow \sec y = x \Rightarrow \frac{d}{dx}\sec y = \frac{d}{dx}x$

$\Rightarrow \tan y \sec y \frac{dy}{dx} = 1 \Rightarrow \frac{dy}{dx} = \frac{1}{\sec y \tan y}$

$= \frac{1}{\sec y \sqrt{\sec^2 y - 1}}$

$= \frac{1}{|x|\sqrt{x^2-1}}$

a $\frac{d}{dx}\sin^{-1}2x = \frac{1}{\sqrt{1-(2x)^2}} \frac{d}{dx}2x$

$= \frac{2}{\sqrt{1-4x^2}}$

a $\frac{d}{dx}\cot^{-1}\sqrt{x} = \frac{-1}{1+(\sqrt{x})^2} \frac{d}{dx}\sqrt{x}$

$= \frac{-1}{1+x} \times \frac{1}{2\sqrt{x}} = \frac{-1}{2x(2\sqrt{x})}$

a $\frac{d}{dx}\sec^{-1}(2x+1) = \frac{1}{|2x+1|\sqrt{(2x+1)^2-1}} \frac{d}{dx}2x+1$

$= \frac{2}{|2x+1|\sqrt{(2x+1)^2-1}} = \frac{2}{|2x+1|\sqrt{4x^2+4x+1-1}}$

$= \frac{2}{|2x+1|\sqrt{4(x^2+x)}} = \frac{2}{2|2x+1|\sqrt{x^2+x}}$

a $\frac{d}{dx}\sec^{-1}x = \frac{1}{|x|\sqrt{x^2-1}}$

$= \begin{cases} \frac{1}{x\sqrt{x^2-1}}, & x > 1 \\ \frac{1}{-x\sqrt{x^2-1}}, & x < -1 \end{cases}$

a $\frac{d}{dx}\operatorname{cosec}^{-1}x = \frac{-1}{|x|\sqrt{x^2-1}}$

$= \begin{cases} \frac{-1}{x\sqrt{x^2-1}}, & x > 1 \\ \frac{1}{x\sqrt{x^2-1}}, & x < -1 \end{cases}$

Derivative of Inverse trignometry functions by proper substitution

General substitution form :-

$\sqrt{1-x^2}$,	$x = \sin\theta$ or $\cos\theta$
$\sqrt{1+x^2}$,	$x = \tan\theta$ or $\cot\theta$
$\sqrt{x^2-1}$,	$x = \sec\theta$ or $\operatorname{cosec}\theta$
$\frac{2x}{1+x^2}$,	$x = \tan\theta$
$\frac{1-x^2}{1+x^2}$,	$x = \tan\theta$
$1-2x^2$,	$x = \sin\theta$
$2x^2-1$,	$x = \cos\theta$
$\sqrt{\frac{1+x}{1-x}}$	$x = \cos 2\theta$
$\sqrt{\frac{1+\cos 2\theta}{1-\cos 2\theta}} = \sqrt{\frac{2\cos\theta}{2}}$	
$3x-4x^3$,	$x = \sin\theta$
$4x^3-3x$,	$x = \cos\theta$

$\sqrt{1-\sin^2\theta} = \cos\theta$

$\sqrt{1+\tan^2\theta} = \sec\theta$

$\sqrt{\sec^2\theta - 1} = \tan\theta$

$\frac{2\tan\theta}{1+\tan^2\theta} = \sin 2\theta$

$\frac{2\tan\theta}{1-\tan^2\theta} = \tan 2\theta$

$\frac{1-\tan^2\theta}{1+\tan^2\theta} = \cos 2\theta$

$1 - 2\sin^2\theta = \cos 2\theta$

$2\cos^2\theta - 1 = \cos 2\theta$

$\sqrt{1+\cos 2\theta} = \sqrt{2}\cos\theta$

$\sqrt{1-\cos 2\theta} = \sqrt{2}\sin\theta$

$3\sin\theta - 4\sin^3\theta = \sin 3\theta$

$4\cos^3\theta - 3\cos\theta = \cos 3\theta$

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Q $\frac{d}{dx} \sin^{-1} 2x\sqrt{1-x^2}$, let $x = \sin\theta$

$\Rightarrow \frac{d}{dx} \sin^{-1} 2\sin\theta\sqrt{1-\sin^2\theta}$

$\Rightarrow \frac{d}{dx} \sin^{-1} 2\sin\theta\cos\theta$

$= \frac{d}{dx} \sin^{-1} \sin 2\theta = \frac{d}{dx} 2\theta = 2\frac{d}{dx}\theta$

$= 2 \times \frac{d}{dx} \sin^{-1} x$

$= 2 \times \frac{1}{\sqrt{1-x^2}}$

Q $\frac{d}{dx} \tan^{-1} \frac{2x}{1-x^2}$ $x = \tan\theta$

$= \frac{d}{dx} \tan^{-1} \frac{\tan 2\theta}{1-(\tan 2\theta)^2}$

$= \frac{d}{dx} \tan^{-1} \tan 2\theta$

$= \frac{d}{dx} 2\theta = 2\frac{d}{dx}\theta \Rightarrow 2\frac{d}{dx}\tan^{-1} x$

$\Rightarrow 2 \times \frac{1}{1+x^2}$

Q $\frac{d}{dx} \sin^{-1} \frac{2x}{1+x^2}$ Let $x = \tan\theta$

$= \frac{d}{dx} \sin^{-1} \frac{\sin 2\theta}{1+(\sin 2\theta)^2}$ $\frac{\tan 2\theta}{1+(\tan 2\theta)^2}$

$= \frac{d}{dx} \sin^{-1} \sin 2\theta$

$= \frac{d}{dx} 2\theta = 2\frac{d}{dx}\theta = 2\frac{d}{dx}\tan^{-1} x$

$= 2 \times \frac{1}{1+x^2}$

Q $\frac{d}{dx} \cos^{-1} \sqrt{\frac{1+x}{2}}$ $x = \cos 2\theta$

$= \frac{d}{dx} \cos^{-1} \sqrt{\frac{1+\cos 2\theta}{2}}$ $\Rightarrow \cos^{-1} x = 2\theta$

$= \frac{d}{dx} \cos^{-1} \sqrt{\frac{2\cos^2\theta}{2}}$ $\Rightarrow \frac{1}{2}\cos^{-1} x = \theta$

$\frac{d}{dx} \sin^{-1} 2x\sqrt{1-x^2}$

Let $x = \cos\theta$

$\frac{d}{dx} \sin^{-1} 2\cos\theta\sqrt{1-\cos^2\theta}$

$= \frac{d}{dx} \sin^{-1} 2\cos\theta.\sin\theta$

$= \frac{d}{dx} \sin^{-1} \sin 2\theta$

$= \frac{d}{dx} 2\theta$

$= 2\frac{d}{dx}\theta$

$= 2\frac{d}{dx}\cos^{-1} x$

$= 2 \times \frac{-1}{\sqrt{1-x^2}}$

$= \frac{d}{dx} \cos^{-1} \cos\theta$

$= \frac{d}{dx}\theta = \frac{d}{dx}\frac{1}{2}\cos^{-1} x = \frac{1}{2}\frac{(-1)}{\sqrt{1-x^2}}$

(9) $\frac{d}{dx} \cot^{-1} \frac{\sqrt{1-x^2}}{x}$

Let $x = \sin 2\theta$

$\Rightarrow \frac{d}{dx} \cot^{-1} \frac{\sqrt{1-(\sin\theta)^2}}{\sin\theta} = \frac{d}{dx} \cot^{-1} \frac{\cos\theta}{\sin\theta}$

$= \frac{d}{dx} \cot^{-1} \cot\theta$

$= \frac{d}{dx}\theta = \frac{1}{\sqrt{1+x^2}} = \frac{d}{dx} \sin^{-1} x$

$= \frac{1}{\sqrt{1-x^2}}$

Q $\frac{d}{dx} \cos^{-1}(2t^2-1)$ Let $t = \cos\theta$

$\frac{d}{dt} \cos^{-1}(2\cos^2\theta - 1)$

$= \frac{d}{dt} \cos 2\theta \cos^{-1} x$

$= \frac{d}{dt} 2\theta = 2\frac{d}{dt}\theta$

$= 2\frac{d}{dx} \cos^{-1} t$

$= 2 \times \frac{(-1)}{\sqrt{1-t^2}}$

Q $\frac{d}{dt} \cos^{-1}\left(\frac{1-t^2}{1+t^2}\right)$

Let $t = \tan\theta$

$\frac{d}{dt} \cos^{-1}\left(\frac{1-\cos^2\theta}{1+\cos^2\theta}\right)$

$= \frac{d}{dt} \cos^{-1}\left(\frac{1-\tan^2\theta}{1+\tan^2\theta}\right)$

$= \frac{d}{dt} \cos^{-1} \cos 2\theta = \frac{d}{dt} 2\theta$

$= 2\frac{d}{dt}\theta = 2\frac{d}{dt}\tan^{-1} t$

$= 2 \times \frac{1}{1+t^2}$

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Q $\frac{d}{dx} \tan^{-1}\left(\frac{1}{1-x+x^2}\right)$

$= \frac{d}{dx} \tan^{-1}\left(\frac{1}{1\cdot x(1-x)}\right) = \frac{d}{dx} \tan^{-1}\left[\frac{x+(1-x)}{1-x(1-x)}\right]$

Let $x = \tan\alpha$

$1-x = \tan\beta$

$= \frac{d}{dx} \tan^{-1}\left[\frac{\tan\alpha + \tan\beta}{1-\tan\alpha\cdot\tan\beta}\right] = \frac{d}{dx} \tan^{-1} \tan(\alpha+\beta)$

$= \frac{d}{dx}(\alpha+\beta)$

$= \frac{d}{dx} \tan^{-1}x + \tan^{-1}(1-x)$

$= \frac{1}{1+x^2} + \frac{1}{1+(1-x)^2}(-1)$

Q $\tan\theta = \left(\frac{1-t}{1+t}\right)$ find $\frac{d\theta}{dt} = ?$

$= \frac{d\theta}{dt} \Rightarrow \theta = \tan^{-1}\frac{1-t}{1+t}$ let $t = \tan z$

$\Rightarrow \theta = \tan^{-1}\frac{\tan\frac{\pi}{4} - \tan z}{1+\tan\frac{\pi}{4}\tan z}$

$\Rightarrow \theta = \tan^{-1}\cdot\tan\left(\frac{\pi}{4} - z\right)$

$\Rightarrow \theta = \frac{\pi}{4} - z$

Q $\frac{d}{dx} \sec^{-1}\left(\frac{x^2+1}{x^2-1}\right)$

$= \frac{d}{dx} \cos^{-1}\left(\frac{x^2-1}{x^2+1}\right)$

$= \frac{d}{dx} \cos^{-1}\left[-\left(\frac{1-x^2}{1+x^2}\right)\right]$

$= \frac{d}{dx} \pi - \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

$= \frac{d}{dx} \pi - \cos^{-1}\left(\frac{1-\tan^2\theta}{1+\tan^2\theta}\right)$

$= \frac{d}{dx} \pi - \cos^{-1}\cos 2\theta$

$= \frac{d}{dx} \pi - 2\tan^{-1}x$

$= 0 - 2\times\frac{1}{1+x^2}$

Q $\tan^{-1}\frac{\sqrt{1+x^2}+\sqrt{1-x^2}}{\sqrt{1+x^2}-\sqrt{1-x^2}}$

$= \frac{d}{dx}\tan^{-1}\frac{\sqrt{1+\cos 2\theta}+\sqrt{1-\cos 2\theta}}{\sqrt{1+\cos 2\theta}-\sqrt{1-\cos 2\theta}}$

$= \frac{d}{dx}\tan^{-1}\frac{\sqrt{2\cos^2\theta}+\sqrt{2\sin^2\theta}}{\sqrt{2\cos^2\theta}-\sqrt{2\sin^2\theta}}$

$= \frac{d}{dx}\tan^{-1}\frac{\sqrt{2}\cos\theta+\sqrt{2}\sin\theta}{\sqrt{2}\cos\theta-\sqrt{2}\sin\theta}$

$= \frac{d}{dx}\tan^{-1}\left(\frac{\cos\theta+\sin\theta}{\cos\theta-\sin\theta}\right) = \frac{d}{dx}\tan^{-1}\left[\frac{1+\tan\theta}{1-\tan\theta}\right]$

$= \frac{d}{dx}\tan^{-1}\left(\tan\left(\frac{\pi}{4}+\theta\right)\right)$

$= \frac{d}{dx}\frac{\pi}{4} + \theta = \frac{d}{dx}\frac{\pi}{4} + \frac{1}{2}\cos^{-1}x^2$

$\vec{OG} = a\hat{i} + a\hat{j} + a\hat{k}$

$\vec{AD} = -a\hat{i} + a\hat{j} + a\hat{k}$

$\cos\theta = \frac{\vec{OG}\cdot\vec{AD}}{|\vec{OG}||\vec{AD}|}$

$\Rightarrow$ co

$\sin^{-1}(-x) = -\sin^{-1}x$

$\cos^{-1}(-x) = \pi - \cos^{-1}x$

$\tan^{-1}(-x) = -\tan^{-1}(x)$

$\cot^{-1}(-x) = \pi - \cot^{-1}(x)$

$\sec^{-1}(-x) = \pi - \sec^{-1}x$

$\operatorname{cosec}^{-1}(-x) = -\operatorname{cosec}^{-1}x$

$\operatorname{cosec}^{-1}(x) = \sin^{-1}\frac{1}{x}$

$\sec^{-1}x = \cos^{-1}\frac{1}{x}$

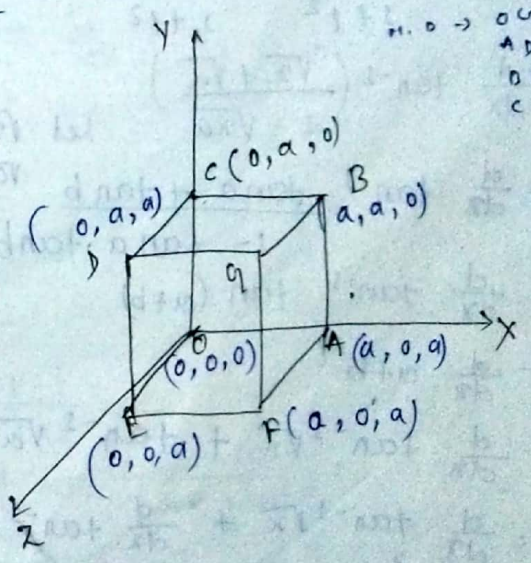
$\cot^{-1}x = \tan^{-1}\frac{1}{x}$

$\sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}$

$\tan^{-1}x + \cot^{-1}x = \frac{\pi}{2}$

$\sec^{-1}x + \operatorname{cosec}^{-1}x = \frac{\pi}{2}$

Ex. 5, 6 7 (d)



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Differentiation by using Logarithm:

Let $y = x^x$

By applying 'ln' in both sides, we have

$\Rightarrow \ln y = \ln x^x$

$\Rightarrow \ln y = x \ln x$

$\Rightarrow \frac{d}{dx} \ln y = \frac{d}{dx} x \ln x \Rightarrow \frac{1}{y}\frac{dy}{dx} = x\frac{d}{dx}\ln x + \ln x \frac{d}{dx} x$

$\Rightarrow \frac{dy}{dx} = y\left[x \times \frac{1}{x} + \ln x\right]$

$\Rightarrow \frac{dy}{dx} = y\, x^x [1 + \ln x)$

2. $\frac{d}{dx} x^{\sin x}$

Let $y = x^{\sin x}$

By applying

$\Rightarrow \ln y = \ln x^{\sin x}$

$\Rightarrow \ln y = \sin x \cdot \ln x$

$\Rightarrow \frac{d}{dx} \ln y = \frac{d}{dx} \sin x \cdot \ln x$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = \cos x \cdot \frac{d}{dx}\ln x + \ln x \frac{d}{dx}\sin x$

$\Rightarrow \frac{dy}{dx} = y\left[\sin x \cdot \frac{1}{x} + \ln x \times \cos x\right]$

$\Rightarrow \frac{dy}{dx} = x^{\sin x}\left[\frac{\sin x + \ln x \cdot \cos x}{x}\right]$

3. $\frac{d}{dx} (\log x)^{\tan x}$

Let $y = (\log x)^{\tan x}$

By applying

$\Rightarrow \frac{d}{dx} \ln y = \ln (\log x)^{\tan x}$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = \frac{d}{dx} \tan x \ln (\log x)$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = \tan x \frac{d}{dx} \ln (\log x) + \ln (\log x) \frac{d}{dx} \tan x$

$\Rightarrow \frac{dy}{dx} = y\left[\tan x \cdot \frac{1}{\log x} \cdot \frac{1}{x} + \ln (\log x) \cdot \sec^2 x\right]$

$\Rightarrow \frac{dy}{dx} = (\log x)^{\tan x}\left[\frac{\tan x}{\log x} + \ln (\log x) \sec^2 x\right]$

4. $\frac{d}{dx} x^{x^x + 5}$

Let $y = x^{x^x + 5}$

By applying 'ln' in both sides, we have

$\Rightarrow \ln y = \ln (x^{x^x + 5})$

$\Rightarrow \ln y = x^x \ln x + \ln 5$

$\Rightarrow \frac{d}{dx} \ln y = \frac{d}{dx} x^x \ln x + \frac{d}{dx} \ln 5$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = x^x \frac{d}{dx} \ln x + \ln x \frac{d}{dx} x^x + \textcircled{2}$

$\Rightarrow \frac{dy}{dx} = y\left[x^x \times \frac{1}{x} + \ln x \cdot\right]$

$\Rightarrow \frac{dy}{dx} = y[1 + \ln x] \Rightarrow \frac{dy}{dx} = (x^x + 5)[1 + \ln x]$

$y = x^x + 5$

$\Rightarrow y = u + v$, $\Rightarrow u = x^x$

$\Rightarrow \ln x = \ln x^x \Rightarrow \ln u = x \ln x$

$\Rightarrow \frac{1}{u}\frac{du}{dx} = x \times \frac{1}{x} + \ln x$

$\Rightarrow \frac{du}{dx} = u[1 + \ln x] = x^x[1 + \log x]$

$\Rightarrow \frac{dy}{dx} = \frac{du}{dx} + \frac{dv}{dx}$

$= x^x (1 + \ln x]$

5. $y = x^{1/x} + (\sin x)^x$

$\Rightarrow y = u + v \Rightarrow u = x^{1/x}$

$\Rightarrow \ln u = \ln x^{1/x}$

$\Rightarrow \frac{1}{u}\frac{du}{dx} = \frac{1}{x} \times \frac{1}{x} + \ln x \frac{(-1)}{x^2}$

$\Rightarrow \frac{du}{dx} = x^{1/x}\left[\frac{1 - \ln x}{x^2}\right]$ ——— ①

$v = (\sin x)^x$

$\Rightarrow \ln v = \ln (\sin x)^x$

$\Rightarrow \ln v = x \ln \sin x$

$\Rightarrow \frac{1}{v}\frac{dv}{dx} = x \frac{1}{\sin x} \cdot \cos x + \ln \sin x$

$\Rightarrow \frac{dv}{dx} = v\left[x \cot x + \ln \sin x\right]$

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$\frac{dy}{dx} = \frac{du}{dx} + \frac{dv}{dx}$

$= x^{1/x}\left[\frac{1-\ln x}{x^2}\right] + \left[x\cot x + \ln\sin x\right]$

Q $(\cos x)^x + x^{\cos x}$

$\frac{d}{dx}(\cos x)^x + x^{\cos x}$

Let $u = (\cos x)^x$

$\ln u = \ln(\cos x)^x$

$\Rightarrow \frac{d}{dx}\ln u = x\ln(\cos x) \Rightarrow \frac{1}{u}\frac{du}{dx} = x\frac{d}{dx}\ln\cos x + \ln\cos x \frac{d}{dx}x$

$\Rightarrow \frac{du}{dx} = u\left[x\cdot\frac{1}{\cos x}\cdot -\sin x + \ln\cos x\cdot 1\right]$

$\Rightarrow \frac{du}{dx} = u\left[\frac{x}{\cos x} - x\tan x + \ln\cos x\right]$

Let $v = x^{\cos x}$

Let $v = \ln(x)^{\cos x}$

$\Rightarrow \frac{d}{dx}\ln v = \cos x\cdot\ln x$

$\Rightarrow \frac{1}{v}\frac{dv}{dx} = \cos x\frac{d}{dx}\ln x + \ln x\frac{d}{dx}\cos x$

$\Rightarrow \frac{dv}{dx} = v\left[\cos x\cdot\frac{1}{x} + \ln x\cdot -\sin x\right]$

$\Rightarrow \frac{dv}{dx} = v\left[\frac{\cos x}{x} + \ln x\cdot -\sin x\right]$

$\frac{dy}{dx} = \frac{du}{dx} + \frac{dv}{dx} = (\cos x)^x\left[-x\cdot\tan x + \ln\cos x\right] + x^{\cos x}\left[\frac{\cos x}{x} + \ln x\cdot -\sin x\right]$

Q $y = x^{x^x}$

$\Rightarrow \ln y = \ln x^{x^x}$

$\Rightarrow \ln y = x^x \ln x$

$\Rightarrow \log(\ln y) = \log(x^x \ln x)$

$\Rightarrow \log(\ln y) = \log x^x + \log(\ln x)$

$\Rightarrow \log(\ln y) = x\ln x + \log(\ln x)$

$\Rightarrow \frac{1}{\ln y}\frac{d}{dx}\ln y = x\frac{d}{dx}\ln x + \ln x\frac{dx}{dx} + \frac{1}{\ln x}\cdot\frac{d}{dx}\ln x$

$\Rightarrow \frac{1}{\ln y}\times\frac{1}{y}\frac{dy}{dx} = x\times\frac{1}{x} + \ln x + \frac{1}{\ln x}\times\frac{1}{x}$

$\Rightarrow \frac{dy}{dx} = y\ln y\left[1 + \ln x + \frac{1}{x\ln x}\right]$

$\Rightarrow \frac{dy}{dx} = x^{x^x}\ln y\left[1 + \ln x + \frac{1}{x\ln x}\right]$

or $\frac{d}{dx}x^x$

$= \frac{d}{dx}e^{\ln x^x} = \frac{d}{dx}e^{x\ln x}$

$= e^{x\ln x}\frac{d}{dx}x\ln x$

$= x^x\left[x\times\frac{1}{x} + \ln x\right]$

$= x^x[1 + \ln x]$

or $\frac{d}{dx}x^{x^x}$

$= \frac{d}{dx}e^{\ln x^{x^x}} = \frac{d}{dx}e^{x^x\ln x}$

$= e^{x^x\ln x}\frac{d}{dx}x^x\ln x = x^{x^x}\left[x^x\frac{d}{dx}\ln x + \ln x\frac{d}{dx}x^x\right]$

$= x^{x^x}\left[x^x\frac{1}{x} + \ln x\cdot\frac{d}{dx}e^{\ln x^x}\right]$

H.W (f) . 7(e) last to first

Derivative of Implicit Functions :-

Q $x^2 + y^3 = 5$

$\Rightarrow \frac{d}{dx}(x^2+y^3) - \frac{d}{dx}(5)$

$\Rightarrow 2x + 3y^2\frac{dy}{dx} = 0$

$\Rightarrow 3y^2\frac{dy}{dx} = -2x$

$\Rightarrow \frac{dy}{dx} = \frac{-2x}{3y^2}$

Q $xy^2 + x^2y + 1 = 0$

$\Rightarrow \frac{d}{dx}xy^2 + x^2y + 1 = \frac{d}{dx}0$

$\Rightarrow \frac{d}{dx}xy^2 + \frac{d}{dx}x^2y + \frac{d}{dx}1 = 0$

$\Rightarrow x\cdot 2y\frac{dy}{dx} + 2x\frac{dy}{dx} = 0$

$\Rightarrow x\cdot 2y\frac{dy}{dx} = -2x$

$\Rightarrow \frac{dy}{dx} = \frac{-2x}{x\cdot 2y}$

$\Rightarrow x\cdot 2y\frac{dy}{dx} + y^2 + x^2\frac{dy}{dx} + y\cdot 2x = 0$

$\Rightarrow x\cdot 2y\frac{dy}{dx} + x^2\frac{dy}{dx} = -y^2 - 2xy$

$\Rightarrow \frac{dy}{dx}(2xy + x^2) = -y^2 - 2xy$

$\Rightarrow \frac{dy}{dx} = \frac{-y^2-2xy}{2xy+x^2}$

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Q. $x^2 + 3y^2 = 5$

$\frac{d}{dx} x^2 + 3y^2 = \frac{d}{dx} 5$

$\Rightarrow 2x + 3 \cdot 2y \frac{dy}{dx} = 0$

$\Rightarrow 3 \cdot 2y \frac{dy}{dx} = -2x$

$\Rightarrow \frac{dy}{dx} = \frac{-2x}{6y} = \frac{-x}{3y}$

Q $y^x = x^{\sin y}$

$\ln y^x = \ln x^{\sin y}$

$\Rightarrow x \ln y = \sin y \ln x$

$\Rightarrow x \cdot \frac{d}{dx} \ln y + \ln y \frac{d}{dx} x = \frac{dy}{dx} \sin y + \sin y \frac{d}{dx} \ln x +$

$\ln x \frac{d}{dx} \sin y$

$\Rightarrow x \cdot \frac{1}{y} \frac{dy}{dx} + \ln y = \sin y \times \frac{1}{x} \frac{dy}{dx} + \ln x \cdot \cos y \frac{dy}{dx}$

$\Rightarrow \frac{x}{y} \frac{dy}{dx} + \ln y = \frac{\sin y}{x} \frac{dy}{dx} + \ln x \cdot \cos y$

$\Rightarrow \frac{dy}{dx} \left(\frac{x}{y} - \ln x \cdot \cos y \right] = \frac{\sin y - x \ln y}{x}$

$\Rightarrow \frac{dy}{dx} \left[\frac{x}{y} - \ln x \cdot \cos y \right] = \frac{\sin y - x \ln y}{x}$

$\Rightarrow \frac{dy}{dx} = y \frac{[\sin y - x \ln y]}{x \cdot y \ln x \cos y}$

IMP.

Q-10 $\sin(x+y) = y \cos(x+y)$

$\Rightarrow y = \tan(x+y) \Rightarrow x+y = \tan^{-1} y$

$\Rightarrow \frac{d}{dx}(x+y) = \frac{d}{dx} \tan^{-1} y \Rightarrow 1 + \frac{dy}{dx} = \frac{1}{1+y^2} \frac{dy}{dx}$

$\Rightarrow \frac{dy}{dx} - \frac{1}{1+y^2} \frac{dy}{dx} = -1$

$\Rightarrow \frac{dy}{dx} \left[1 - \frac{1}{1+y^2} \right] = -1 \Rightarrow \frac{dy}{dx} \left[\frac{1+y^2-1}{1+y^2} \right] = -1$

$\Rightarrow \frac{dy}{dx} = \frac{-(1+y^2)}{y^2}$

Qn $\frac{dy}{dx} x^2 + 3y^2 - 5 = 0$

$\Rightarrow \frac{dy}{dx} = \left[\frac{-2x}{3 \cdot 2y} \right]$

$\Rightarrow \frac{dy}{dx} \left[\frac{-2x}{6y} \right]$

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Differentiation of parametric functions :-

$\frac{dx}{dt} = 2a$ ——— (i) $\Rightarrow \frac{dy}{dt} = \frac{1}{2} a \times 2t = at$ ——— (ii)

$\frac{dy/dt}{dx/dt} = \frac{\frac{1}{2} a 2t}{2a} = \frac{at}{2a} = \frac{t}{2}$

Q $x = a\cos\theta$, $y = a\sin\theta$

$\frac{dx}{d\theta} = a(-\sin\theta)$, $\frac{dy}{d\theta} = a\cos\theta$

$\Rightarrow \frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}} = \frac{a\cos\theta}{-a\sin\theta} \Rightarrow \frac{dy}{dx} = -\cot\theta$

Q $x = a\cos^3 t$; $y = a\sin^3 t$, at $= \frac{\pi}{4}$

$\frac{dx}{dt} = -a\,3\cos^2 t \cdot \sin t$ ——— (i)

$\frac{dy}{dt} = a\,3\sin^2 t \cdot \cos t$ ——— (ii)

$\frac{dy}{dt} / \frac{dx}{dt} = \frac{a\,3\sin^2 t \cdot \cos t}{-a\,3\cos^2 t \cdot \sin t} \Rightarrow \frac{dy}{dx} = -\tan t$

$\Rightarrow \frac{dy}{dx} = -\tan\frac{\pi}{4} \Rightarrow \frac{dy}{dx} = -1$

Derivative of a function w.r.t another function :-

$y = \sin x$ $z = \log x$

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Q $y = (\sqrt{x})^{x^{x^{\cdots}}}$ to ∞ $\Rightarrow y = (\sqrt{x})^{y}$

$\Rightarrow \ln y = y \ln \sqrt{x}$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = y \cdot \frac{d}{dx}\ln\sqrt{x} + \ln\sqrt{x}\frac{dy}{dx}$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = y \cdot \frac{1}{x} + \ln\sqrt{x}\frac{dy}{dx}$

$\Rightarrow \frac{1}{y}\frac{dy}{dx} = \frac{y}{x} + \ln\sqrt{x}\frac{dy}{dx}$

$y = (x^{1/2})^{x^{x^{\cdots}}}$ to ∞

$y = (x^{1/2})^{y}$

$y = \left(x^{x^{x^{\cdots}}}\right)^{1/2}$ to ∞

$y = (x^{y})^{1/2}$

$y^2 = x^{y}$

$\Rightarrow y^2 = x^{y^2} \Rightarrow 2\ln y = y^2 \ln x$

$\Rightarrow 2\frac{d}{dx}\ln y = x\frac{d}{dx}\ln y + \ln y \frac{d}{dx}x$

$\Rightarrow 2\frac{1}{y}\frac{dy}{dx} = \frac{x}{y}\frac{dy}{dx} + \ln y$

$\Rightarrow \frac{2}{y}\frac{dy}{dx} - \frac{x}{y}\frac{dy}{dx} = \ln y$

$\Rightarrow \frac{dy}{dx}\left[\frac{2}{y} - \frac{x}{y}\right] = \ln y \Rightarrow \frac{dy}{dx}\left[\frac{2-x}{y}\right] = \ln y$

$\Rightarrow \frac{dy}{dx} \Rightarrow 2\ln y = y^2 \ln x \Rightarrow 2x\frac{1}{y}\frac{dy}{dx} = y^2\frac{1}{x} + (\ln x)2y\frac{dy}{dx}$

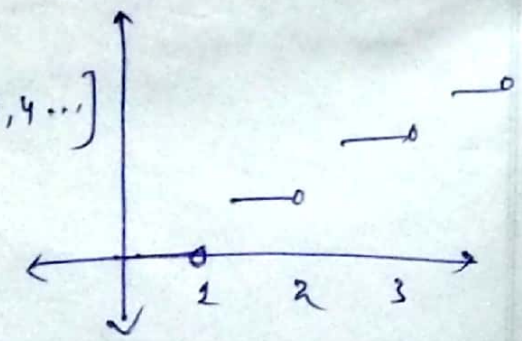
$\Rightarrow \frac{2}{y}\frac{dy}{dx} = \frac{y^2}{x} + (\ln x)2y\frac{dy}{dx}$

$\Rightarrow \frac{dy}{dx}\left(\frac{2}{y} - (\ln x)2y\right) = \frac{y^2}{x} \Rightarrow \frac{dy}{dx}\cdot\left[\frac{2 - \ln x\, 2y^3}{y}\right] = \frac{y^3}{x}$

$\Rightarrow \frac{dy}{dx} = \frac{\frac{y^2}{x}}{\frac{2-\ln x 2y^2}{y}} \Rightarrow \frac{dy}{dx} = \frac{y^2}{x}\times\frac{y}{2-\ln x\, 2y^2} = \frac{y^3}{x[2-\ln x 2y^2]}$

Q Given an example of a function which is not continuous as well as not differentiable at a point.

• $\frac{d}{dx}[x]$ at $(1,2,3,4\cdots)$



$(x+1)^{[x]}$

$x(x+1)$

$x\cdot\frac{d}{dx}x + 1 + x + 1\frac{d}{dx}1$

$x + x + 1 = 2x + 1$

$\frac{d}{dx} e^{[x]\ln(x+1)}$

$\Rightarrow \frac{d}{dx} e^{3\ln(x+1)}$ when $3 \le x < 4$

$\Rightarrow \frac{d}{dx}(x+1)^3 \Rightarrow 3(x+1)^2$

Q Prove that the derivative of a non constant even function is a odd function, IMP.

even

$f(-x) = f(x)$

$\Rightarrow f'(-x)\frac{d}{dx}(-x) = f'(x)$

$\Rightarrow f'(-x)(-1) = f'(x)$

$\Rightarrow f'(-x) = -f'(x)$

Prove that the derivative of a non constant odd function is a even function

$f(-x) = -f(x)$

$\Rightarrow f'(-x)\frac{d}{dx}(-x) = -f'(+x)$

$\Rightarrow f'(-x)(-1) = -f'(x)$

$\Rightarrow f'(-x) = f'(x)$ (proved)

Second derivative :-

$y = x^2 \Rightarrow \frac{d}{dx}(y) = \frac{d}{dx}x^2$

$\Rightarrow \frac{dy}{dx} = 2x$ (first derivative) $y_1 = Dy = f'x$

$\Rightarrow \frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d}{dx}2x$

$\Rightarrow \frac{d^2y}{dx^2} = 2$ (second derivative)

$y_2 = D^2y = f''(x)$

$\Rightarrow \frac{d}{dx}\left(\frac{d^2y}{dx^2}\right)\frac{dx}{dx}$

IMP $\Rightarrow \frac{d^3y}{dx^3} = 0$ (third Derivative)

Q $y = \tan^{-1}x$, then P.T $(1+x^2)y_2 + 2xy_1 = 0$

$\Rightarrow \frac{d}{dx}(y) = \frac{d}{dx}\tan^{-1}x$

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Q-1, 2, 3, 4

Q If $y = e^{a\sin^{-1}x}$ then P.T

$\Rightarrow \frac{d}{dx}y = \frac{d}{dx}e^{a\sin^{-1}x}$

$\Rightarrow y_1 = e^{a\sin^{-1}x}\frac{d}{dx}a\sin^{-1}x$

$\Rightarrow y_1 = y\,a\frac{1}{\sqrt{1-x^2}} \Rightarrow y_1 = \frac{ya}{\sqrt{1-x^2}}$

$\Rightarrow y_1\sqrt{1-x^2} = ya$

$\Rightarrow (1-x^2)y_1^2 = y^2a^2$

$\Rightarrow 1-x^2\frac{d}{dx}y_1^2 + y_1^2\frac{d}{dx}1-x^2 = a^2 2y\frac{dy}{dx}$

$\Rightarrow 1\cdot x^2 2y_1 + y_1^2\cdot 2x = a^2 2yy_1$

Important facts:-

- If f & g are two continuous function then f+g, f-g, kf, fg, $\frac{f}{g}$ $(g\neq 0)$, & $\frac{1}{f}$ $(f\neq 0)$ are continuous function.
- Polynomial function is continuous everywhere.

eg. $f(x) = 2x-3$

$f(x) = 5x^2-2x+7$

$f(x) = a_0 + a_1x + a_2x^2 + \cdots + a_nx^n$

- Rational function are continuous in their respective domain.

eg. $\frac{1}{x}$

- Modulus function is continuous & everywhere.
- If $|f|$ is continuous if f is continuous
- Logarithemic function are continuous in their respective domains.

- Exponential function:-
- e^x is continuous everywhere.
- Sine and cos function continuous everywhere.
- Tan, cot, sec & cosec are continuous in respective domain.
- If f is a continuous function defined on $[a,b]$ such that $f(a)\,f(b) < 0$ then their exist at least 1 solution of the equation $f(x) = 0$ in the open interval (a,b)

Q prove that $x = \cos x$ (for some $\exists$) $x \in (0, \frac{\pi}{2})$

Sol^n $\Rightarrow x - \cos x = 0$

$f(x) = x - \cos x$

Since x is continuous because x is polynomial function

$\cos x$ also continuous everywhere

so, $x - \cos x$ is continuous everywhere

$f(a) = f(0) = 0 - \cos 0 = -1$

$f(b) = f(\frac{\pi}{2}) = \frac{\pi}{2} - \cos\frac{\pi}{2}$

$= \frac{\pi}{2}$

$f(a)\cdot f(b) = (-1)\frac{\pi}{2}$

$f(x) = 0 \Rightarrow x - \cos x = 0$

$\Rightarrow x = \cos x$ (proved)

- If 'f' is continuous function $[a,b]$ and k is any real number between $f(a)$ & $f(b)$ then there exist atleast one solution of the equation $f(x) = k$ in the open interval.

Q prove that the expression $2^x + x^2$ attains the value for some value of $x \in (0,1)$

$f(x) = 2^x + x^2$

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$f(0) = 2^0 + 0^2 = 1$

$f(1) = 2^1 + 1^2 = 3$

$f(0) < 2 < f(1)$

$\Rightarrow f(x) = 2$

If f on function a, b

(i) continuous on the closed interval $[a, b]$

(ii) Differentiable on the open interval (a, b)

(iii) $f(a) = f(b)$

then there exists at least a point $c \in (a, b)$

$f'(c) = 0$

IMP what is the geometrical significance of lagrance mean value Theorem?

Under the hypothesis of Lagrance mean value theorem the tangent dracon to the curve $y=f(x)$ at $x=c$ will be parallel to the chord joining $\{a, f(a)\}$ an $\{b, f(b)\}$

Q verify Lagrance mean value Theorem $f(x) = 2x^2 - 3x + 7$ on $[1,2]$

Sol $\therefore f(x) = 2x^2 - 3x + 7$ is a polynomial function, hence

(i) it is contineous in $[1.2]$

(ii) it is diff. in $(1,2)$

$f(a) = f(1) = 2(1)^2 - 3(1) + 7 = 6$

$f(b) = f(2) = 2(2)^2 - 3(2) + 7 = 9$

$f'(x) = 4x - 3$

By LMV

$$f'(c) = \frac{f(b) - f(a)}{b - a}$$

$$\Rightarrow 4c - 3 = \frac{9-6}{2-1}$$

$$\Rightarrow 4c - 3 = 3 \quad \Rightarrow 4c = 6 \quad \Rightarrow c = \frac{6}{4} = \frac{3}{2}$$

$$= 1.5$$

$1.5 \in (1,2)$

Cauchy's Mean value Theorem:-

If f & g are two functions

(i) both are cont. in the closed interval $[a,b]$

(ii) both are Diff. in the open interval (a,b)

(iii) $g'(c) \neq 0$

then there exist at least a point $c \in (a,b)$

such that $\frac{f'(c)}{g'(c)} = \frac{f(b) - f(a)}{g(b) - g(a)}$

Q prove by using Lagrance Mean value Theorem $\sin x < x$, $\exists\ x \in (0, \frac{\pi}{2})$

Sol $\therefore$ ~~Sinx function~~ $\sin x < x$

$\Rightarrow \sin x - x < 0$

$f(x) = \sin x - x$

$\therefore \sin x$ is cont. everywhere and x is cont. everywhere

$\Rightarrow f(x) = \sin x - x$ is cont. $[0, \frac{\pi}{2}]$

$\therefore \sin x$ is Diff. everywhere and x is Diff. everywhere

$\Rightarrow f(x) = \sin x - x$ is Diff $[0, \frac{\pi}{2}]$

$a = 0, \quad b = x \in (0, \frac{\pi}{2})$

$f(a) = \sin 0 - 0 = 0$

$f(b) = \sin x - x$

$f'(x) = \cos x - 1$

By LMV $f'(c) = \frac{f(b) - f(a)}{b - a}$

$$\Rightarrow \cos c - 1 = \frac{\sin x - x - 0}{x - 0}$$

$$\Rightarrow \cos c - 1 = \frac{\sin x - x}{x}$$

$$\Rightarrow \frac{\sin x - x}{x} < 0 \quad \because \cos c - 1 < 0$$

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$\Rightarrow \sin x - x < 0$

$\Rightarrow \sin x < x$ (proved)

Differentiability :-

If f is a real valued function defined on $[a,b]$, then 'f' is differentiable at $x=c \in (a,b)$ if and only if

$$\lim_{x \to c} \frac{f(x) - f(c)}{x - c}$$ exists finitely

LHL

$$\lim_{x \to c^-} \frac{f(x) - f(c)}{x - c}$$

$$= \lim_{h \to 0} \frac{f(c-h) - f(c)}{c - h - c}$$

$$= \lim_{h \to 0} \frac{f(c-h) - f(c)}{-h}$$

RHL

$$\lim_{x \to c^+} \frac{f(x) - f(c)}{x - c}$$

$$= \lim_{h \to 0} \frac{f(c+h) - f(c)}{c + h - c}$$

$$= \lim_{h \to 0} \frac{f(c+h) - f(c)}{h}$$

LHD $f'(c^-) = \lim_{h \to 0} \frac{f(c-h) - f(c)}{-h}$

RHD $f'(c^+) = \lim_{h \to 0} \frac{f(c+h) - f(c)}{h}$

Q

$f(c) = f(0) = |0| = 0$

$f(c-h) = f(0-h) = |0-h| = h$

$f(c+h) = f(0+h) = |0+h| = h$

$f'(c^-) = \lim_{h \to 0} \frac{f(c-h) - f(c)}{-h}$

$= \lim_{h \to 0} \frac{h - 0}{-h} = -1$

$f'(c^+) = \lim_{h \to 0} \frac{f(c+h) - f(c)}{h}$

$= \lim_{h \to 0} \frac{h}{h} = 1$

$\because f'(c^-) \neq f(c^+)$

$\Rightarrow f$ is not differentiable at $x = 0$.

Q $f(x) = \left|1 - \frac{1}{x}\right|$ at $x = 1$

$f(c) = f(1) = \left|1 - \frac{1}{1}\right| (0) = 0$

$f(c-h) = f(1-h) = \left|1 - \frac{1}{1-h}\right| = \left|\frac{1-h-1}{1-h}\right| = \frac{h}{1-h}$

$f(c+h) = f(1+h) = \left|1 + \frac{1}{1+h}\right| = \left|\frac{1+h+1}{1+h}\right| = \frac{h}{1+h}$

$f'(c^-) = \lim_{h \to 0} \frac{f(c-h) - f(c)}{-h}$

$= \lim_{h \to 0} \frac{\frac{h}{1-h} - 0}{-h} = \lim_{h \to 0} \frac{h - 1 + h}{\frac{1-h}{-h}}$

$= \lim_{h \to 0} \frac{h}{1-h} \times \frac{1}{-h} = -1$

RHD $f'(c^+) = \lim_{h \to 0} \frac{f(c+h) - f(c)}{h}$

$= \lim_{h \to 0} \frac{\frac{h}{1+h} - 0}{h}$

$= \lim_{h \to 0} \frac{h}{1+h} \times \frac{1}{h} = 1$

Q $f(x) = x^2 |x|$ at $x = 0$

$f(c) = f(0) = 0^2 |0| = 0$

$f(c+h) = (0+h)^2 |0+h| = h^3$

$f(c-h) = (0-h)^2 |0-h| = -h^3$

$f'(c^-) = \lim_{h \to 0} \frac{f(c-h) - f(c)}{-h} = \frac{-h^3 - 0}{-h} = h^2$

$f'(c^+) = \lim_{h \to 0} \frac{f(c+h) - f(c)}{h} = \frac{h^3 - 0}{h} = h^2$

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Integration

The process by which we can get antiderivative of a function.

Integration is the reverse process of differentiation.

Antiderivatives also called primitive.

Integration is a one-many relation i.e. a function can have more than one antiderivatives.

A constant is added after every integration in order to represent many anti derivatives.

$$\int f(x)\,dx = F(x) + c$$

$f(x)$ ↓ Integrand, $F(x)$ ↓ Integral

Formulae :-

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} + c \quad , n \neq -1$$

$$\int x^{2/3}\,dx = \frac{x^{5/3}}{5/3} + c = \frac{3}{5}x^{5/3} + c$$

$$\int \frac{1}{\sqrt{x}}\,dx = \int x^{-1/2}\,dx = \frac{x^{1/2}}{1/2} + c$$

$$\int \frac{1}{\sqrt{x}}\,dx = 2\sqrt{x} + c$$

$$= \boxed{2\sqrt{x} + c}$$

Q-1 $$\int x^{0.8}\,dx = \frac{x^{0.8+1}}{0.8+1} + c$$

$$= \frac{x^{1.8}}{1.8} + c$$

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⊜ $\int \frac{1}{x^2}\,dx = \int x^{-2}\,dx$

$= \frac{x^{-1}}{-1} + c = -x^{-1} + c$

$\int x^{-1}\,dx = \frac{x^0}{0} + c$

$\boxed{\int \frac{1}{x^2}\,dx = \frac{-1}{x} + c}$

$\boxed{\int x^{-1}\,dx = \int \frac{1}{x}\,dx = \ln|x| + c}$

$\boxed{\int a^x\,dx = \frac{a^x}{\ln a} + c, \quad a > 0, \ a \neq 1}$

$\int e^x\,dx = e^x + c$

Trignometry formulae :-

$\int \sin x\,dx = -\cos x + c$

$\int \cos x\,dx = \sin x + c$

$\int \sec^2 x\,dx = \tan x + c$

$\int \operatorname{cosec}^2 x\,dx = -\cot x + c$

$\int \sec x \tan x\,dx = \sec x + c$

$\int \operatorname{cosec} x \cot x\,dx = -\operatorname{cosec} x + c$

$\int \frac{1}{\sqrt{1-x^2}}\,dx = \sin^{-1} x + c$

$\int \frac{1}{1+x^2}\,dx = \tan^{-1} x + c$

$\int \frac{1}{x\sqrt{x^2-1}}\,dx = \sec^{-1} x + c$

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Q $\int \frac{x^2}{\sqrt{1-x^2}+\sqrt{1-x^2}}\,dx$

$= \int \frac{x^2+(1-x^2)}{\sqrt{1-x^2}}\,dx = \int \frac{1}{\sqrt{1-x^2}}\,dx$

$= \sin^{-1}x + c$

Q $\int \frac{\cos 2x}{\cos x - \sin x}\,dx$

$= \int \frac{\cos^2 x - \sin^2 x}{\cos x - \sin x}\,dx$

$= \int \frac{(\cos x + \sin x)(\cos x - \sin x)}{(\cos x - \sin x)}\,dx$

$= \int \cos x + \sin x\,dx = \sin x - \cos x + c$

Integration by substitution :-

Q $\int \cos 7x\,dx$ let $t = 7x$

$\frac{dt}{dx} = 7 \Rightarrow dx = \frac{dt}{7}$

$\Rightarrow \int \cos t \frac{dt}{7}$

$= \frac{1}{7}\int \cos t\,dt = \frac{1}{7}\sin t + c$

$= \frac{1}{7}\sin 7x + c$

Q $\int \frac{dx}{x[1+(\ln x)^2]}$ let $t = \ln x$

$\frac{dt}{dx} = \frac{1}{x}$

$\Rightarrow dx = \frac{dx}{x}$

$= \int \frac{dt}{1+t^2}$

$= \tan^{-1}t + c$

$= \tan^{-1}(\ln x) + c$

Q $\int \sec e^x \cdot \tan e^x \cdot e^x\,dx$ let $e^x = t$

$\Rightarrow \frac{dt}{dx} = e^x$

$\Rightarrow dt\ e^x dx$

$= \int \sec t \cdot \tan t \cdot dt$

$= \sec t + c$

$= \sec(e^x) + c$

Q $\int \frac{\sec^2 \sqrt{x}}{\sqrt{x}}\,dx$ let $t = \sqrt{x}$

$\Rightarrow \frac{dt}{dx} = \frac{1}{2\sqrt{x}} \Rightarrow dx = 2\sqrt{x}\,dt$

$= \int \sec^2 t \cdot 2\,dt$

$= 2\tan t + c = 2\tan\sqrt{x} + c$

Q $\int \frac{\operatorname{cosec}^2 x}{11+\cot x}\,dx$ let $t = 11 + \cot x$

$\frac{dt}{dx} = -\operatorname{cosec}^2 x$

$\Rightarrow dt = -\operatorname{cosec}^2 x\,dx$

$\Rightarrow -\int \frac{\operatorname{cosec}^2 x\,dt}{t}$

$= -\ln|11+\cot x| + c$

Shortcut

$\int f(x)\,dx = F(x) + c$

$\int f(\lambda x)\,dx = \frac{F(\lambda x)}{\lambda} + c$

Q $\int \cos\frac{3x}{2}\,dx = \frac{\sin\frac{3x}{2}}{3/2} + c = \frac{2}{3}\sin\frac{3x}{2} + c$

Q $\int \sec\sqrt{3}x \tan\sqrt{3}x\,dx = \frac{\sec\sqrt{3}x}{\sqrt{3}} + c$

Q $\int a^{5x}\,dx = \frac{a^{5x}}{5(\ln a)} + c$

Q $\int \operatorname{cosec}(x+2)\cot(x+2)\,dx$ let $t = x+2$

$\frac{dt}{dx} = 1$

$\Rightarrow dt = dx$

$= -\operatorname{cosec}t\cot t\,dt$

$= -\operatorname{cosec}(x+2) + c$

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Q $\int \sin(6x-5)\,dx$

let $\frac{dt}{dx} = 6 \Rightarrow dt = 6dx$

$= \int \sin t \frac{dt}{6}$

$= \frac{1}{6}\int \sin t\,dt = -\frac{\cos(6x-5)}{6} + c$

Q $\int \frac{1}{17x+19}\,dx = \frac{\ln|17x+19|}{17} + c$

Q $\int \frac{dx}{\sqrt{5x-2}}$

$= \int \frac{5\,dt}{\sqrt{t}}$

$t = 5x-2$

$\frac{dt}{dx} = 5 \Rightarrow dt = 5dx$

$= 5\int t^{1/2}$

$= \frac{5t^{3/2}}{3/2} + c = \frac{10(5x-2)^{3/2}}{3} + c$

$= \frac{2\sqrt{5x-2}}{5} + c$

formula derive :-

Q $\int \tan x\,dx$

$= \int \frac{\sin x}{\cos x}\,dx$

let $t = \cos x$

$\frac{dt}{dx} = -\sin x$

$\Rightarrow -dt = \sin x\,dx$

$= \int \frac{-dt}{t}$

$= -\ln|t| + c$

$= -\ln|\cos x| + c = \ln\left|\frac{1}{\cos x}\right| + c$

$= \boxed{\ln|\sec x| + c}$

(ii) $\int \cot x\,dx$

$= \int \frac{\cos x}{\sin x}\,dx$

let $t = \sin x$

$\Rightarrow \frac{dt}{dx} = \cos x \Rightarrow dt = \cos x\,dx$

$= \int \frac{dt}{t} = \ln|t| + c$

$= \ln|\sin x| + c$

(iii) $\int \sec x\,dx = \int \frac{\sec x(\sec x + \tan x)}{(\sec x + \tan x)}\,dx$

$= \int \frac{\sec^2 x + \sec x \tan x}{\sec x + \tan x}\,dx$

$t = \sec x + \tan x$

$\frac{dt}{dx} = \sec x \cdot \tan x + \sec^2 x$

$= \int \frac{dt}{t}$

$= \ln|t| + c = \ln|\sec x + \tan x| + c$

(iv) $\int \operatorname{cosec} x\,dx = \int \frac{\operatorname{cosec} x(\operatorname{cosec} x \mp \cot x)}{(\operatorname{cosec} x \mp \cot x)}$

$= \int \frac{\operatorname{cosec}^2 x \mp \operatorname{cosec} x \cdot \cot x}{(\operatorname{cosec} x + \cot x)}$

$t = \operatorname{cosec} x \mp \cot x$

$\Rightarrow \frac{dt}{dx} = \mp \operatorname{cosec} x \cdot \cot x + \operatorname{cosec}^2 x$

$\Rightarrow dt = \mp \operatorname{cosec} x \cdot \cot x + \operatorname{cosec}^2 x\,dx$

$\Rightarrow dt = \operatorname{cosec}^2 x - \operatorname{cosec} x \cdot \cot x$

$= \int \frac{dt}{t}$

$= \ln|t| + c = \ln|\operatorname{cosec} x - \cot x| + c$

Q $\boxed{\int \frac{f'(x)}{f(x)}\,dx = \ln|f(x)| + c}$

Q $\int (\sec 2x - 3)^2\,dx$

$= \int \sec^2 2x + 9 - 2 \cdot \sec 2x \cdot 3\,dx$

$= \int \sec^2 2x\,dx + \int 9\,dx - 6\int \sec 2x\,dx$

$= \frac{\tan 2x}{2} + 9x - 6\ln\left|\frac{\sec 2x}{2} + \frac{\tan 2x}{2}\right| + c$

$= \frac{1}{2}\left[\tan 2x + 9x - 3\ln|\sec 2x + \tan 2x|\right] + 9x + c$

Q $\int 3^x e^{2x}\,dx$

$= \int (3e^2)^x\,dx = \frac{(3e^2)^x}{\ln(3e^2)} + c = \frac{3^x e^{2x}}{\ln 3 + 2} + c$

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Any (integral) powers of $\tan x$ & $\cot x$:-

$$\int (\tan x)^n dx = \int (\tan x)^{n-2} \tan^2 x \, dx$$

$$= \int (\tan x)^{n-2} (\sec^2 x - 1) \, dx$$

$$\int (\cot x)^n dx = \int (\cot x)^{n-2} \cot^2 x \, dx$$

$$= \int (\tan x)^{n-2} (\operatorname{cosec}^2 x - 1) \, dx$$

Q $\int \tan^3 x \, dx = \int \tan x \cdot \tan^2 x \, dx$

$$= \int \tan x (\sec^2 x - 1) \, dx = \int \tan x \sec^2 x \, dx - \int \tan x \, dx$$

$$= \int t \, dt - \int \tan x \, dx \quad \text{let } t = \tan x, \; dt = \sec^2 x \, dx$$

$$= \frac{t^2}{2} - \ln|\sec x| + c$$

Q $\int \cot^6 x \, dx$

$$= \int \cot^4 x \cdot \cot^2 x \, dx = \int \cot^4 x \cdot (\operatorname{cosec}^2 x - 1) \, dx$$

$$= \int \cot^4 x \operatorname{cosec}^2 x \, dx - \int \cot^4 x \, dx$$

$$= \int t^4 (-dt) - \int \cot^2 x (\operatorname{cosec}^2 x - 1) dx \quad \text{let } t = \cot x \Rightarrow \frac{dt}{dx} = -\operatorname{cosec}^2 x$$

$$= -\int t^4 dt - \int \cot^2 x \operatorname{cosec}^2 x - \cot^2 x \, dx \Rightarrow -dt = \operatorname{cosec}^2 x \, dx$$

$$= -\int t^4 dt - \int t^2 (-dt) + \int \cot^2 x \, dx$$

$$= -\int t^4 dt + \int t^2 dt + \int \operatorname{cosec}^2 x - 1 \, dx$$

$$= -\frac{t^5}{5} + \frac{t^3}{3} + (-\cot x - x) + C$$

Q $\int \tan^5 x \, dx$

$$= \int \tan^3 x \tan^2 x \, dx$$

$$= \int \tan^3 x (\sec^2 x - 1) \, dx$$

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~~$\int \sec^{70} x \cdot \tan x \, dx$~~

Exercise - 9(d)

formulae :- ① $\int \frac{dx}{\sqrt{a^2 - x^2}} = \sin^{-1}\frac{x}{a} + c$

$\Rightarrow \int \frac{dx}{a^2 - x^2}$ let $x = a\sin\theta \Rightarrow \frac{dx}{d\theta} = a\cos\theta$

$\Rightarrow dx = a\cos\theta \, d\theta$

$= \int \frac{a\cos\theta \, d\theta}{\sqrt{a^2 - a^2\sin^2\theta}} = \int \frac{a\cos\theta \, d\theta}{\sqrt{a^2(1 - \cos^2\theta)}}$

$= \int \frac{a\cos\theta \, d\theta}{a\cos\theta} = \theta + c$

$= \sin^{-1}\frac{x}{a} + c$

② $\int \frac{dx}{\sqrt{8 - x^2}} = \int \frac{dx}{\sqrt{(2\sqrt{2})^2 - x^2}}$

$= \sin^{-1}\frac{x}{2\sqrt{2}} + c$

③ $\int \frac{dx}{\sqrt{11 - 4x^2}} = \frac{1}{2}\int \frac{dx}{\sqrt{(\sqrt{11})^2 - (2x)^2}}$

$= \frac{1}{2}\sin^{-1}\left(\frac{2x}{\sqrt{11}}\right) + c$

OR $\int \frac{dx}{\sqrt{4\left(\frac{11}{4} - x^2\right)}} = \frac{1}{2}\int \frac{dx}{\sqrt{\left(\frac{\sqrt{11}}{2}\right)^2 - x^2}} = \frac{1}{2}\sin^{-1}\left(\frac{2x}{\sqrt{11}}\right) + c$

④ $\int \frac{dx}{\sqrt{7 - 3x^2}} = \int \frac{dx}{\sqrt{(\sqrt{7})^2 - (\sqrt{3}x)^2}}$

$= \frac{1}{\sqrt{3}}\sin^{-1}\left(\frac{\sqrt{3}x}{\sqrt{7}}\right) + c$

⑤ $\int \frac{dx}{x\sqrt{17 - (\ln x)^2}}$ $z = \ln x$

$\Rightarrow \frac{dz}{dx} = \frac{1}{x} \Rightarrow dz = \frac{dx}{x}$

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$= \int \frac{dz}{\sqrt{(\sqrt{17})^2 - (z)^2}} = \sin^{-1}\left(\frac{z}{\sqrt{17}}\right) + c$

$= \sin^{-1}\left(\frac{e^x}{\sqrt{17}}\right) + c$

Q $\int \frac{dx}{\sqrt{9 - x^2 - 4x}} = \int \frac{dx}{\sqrt{-x^2 - 4x + 9}}$

$= \int \frac{dx}{\sqrt{9 - (x^2 + 4x + 4 - 4)}} = \int \frac{dx}{\sqrt{9 - (x+2)^2 + 4}}$

$= \int \frac{dx}{\sqrt{13 - (x+2)^2}} = \int$

$t = x + 2$

$dt = 1\, dx$

$= \int \frac{dt}{\sqrt{(\sqrt{13})^2 - (t)^2}} = \sin^{-1}\left(\frac{t}{\sqrt{13}}\right) + c$

$= \sin^{-1}\left(\frac{x+2}{\sqrt{13}}\right) + c$

Form : - 02

$\int \frac{dx}{a^2 + x^2} = \frac{1}{a} \tan^{-1}\left(\frac{x}{a}\right) + c$

$t = a \tan\theta$

$\Rightarrow dx = a \sec^2\theta$

$= \int \frac{a \sec^2\theta \, d\theta}{a^2 + a^2 \tan^2\theta}$

$= \int \frac{a^2 \sec^2\theta \, d\theta}{a^2 \sec^2\theta} = \frac{1}{a} \int d\theta = \frac{1}{a}\theta + c$

$= \frac{1}{a} \tan^{-1}\left(\frac{x}{a}\right) + c$

Q $\int \frac{dx}{2 + x^2} = \int \frac{dx}{(\sqrt{2})^2 + x^2}$

$= \frac{1}{\sqrt{2}} \tan^{-1}\left(\frac{x}{\sqrt{2}}\right) + c$

Q $\int \frac{dx}{3 + 7x^2} = \int \frac{dx}{(\sqrt{3})^2 + (\sqrt{7}x)^2}$

$= \frac{1}{\sqrt{3}\sqrt{7}} \tan^{-1}\left(\frac{\sqrt{7}x}{\sqrt{3}}\right) + c$

$= \frac{1}{\sqrt{21}} \tan^{-1}\left(\frac{\sqrt{7}x}{\sqrt{3}}\right) + c$

Q $\int \frac{e^x dx}{25 + e^{2x}} = \int \frac{e^x dx}{(5)^2 + (e^x)^2}$

$t = e^x$

$dt = e^x dx$

$= \int \frac{dt}{(5)^2 + (t)^2} = \tan^{-1}\left(\frac{t}{5}\right) + c$

$= \frac{1}{5} \tan^{-1}\left(\frac{e^x}{5}\right) + c$

Form : 03

$\int \frac{dx}{x\sqrt{x^2 - a^2}} = \frac{1}{a} \sec^{-1}\left(\frac{x}{a}\right) + c$

let $x = a \sec\theta$

$\Rightarrow \frac{dx}{d\theta} = a \sec\theta \tan\theta \Rightarrow dx = a \sec\theta \tan\theta \, d\theta$

$\int \frac{a \sec\theta \tan\theta \, d\theta}{a \sec\theta \sqrt{a^2 \sec^2\theta - a^2}} = \int \frac{\tan\theta \, d\theta}{\sqrt{a^2 \tan^2\theta}}$

$= \int \frac{\tan\theta \, d\theta}{a \tan\theta} = \frac{1}{a} \int d\theta$

$= \frac{1}{a}\theta + c = \frac{1}{a} \sec^{-1}\frac{x}{a} + c$

Form = 04

$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left|x + \sqrt{x^2 + a^2}\right| + c$

$\int \frac{dx}{\sqrt{x^2 + a^2}}$

let $x = a \tan\theta$

$\frac{dx}{d\theta} = a \sec^2\theta$

$\Rightarrow dx = a \sec^2\theta \, d\theta$

$= \int \frac{a \sec^2\theta \, d\theta}{\sqrt{a^2 \tan^2\theta + a^2}}$

$= \int \frac{a \sec^2\theta \, d\theta}{\sqrt{a^2 \sec^2\theta}} = \int \frac{a \sec^2\theta \, d\theta}{a \sec\theta}$

$= \int \sec\theta \, d\theta = \ln|\sec\theta + \tan\theta| + c$

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Integration by parts :-

I - Inverse trignometry - $\sin^{-1}x$

L - Logarithm - $\ln, \log_2 x$

A - Algebraic - $\sqrt{x}, x$

T - Trignometric - sc csc

E - Exponential - $e^x, e^{2x}, 2^x, \frac{a^x}{b^x}$

$\int (u \cdot v)\, dx$ — 1st

$= \boxed{u \int v\, dx - \int \left(\frac{d}{dx} u \cdot \int v\, dx\right) dx}$

$\int x e^x$

$= x \int e^x dx - \int \left(\frac{d}{dx} x \int e^x dx\right) dx$

$= x e^x - \int e^x dx$

$= x e^x - e^x + C$

$\int x \cos x\, dx$

$= x \int \cos x\, dx - \int \left(\frac{d}{dx} x \int \cos x\, dx\right) dx$

$= x \sin x - \int 1 \sin x\, dx$

$= x \sin x + \cos x + C$

$\int x^2 e^x dx$

$= x^2 \int e^x dx - \int \left(\frac{d}{dx} x^2 \int e^x dx\right) dx$

$= x^2 e^x - \int 2x \cdot e^x dx$

$= x^2 e^x - \left[2x \int e^x dx - \int \left(\frac{d}{dx} 2x \int e^x dx\right) dx\right]$

$= x^2 e^x - \left[2x e^x - 2 \int e^x dx\right]$

$= x^2 e^x - 2x e^x + 2e^x + C$

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$$A+B+C = \tan^{-1}\sqrt{\frac{xyz}{yz}} + \tan^{-1}\sqrt{\frac{xyz}{xz}} + \tan^{-1}\sqrt{\frac{xyz}{xy}} - \tan^{-1}\sqrt{\frac{xyz}{xyz}}$$

$$= \frac{x\sqrt{xyz}}{xyz} + \frac{y\sqrt{xyz}}{xyz} + \frac{z\sqrt{xyz}}{xyz} - \frac{xyz}{xyz}$$

$$= \frac{\sqrt{xyz}}{xyz}(x+y+z-xyz)$$

$$= \frac{\sqrt{xyz}}{xyz}(xyz-xyz) = 0$$

from LHS

$$\tan^{-1}\left(\frac{0}{1-AB-BC-AC}\right)$$

$$= 0+\pi \quad [\because$$

$$= \pi$$

Partial fraction Method :-

partial fraction

The method by which a bigger can be broken down into smaller parts is called partial fraction. P·f method is only aplicable for p·f. (Highest power of Nr < Degree of Dr)

form : 01 (linear factor)

[Every linear factor takes single constant]

$$\int \frac{2x}{(x-3)(x-2)} =$$

$$\int \frac{3x+1}{(x-1)(x-3)}\,dx$$

let $\frac{3x+1}{(x-1)(x-3)} = \frac{A}{(x-1)} + \frac{B}{(x-3)}$

$$\Rightarrow \frac{3x+1}{(x-1)(x-3)} = \frac{A(x-3)+B(x-1)}{(x-1)(x-3)}$$

$$\Rightarrow 3x+1 = A(x-3)+B(x-1)$$

when $x=3$

$$\Rightarrow 9+1 = A(0)+2B \Rightarrow B=5$$

when $x=1$

$$\Rightarrow 3+1 = A-2A \Rightarrow -2A=4$$

$$\Rightarrow A=-2$$

So $\int \frac{3x+1}{(x-1)(x-3)}\,dx = \int \frac{-2}{x-1}\,dx + \int \frac{5}{x-3}\,dx$

$$= -2\ln|x-1| + 5\ln|x-3| + C$$

$$\int \frac{x^2-3}{(2x-1)(x+3)(x-1)}\,dx$$

$$\Rightarrow \frac{x^2-3}{(2x-1)(x+3)(x-1)} = \frac{A}{(2x-1)} + \frac{B}{(x+3)} + \frac{C}{(x-1)}$$

$$\Rightarrow \frac{x^2-3}{(2x-1)(x+3)(x-1)} = \frac{A(x+3)(x-1)+B(2x-1)(x-1)+C(2x-1)(x+3)}{(2x-1)(x+3)(x-1)}$$

$$\Rightarrow x^2-3 = A(x+3)(x-1)+B(2x-1)(x-1)+C(2x-1)(x+3)$$

when $x=-3$

$$\Rightarrow x^2-3 = -7B(-4)$$

$$\Rightarrow x^2-3 = 28B \Rightarrow 9-3 = 28B$$

$$\Rightarrow 6 = 14B \Rightarrow B = \frac{6}{14} = \frac{3}{7}$$

when $x=-1$

$$\Rightarrow 1-3 = C(2+1)(2)$$

$$\Rightarrow -2 = 6C \Rightarrow C = -\frac{1}{2}$$

when $x=0$

$$\Rightarrow -3 = 3A + B - 3C$$

$$\Rightarrow -3 = 3A - \frac{3}{7} + \frac{3}{2}$$

$$\Rightarrow -3 = 3A - \frac{3}{14}$$

$$\Rightarrow -3 + \frac{3}{14} = 3A \Rightarrow \frac{-42+3}{14} = 3A$$

$$\Rightarrow A = \frac{-39}{14}$$

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$$\int \frac{x^2-3\,dx}{(2x-1)(x+3)(x-1)} = \int \frac{11/7}{2x-1} + \int \frac{3/14}{x+3} + \int \frac{-1/2}{x-1}$$

$$= \frac{11}{7}\int \frac{dx}{2x-1} + \frac{3}{14}\int \frac{dx}{x+3} - \frac{1}{2}\int \frac{dx}{x-1}$$

$$= \frac{11}{7}\cdot\frac{1}{2}\ln|2x-1| + \frac{3}{14}\ln|x+3| - \frac{1}{2}\ln|x-1|$$

Q $\int \frac{x^2+11x+13}{x^2-5x+6}\,dx = \int 1 + \frac{16x+7}{x^2-5x+6}\,dx$

$= x + 5$ let

let $\frac{16x+7}{x^2-5x+6} = \frac{16x+7}{(x-2)(x-3)} = \frac{A}{x-2} + \frac{B}{(x-3)}$

$\Rightarrow \frac{16x+7}{(x-2)(x-3)} = \frac{A(x-3) + B(x-2)}{(x-2)(x-3)}$

$\Rightarrow 16x+7 = A(x-3) + B(x-2)$

when $x=3$

$\Rightarrow 48+7 = B \Rightarrow B = 55$

when $x=2$

$\Rightarrow 32+7 = -A$

$\Rightarrow A = -39$

$\int \frac{16x+7}{x^2-5x+6} = \int \frac{-39}{x-2}\,dx + \int \frac{55\,dx}{x-3}$

$= x - 39\ln|x-2| + 55\ln|x-3| + C$

Form: 02 Linear factor repeating

A repeating linear factor takes as many single constant as its number of repeatation then.

$$\frac{5x^2+8}{(x+3)(x-6)^3} = \frac{A}{x+3} + \frac{B}{(x-6)^3} + \frac{C}{(x-6)^2} + \frac{D}{(x-6)}$$

Formula

$$\int \frac{dx}{x^2-a^2} = \frac{1}{2a}\ln\left|\frac{x-a}{x+a}\right| + C$$

$$\int \frac{dx}{a^2-x^2} = \frac{1}{2a}\ln\left|\frac{a+x}{a-x}\right| + C$$

Q $\int \frac{e^x}{e^{2x}+3e^x+1}\,dx$

$e^x = z$

$\frac{dz}{dx} = e^x$

$\Rightarrow dz = e^x dx$

$= \int \frac{dz}{z^2+3z+1}$

$= \int \frac{dz}{z^2+3z+\frac{9}{4}+1-\frac{9}{4}}$

$= \int \frac{dz}{\left(z+\frac{3}{2}\right)^2 - \left(\frac{\sqrt{5}}{2}\right)^2} = \frac{1}{2\left(\frac{\sqrt{5}}{2}\right)}\ln\left|\frac{z+\frac{3}{2}-\frac{\sqrt{5}}{2}}{z+\frac{3}{2}+\frac{\sqrt{5}}{2}}\right| + C$

$= \frac{1}{\sqrt{5}}\ln\left|\frac{z+\frac{3}{2}-\frac{\sqrt{5}}{2}}{z+\frac{3}{2}+\frac{\sqrt{5}}{2}}\right| + C$

$= \frac{1}{\sqrt{5}}\ln\left|\frac{e^x+\frac{3}{2}-\frac{\sqrt{5}}{2}}{e^x+\frac{3}{2}+\frac{\sqrt{5}}{2}}\right| + C$

Q $\int \frac{dx}{\sin x\,(3+2\cos x)}$

$= \int \frac{\sin x\,dx}{\sin^2 x\,(3+2\cos x)}$

$= \int \frac{\sin x\,dx}{(1-\cos^2 x)(3+2\cos x)}$

$= -\int \frac{dz}{(1-z^2)(3+2z)} = \int \frac{dz}{(z+1)(z-1)(3+2z)}$

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Rule - 03 Quadratic factor

Every quadratic factor takes a pair of constant.

Eg. $\frac{1}{(x-2)(x^2+1)} = \frac{A}{x-3} + \frac{Bx+C}{x^2+1}$

Eg. $\frac{1}{(x^2+3)(x^2+6)} = \frac{Ax+B}{x^2+3} + \frac{Cx+D}{x^2+6}$

(3) (11) $\int \frac{5x}{(x^2-2x+2)(x+1)} dx$

let $\frac{5x}{(x^2-2x+1)(x+1)} = \frac{A}{x+1} + \frac{Bx+C}{x^2-2x+C}$

$= \frac{A(x^2-2x+2) + (x+1)(Bx+C)}{(x+1)(x^2-2x+2)}$

$\Rightarrow A(x^2-2x+2) + (x+1)(Bx+C) = 5x$

When $x = -1$, $\Rightarrow A(5) = -5$

$\Rightarrow \boxed{A = -1}$

$x = 0$ $2A + C = 0$

$\Rightarrow C = -2A$

$\Rightarrow \boxed{C = 2}$

$x = 1$, $\Rightarrow -1 + 2B + 2C = 5$

$\Rightarrow -1 + 2B + 4 = 5$

$\Rightarrow 3B = 1$

So, $\int \frac{5x\,dx}{(x^2-2x+2)(x+1)} = \int \frac{-1\,dx}{x+1} + \int \frac{x+2\,dx}{x^2-2x+2}$

$= -1\int \frac{dx}{x+1} + \frac{1}{2}\int \frac{2x-2+6}{x^2-2x+2} dx$

Special problem

$\int \frac{x^2+1}{x^4+1} dx$

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Integration of irrational functions:-

$$\int \frac{\sqrt{x-3}}{x}\,dx$$

$$= \int \frac{z}{z^2+3} \cdot 2z\,dz = 2\int \frac{z^2+3-3}{z^2+3}\,dz$$

$$= 2\int 1 - \frac{3}{z^2+3}\,dz = 2\left[z - 3\frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{z}{\sqrt{3}}\right)\right] + c$$

$$= 2\left[(x-3) - 3\frac{1}{\sqrt{3}}\tan^{-1}\frac{(x-3)}{\sqrt{3}}\right] + c$$

$$\int \frac{dx}{\sqrt{x} - \sqrt[3]{x}}$$

Let $x = z^6$

$$\Rightarrow \frac{dx}{dz} = 6z^5$$

$$\Rightarrow dx = 6z^5$$

$$= 6\int \frac{z^5\,dz}{z^3 - z^2}$$

$$= 6\int \frac{z^5\,dz}{z^2(z-1)}$$

$$= 6\int \frac{z^3 - 1 + 1}{z-1}\,dz = 6\int \frac{z^3-1}{z-1}\,dz + \frac{1}{z-1}\,dz$$

$$\int (3x+1)(x-2)^{9/2}\,dx$$

Let $x - 2 = z^2$

$$\Rightarrow \frac{dx}{dz} = 2z \Rightarrow dx = 2z\,dz$$

$$= \int \{3(z^2+2)+1\} \cdot (z^2)^{9/2} \cdot 2z\,dz$$

$$= \int (3z^2+7)\,z^{10}\,dz$$

$$= 2\int 3z^{12} + 7z^{10}\,dz$$

$$= \frac{6}{13}z^{13} + \frac{14}{11}z^{11} + c$$

$$= \left[\frac{6}{13}(x-2)^{13/2} + \frac{14}{11}(x-2)^{11/2}\right] + c$$

11. $\int \sqrt{4x^2 - 4x + 5}\,dx$

$$= \int \sqrt{4\left(x^2 - x + \frac{5}{4}\right)}\,dx = 2\int \sqrt{x^2 - x + \frac{1}{4} + \frac{5}{4} - \frac{1}{4}}\,dx$$

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$= 2\int \sqrt{\left(x-\frac{1}{2}\right)^2+1}\,dx$

(4) $\int \frac{dx}{\text{Linear}\sqrt{\text{Quadratic}}}$ $\int \frac{dx}{l\sqrt{Q}}$

For integration of the form $\int \frac{dx}{l\sqrt{Q}}$, put linear $\left(l=\frac{1}{z}\right)$

Q $\int \frac{dx}{(x-3)\sqrt{x^2+5x+27}}$

let $x-3=\frac{1}{z}$

$\Rightarrow 1=\frac{-1}{z^2}dz$

$\Rightarrow dx=\frac{-1}{z^2}dz$

$\Rightarrow x=\frac{1}{z}+3=\frac{1+3z}{z}$

$= \int \frac{-1/z^2\,dz}{\frac{1}{z}\sqrt{\left(\frac{1+3z}{z}\right)^2+5\left(\frac{1+3z}{z}\right)+27}}$

$= \int \frac{-1/z^2\,dz}{\frac{1}{z}\sqrt{(1+3z)^2+5z(1+3z)+27z^2}}$

$= \int \frac{-1/z^2\,dz}{\frac{1}{z^2}\sqrt{9z^2+6z+1+5z+15z^2+27z^2}}$

$= -\int \frac{dz}{\sqrt{51z^2+11z+1}} = -\frac{1}{\sqrt{51}}\int \frac{dz}{\sqrt{z^2+\frac{11}{51}z+\frac{121}{10404}+\frac{1}{51}-\frac{121}{10404}}}$

$= \frac{-1}{\sqrt{51}}\int \frac{dz}{\sqrt{\left(z+\frac{11}{102}\right)^2+\alpha^2}}$

$= \frac{-1}{\sqrt{51}}\cdot$

Q $\int \frac{dx}{(2-x)\sqrt{x^2-4x+5}}$

let $2-x=\frac{1}{z}$

$\Rightarrow -1=\frac{-1}{z^2}\frac{dz}{dx}$

$\Rightarrow dx=\frac{1}{z^2}dz$

$= \int \frac{1/z^2\,dz}{\frac{1}{z}\sqrt{\left(\frac{2z-1}{z}\right)^2-4\left(2-\frac{1}{z}\right)+5}}$

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Note - 1 for integration of the form $\int \frac{dx}{a+b\cos x}$, $\int \frac{dx}{a\sin x+b\cos x}$, $\int \frac{dx}{a\sin x+b\cos x+c}$, $\int \frac{dx}{a+b\sin x}$

put $\sin x = \frac{2\tan x/2}{1+\tan^2 x/2}$

$\cos x = \frac{1-\tan^2 x/2}{1+\tan^2 x/2}$

Q $\int \frac{dx}{2\sin x+3\cos x}$

$= \int \frac{dx}{2\cdot\frac{2\tan x/2}{1+\tan^2 x/2} + 3\,\frac{1-\tan^2 x/2}{1+\tan^2 x/2}}$

$= \int \frac{dx}{\frac{4\tan x/2 + 3-3\tan^2 x/2}{1+\tan^2 x/2}} = \int \frac{\sec^2 x/2\, dx}{4\tan x/2 + 3 - 3\tan^2 x/2}$

$= \int \frac{2\,dz}{4z+3-3z^2}$ $\quad z = \tan x/2$

$\Rightarrow \frac{dz}{dx} = \frac{1}{2}\sec^2 x/2$

$\Rightarrow 2dz = \sec^2 \frac{x}{2}\, dx$

$= \frac{-2}{3}\int \frac{dz}{z^2 - \frac{4}{3}z - 1}$

$= -\frac{2}{3}\int \frac{dz}{z^2 - \frac{4}{3}z + \frac{4}{9} - 1 - \frac{4}{9}}$

$= \frac{-2}{3}\int \frac{dz}{(z-\frac{2}{3})^2 - (\frac{\sqrt{13}}{3})^2}$

$= \frac{-2}{3}\cdot\frac{1}{2(\frac{\sqrt{13}}{3})} \ln\left|\frac{z-\frac{2}{3}-\frac{\sqrt{13}}{3}}{z-\frac{2}{3}+\frac{\sqrt{13}}{3}}\right| + c$

(VI) $\int \frac{dx}{1+\cos x+\sin x}$

$= \int \frac{dx}{1+\frac{1-\tan^2 x/2}{1+\tan^2 x/2} + \frac{2\tan x/2}{1+\tan^2 x/2}}$

$= \int \frac{dx}{1+\tan^2 x/2 + 1-\tan^2 x/2 + 2\tan x/2}$

$= \int \frac{dx\,\sec^2 x/2}{2+2\tan x/2}$ $= \frac{dx\,\sec^2 x/2}{2(1+\tan x/2)}$

$z = 2+2\tan x/2$

$\frac{dz}{dx} = \frac{2}{2}\sec^2 x/2$

$\Rightarrow dz = \sec^2 x/2\, dx$

$= \int \frac{dz}{z}$

$= \ln|z| + c$

$= \ln|2+2\tan x/2| + c$

Note - 2 for integration of the form $\int \frac{dx}{a+b\sin^2 x}$, $\int \frac{dx}{a+b\cos^2 x}$, $\int \frac{dx}{a\sin^2 x+b\cos^2 x}$, $\int \frac{dx}{a\sin^2 x+b\cos^2 x+c}$, $\int \frac{dx}{a\sin^2 x+b\cos^2 x+c\sin x\cdot\cos x+k}$

divide $\cos^2 x$ in both Nr (अंश) & Dr (हर)

Q $\int \frac{d\theta}{2+3\cos^2\theta - 4\sin^2\theta}$

$= \int \frac{\frac{1}{\cos^2\theta}\,d\theta}{\frac{2}{\cos^2\theta} + \frac{3\cos^2\theta}{\cos^2\theta} - \frac{4\sin^2\theta}{\cos^2\theta}}$ $= \int \frac{\frac{1}{\cos^2\theta}\sec^2\theta}{2\sec^2\theta+3-4\tan^2\theta}$

$= \int \frac{\sec^2\theta\, d\theta}{2\sec^2\theta+3-4\tan^2\theta}$

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$$= \int \frac{\sec^2\theta \, d\theta}{2(1+\tan^2\theta)+3-4\tan^2\theta}$$

$z = \tan\theta$

$\frac{dz}{d\theta} = \sec^2\theta$

$\Rightarrow dz = \sec^2\theta \, d\theta$

$$= \int \frac{dz}{2(1+z^2)+3-4z^2}$$

$$= \int \frac{dz}{5-2z^2} = \int \frac{dz}{(\sqrt{5})^2-(\sqrt{2}z)^2}$$

$$= \frac{1}{\sqrt{2}\,2\sqrt{5}} \ln\left|\frac{\sqrt{5}+\sqrt{2}z}{\sqrt{5}-\sqrt{2}z}\right| + c$$

Note-3 for integration of the form $\int \frac{a\sin x + b\cos x}{c\sin x + d\cos x}$

$N^r = A(D^r) + B(D^{r'})$

ଅଥ = A (ଧ୍ରୁବ) + B (ଧ୍ରୁବ ର ଧାରକାଳିକ)

Q $\int \frac{3\sin x - 2\cos x}{8\sin x + 5\cos x} dx$

$= 3\sin x - 2\cos x = A(8\sin x + 5\cos x) + (8\cos x - 5\sin x)$

$= 8A\sin x + 5A\cos x + 8B\cos x - 5B\sin x$

$= (8A - 5B)\sin x + (5A + 8B)\cos x$

Compairing $(\times 5)$ $8A - 5B = 3$ $\quad 40A - 25B = 15$

$(\times 2)$ $5A + 8B = -2$ $\quad 40A + 64B = -16$

$-89B = 31$

$\Rightarrow B = \frac{-31}{89}$

$8A - 5B = 3$

$\Rightarrow 8A - 5\left(\frac{-31}{89}\right) = 3$

$\Rightarrow 8A + \frac{155}{89} = 3 \quad \Rightarrow 712A + 155 = 267$

$\Rightarrow A = \frac{14}{89}$

So, $3\sin x - 2\cos x = \frac{14}{89}(8\sin x + 5\cos x) + \frac{-31}{89}(8\cos x - 5\sin x)$

$$\Rightarrow \int \frac{3\sin x - 2\cos x}{8\sin x + 5\cos x} dx = \int \frac{14}{89} dx - \frac{31}{89}\int \frac{8\cos x - 5\sin x}{8\sin x + 5\cos x} dx$$

$$= \frac{14}{89}x - \frac{31}{89}\ln|8\sin x + 5\cos x| + c$$

Note-4

form-1

For the integration of the form $\int \frac{dx}{\sin(a+b\sin x)}$, $\int \frac{dx}{\cos x(a+b\cos x)}$ apply partial fraction

Q $\int \frac{dx}{\sin x(3-2\sin x)}$

Let $\frac{1}{\sin x(3-2\sin x)} = \frac{A}{\sin x} + \frac{B}{3-2\sin x} = \frac{A(3-2\sin x)+B\sin x}{\sin x(3-2\sin x)}$

$\Rightarrow A(3-2\sin x) + B\sin x = 1$

put $x = 0$, $A(3-0) + B\cdot 0 = 1$

$\Rightarrow 3A = 1 \Rightarrow A = 1/3$

$x = \pi/2$ $\quad A(3-2) + B = 1 \Rightarrow A + B = 1 \Rightarrow B = 2/3$

So, $\int \frac{1}{\sin x(3-2\sin x)} dx = \int \frac{1/3\, dx}{\sin x} + \int \frac{2/3}{3-2\sin x} dx$

$= \frac{1}{3}\int \operatorname{cosec} x \, dx + \frac{2}{3} I$

form-02 :-

For the integration of the form $\int \frac{dx}{\sqrt{\sin x}(a+b\cos x)}$

Free factor

$\int \frac{dx}{\sqrt{\cos x}(a+b\sin x)}$

Multiply the free factor in thoth N^r and D^r and then apply partial fraction.

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$\Rightarrow \frac{1}{10}\int\frac{dz}{z-1} - \frac{1}{2}\int\frac{dz}{z+1} + \frac{4}{5}\int\frac{dz}{2z+3}$

$\Rightarrow \frac{1}{10}\ln|z-1| - \frac{1}{2}\ln|z+1| + \frac{4}{10}\ln|2z+3| + c$

Note - 5

Two integration of the form $\frac{\sin(p\pm q)x}{\sin px \text{ or } \cos qx}$,

Express N^R in terms of D^R

$$\int \frac{\sin(11x)}{\cos 8x \cos 3x}\,dx$$

$$= \int \frac{\sin(8x+3x)}{\cos 8x \cos 3x}\,dx = \int \frac{\sin 8x\cos 3x + \cos 8x \sin 3x}{\cos 8x \cdot \cos 3x}$$

$$= \int \frac{\sin 8x \cos 3x}{\cos 8x \cos 3x}\,dx + \int \frac{\cos 8x \sin 3x}{\cos 8x \cos 3x}$$

$$= \int \tan 8x\,dx + \int \tan 3x\,dx$$

$$= \frac{1}{8}\ln\sec 8x + \frac{1}{3}\ln\sec 3x + c$$

3 SE

$$\int \frac{x^2}{1+x^3}\,dx \qquad z = 1+x^3$$

$$\frac{dz}{dx} = 3x^2$$

$$dz = 3x^2\,dx$$

$$3\int \frac{dz}{1+z}$$

$$3\ln|1+z^3| + c$$

$$\int \frac{2\cos x}{\sin^2 x} \qquad z = \sin x$$

$$\frac{dz}{dx} = \cos x$$

$$2\int \frac{dz}{z^2}$$

$$= 2\int z^{-2}\,dz = 2\frac{z^{-2}}{-2} = -\frac{\sin^{-2}}{\cdot}$$

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$$= \int \frac{7\,dz}{\sqrt{z^2+(\sqrt{37})^2}} + 36 \int \frac{\sin x\,dx}{\sqrt{1+36\cos^2 x}}$$

Definite Integration

Fundamental Theorem of calculus (Leibnitz)

If $F(x)$ is one of anti-derivatives of

$$\int_a^b f(x)\,dx = F(x)\Big]_a^b$$

$$= f(b) - f(a)$$

eg. $\int_2^3 \frac{1}{x}\,dx$

$= [\ln x]_2^3$

$= [\ln 3 - \ln 2]$

$= \ln 3/2$

Q. $\int_0^{\pi/2} \frac{\cos x}{1+\sin x}\,dx$

$= \int_1^2 \frac{dz}{z}$

$= [\ln z]_1^2 = \ln 2 - \ln 1$

$= \ln 2$

Q. $\int_0^{\ln 2} \frac{dx}{\sqrt{e^{2x}-1}}$

$= \int_0^{\ln 2} \frac{e^x\,dx}{e^x\sqrt{(e^x)^2-1}}$

$\int_2^3 \frac{1}{x}\,dx$

$= [\ln x + 4]_2^3$

$= (\ln 3 + 4) - (\ln 2 + 4)$

$= \ln 3 - \ln 2 = \ln 3/2$

Let $z = 1+\sin x$

$\frac{dz}{dx} = \cos x$

$dz = \cos x$

$x = 0, \quad z = 1$

$x = \pi/2 = 1+\sin \pi/2$

$= 1+1 = 2$

Let $z = e^x$

$\frac{dz}{dx} = e^x$

$\Rightarrow dx = e^x dx$

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Properties

① Dummy Variable :-

$$\int_a^b f(x)\,dx = \int_a^b f(y)\,dy = \int_a^b f(t)\,dt$$

eg:- $\int_0^{\pi} \cos 3x\,dx = \int_0^{\pi} \cos 3\theta\,d\theta$

② $f(x) = 4x^3$

$$\int_2^3 f(x)\,dx = \int_2^3 4x^3\,dx = (x^4)_2^3 = 3^4 - 2^4 = 81 - 16 = 65$$

$$\int_2^3 f(y)\,dy = \int_2^3 4y^3\,dy = (y^4)_2^3 = 3^4 - 2^4 = 81 - 16 = 65$$

Reversal of limit :-

$$\int_a^b f(x)\,dx = [F(x)]_a^b = F(b) - F(a) = \lambda$$

$$\int_b^a f(x)\,dx = [f(x)]_b^a = f(a) - f(b) = -\lambda$$

$$\int_a^b f(x)\,dx = -\int_b^a f(x)\,dx$$

③ Breaking of the limits :-

$$\int_a^b f(x)\,dx = \int_a^c f(x)\,dx + \int_c^b f(x)\,dx$$

Proof

$$\int_a^b f(x)\,dx = [f(x)]_a^b = f(b) - f(a)$$

$$\int_a^c f(x)\,dx = f(c) - f(a),$$

$$\int_c^b f(x)\,dx = f(b) - f(c)$$

$f(b) - f(a)$ proved

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prop P-05

$$\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$$

$$= \int_{\pi/6}^{\pi/2} \frac{\sin x}{\sin x + \cos x}\,dx \quad \text{——— (1)}$$

$$= \int_{\pi/6}^{\pi/3} \frac{\sin(\pi/6 + \pi/3 - x)}{\sin(\pi/6 + \pi/3 - x) + \cos x(\pi/6 + \pi/3 - x)}\,dx$$

$$= \int_{\pi/6}^{\pi/3} \frac{\sin(\pi/2 - x)}{\sin(\pi/2 - x) + \cos(\pi/2 - x)}\,dx \Rightarrow I = \int_{\pi/6}^{\pi/3} \frac{\cos x}{\cos x + \sin x}\,dx \quad \text{——— (II)}$$

Adding eqn (I) & eqn (II)

$$\Rightarrow 2I = \int_{\pi/6}^{\pi/3} dx \Rightarrow 2I = (x)_{\pi/6}^{\pi/3}$$

$$\Rightarrow I = \frac{\pi/3 - \pi/6}{2} = \pi/12$$

$$\Rightarrow \int_{\pi/6}^{\pi/3} \frac{\sin x}{\sin x + \cos x}\,dx = \pi/12$$

$$I \Rightarrow \int_1^3 \frac{\sqrt{x}}{\sqrt{x} + \sqrt{4-x}}\,dx \quad \text{——— (1)}$$

put $x = 1+3-x$

$$= \int_1^3 \frac{\sqrt{4-x}}{\sqrt{4-x} + \sqrt{4-(4-x)}} \Rightarrow I = \int_1^3 \frac{\sqrt{4-x}}{\sqrt{4-x} + \sqrt{x}}\,dx \quad \text{——— (2)}$$

Adding eqn (1) & (2)

$$\Rightarrow 2I = \int_1^3 1\,dx$$

$$\Rightarrow 2I = (x)_1^3 \Rightarrow I = \frac{3-1}{2} = 1$$

$$\Rightarrow \int_1^3 \frac{\sqrt{x}}{\sqrt{x} + \sqrt{4-x}}\,dx = 1$$

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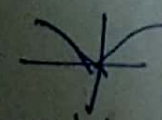
prop - 06 (Even / odd functions)

Even

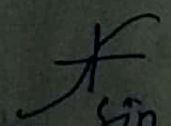
$f(-x) = f(x)$



$\cos x, \sec x, \ldots (x^2, x^4, x^6, x^8, \ldots)$

odd

$f(-x) = -f(x)$



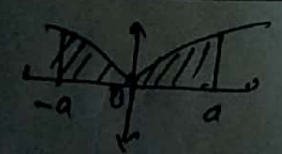
$\sin, \tan, \cot, \operatorname{cosec} x, \text{signum}\, x, (x^1, x^3, x^5, x^7 \ldots)$

$$\boxed{\begin{array}{l} 0(+,-)\,0 = 0, \quad 0(\times \div)\,0 = E \\ e^{odd} = 0, \quad 0^{even} = 0 \end{array}}$$

$E(+ - \times \div)\,E = E$

$E^{\text{any no}} = E$

$$\boxed{\int_{-a}^{a} f(x)\,dx = \begin{cases} 2\int_0^a f(x)\,dx, & f(x) \text{ is even} \\ 0, & f(x) \text{ is odd} \end{cases}}$$



Q $\displaystyle\int_{-\pi/3}^{\pi/3} \frac{\tan^3 6x \cdot \operatorname{cosec} 5x}{x \cdot \cos x}\,dx = 0$ $\left[\frac{0 \cdot 0}{0 \cdot e} = \frac{e}{0 \cdot e} = \frac{e}{0} = 0\right]$

Q $\displaystyle\int_{-3}^{3} x^{101} + x^2 + x^{27}\,dx$

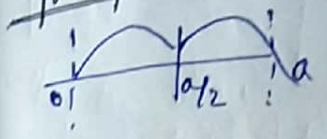
$\displaystyle = \int_{-3}^{3} x^{101} + x^{27}\,dx + \int_{-3}^{3} x^2\,dx$

$\displaystyle = 0 + 2\int_{-3}^{3} x^2\,dx = 2\left[\frac{x^3}{3}\right]_{-3}^{3}$

$\displaystyle = 2\left[\frac{(3)^3}{3} - \frac{(-3)^3}{3}\right] = 2[9 + 9]$

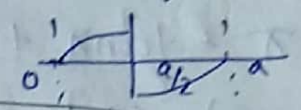
$= 36$

prop - 07



$f(x) = f(a-x)$, $f(x)$ is sym about $x = a/2$

$f(x) = -f(a-x)$



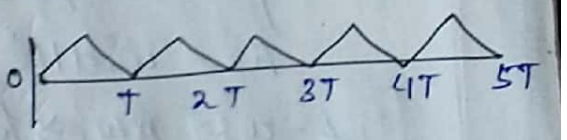
$f(x)$ is anti sym about $x = a/2$

$$\boxed{\int_0^a f(x)\,dx = \begin{cases} 2\int_0^{a/2} f(x)\,dx, & f(x) = f(a-x) \\ 0, & f(x) = -f(a-x) \end{cases}}$$

prop - 8 (Periodic function)

$f(x)$ is a periodic fun. with period (T)

$$\boxed{\int_0^{nT} f(x)\,dx = n\int_0^{T} f(x)\,dx}$$



IMPQ 1. $\displaystyle\int_0^{\pi/2} \ln \sin x\,dx = \int_0^{\pi/2} \ln \cos x\,dx = \frac{\pi}{2} \ln \frac{1}{2}$

Q $\displaystyle I = \int_0^{\pi} \frac{x \tan x}{\sec x + \tan x}\,dx$

$\displaystyle = \int_0^{\pi} \frac{(\pi - x)\tan(\pi - x)}{\sec(\pi - x) + \tan(\pi - x)}$

$\displaystyle = \int_0^{\pi} \frac{(\pi - x)(-\tan x)}{(-\sec x) - \tan x}\,dx = \int_0^{\pi} \frac{(\pi - x)(\tan x)}{(\sec x + \tan x)}\,dx$

$\displaystyle = \int_0^{\pi} \frac{\pi \tan x}{\sec x + \tan x}\,dx - \int_0^{\pi} \frac{x \tan x}{\sec x + \tan x}\,dx$

$\displaystyle \Rightarrow 2I = \int_0^{\pi} \frac{\pi \tan x}{\sec x + \tan x}\,dx$

$\displaystyle \Rightarrow 2I = \pi\int_0^{\pi} \frac{\tan x}{(\sec x + \tan x)} \frac{(\sec x - \tan x)}{(\sec x - \tan x)}$

$\displaystyle \Rightarrow 2I = \pi\int_0^{\pi} \frac{\tan x \sec x - \tan^2 x}{(\sec^2 x) - (\tan^2 x)}\,dx$

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Integration (Anti derivative) / Primitive

① $\int x^n dx = \frac{x^{n+1}}{n+1} + c$, $n \neq -1$

$\int \sqrt{x}\, dx =$

$= \int x^{1/2} dx = \frac{x^{3/2}}{3/2}$

$\int x^0 dx = \frac{x^1}{1} + c$

$\int 1\, dx = x + c$

$\int dx = x + c$

② $\int \frac{1}{x} dx = \ln x + c$

③ $\int a^x dx = \frac{a^x}{\ln a} + c$, $a > 0$, $a \neq 1$

Q $\int (-3)^x = \frac{(-3)^x}{\ln}$ not defined

④ $\int e^x dx = e^x + c$

⑤ $\int \sin x\, dx = -\cos x + c$

⑥ $\int \cos x\, dx = \sin x + c$

⑦ $\int \tan x\, dx = \ln \sec x + c$

⑧ $\int \cot x\, dx = \ln \sin$

⑨ $\int \sec x\, dx = \ln |\sec x + \tan x| + c$

⑩ $\int \operatorname{cosec} x\, dx = \ln |\operatorname{cosec} x - \cot x| + c$

⑪ $\int \sec^2 x\, dx = \tan x + c$

⑫ $\int \operatorname{cosec}^2 x\, dx = -\cot x + c$

⑬ $\int \sec x \tan x\, dx = \sec x + c$

⑭ $\int \operatorname{cosec} x \cot x\, dx = -\operatorname{cosec} x + c$

$\Rightarrow \int u \pm v\, dx = \int u\, dx \pm \int v\, dx$

$\int \sin x + e^x dx$

$= \int \sin x\, dx + \int e^x dx$

$= -\cos x + e^x + c$

$\Rightarrow \int k f(x)\, dx = k \int f(x)\, dx$

$\int 2x^5 dx = 2 \int \frac{x^6}{6} + c$

Q (i) $\int 2\, dx$

$= 2 \int dx$

$= 2x + c$

(ii) $\int 3x^2 dx$

$= 3 \int x^2 dx$

$= 3 \frac{x^3}{3} + c = x^3 + c$

(iii) $\int x^5 dx$

$= \frac{x^6}{6} + c$

(vi) $\int 2\sqrt{x} + \frac{3}{\sqrt{x}} dx$

$= 2 \int \sqrt{x} dx + \int \frac{3}{\sqrt{x}} dx$

$= 2 \frac{x^{3/2}}{3/2} + 3 \int \frac{1}{\sqrt{x}} dx$

$= 2 \frac{x^{3/2}}{3/2} + 3 \int x^{-1/2} dx$

$= 2 \frac{x^{3/2}}{3/2} + 3 \cdot \frac{x^{1/2}}{1/2} + c$

(vii) $\int x^{4/7} + \frac{1}{x^{1/3}} dx$

$= \int x^{4/7} dx + \int \frac{1}{x^{1/3}} dx = \frac{x^{4/7+1}}{4/7+1} + \frac{x^{-1/3+1}}{-1/3+1}$

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$= \int \frac{dx}{\cos^2 x} = \int \sec^2 x \, dx$

$= \tan x + c$

Q $\int \frac{dx}{1-\cos^2 x}$

$= \int \frac{1}{\sin^2 x} dx$

$= \int \operatorname{cosec}^2 x \cdot dx = -\cot x + c$

Q $\int \frac{2\cos x}{1-\cos^2 x} dx$

$= 2\int \frac{\cos x}{1-\cos^2 x} dx = 2\int \frac{\cos x}{\sin^2 x} dx$

$= 2\int \frac{\cot x}{\sin x} dx$

$= 2\int \cot x \cdot \operatorname{cosec} x \, dx$

$= 2(-\operatorname{cosec} x) + c$

Q $\int \frac{1-\sin^3 x}{\sin^2 x} dx = \int \frac{1}{\sin^2 x} - \frac{\sin^3 x}{\sin^2 x} dx$

$= \int \operatorname{cosec}^2 x - \sin x \, dx$

$= \int \operatorname{cosec}^2 x \, dx - \int \sin x \, dx$

$= -\cot x + \cos x + c$

Q $\int e^x + 2 \, dx = \int e^x dx + \int 2 \, dx$

$= e^x + 2x + c$

Q $\int 3^x dx$

Q

$= \frac{3^x}{\ln 3} + c$

Q $\int a^{x+2} dx = \frac{a^{x+2}}{\ln a}$

$= \int a^x \cdot a^2 dx = a^2 \int a^x dx$

$= a^2 \frac{a^x}{\ln a} + c = \frac{a^{x+2}}{\ln a} + c$

Q $\int (2x+3)^5 dx$

$= \frac{(2x+3)^6}{6 \times 2} + c$ $\left[\int (ax+b)^n dx = \frac{(ax+b)^{n+1}}{(n+1)}\right]$

Q $\int (3-5x)^{-4} dx$

$= \int (-5x+3)^{-4} dx = \frac{(-5x+3)^{-3}}{-3 \times -5} + c$

$= \frac{(-5x+3)^{-3}}{15} + c$

* $\int a^x dx = \frac{a^x}{\ln a} + c \longrightarrow * \int a^{mx} dx = \frac{a^{mx}}{(\ln a) m}$

* $\int 3^{5x+2} dx = \frac{3^{5x+2}}{(\ln 3) 5} + c$

* $\int a^{x+2} dx$ * $\int e^x dx + c \longrightarrow * \int e^{mx} dx$

$= \frac{a^{x+2}}{\ln a} + c$ $= \frac{e^{mx}}{m} + c$

* $\int e^{-x} + c$

$= \frac{e^{-x}}{-1} + c$

$= -e^{-x} + c$

* $\int \sin x \, dx = -\cos x + c$ * $\int \sin mx \, dx = \frac{-\cos mx}{m} + c$

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Q $\int a^{3x}\,dx = \frac{a^{3x}}{(\ln a)3} + c$

Q $\int \frac{e^{2x}+1}{e^x}\,dx = \int \frac{e^{2x}}{e^x} + \frac{1}{e^x}\,dx$

$= \int e^x + e^{-x}\,dx = e^x + e^{-x} + c$

(15) $\int \frac{1}{\sqrt{1-x^2}}\,dx = \sin^{-1}x + c$ or $-\cos^{-1}x + c$

(16) $\int \frac{1}{1+x^2}\,dx = \tan^{-1}x + c$ or $-\cot^{-1}x + c$

(17) $\int \frac{1}{x\sqrt{x^2-1}}\,dx = \sec^{-1}x + c$ or $-\operatorname{cosec}^{-1}x + c$

Q $\int \frac{5}{\sqrt{1-x^2}} + \frac{7}{1+x^2}\,dx$

$= 5\int \frac{1}{\sqrt{1-x^2}}\,dx + 7\int \frac{7}{1+x^2}\,dx = 5\sin^{-1}x + 7\tan^{-1}x$

Q $\int \sqrt{1-x^2} + \frac{x^2}{\sqrt{1-x^2}}\,dx = \int \frac{1-x^2+x^2}{\sqrt{1-x^2}}\,dx$

$= \int \frac{1}{\sqrt{1-x^2}}\,dx = \sin^{-1}x + c$

Q $\int \frac{x^2+\sqrt{x^2-1}}{x^3\sqrt{x^2-1}}\,dx = \int \frac{x^2}{x^3\sqrt{x^2-1}} + \frac{\sqrt{x^2-1}}{x^3\sqrt{x^2-1}}\,dx$

$= \int \frac{1}{x\sqrt{x^2-1}} + \frac{1}{x^3}\,dx = \int \frac{1}{x\sqrt{x^2-1}}\,dx + \int x^{-3}\,dx$

$= \sec^{-1}x + \frac{x^{-2}}{-2} + c$

Integration by substitution:-

Q $\int \sin 3x\,dx$ $\quad t = 3x \Rightarrow \frac{dt}{dx} = 3 \Rightarrow dx = \frac{dt}{3}$

$= \int \sin t \left(\frac{dt}{3}\right)$

$= \frac{1}{3}\int \sin t\,dt$

$= \frac{1}{3}(-\cos t) + c$

$= \frac{-\cos 3x}{3} + c$

Q $\int \cos(2-7x)\,dx$ $\quad t = 2-7x$

$\frac{dt}{dx} = -7 \Rightarrow dx = \frac{dt}{-7}$

$= \int \cos t \left(\frac{dt}{-7}\right)$

$= -\frac{1}{7}\int \cos t\,dt$

$= \frac{-1}{7}\sin t + c = \frac{-1}{7}\sin(2-7x) + c$

Q $\int \sin\frac{x}{2}\,dx$ $\quad t = \frac{x}{2} \Rightarrow \frac{dt}{dx} = \frac{2}{4}$

$\Rightarrow \frac{dt}{dx} = \frac{1}{2} \Rightarrow dx = 2dt$

$= \int \sin t\; 2dt$

$= -2\cos t + c$

$= -2\cos\left(\frac{x}{2}\right) + c$

Q $\int \sec^2 4x\,dx$ $\quad t = 4x \Rightarrow \frac{dt}{dx} = 4$

$\Rightarrow dx = \frac{dt}{4}$

$= \int \sec^2 t \left(\frac{dt}{4}\right) + c$

$= \frac{1}{4}\tan 4x + c$

$\frac{3x^2(x^2-1)}{(x^2+1)(x^2-1)} = \frac{3x^4 - 3x^2}{x^4 - x^2 + x^2 - 1}$

$= \frac{3x^4 - 3x^2}{x^4 - 1}$

$\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x}$

$\frac{\sin^2 + \cos^2 x}{\cos x \cdot \sin x}$

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Q $\int \sin x \cos x \, dx$ $= \frac{1}{2}\int 2\sin x \cos x$

$= \frac{1}{2}\int \sin 2x \, dx = \frac{1}{2}\left(\frac{-\cos 2x}{2}\right) + c$

OR $\int t \cos x \, dx$ $\quad t = \sin x$

$\frac{dt}{dx} = \cos x \Rightarrow dt = \cos x \, dx$

$= \int t \, dt = \frac{t^2}{2} + c = \frac{\sin^2 x}{2} + c$

Q $\int \tan^3 x \sec^2 x \, dx$ $\quad t = \tan x$

$= \int t^3 \, dt$ $\quad \frac{dt}{dx} = \sec^2 x$

$dt = dx \sec^2 x$

$= \frac{t^4}{4} + c$

$= \frac{\tan^4 x}{4} + c$

Q $\int \frac{\sin x}{\cos^3 x} dx$ $\quad t = \cos x$

$\frac{dt}{dx} = -\sin x$

$\Rightarrow -dt = \sin x \, dx$

$= \int \frac{-dt}{t^3}$

$= -\int t^{-3} dt = -\left(\frac{t^{-2}}{-2} + c\right)$

$= \frac{-(\cos x)^{-2}}{-2} + c$

Q $\int \frac{\operatorname{cosec}^2(\ln x)}{x} dx$ $\quad t = \ln x$

$\Rightarrow \frac{dt}{dx} = \frac{1}{x}$

$\Rightarrow dt = dx$

$= \int \operatorname{cosec}^2 t \, dx$

$= -\cot t + c$

$= -\cot(\ln x) + c$

$-1/2 \quad +1 \quad -1+2$

$\quad\quad\quad

Q $\int \sin x \cos 4x \, dx = \frac{1}{2}\int \sin(3x) - \sin(5x)$

$= \frac{1}{2}\left[\frac{-\cos 3x}{3} - \frac{\cos 5x}{5}\right] + C$

Q $\int \sin 6x \sin 3x \, dx = \frac{1}{2}\int \cos 3x - \cos 9x$

$= \frac{1}{2}\left[\frac{\sin 3x}{3} - \frac{\sin 9x}{9}\right] + C$

Q $\int \cos 3x \sin 4x \, dx = \frac{1}{2}\int \sin x + \sin 7x$

$= \frac{1}{2}\left[-\cos x + \frac{-\cos 7x}{7}\right] + C$

$= \frac{1}{2}\left[-\cos x - \frac{\cos 7x}{7}\right] + C$

Q $\int \cos 4x \cos 5x \sin 2x \, dx$

$= \frac{1}{2}\int [\cos(4x - 5x) + \cos(4x + 5x)] \sin 2x \, dx$

$= \frac{1}{2}\int [\cos(-x) + \cos 9x] \sin 2x \, dx$

$= \frac{1}{2}\int \cos 2x \cos x + \sin 2x \cos 9x \, dx$

$= \frac{1}{2}\int \frac{1}{2}[\sin x + \sin 3x] + \frac{1}{2}[\sin(-7x) + \sin 11x] \, dx$

$= \frac{1}{4}\int \sin x + \sin 3x - \sin 7x + \sin 11x \, dx$

$= \frac{1}{4}\left[-\cos x - \frac{\cos 3x}{3} + \frac{\cos 7x}{7} - \frac{\cos 11x}{11}\right] + C$

(1) C

Form = 02

$\cos^2 2x = \frac{1+\cos 4x}{2}$

→ $\int \sin^2 x \, dx$, $\int \sin^4 x \, dx$

$\sin^2 x = \frac{1-\cos 2x}{2}$	$\sin^4 x =$
$\cos^2 x = \frac{1+\cos 2x}{2}$	$\cos^4 x =$

Q $\int \cos^2 x = \int \frac{1+\cos 2x}{2} dx$

$= \frac{1}{2}\int 1 + \cos 2x \, dx = \frac{1}{2}\left[x + \frac{\sin 2x}{2}\right] + C$

Q $\int \sin^2 x = \int \frac{1-\cos x}{2} = \frac{1}{2}\int 1 - \cos 2x$

$= \frac{1}{2}\left[x - \frac{\sin 2x}{2}\right] + C$

Q $\int \cos^4 x \, dx = \int (\cos^2 x)^2 \, dx$

$= \int \left(\frac{1+\cos 2x}{2}\right)^2 dx = \frac{1}{4}\int (1+\cos 2x)^2 \, dx$

$= \frac{1}{4}\int 1 + \cos^2 2x + 2\cos 2x \, dx$

$= \frac{1}{4}\int 1 + \frac{1+\cos 4x}{2} + 2\cos 2x \, dx$

$= \frac{1}{4}\int \frac{2 + 1 + \cos 4x + 4\cos 2x}{2} dx$

$= \frac{1}{8}\int 3 + \cos 4x + 4\cos 2x \, dx$

$= \frac{1}{8}\left[3x + \frac{\sin 4x}{4} + \frac{4\sin 2x}{2}\right] + C$

Q $\int \sin^4 x \, dx = \int (\sin^2 x)^2 \, dx$

$= \int \left(\frac{1-\cos 2x}{2}\right)^2 dx = \frac{1}{4}\int (1-\cos 2x)^2 dx$

$= \frac{1}{4}\int 1 + \cos^2 2x - 2\cos 2x \, dx$

$\Rightarrow \frac{1}{4}\int 1 + \frac{1+\cos 4x}{2} - 2\cos 2x \, dx$

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$= \frac{1}{4}\int \frac{2+1+\cos 4x - 4\cos 2x}{2}\,dx$

$= \frac{1}{8}\int 3+\cos 4x - 4\cos 2x\,dx$

$= \frac{1}{8}\left[3x + \frac{\sin 4x}{4} - \frac{4\sin 2x}{2}\right] + c$

Form - 03

$\int \sin^3 x\,dx$, $\int \cos^3 x\,dx$

$\int \sin^5 x\,dx$ $\int \cos^5 x\,dx$

$\int \sin^7 x\,dx$ $\int \cos^7 x\,dx$

Q $\int \sin^3 x\,dx = \int \sin^2 x \cdot \sin x\,dx$

$= \int (1-\cos^2 x)\sin x\,dx$

$t = \cos x$

$\frac{dt}{dx} = -\sin x$

$\Rightarrow -dt = \sin x\,dx$

$= \int (1-t^2)(-dt)$

$= \int t^2 - 1\,dt$

$= \frac{t^3}{3} - t + c = \frac{\cos^3 x}{3} - \cos x + c$

Q $\int \cos^3 x\,dx = \int \cos^2 x \cdot \cos x\,dx$

$= \int (1-\sin^2 x)\cdot \cos x\,dx$

$t = \sin x$

$\frac{dt}{dx} = \cos x$

$dt = \cos x\,dx$

$= \int (1-t^2)\,dt$

$= \int 1 - t^2\,dt$

$= \left[t - \frac{t^3}{3}\right] + c = \left[\sin x - \frac{\sin^3 x}{3}\right]$

Q $\int \sin^5 x\,dx = \int \sin^4 x \sin x\,dx$

$= \int (\sin^2 x)^2 \cdot \sin x\,dx$

$= \int (1-\cos^2 x)^2 \sin x\,dx$

$= \int (1-t^2)^2 \cdot (-dt)$

$= -\int 1 + t^4 - 2t^2\,dt$

$= -\int t + \frac{t^5}{5} - \frac{2t^3}{3} + c$

$= -\left[\cos x + \frac{\cos^5 x}{5} - \frac{2\cos^3 x}{3}\right] + c$

$-t = \cos x$

$\frac{dt}{dx} = -\sin x$

$\Rightarrow -dt = \sin x\,dx$

Q $\int \cos^5 x\,dx = \int \cos^4 x \cdot \cos x\,dx$

$= \int (\cos^2 x)^2 \cdot \cos x\,dx$

$= \int (1-\sin^2 x)^2 \cdot \cos x\,dx$

$t = \sin x$

$\frac{dt}{dx} = \cos x$

$dt = \cos x\,dx$

$= \int (1-t^2)^2 \cdot (dt)$

$= \int 1 + t^4 - 2t^2\,(dt)$

$= \left[t + \frac{t^5}{5} - \frac{2t^3}{3}\right]$

$= \left[\sin x + \frac{\sin^5 x}{5} - \frac{2\sin^3 x}{3}\right]$

Form = 04

$\int \sin^m x \cos^n x\,dx$

or $\int \frac{\sin^m x}{\cos^n x}\,dx$

Case-1 when both are even

$\int \sin^2 x \cos^2 x\,dx$

$= \int \left(\frac{1-\cos 2x}{2}\right)\left(\frac{1+\cos 2x}{2}\right)dx = \frac{1}{4}\int 1 - \cos^2 2x\,dx$

$= \frac{1}{4}\int \sin^2 2x\,dx$

$= \frac{1}{4}\int \frac{1-\cos 4x}{2}\,dx = \frac{1}{8}\int 1 - \cos 4x\,dx$

$= \frac{1}{8}\left[x - \frac{\sin 4x}{4}\right] + c$

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case-2 when both are odd.

$\int \sin^5x \cos^3x\,dx$

$= \int \sin^5x \cos^2x \cos x\,dx = \int \sin^5x (1-\sin^2x)\cos x\,dx$

$= \int \sin^5x (1-\sin^2x)^2 \cos x\,dx$ $\quad t = \sin x$

$\frac{dt}{dx} = \cos x$

$\Rightarrow dt = \cos x\,dx$

$= \int t^5 (1-t^2)\,dt$

$= \int t^5 - t^7\,dt$

$= \frac{t^6}{6} - \frac{t^8}{8} + c = \frac{\sin^6x}{6} - \frac{\sin^8x}{8} + c$

case-3 when one is even & other is odd

$\int \sin^4x \cos^3x\,dx$

$= \int \sin^4x \cos^2x\,dx$

$= \int \sin^4x (1-\sin^2x)\cos x\,dx$ $\quad t = \sin x$

$\frac{dt}{dx} = \cos x$

$= \int t^4 (1-t^2)\,dt$ $\quad dt = \cos x\,dx$

$= \int t^4 - t^6\,dt$

$= \frac{t^5}{5} - \frac{t^7}{7} + c = \frac{\sin^5}{5} - \frac{\sin^7}{7} + c$

Q $\int \sin^3x\,dx$

$\sin 3x = 3\sin x - 4\sin^3x$

$\Rightarrow 4\sin^3x = 3\sin x - \sin 3x$

$\Rightarrow \sin^3x = \frac{3\sin x - \sin 3x}{4}$

$= \int \frac{3\sin x - \sin 3x}{4}$

$= \frac{1}{4}\int 3\sin x - \sin 3x\,dx$

$= \frac{1}{4}\left[3(-\cos x) + \frac{\cos 3x}{3}\right] + c$

Q $\int \cos^3x\,dx$ $\qquad \cos 3x = 4\cos^3x - 3\cos x$

$\Rightarrow \frac{\cos 3x + 3\cos x}{4} = \cos^3x$

$= \int \frac{\cos 3x + 3\cos x}{4}\,dx$

$= \frac{1}{4}\int \cos 3x + 3\cos x\,dx = \frac{1}{4}\left[\frac{\sin 3x}{3} + 3\sin x\right] + c$

(3) (a) $\int \sin^4x \cos^4x\,dx$

$= \int \sin^4x$

Q $\int \sin^6x\,dx$

$\int (\sin^3x)^2\,dx$

$\sin 3x = 3\sin x - 4\sin^3x$

$\Rightarrow \sin^3x = \frac{3\sin x - \sin 3x}{4}$

$= \int \left(\frac{3\sin x - \sin 3x}{4}\right)^2 dx$

$= \frac{1}{16}\int 9\sin^2x + \sin^2 3x - 6\sin 3x \sin x\,dx$

$= \frac{1}{16}\left[9\int \frac{1-\cos 2x}{2}\,dx + \int \frac{1-\cos 2x}{2}\,dx - \frac{6}{2}\int \cos 2x - \cos 4x\,dx\right]$

$= \frac{1}{16}\left[\frac{9}{2}\left(x - \frac{\sin 2x}{2}\right) + \frac{1}{2}\int \left(x - \frac{\sin 6x}{6}\right) - 3\left(\frac{\sin 2x}{2} - \frac{\sin 4x}{4}\right)\right] + c$

Q $\int \tan^5\theta \sec^4\theta\,d\theta$

$= \int \tan^5\theta \sec^2\theta \sec^2\theta\,d\theta$

$= \int \tan^5\theta (1+\tan^2\theta)(\sec^2\theta)$ $\quad t = \tan\theta$

$= \int t^5(1+t^2)\,dt = \int t^5 + t^7\,dt$ $\quad \Rightarrow \frac{dt}{d\theta} = \sec^2\theta$

$\Rightarrow dt = \sec^2\theta\,d\theta$

$= \frac{t^6}{6} + \frac{t^8}{8} + c = \frac{\tan^6\theta}{6} + \frac{\tan^8\theta}{8} + c$

Q $\int \cot^4\theta \operatorname{cosec}^4\theta\,d\theta$

$= \int \cot^4\theta \operatorname{cosec}^2\theta \operatorname{cosec}^2\theta\,d\theta$ $\quad t = \cot\theta$

$= \int \cot^4\theta (1+\cot^2\theta)\operatorname{cosec}^2\theta\,d\theta$ $\quad \Rightarrow \frac{dt}{d\theta} = -\operatorname{cosec}^2\theta$

$= \int t^4(1+t^2)(-dt)$ $\quad \Rightarrow -dt = \operatorname{cosec}^2\theta\,d\theta$

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$= -\int t^4 + t^6\, dt$

$= -\frac{t^5}{5} + \frac{t^7}{7} + C = -\frac{\cot^5\theta}{5} + \frac{\cot^7\theta}{7} + C$

Q $\int \sec^{11}\theta \tan\theta\, d\theta$

$= \int \sec^{10}\theta \cdot \sec\theta \cdot \tan\theta\, d\theta$

$t = \sec\theta$

$\Rightarrow \frac{dt}{d\theta} = \sec\theta \cdot \tan\theta$

$\Rightarrow dt = \sec\theta \cdot \tan\theta\, d\theta$

$\int \sec^{2n+1}\theta \tan^{2n+1}\theta \cdot d\theta$

$t = \sec\theta$

$\Rightarrow \int t^{10} \cdot dt$

$= \frac{t^{11}}{11} + C$

$= \frac{\sec^{11}\theta}{11} + C$

Q $\int \cot\theta \operatorname{cosec}^7\theta\, d\theta$

$= \int \operatorname{cosec}^6\theta \cdot \operatorname{cosec}\theta \cdot \cot\theta$

$t = \operatorname{cosec}\theta$

$\Rightarrow \frac{dt}{d\theta} = -\operatorname{cosec}\theta \cdot \cot\theta$

$\Rightarrow -dt = \operatorname{cosec}\theta \cdot \cot\theta\, d\theta$

$= \int t^6 (-dt)$

$= -\left(\frac{t^7}{7} + C\right) = -\left(\frac{\operatorname{cosec}^7\theta}{7} + C\right)$

Form NO - 05

* $\int \frac{dx}{\sqrt{a^2 - x^2}} = \sin^{-1}\frac{x}{a} + C$

Q $\int \frac{dx}{\sqrt{4 - x^2}} = \int \frac{dx}{\sqrt{2^2 - x^2}} = \sin^{-1}\frac{x}{2} + C$

Q $\int \frac{dx}{\sqrt{5 - x^2}} = \int \frac{dx}{\sqrt{(\sqrt{5})^2 - x^2}} = \sin^{-1}\frac{x}{\sqrt{5}} + C$

Q $\int \frac{dx}{\sqrt{9 - 4x^2}} = \int \frac{dx}{\sqrt{3^2 - (2x)^2}} = \frac{1}{2}\sin^{-1}\frac{2x}{3} + C$

Or $= \frac{1}{2}\int \frac{dt}{\sqrt{3^2 - t^2}}$

Let $t = 2x$

$\frac{dt}{dx} \cdot 2 \Rightarrow dx = \frac{dt}{2}$

$= \frac{1}{2}\int \frac{dt}{\sqrt{3^2 - t^2}} = \frac{1}{2}\sin^{-1}\frac{t}{3} + C$

$= \frac{1}{2}\left[\sin^{-1}\frac{2x}{3} + C\right]$

Q $\int \frac{dx}{\sqrt{11 - 4x^2}} = \int \frac{dx}{\sqrt{(\sqrt{11})^2 - (2x)^2}}$

$= \frac{1}{2}\left[\sin^{-1}\frac{2x}{\sqrt{11}} + C\right]$

Q $\int \frac{e^{3x}\, dx}{\sqrt{4 - e^{6x}}}$

$= \int \frac{e^{3x}\, dx}{\sqrt{(2)^2 - (e^{3x})^2}}$

$t = e^{3x}$

$\frac{dt}{dx} = e^{3x} \cdot 3$

$\Rightarrow dx = \frac{dt}{3e^{3x}}$

$\frac{dt}{3} = e^{3x}\, dx$

$= \int \frac{\frac{dt}{3}}{\sqrt{(2)^2 - (e^{3x})^2}}$

$= \frac{1}{3}\int \frac{dt}{\sqrt{2^2 - (e^{3x})^2}} = \frac{1}{3}\left[\sin^{-1}\frac{e^{3x}}{2} + C\right]$

Q $\int \frac{dx}{2\sqrt{25 - (\ln x)^2}}$

$= \int \frac{dx}{2\sqrt{(5)^2 - (\ln x)^2}}$

$= \int \frac{dx}{x\sqrt{(5)^2 - (\ln x)^2}}$

$= \sin^{-1}\left(\frac{\ln x}{5}\right) + C$

$t = \ln x$

$\frac{dt}{dx} = \frac{1}{x}$

$\Rightarrow dt\, x = dx$

$= \int \frac{dt}{\sqrt{(5)^2 - t^2}}$

Q $\int \frac{\cos\theta}{\sqrt{4 - \sin^2\theta}}\, d\theta = \int \frac{\cos\theta}{\sqrt{(2)^2 - (\sin\theta)^2}}\, d\theta$

$= \int \frac{\cos\theta}{\sqrt{2^2 - t^2}} \cdot \frac{dt}{\cos\theta}$

$t = \sin\theta$

$\frac{dt}{d\theta} = \cos\theta$

$\Rightarrow \frac{dt}{\cos\theta} = d\theta$

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$= \int \frac{dt}{\sqrt{(2)^2 - t^2}}$ $= \sin^{-1}\frac{t}{2} + C$

$= \sin^{-1}\frac{\sin\theta}{2} + C$

$$* \boxed{\int \frac{dx}{a^2+x^2} = \frac{1}{a}\tan^{-1}\frac{x}{a} + C}$$

Q $\int \frac{dx}{4+x^2} = \int \frac{dx}{(2)^2+(x)^2}$

$= \frac{1}{2}\tan^{-1}\frac{x}{2} + C$

Q $\int \frac{dx}{3x^2+7} = \int \frac{dx}{(\sqrt{7})^2 + (\sqrt{3}x)^2}$

$= \frac{1}{\sqrt{3}\sqrt{7}}\tan^{-1}\frac{\sqrt{3}x}{\sqrt{7}} + C$

Q $\int \frac{e^{4x}}{e^{8x}+4} = \int \frac{e^{4x}}{(e^{4x})^2+4}\,dx$

$= \int \frac{e^{4x}}{e^{(2)^2} + (t)^2} \frac{dt}{4e^{4x}}$ $\quad t = e^{4x}$

$\frac{dt}{dx} = 4e^{4x}$

$= \frac{1}{4}\int \frac{dt}{(2)^2+t^2}$ $\quad \Rightarrow dx = \frac{dt}{4e^{4x}}$

$= \frac{1}{4}\frac{1}{2}\tan^{-1}\frac{t}{2} + C$

$= \frac{1}{8}\tan^{-1}\frac{e^{4x}}{2} + C$

Q $\int \frac{dx}{x[(\ln x)^2 + 25}$ $= \int \frac{dx}{x(5)^2 + (\ln x)^2}$

$t = \ln x$

$\frac{dt}{dx} = \frac{1}{x}$

$\Rightarrow dx = dt\,x$

$= \int \frac{dt\,x}{x(5)^2 + (t)^2}$

$= \int \frac{dt}{(5)^2+t^2}$

$= \frac{1}{5}\tan^{-1}\frac{t}{5} + C = \frac{1}{5}\tan^{-1}\frac{\ln x}{5} + C$

$* \int \frac{dx}{x\sqrt{x^2-1}} = \sec^{-1}x + C.$

$* \int \frac{dx}{x\sqrt{x^2-a^2}} = \frac{1}{a}\sec^{-1}\frac{x}{a} + C$

Q $\int \frac{dx}{x\sqrt{4x^2-9}} = \int \frac{dx}{x\sqrt{(2x)^2-(3)^2}}$

$t = 2x$

$\Rightarrow \frac{dt}{dx} = 2$

$\Rightarrow dx = \frac{1}{2}dt = dx$

$= \int \frac{dt}{2x\sqrt{(2x)^2 t^2 - (3)^2}}$

$= \int \frac{dt}{t\sqrt{t^2-3^2}}$

$= \frac{1}{3}\sec^{-1}\frac{t}{3} + C = \frac{1}{3}\sec^{-1}\frac{2x}{3} + C$

Q $\int \frac{dx}{\sqrt{e^{4x}-5}} = \int \frac{dx}{\sqrt{(e^{2x})^2 - (\sqrt{5})^2}}$

imp - this concept - may be board

$t = e^{2x}$

$\frac{dt}{dx} = 2e^{2x}$

$\Rightarrow dx = \frac{dt}{2e^{2x}}$

$= \int \frac{dt}{2e^{2x}\sqrt{(t)^2 - (\sqrt{5})^2}}$

$= \int \frac{dt}{2t\sqrt{t^2-(\sqrt{5})^2}} = 2\int \frac{dt}{\sqrt{t^2-(\sqrt{5})^2}}$

$= 2\frac{1}{\sqrt{5}}\sec^{-1}\frac{e^{2x}}{\sqrt{5}} + C$

$$* \boxed{\int \frac{dx}{\sqrt{a^2+x^2}} = \ln\left|x + \sqrt{a^2+x^2}\right| + C}$$

Q $\int \frac{dx}{\sqrt{x^2+4}} = \ln\left|x + \sqrt{x^2+4}\right| + C$

Q $\int \frac{dx}{\sqrt{3x^2+4}} = \int \frac{dx}{(\sqrt{3}x)^2 + (2)^2}$

$= \frac{1}{\sqrt{3}}\ln\left|\sqrt{3}x + \sqrt{(\sqrt{3}x)^2 + (2)^2}\right| + C$

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Q $\int \frac{e^x \cos e^x \, dx}{\sin^2 e^x + 9}$ $\int \frac{e^x \cos e^x \, dx}{\sin^2 e^x + 9}$

$t = \sin e^x$

$\Rightarrow \frac{dt}{dx} = \cos e^x \cdot e^x$

$\Rightarrow dt = \cos e^x \cdot e^x$

$\int \frac{dt}{(t)^2 + (3)^2}$

$\ln \left| x + \sqrt{t^2 + 3^2} \right| + C$

$\ln \left| \sin e^x + \sqrt{\sin^2 e^x + 3^2} \right| + C$

* $\boxed{\int \frac{dx}{\sqrt{x^2 - a^2}} = \ln \left| x + \sqrt{x^2 - a^2} \right| + C}$

① $\int \frac{dx}{\sqrt{4x^2 - 6}}$ $\int \frac{dx}{\sqrt{(2x)^2 - (\sqrt{6})^2}}$

$= \frac{1}{2} \left[\sin^{-1} \frac{2x}{\sqrt{6}} + C \right]$

② $\int \frac{dx}{\sqrt{6 - 4x^2}}$ $= \int \frac{dx}{\sqrt{(\sqrt{6})^2 - (2x)^2}}$

$t = 2x$

$\Rightarrow \frac{dt}{dx} = 2$

$\Rightarrow dx = \frac{dt}{2}$

$= \int \frac{\frac{dt}{2}}{\sqrt{(\sqrt{6})^2 - (2x)^2}}$

$= \frac{1}{2} \int \frac{dt}{\sqrt{(\sqrt{6})^2 - (2x)^2}}$ $= \frac{1}{2} \ln \left| 2x + \sqrt{(2x)^2 - (\sqrt{6})^2} \right| + C$

Integration by parts :-

I - Inv. trignometric function $\sin^{-1} x$, $\cos^{-1} x$
L - Logarithmic function
A - Algebric function
T - Trignometric function
E - Exponential function e^x, a^x, 2^x

$\int uv = \int \underset{I}{u} \, \underset{II}{v}$

* $\boxed{\int uv = u \int v \, dx - \int \frac{d}{dx} u \int v \, dx \, dx}$

Q $\int x e^x \, dx$

$= x \int e^x dx - \int \frac{d}{dx} x \int e^x \, dx \, dx$

$= x e^x - \int 1 \cdot e^x \, dx$

$= x e^x - e^x + C$

Q $\int x \cos x$

$= x \int \cos x \, dx - \int \frac{d}{dx} x \int \cos x \, dx \, dx$

$= x \sin x - \int 1 \cdot \sin x \, dx$

$= x \sin x - (-\cos x) + C$

$= x \sin x + \cos x + C$

Q $\int (1+x) e^x \, dx$

$= (1+x) \int e^x dx - \int \frac{d}{dx} (1+x) \int e^x \, dx \, dx$

$= (1+x) e^x - \int 1 \cdot e^x \, dx$

$= (1+x) e^x - e^x + C$

Q $\int x \cos^2 x \, dx$

$= x \int \cos^2 x \, dx - \int \frac{d}{dx} x \int \cos^2 x \, dx \, dx$

$= x \left(\frac{1 + \cos 2x}{2} \right) - \int 1 \cdot \left(\frac{1 + \cos 2x}{2} \right) dx$

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$$= \int \frac{(x^2)^3+1-1}{x^2+1}\,dx = \int \frac{(x^2)^3+1}{x^2+1} - \frac{1}{x^2+1}\,dx$$

$$= \int \frac{(x^2+1)(x^4-x^2+1)}{(x^2+1)} - \frac{1}{(x^2+1)}\,dx$$

$$= \int (x^4 - x^2 + 1) - \frac{dx}{x^2+1}$$

Q $\int \frac{x^4+x^3+x^2+x+2}{x^2+1}\,dx$

$x^2+1 \;\big|\; x^4+x^3+x^2+x+2 \;\big|\; x^2+x$

x^4+x^2

x^3+x+2

x^3+x

$+2$

$$= \int x^2 + x + \frac{2}{x^2+1}\,dx$$

$$= \int x^2 + \int x + 2\int \frac{dx}{x^2+1}$$

$$= \frac{x^3}{3} + \frac{x^2}{2} + 2\tan^{-1}x + c$$

OR $\int \frac{x^4+x^3+x^2+x+2}{x^2+1}\,dx$

$$= \int \frac{x^4+x^2+x^3+2}{x^2+1}\,dx = \int \frac{x^2(x^2+1)+x(x^2+1)+2}{x^2+1}\,dx$$

Form :- 10

$$\boxed{\int [f(x)]^n \cdot f'(x)\,dx = \frac{[f(x)]^{n+1}}{n+1} + c}$$

Q $\int \sin^5 x \cos x\,dx$

$$= \frac{\sin^6 x}{6} + c$$

Q $\int x\sqrt{x^2+3}\,dx = \frac{1}{2}\int (x^2+3)^{1/2}\,2x\,dx$

$$= \frac{1}{2}\,\frac{(x^2+3)^{3/2}}{3/2} + c$$

Q $\int (x^4-3x^2+1)^4 \cdot (2x^3-3x)\,dx$

$$= \frac{1}{2}\,\frac{(x^4-3x^2+1)^5}{5} + c$$

Form :- 11

$$\boxed{\int \frac{f'(x)}{\sqrt{f(x)}}\,dx = 2\sqrt{f(x)} + c}$$

Q $\int \frac{\cos x}{\sqrt{\sin x}}\,dx = 2\sqrt{\sin x} + c$

Q $\int \frac{x}{\sqrt{x^2-a^2}}\,dx$

$$= \frac{1}{2}\int \frac{2x}{\sqrt{x^2-a^2}} = \frac{1}{2}\times 2\sqrt{x^2-a^2} + c$$

Form :- 12

$$\boxed{\int \frac{f'(x)}{f(x)}\,dx = \ln|f(x)| + c}$$

Q $\int \cot x\,dx = \int \frac{\cos x}{\sin x}\,dx$

$$= \ln \sin x + c$$

Q $\int \frac{\operatorname{cosec}^2 x}{1+\cot x}\,dx = -\int \frac{-\operatorname{cosec}^2 x}{1+\cot x}\,dx$

$$= -\ln|1+\cot x| + c$$

Q $\int \frac{3x+4}{x^2+4}\,dx$

$$= \int \frac{3x}{x^2+4}\,dx + \int \frac{4}{x^2+4}\,dx$$

$$= 3\int \frac{x}{x^2+4}\,dx + 4\int \frac{1}{x^2+2^2}\,dx$$

$$= \frac{3}{2}\int \frac{2x}{x^2+4}\,dx + 4\times\frac{1}{2}\tan^{-1}\frac{x}{2} + c$$

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Form

* $\int \sqrt{a^2-x^2}\,dx = \frac{x}{2}\sqrt{a^2-x^2} + \frac{a^2}{2}\sin^{-1}\frac{x}{a} + c$

* $\int \sqrt{x^2+a^2}\,dx = \frac{x}{2}\sqrt{x^2+a^2} + \frac{a^2}{2}\ln\left|x+\sqrt{x^2+a^2}\right| + c$

* $\int \sqrt{x^2-a^2}\,dx = \frac{x}{2}\sqrt{x^2-a^2} - \frac{a^2}{2}\ln\left|x+\sqrt{x^2-a^2}\right| + c$

(i) $\int \sqrt{9-x^2}\,dx = \int \sqrt{(3)^2-(x)^2}$

$= \frac{x}{3}\sqrt{(3)^2-(x)^2} + \frac{(3)^2}{2}\sin^{-1}\frac{x}{3} + c$

(ii) $\int \sqrt{16-x^2}\,dx = \int \sqrt{(4)^2-(x)^2}$

$= \frac{x}{4}\sqrt{(4)^2-(x)^2} + \frac{(4)^2}{2}\sin^{-1}\frac{x}{4} + c$

(iii) $\int \sqrt{5-(4x)^2}\,dx = \int \sqrt{(\sqrt{5})^2-(2x)^2}\,dx$

$t = 2x$

$\frac{dt}{dx} = 2$

$\Rightarrow dx = \frac{dt}{2}$

$= \frac{1}{2}\int \sqrt{(\sqrt{5})^2-(t)^2}\,dt$

$= \frac{1}{2}\cdot\frac{t}{2}\sqrt{(\sqrt{5})^2+(t)^2} + \frac{(\sqrt{5})^2}{2}\sin^{-1}\frac{t}{\sqrt{5}} + c$

$= \frac{2x}{2}\sqrt{(\sqrt{5})^2-(2x)^2} + \frac{(\sqrt{5})^2}{4}\sin^{-1}\frac{2x}{\sqrt{5}} + c$

(iv) $\int e^2\sqrt{4-e^{2z}}\,dz$

$t = e^z$

$\Rightarrow \frac{dt}{dz} = e^z$

$\Rightarrow dt = e^z\,dz$

$= \int e^2\sqrt{(2)^2-(e^z)^2}\,dz$

$= \int \sqrt{(2)^2-(t)^2}\,dt$

$= \frac{e^2}{2}\sqrt{(2)^2-(e^z)^2} + 2\sin^{-1}\frac{e^z}{2} + c$

(v) $\int \sqrt{x^2+4}\,dx$

$= \int \sqrt{x^2+(2)^2} = \frac{x}{2}\sqrt{x^2+2^2} + \frac{2^2}{2}\ln\left|x+\sqrt{x^2+2^2}\right| + c$

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Form

$$\int e^x [f(x) + f'(x)]\,dx = e^x f(x) + C$$

Q $\int e^x [\sin x + \cos x]\,dx = e^x \sin x + C$

Q $\int e^x [\tan x + \ln \sec x] = e^x \ln|\sec x| + C$

Q $\int e^x [1 + x \ln x] + C = e^x \ln|x \ln x| + C$

Q $\int \frac{e^x}{x} [1 + x \ln x] + C = \int e^x \left[\frac{1}{x} + \ln x\right] dx$

$= e^x \ln x + C$

Differential equation :-

Order & Degree :-

Differential equation

Formation Solution

Formation of differential Equation

(By eliminating arbitrary constant)

Type = 01

$y = A\sec x$

$y_1 = A\sec x \cdot \tan x$

$\Rightarrow y_1 = y\tan x$

$\Rightarrow y_1 - y\tan x = 0$

Q $y = A\sin x \Rightarrow A = y/\sin x$

$y_1 = A\cos x$

$y_1 = y/\sin x \cdot \cos x$

$\Rightarrow y_1 = y\dfrac{\cos x}{\sin x}$ $\Rightarrow y_1 = y\cot x$

$\Rightarrow y_1 - y\cot x = 0$

Q **Type - 02**

$y = Ae^t + Be^{2t}$

$\Rightarrow y_1 = Ae^t + B2e^{2t}$

$\Rightarrow y_2 = Ae^t + B2e^{2t} \times 2$

$\Rightarrow y_2 = Ae^t + B4e^{2t}$ $\Rightarrow Ae^t + B4e^{2t} - y_2 = 0$

$$\begin{vmatrix} e^t & e^{2t} & -y \\ e^t & 2e^{2t} & -y_1 \\ e^t & 4e^{2t} & -y_2 \end{vmatrix} = 0$$

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$\Rightarrow -e^t e^{2t} \begin{vmatrix} 1 & 1 & y \\ 1 & 2 & y_1 \\ 1 & 4 & y_2 \end{vmatrix} = 0$

$\Rightarrow 1(2y_2 - 4y_1) - 1(y_2 - y_1) + y(4-2) = 0$

$\Rightarrow 2y_2 - 4y_1 - y_2 + y_1 + 4y - 2y = 0$

$\Rightarrow y_2 - 3y_1 + 2y = 0$

Ex $y = a\sin^{-1}x + b\cos^{-1}x$

$\Rightarrow y_1 = \frac{a}{\sqrt{1-x^2}} - \frac{b}{\sqrt{1-x^2}}$

$\Rightarrow y_1 = \frac{a-b}{\sqrt{1-x^2}} \Rightarrow \sqrt{1-x^2}\, y_1 = a-b$

$\Rightarrow \sqrt{1-x^2}\, y_2 + \frac{y_1 \cdot (-2x)}{2\sqrt{1-x^2}} = 0$

$\Rightarrow \frac{(1-x^2)y_2 - xy_1}{\sqrt{1-x^2}} = 0$

$\Rightarrow (1-x^2)y_2 - xy_1 = 0$

solution of Differential equation :-

- General soln
- particular soln

General solution :-

- Variable separation Method
- Homogenous differential equation
- Linear diff. eqn.

Type - 01 Solve $\frac{dy}{dx} = f(x)$

$\Rightarrow dy = f(x)\,dx$

$\Rightarrow \int dy = \int f(x)\,dx$

$\Rightarrow \frac{dy}{dx} = \frac{e^x+1}{e^x}$

$\Rightarrow dy = \frac{e^x+1}{e^x}dx \Rightarrow \int dy = \int \frac{e^x+1}{e^x}dx$

$\Rightarrow \int dy = \int e^x + e^{-x} \Rightarrow y = e^x - e^{-x} + c$

solve $\frac{dy}{dx} = x\cos x$

$\Rightarrow \int dy = \int x\cos x\,dx$

$\Rightarrow y = x\int \cos x\,dx - \int \left[\frac{d}{dx}x \int \cos x\,dx\right]dx$

$\Rightarrow y = x\sin x - \int 1 \sin x\,dx$

$\Rightarrow y = x\sin x + \cos x + c$

Type - 02

Solve $\frac{dy}{dx} = f(y)$

$\Rightarrow \int dx = \int \frac{dy}{f(y)}$

$\Rightarrow$ Solve $\frac{dy}{dx} = y + 2$

$\Rightarrow \int \frac{dy}{y+2} = \int dx \Rightarrow$

$= \ln|y+2| = x + c$

Type - 03

Solve $\frac{dy}{dx} = f(x)\,f(y)$. or $\frac{dy}{dx} = \frac{f(x)}{f(y)}$

$\Rightarrow \int \frac{dy}{f(y)} = \int f(x)\,dx$

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solve $\frac{dy}{dx} = (x^2+1)(y^2+1)$

$\Rightarrow \frac{dy}{(y^2+1)} = \int (x^2+1)\,dx$

$\Rightarrow \tan^{-1}y = \frac{x^3}{3} + x + c$

Type - 04

solve $\frac{d^2y}{dx^2} = f(x)$

Let $p = \frac{dy}{dx}$

$\Rightarrow \frac{d}{dx}\left(\frac{dy}{dx}\right) = f(x)$

$\Rightarrow \int \frac{dp}{dx} = \int f(x) \Rightarrow \int dp = \int f(x)\,dx$

$\Rightarrow p = f_1(x) + c$

$\Rightarrow \frac{dy}{dx} = f_1(x) + c \Rightarrow \int dy = \int f_1(x) + c\,dx$

$\Rightarrow y = f_2(x) + cx + K$

Solve $\frac{d^2y}{dx^2} = 12x^2 + 12x$ let $p = \frac{dy}{dx}$

$\Rightarrow \frac{d}{dx}\left(\frac{dy}{dx}\right) = 12x^2 + 12x$

$\Rightarrow \frac{dp}{dx} = 12x^2 + 12x \Rightarrow \int dp = \int 12x^2 + 12x\,dx$

$\Rightarrow p = 12\frac{x^3}{3} + 12\frac{x^2}{2} + c$

$\Rightarrow p = 4x^3 + 6x^2 + c$

$\Rightarrow \frac{dy}{dx} = 4x^3 + x^2 + c \Rightarrow \int dy = \int 4x^3 + x^2 + c$

$\Rightarrow y = 4\frac{x^4}{4} + \frac{x^3}{3} + cx + K$

$\Rightarrow y = x^4 + \frac{x^3}{3} + cx + K$

Particular solution :-

Solve $\frac{dy}{dx} = \cos x$, given that $y = 2$ when $x = 0$

$\Rightarrow \int dy = \int \cos x\,dx$

$\Rightarrow \boxed{y = \sin x + c}$

$\Rightarrow 2 = \sin 0 + c$

$\Rightarrow 2 = 0 + c$

$\Rightarrow c = 2$

Hence the particular sol^n is $y = \sin x + 2$

Solve $\frac{d^2y}{dx^2} = 6x$ given that $y = 1$, $\frac{dy}{dx} = 2$ when $x = 0$

let $\frac{dy}{dx} = p$

$\frac{d}{dx}\left(\frac{dy}{dx}\right) = 6x$

$\Rightarrow \frac{d}{dx}p = 6x \Rightarrow \int dp = \int 6x\,dx$

$\Rightarrow p = 6\frac{x^2}{2} + c \Rightarrow p = 3x^2 + c$

$\Rightarrow \frac{dy}{dx} = 3x^2 + c \Rightarrow \int dy = \int 3x^2 + c\,dx$

$\Rightarrow y = 3\frac{x^3}{3} + cx + K$

$\Rightarrow y = x^3 + cx + K$

$\Rightarrow 1 = 0 + 0 + 0 + K$

$\Rightarrow \boxed{K = 1}$

$\Rightarrow \frac{dy}{dx} = 3x^2 + c \Rightarrow 2 = 0 + c$

$\Rightarrow c = 2$

Hence particular solution $y = x^3 + 2x + 1$

(imp) **Type - 06**

$\boxed{\text{Solve } \frac{dy}{dx} = f(ax+by+c)}$

Q solve $\frac{dy}{dx} = \cos(x+y)$ let $x+y = t$

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$\Rightarrow \frac{dt}{dx} - 1 = \cos t$

$\Rightarrow \frac{dt}{dx} = 1 + \cos t$

$\Rightarrow \int \frac{dt}{1+\cos t} = \int dx$

$\Rightarrow \int \frac{dt}{2\cos^2 \frac{t}{2}} = \int dx$

$\Rightarrow \frac{1}{2} \cdot \frac{\tan t/2}{1/2} = x + C$

$\Rightarrow \tan t/2 = x + C$

$\Rightarrow \frac{dt}{dx} - 1 = \frac{dy}{dx}$

$\Rightarrow \frac{dt}{dx} - 1 = \frac{dy}{dx}$

$\Rightarrow \frac{1}{2} \int \sec^2 \frac{t}{2}\, dt = \int dx$

IMP

Type -07 · Homogeneous Differential equation

solve $\boxed{\frac{dy}{dx} = \frac{f(x,y)}{g(x,y)}}$

Q solve $(x+y)\,dy + (x-y)\,dx = 0$

$\Rightarrow (x+y)\,dy = -(x-y)\,dx$

$\Rightarrow \frac{dy}{dx} = \frac{y-x}{x+y}$ (Homogeneous)

let $y = vx$

$\Rightarrow \frac{d(vx)}{dx} = \frac{(vx) - x}{x + (vx)}$

$\Rightarrow x\frac{dv}{dx} + v = \frac{x[v-1]}{x[v+1]}$

$\Rightarrow x\frac{dv}{dx} = \frac{[v-1]}{[v+1]} - v$

$\Rightarrow x\frac{dv}{dx} = \frac{v-1-v-v^2}{1+v}$

$\Rightarrow x\frac{dv}{dx} = \frac{-(1+v^2)}{1+v}$

~~let $y = vx$~~

$\Rightarrow \int \frac{1+v}{1+v^2}\,dv = -\int \frac{1}{x}\,dx$

$\Rightarrow \int \frac{1}{1+v^2}\,dv + \frac{1}{2}\int \frac{2v}{1+v^2}\,dv = -\int \frac{1}{x}\,dx$

$\Rightarrow \tan^{-1} v + \frac{1}{2}\ln|1+v^2| = -\ln x + C$

$\Rightarrow \tan^{-1}\frac{y}{x} + \frac{1}{2}\ln\left|1 + \frac{y^2}{x^2}\right| = -\ln x + C$

$\Rightarrow \tan^{-1}\frac{y}{x} + \ln\left(\frac{x^2+y^2}{x^2}\right)^{1/2} = -\ln x + C$

$\Rightarrow \tan^{-1}\frac{y}{x} + \ln\sqrt{y^2+x^2} - \ln x = -\ln x + C$

$\Rightarrow (x^2 - y^2)\,dx + 2xy\,dy = 0$

$\Rightarrow 2xy\,dy = -(x^2 - y^2)\,dx$

$\Rightarrow \frac{dy}{dx} = \frac{-x^2-y^2}{2xy} \Rightarrow \frac{dy}{dx} = \frac{y^2-x^2}{2xy}$

$\Rightarrow \frac{d(vx)}{dx} = \frac{(vx)^2 - x^2}{2x(vx)}$ let $y = vx$

$\Rightarrow x\frac{dv}{dx} + v = \frac{x^2[v^2-1]}{2x^2v}$

$\Rightarrow x\frac{dv}{dx} + v = \frac{[v^2-1]}{2v}$

$\Rightarrow x\frac{dv}{dx} = \left[\frac{v^2-1}{2v}\right] - v$

$\Rightarrow x\frac{dv}{dx} = \frac{v^2-1-2v^2}{2v} \Rightarrow x\frac{dv}{dx} = \frac{-v^2-1}{2v}$

$\Rightarrow x\frac{dv}{dx} = -\frac{(1+v^2)}{2v}$

$\Rightarrow \int \frac{2v}{1+v^2}\,dv = -\int \frac{1}{x}\,dx \Rightarrow \ln|1+v^2| = -\ln x + \ln$

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$\Rightarrow \ln|1+v^2| = \ln\left(\frac{c}{x}\right)$

$\Rightarrow 1+v^2 = \frac{c}{x} \Rightarrow 1+\frac{y^2}{x^2} = \frac{c}{x}$

$\Rightarrow \frac{x^2+y^2}{x^2} = \frac{c}{x} \Rightarrow x^2+y^2 = cx$

Type - 05

Imp! $\left[\frac{dy}{dx} = \frac{a_1x+b_1y+c_1}{a_2x+b_2y+c_2} \left(\text{when } \frac{a_1}{a_2} = \frac{b_1}{b_2}\right)\right]$

Q $(2x+y+1)dx + (4x+2y-1)dy = 0$

$\Rightarrow (2x+y+1)dx = -(4x+2y-1)dy$

$\Rightarrow \frac{dy}{dx} = \frac{-(2x+y+1)}{(4x+2y-1)} \quad \left(\because \frac{2}{4} = \frac{1}{2}\right)$

$\Rightarrow \frac{dy}{dx} = \frac{-(2x+y+1)}{2(2x+y)-1}$

$z = 2x+y$

$\frac{dz}{dx} = 2+\frac{dy}{dx}$

$\Rightarrow \frac{dz}{dx} - 2 = \frac{dy}{dx}$

$\Rightarrow \frac{dz}{dx} - 2 = \frac{-(z+1)}{2z-1}$

$\Rightarrow \frac{dz}{dx} = \frac{-(z+1)}{2z-1} + 2$

$\Rightarrow \frac{dz}{dx} = \frac{-z-1+4z-2}{2z-1}$

$\Rightarrow \frac{dz}{dx} = \frac{3z-3}{2z-1}$

$\Rightarrow \frac{dz}{dx} = \frac{3(z-1)}{2z-1} \Rightarrow \int \frac{2z-1}{z-1}dz = \int 3\,dx$

$\Rightarrow \int 2 + \frac{1}{z-1}dz = \int 3\,dx$

$\Rightarrow 2z + \ln|z-1| = 3x+c$

Solve $(4x+6y+5)dx - (2x+3y+4)dy = 0$

$(4x+6y+5)dx = (2x+3y+4)dy$

$\Rightarrow \frac{dy}{dx} = \frac{4x+6y+5}{2x+3y+4}$

$\Rightarrow \frac{dy}{dx} = \frac{2(2x+3y)+5}{(2x+3y)+4}$

let $2x+3y = z$

$\frac{dz}{dx} = 2+3\frac{dy}{dx}$

$\Rightarrow \frac{\frac{dz}{dx}-2}{3} = \frac{dy}{dx}$

$\Rightarrow \frac{\frac{dz}{dx}-2}{3} = \frac{2z+5}{z+4}$

$\Rightarrow \frac{dz}{dx} - 2 = \frac{6z+15}{z+4} \Rightarrow \frac{dz}{dx} = \frac{6z+15}{z+4}+2$

$\Rightarrow \frac{dz}{dx} = \frac{6z+15+2z+8}{z+4} \Rightarrow \frac{dz}{dx} = \frac{8z+23}{z+4}$

$\Rightarrow \int \frac{z+4}{8z+23}dz = \int dx$

$\Rightarrow \int \frac{1}{8} + \frac{9/8}{8z+23}dz = \int dx$

$\Rightarrow \frac{1}{8}\int dz + \frac{9}{8}\int \frac{1\times 8}{8z+23}dz = \int dx$

$\Rightarrow \frac{1}{8}z + \frac{9}{64}\ln|8z+23| = x+c$

$\Rightarrow \frac{1}{8}(2x+3y) + \frac{9}{64}\log\{(16x+24y+23)\} = x+c$

Type - 09 Linear Diff. eqn

Working process

Step - 01

Reduce the given differential equation to its standard form.

$\frac{dy}{dx} + Py = Q$, where $P, Q = f(x)$

or $\frac{dx}{dy} + Px = Q$

Step - 02 Find the integrating factor

$I.F = e^{\int P dx}$ or $I.F = e^{\int P dy}$

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Date 28/04/2020
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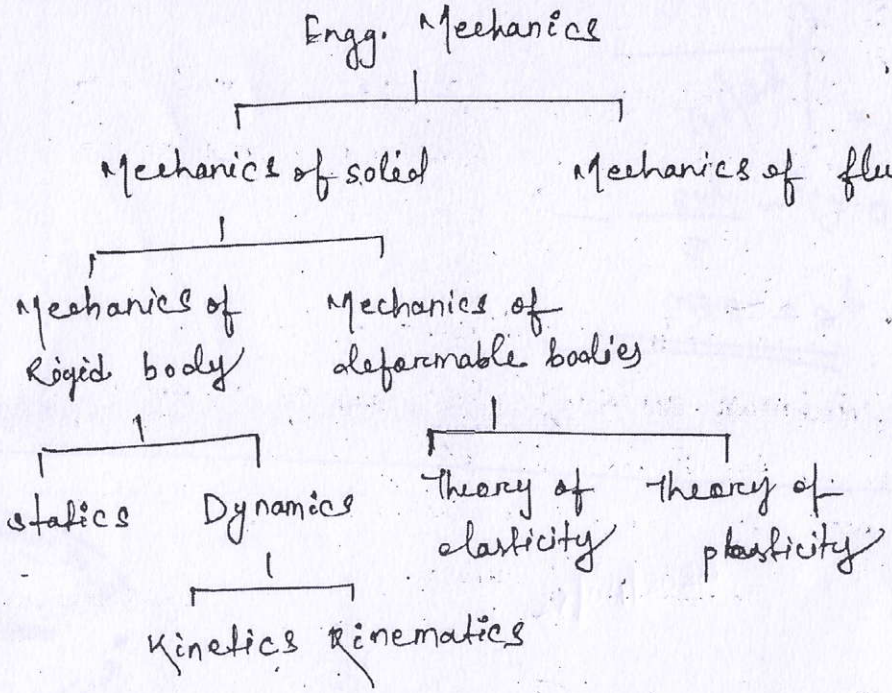
<FUNDAMENTALS OF ENGG. MECHANICS>

<CHAPTER-01>

- Mechanics may be defined as the branch of science which deals with the study of effect of forces on material bodies in state of rest or state of motion.
- Applications of laws of mechanics to field of problems / real life problem is termed as Engg. Mechanics.



Statics

It is that branch of mechanics that deals with the forces and their effect on body at rest.

Dynamics

It is the study of motion of rigid bodies & their relation with the forces causing them.

Kinetics

It deals with the laws of motion of bodies under the action of forces. It gives the relationship between forces & their resulting motions.

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Kinematics

It deals with the motion of bodies without considering the causes of motion.

Rigid Body

A rigid body is such that a solid body in which the distance between any two arbitrary points remains constant even if a force is applied to it.

Body

An object is an identifiable collection of matter ~~not~~ constrained by boundary called as body.

particle

A particle is defined as a material point or point mass with any dimensions or known as particle. When the size of the body is extremely small compared with its range of motion, it may in certain cases be considered as particle.

Some Important Terms in Mechanics

Mass : Mass is the quantity of matter in a body.

(∵ matter → substance of which physical bodies are composed)

denoted as (m)

Weight : It is force with which a body is attracted towards the center of the earth under its gravitational pull.

$(W) = m \times g$

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Time : Time is the measure of sequence of events. denoted as (t).

Space : Space refers to the geometrical region

length : The linear distance is known as length. denoted as (L).

Units & Dimensions

All physical quantities are divided into two groups.

Fundamental / basic quantities	Derived quantities
mass	speed, force
length	area, momentum
Time	volume
	velocity

Units

Units is defined as the numerical standard used to measure the quantitative dimensions of a physical quantity.

Types of unit system

M.K.S → meter - kilogram - sec.

C.G.S → centimetre - gram - sec

F.K.S → Foot - kilogram - sec

S.I → International system of units.

(* Most accepted unit system all over the world. It consist of 7 base units & 2 supplymentry units & a numbere of derived units

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Scalars & Vectors

Scalar

A scalar quantity is a physical quantity which needs only magnitude but no direction.

eg. Mass, area, volume, temperature, energy

Vector

A vector quantity is a physical quantity which needs both magnitude & direction for it's specification.

eg. velocity, displacement, accln, forces momentum etc..

It is represented as $\longrightarrow$

2) $v = u + at$

check

$\Rightarrow L^1T^{-1} = L^1T^{-1} + L^1T^{-2}\,T^1$

$\Rightarrow L^1T^{-1} = L^1T^{-1} + L^1T^{-1}$

2) $v^2 - u^2 = 2as$

$[LT^{-1}]^2 - [LT^{-1}]^2 = 2[LT^{-2}][L]$

or $L^2T^{-2} - L^2T^{-2} = 2L^2T^{-2}$

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1.2 ~~Chapter 2~~ FORCE

Force is defined as the external agency that changes or tends to change the state of rest or uniform straight line motion of a body of to which it is applied.

- force is a vector quantity, we can specify it
  → it's magnitude
  → it's point of application
  → the direction of its application.

Unit:

. $F = m \times a$ (Newton's 2nd law)

(C.G.S unit)

m → mass of a body

a → accelⁿ.

1 dyne = 0.00001 N

or 1 dyne = 10^{-5} N

or 1 N = 10^5 dyne.

In S.I unit 1 Newton.

$1\ N = 1\ kg \times 1\ m/s^2$

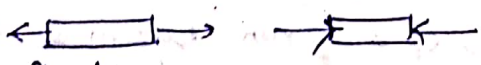
$1\ N = 1\ kg\ m/s^2$

Representation

Force is a vector quantity, the sign for a force is → or ← (straight line with arrow head)

Characteristics of force

1. Magnitude of force.
2. The direction of force or line of action of force. (i.e upward, downward, east, west etc)
3. Nature of Force. (either pull or push type)



4. Point of application
5. physical independence of a force.
6. Transmissibility of forces.
7. Superposition of forces
8. Reaction force generated by the action forces.

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Effect of a Force

A force may produce one or more of the following changes or effects in a body.

→ It may change the state of the body.
(If body at rest → motion
If body is in motion → accelerate)

→ It may change the direction of the motion of a body.

→ It may retard the forces. (de-acceleration)

→ The forces acting on a body, may give rise to internal stresses.

→ May produce turning effect.

Physical Independence of Force

~~If no. of forces acts on a particle simultaneously then the effect of each force in the group~~

The resultant of a number of forces will have the same effect as produced by all forces acts when acts individually / separately.

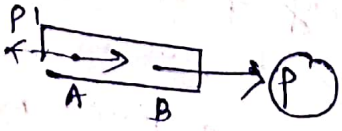
or

If a no. of forces are acting simultaneously on a particle, then the resultant of these forces will have the same effect as produced by all forces.

Principle of Superposition

The action of a given system of forces on a rigid body will not be changed if we add or subtract from them another system of forces in equilm.





does not change.

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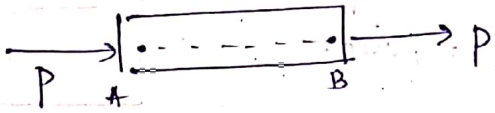
Theorem of Transmissibility of force

The point of application of a force may be transmitted along its line of action to another point without changing the effect of the force on any rigid body to which it may be applied.



Action & Reaction

Newton's 3rd Law:

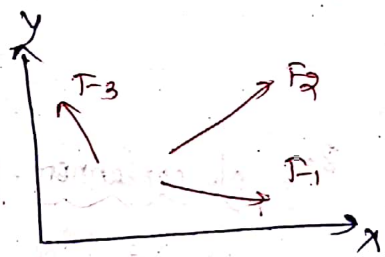
"To every action, there is an equal & opposite reaction."

Any force or action causes an equal & opposite force from the support or point of application.

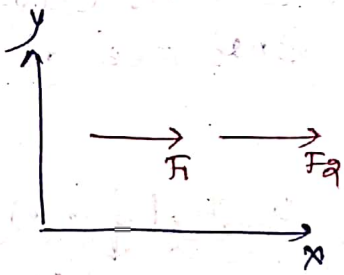
System of Forces

Type of Force

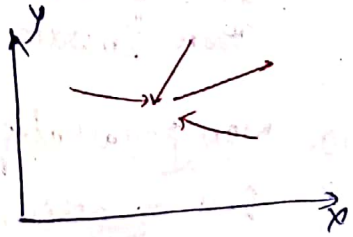
1. coplaner —
whose line of action lies on the same plane. It may be ∥ or non ∥.



2. colinnear —
whose line of action lies on the same line



5. concurrent —
The forces which meet at a single point —



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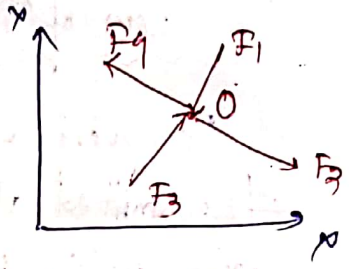
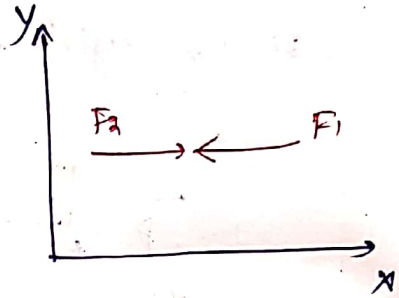
4. Coplannere Cocurrent

The forces which meet at one point & also their line of action lies in one plane.



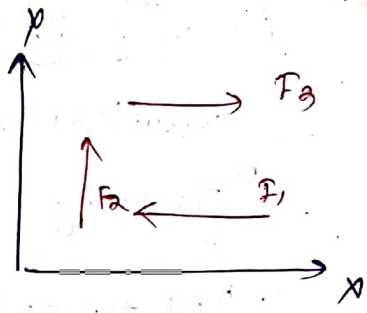
5. collinear concurrent

The forces whose line of action meet at one point.



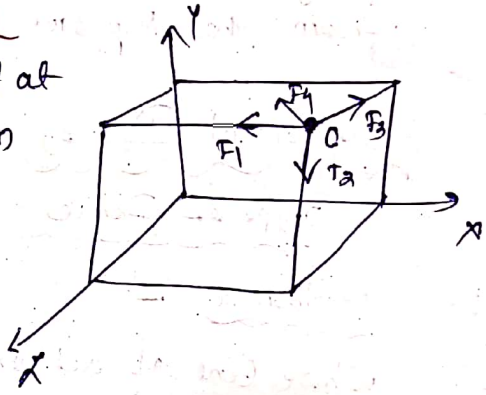
6. Coplannere non concurrent

The forces whose line of action do not meet at a point.



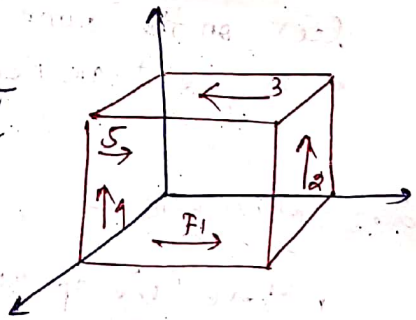
7. Non coplannere concurrent

whose line of action meet at one point but do not lie in same plane.



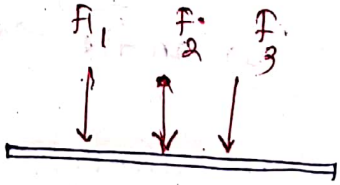
8. No coplannere non concurrent

Whose line of action do not lie on the same plane & they donot meet at one point



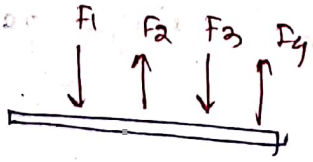
9. Parallel forces

line of action are || to each other in same direction.



10. Non parallel forces

line of action || to each each other but directed in opposite direction.



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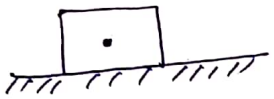
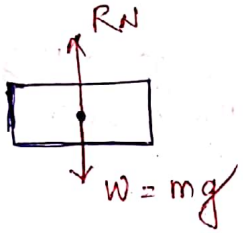
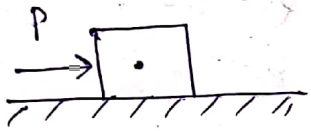
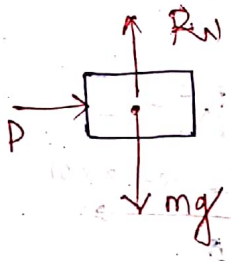
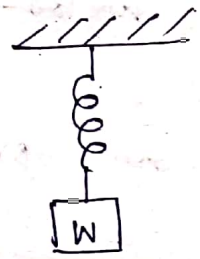
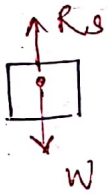
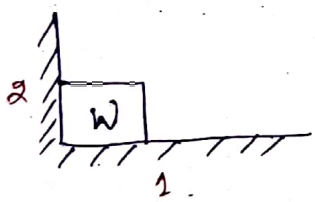
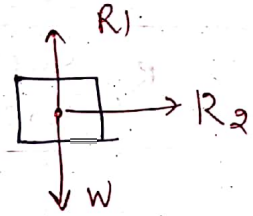
Freebody Diagram

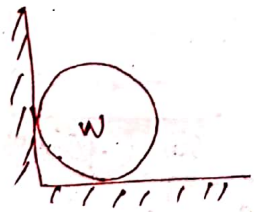
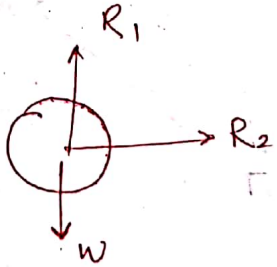
Freebody diagram is a sketch of the isolated body, which shows the external forces on the body & the reaction forces acting on it.

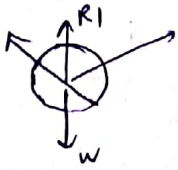
1)  ⇒ 

2)  ⇒ 

3)  ⇒ 

4)  ⇒ 

5)  ⇒ 

6)  ⇒ 

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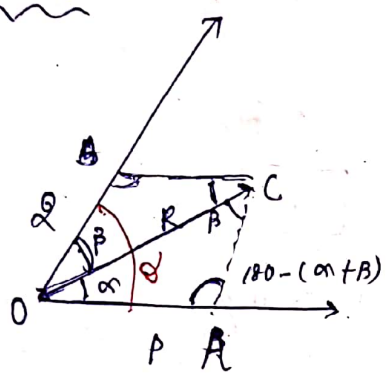
1.3 RESOLUTION OF FORCES

- Resolution is the process of splitting of a given force into a set of forces or a number of components with out changing its effect on the body.

- A force is generally resolved along two mutually perpendicular directions.

Case-1



$OA = P$

$OB = Q = AC$

$OC = R$

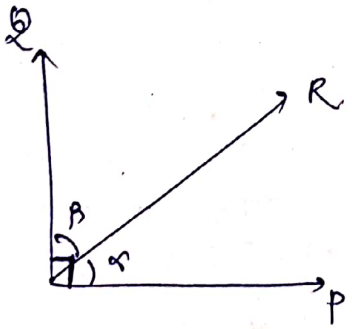
In ΔAOC $\quad \frac{OA}{\sin\beta} = \frac{AC}{\sin\alpha} = \frac{OC}{\sin\{180-(\alpha+\beta)\}}$

$\Rightarrow \frac{P}{\sin\beta} = \frac{Q}{\sin\alpha} = \frac{R}{\sin(\alpha+\beta)}$

$$P = R\frac{\sin\beta}{\sin(\alpha+\beta)}$$

$$Q = R\frac{\sin\alpha}{\sin(\alpha+\beta)}$$

Case-2



$\alpha+\beta = 90^\circ$

$\beta = 90^\circ - \alpha$

$P = R\frac{\sin(90-\alpha)}{\sin(90+0)} = 1$

$$P = R\cos\alpha$$

$Q = \frac{R\sin\alpha}{\sin 90^\circ} \Rightarrow$

$$Q = R\sin\alpha$$

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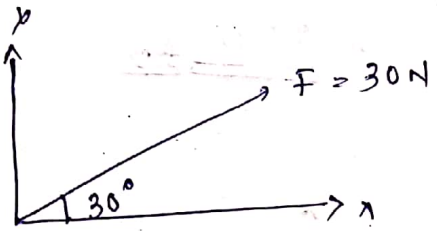
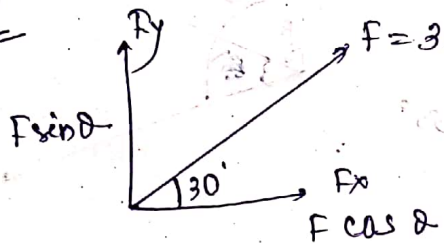
Though resolution of force is possible in any given directions, we frequently use resolution with rectangulare components, which are always perpendicular to each other.

1)



Soln

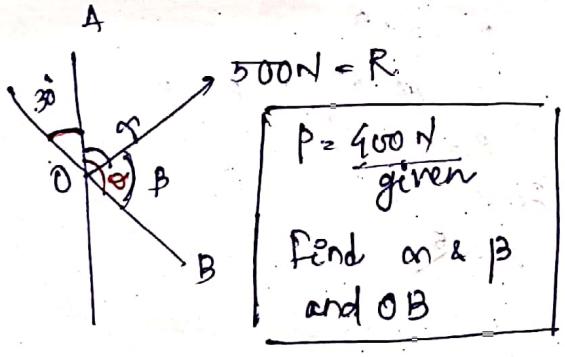


$F_x = F \cos\theta = 30 \times \cos 30^\circ = 25.98$ AN

$F_y = F \sin\theta = 30 \times \sin 30^\circ = 15$ AN

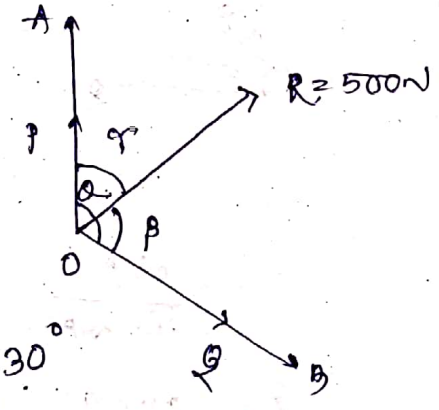
$F = F_x + F_y$

2)



P = 400 N given

Find α & β and OB



$\sin\beta = \frac{P}{R} \sin\theta$ $\quad \theta = 180 - 30^\circ$

$= 150^\circ$

$= \frac{400}{500} \sin 150^\circ$

$= 0.8 \times \sin 150^\circ$

$= 0.4$

$\beta = \sin^{-1} 0.4$

$= 23.57$

$\alpha + \beta = \theta$

$\alpha = \theta - \beta$

$= 150 - 23.57$

$\alpha = 126.42$

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1.4 COMPOSITION OF FORCES

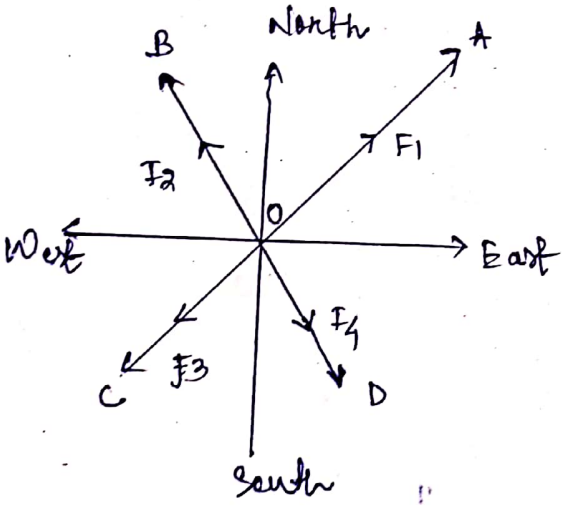
- The process of reduction of a given system of forces to a single force which could replace all other forces and produce the same effect as produced by the system of forces is called composition of forces.
- The single force is called as resultant force.

Space diagram

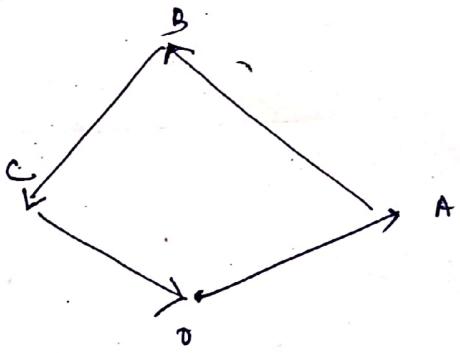
It is a position diagram showing the various forces along with their magnitude, point of application & line of action.

Vector diagram

It is a vector diagram corresponding to a space diagram.



Space diagram



vector diagram

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Laws for Composition of Forces

There are three laws for composition of forces & hence determine of resultant of a system of concurrent forces.

They are

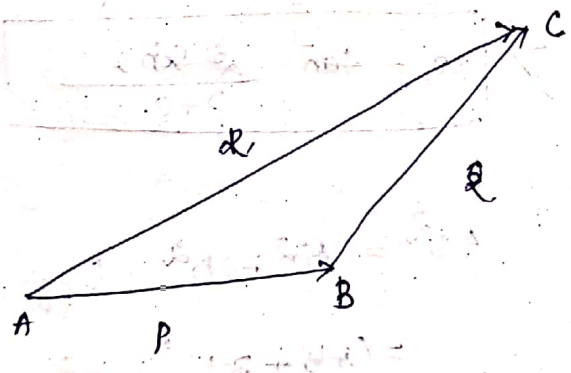
i) Triangle law of composition of forces

ii) parallelogram " " "

iii) Polygon " " "

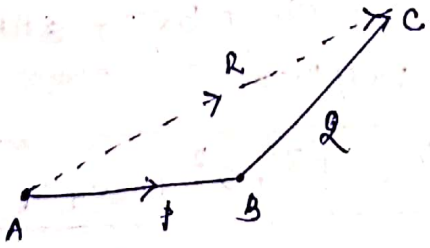
1) Triangle law of composition of forces statement

If the forces, are represented both in magnitude & direction, by the two sides of a triangle taken in the same order, their resultant is resultant (in magnitude and direction) by the third side of the triangle taken in the opposite order.



$R = P + Q$

Analytical Methods → consider 2 forces acting on same order.



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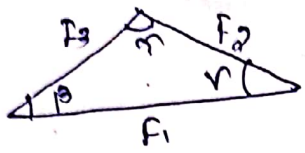
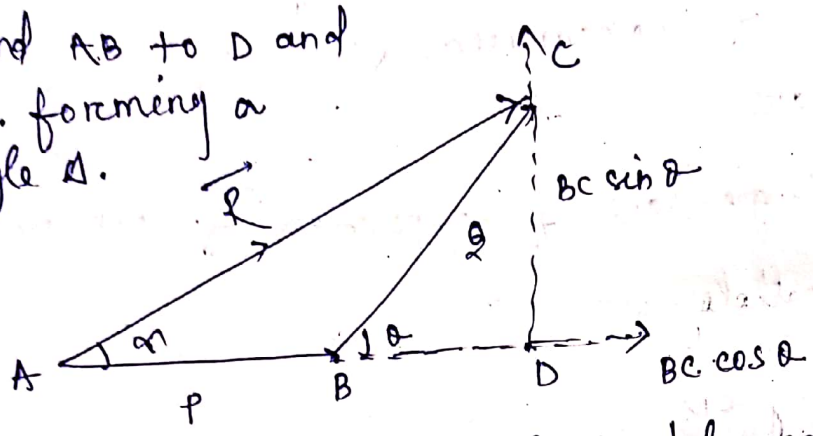
Let for sine law



$$\frac{F_1}{\sin\alpha} = \frac{F_2}{\sin\beta} = \frac{F_3}{\sin\gamma}$$

Now extend AB to D and Join CD. forming a right angle Δ.



$\vec{Q}$ makes angle θ with horizental. and

$\vec{R}$ makes angle α " with $\vec{P}$.

$$\tan\alpha = \frac{CD}{AD} \quad (\text{In } \Delta ADC)$$

$$= \frac{CD}{AB+BD} = \frac{BC\sin\theta}{AB+BD} = \frac{BC\sin\theta}{P+BC\cos\theta}$$

$$\Rightarrow \tan\alpha = \frac{BC\sin\theta}{P+BC\cos\theta} = \frac{Q\sin\theta}{P+Q\cos\theta}$$

$$\Rightarrow \tan^{-1} \Rightarrow \boxed{\alpha = \tan^{-1}\frac{Q\sin\theta}{P+Q\cos\theta}}$$

By in ΔADC $\quad AC^2 = AD^2 + CD^2$ (pythagoras theorem)

$$= (AB+BD)^2 + CD^2$$

$$= AB^2 + BD^2 + 2\cdot AB\cdot BD + CD^2$$

$$= AB^2 + BD^2 + CD^2 + 2AB\cdot BD$$

$$= AB^2 + BC^2 + 2AB\cdot BC\cos\theta$$

Replacing with vectors.

$$\boxed{R^2 = P^2 + Q^2 + 2PQ\cos\theta}$$

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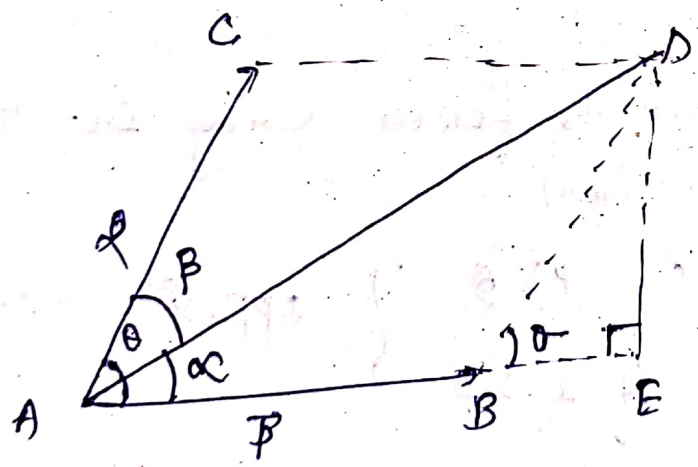
Parallelogram Law of composition of forces

Analytical

Consider 2 forces $\vec{P}$ & $\vec{Q}$ are acting on two sides of a ||gram, at point A, at an angle θ.



$AC = BC$

$AB = CD$

Let BD makes an angle α with area horizontal..

extend AB upto E & join DE.

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Now in ΔDEA is an rightangled Δ.

Acc. to pythagoras.

$$AD^2 = ED^2 + AE^2$$
$$= (AB + BE)^2 + ED^2$$
$$= AB^2 + BE^2 + 2 \cdot AB \cdot BE + ED^2$$
$$= AB^2 + BE^2 + ED^2 + 2AB \cdot BE$$
$$= AB^2 + BD^2 + 2 \cdot AB \cdot BD \cos\theta$$

$BE = BD\cos\theta$, $DE = BD\sin\theta$

$$\Rightarrow AD^2 = AB^2 + BD^2 + 2 \cdot AB \cdot BD \cos\theta$$
$$\Rightarrow \boxed{R^2 = P^2 + Q^2 + 2 \cdot P \cdot Q \cos\theta}$$

$$\Delta AED \quad \tan\alpha = \frac{ED}{AE} = \frac{BD\sin\theta}{AB + BE} = \frac{BD\sin\theta}{AB + BD\cos\theta}$$

$$\Rightarrow \boxed{\alpha = \tan^{-1}\frac{Q\sin\theta}{P + Q\cos\theta}}$$

Special cases

1) when 2 forces P & Q acts at very small angle $\theta \approx 0^\circ$ then.

$R^2 = P^2 + Q^2 + 2PQ$ when the forces acting in same direction)

$\Rightarrow R = \sqrt{P^2 + Q^2 + 2PQ}$

$R = \sqrt{(P+Q)^2}$ $R = P - Q$ if $P > Q$ } opposite direction

$\Rightarrow R = P + Q$ $R = Q - P$ if $Q > P$. }

$\theta = 0^\circ$ $R^2 = P^2 + Q^2 + 2PQ\cos 0^\circ$. $\cos\theta^\circ = 0^\circ = 1$

$$\Rightarrow R^2 = (P+Q)^2$$
$$\Rightarrow R = (P+Q)$$

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$\theta = 180^\circ$

$R^2 = P^2 + Q^2 + 2PQ \cos 180^\circ$

$= P^2 + Q^2 - 2PQ$

$R^2 = (P-Q)^2$

$\Rightarrow R = P - Q$

$\theta = 90^\circ$

$R = P^2 + Q^2 + 2PQ \cos 90^\circ$

$R = \sqrt{P^2 + Q^2}$

Composition of Forces by Method of Resolution.

When a no. of forces acting at a point can be obtained easily by resolving each of the forces into their respective rectangular components.

$\Sigma F_x = F_{x1} + F_{x2} + F_{x3} + \cdots$

$\Sigma F_y = F_{y1} + F_{y2} + F_{y3} + \cdots$

$R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$\tan\theta = \frac{\Sigma F_y}{\Sigma F_x}$

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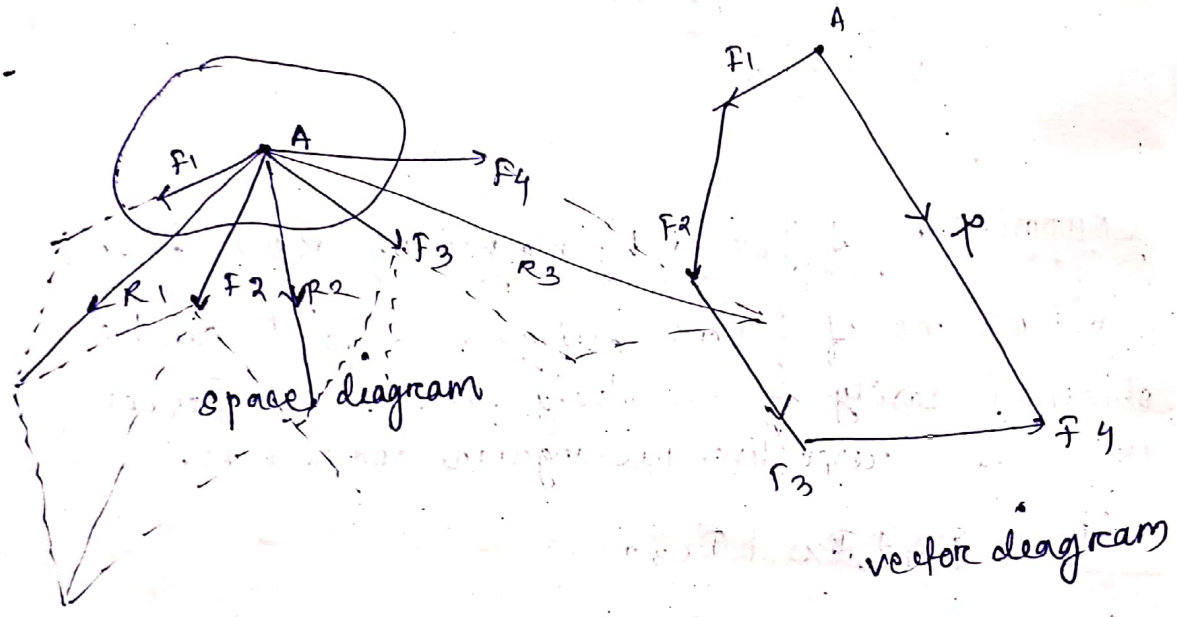
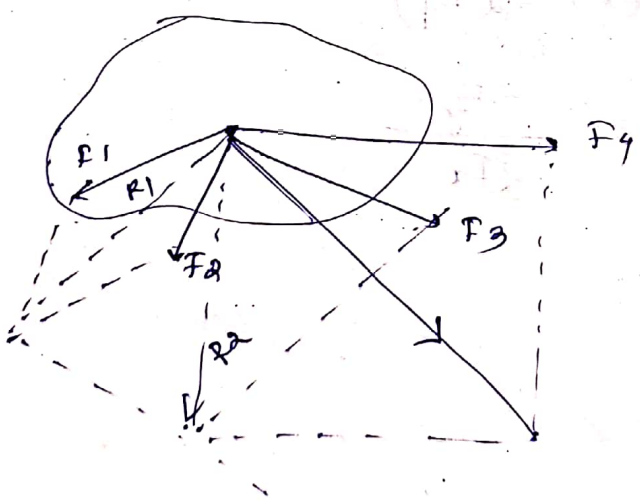
3) Polygon Law of forces

If a no. of forces acting symeltaneously at a point are represented by the side of an open polygon, all taken in same order, then their resultant is represented by the closing side of the polygon taken in opposite order.





take R_1 by F_1 & P_2
take R_2 by R_1 & F_3
take R_3 by R_2 & F_4

by ||gram methode.

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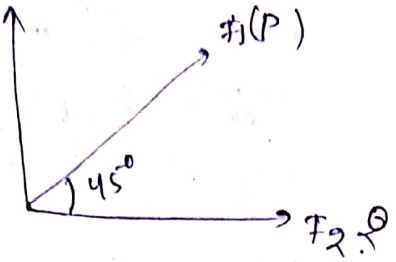
2) Two forces of 4N & 6N making an angle 45° with each other. Determine resultant force.



$R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$= 4^2 + 6^2 + 2 \times 24 \times \cos 45^\circ$

$\Rightarrow R^2 = 16 + 36 + 33.94$

$\Rightarrow R = 9.27\ N$ Ans

$$\tan\alpha = \frac{Q\sin\theta}{R + Q\cos\theta} = \frac{6 \times \sin 45^\circ}{4 + 6 \times \cos 45^\circ}$$

$$= \frac{6 \times 0.707}{4 + 4.24}$$

$$= \frac{4.242}{8.24} = 0.51$$

$\Rightarrow \alpha = \tan^{-1} 0.51$

$\Rightarrow \alpha = 27.02$

3) Resultant of two forces acting at right angle is given by 1000 N. The magnitude of both forces is same. Determine the magnitude of the forces & angle of the resultant.

Sol:

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$F_1 = F_2 = F$

$$R = \sqrt{F^2 + F^2 + 2F^2\cos 90^\circ}$$

$\Rightarrow (1000)^2 = 2F^2 + F^2 + 2F^2\cos 90^\circ$

$\Rightarrow 2F^2 = (1000)^2$

$\Rightarrow F = 707.2\ N$

$$\tan\alpha = \frac{F\sin\theta}{F + F\cos\theta} = \frac{707 \times \sin 90^\circ}{707 + 707 \times \cos 90^\circ}$$

$= 1$

$\Rightarrow \alpha = 45^\circ$

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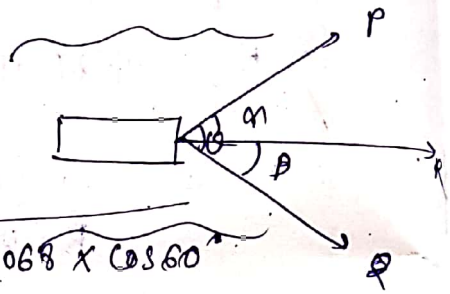
Q) A boat is moving uniformly along a canal by two ropes pulling with forces $P = 890\ N$ & $Q = 1068\ N$ acting with an angle $60°$ betⁿ them. Determine the magnitude of resultant pull on the boat & the angle α & β as shown in fig.

$P = 890\ N \qquad \theta = 60°$

$Q = 1068\ N$



$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$

$$\Rightarrow R = \sqrt{(890)^2 + (1068)^2 + 2 \times 890 \times 1068 \times \cos 60°}$$

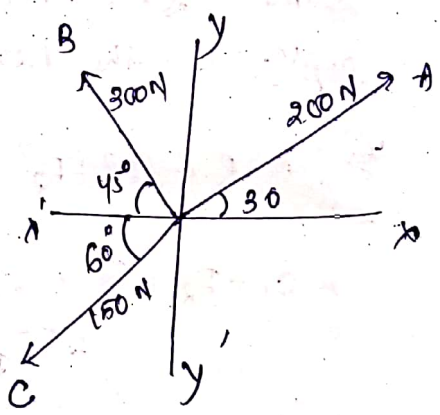
$$\Rightarrow R = 1689\ N$$

$$\alpha = \tan^{-1}\frac{Q\sin\theta}{P + Q\cos\theta} = \tan^{-1} 0.65$$

$$\Rightarrow \alpha = 33°$$

$$\Rightarrow \beta = 60° - 33° = 27°$$

Q)



$$\Sigma F_x = 200\cos 30° + 300\cos 45° - 150\cos 60°$$

$$= -113.9\ N$$

$$\Sigma F_y = 200\sin 30° + 300\cos 45° - 150\cos 60°$$

$$= 182.2\ N$$

$$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = 217\ N$$

$$\tan\theta = \frac{\Sigma F_y}{\Sigma F_x}$$

$$\Rightarrow \theta \approx 60°$$

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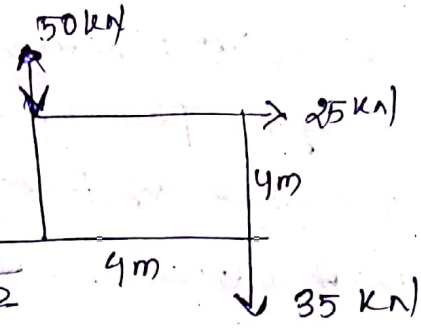
Q) $\Sigma H = 25 - 20 = 5\,kN$

$\Sigma V = -50 + (-35)$

$= -85\,kN$

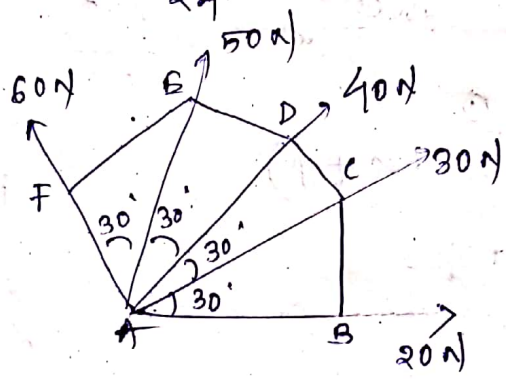


$R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} = \sqrt{5^2 + (-85)^2}$

$= 85.15\,kN$

$\tan\theta = \frac{\Sigma V}{\Sigma H} \Rightarrow \theta = \tan^{-1}\frac{\Sigma V}{\Sigma H} = 86.6^\circ$

Q)



$\Sigma H = 20\cos 0^\circ + 30\cos 30^\circ + 40\cos 60 + 50\cos 90^\circ + 60\cos 120^\circ = 36.0\,N$

$\Sigma V = 20\sin 0 + 30\sin 30 + 40\sin 60 + 50\sin 90 + 60\sin 120^\circ$

$= 151.6\,N$

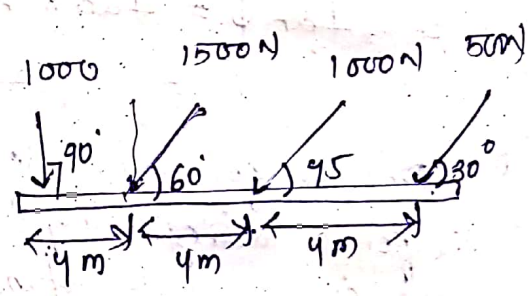
$R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} = 155.8\,N$

$\theta = \tan^{-1}\frac{\Sigma V}{\Sigma H} = 76.6^\circ$ Ans

ΣH = +ve, ΣV = +ve } Resultant lies bet^n 0 to 90°

Q) $\Sigma H = 1000 + 1500\cos 60^\circ + 1000\cos 45^\circ + 500\cos 30^\circ$

$= 1890\,N$



$\Sigma V = 1000 + 1500\sin 60^\circ + 1000\sin 45^\circ + 500\sin 30^\circ = 3256\,N$

$R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} = 3765\,N$ $\theta = \tan^{-1}\Sigma V/\Sigma H = 59.89$

θ will be° 0 to 90°

$R\bar{x} = 1000\times 0 + 1500\times\sin 60^\circ\times 4 + 1000\times\sin 45^\circ\times 8 + 500\sin 30^\circ\times 12$

$\bar{x} = 4.2500$ m

Find the magnitude, direⁿ & position of Resultant force.

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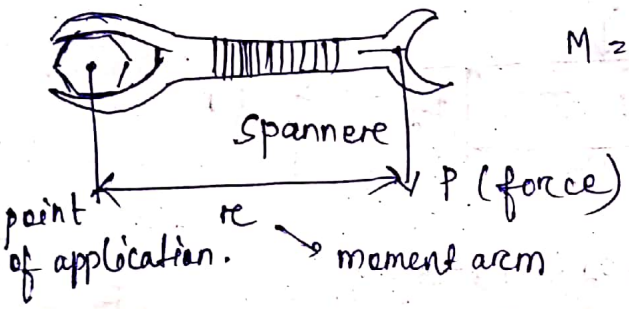
1.5 MOMENT OF A FORCE & COUPLE

The moment of a force with respect to a point is equal to the product of the magnitude of the force & perpendicular distance from the point to the line of action of the force.

$M = P * S$ $\quad P \rightarrow$ acting on the body

$S \rightarrow \perp$ distance bet^n the point, about which the moment is req & the line of action of the force.



$M = P \times r$

Units

$M = P \times r$

= Newton x meter

= NM or KN-m.

Types of Moment

1) clockwise

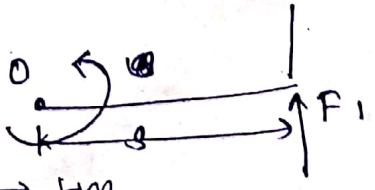
The moment of a force whose effect is to turn or rotate about the moment center in clock direc^n.



Sign convention → −ve

2) Anticlockwise

The moment of a force whose effect is to turn about the moment center in anticlockwise direc^n.



→ +ve

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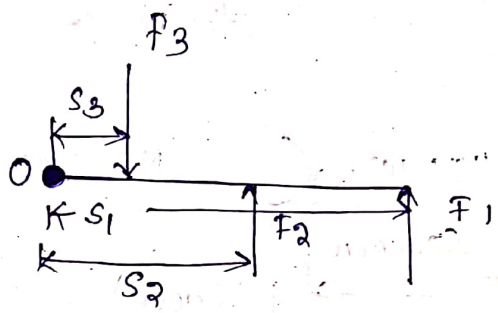
For rotary motion two quantities are always needed i.e force & moment. These two quantity combined in to a single term known as torque (M) moment or torque (τ)

Combinations of Moment

When general forces, in one plane, are involved it is seen that some forces tend to rotate clockwise direⁿ & some tend to produce anticlockwise direⁿ about the same center.

So net torque or moment of several forces about a common moment center.

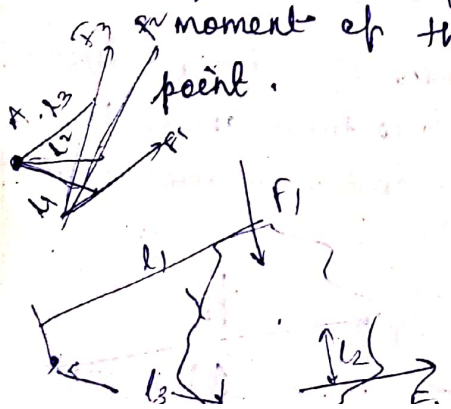


$\tau = F_1 S_1 + F_2 S_2 - F_3 S_3$

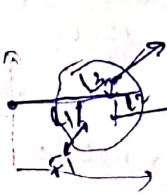
$F_1 \rightarrow$ ↻
$F_2 \rightarrow$ ↻
$F_3 \rightarrow$ ↺

Varignon's Theorem <Law of moments>

If a no. of coplanner forces act simultaneously on a particle, the algebraic sum of the moments of all the forces about any point is equal to the moment of their resultant forces about the same point.



$$\Sigma M^F = M^R$$



$$R \times x = F_1 l_1 + F_2 l_2 + F_3 l_3$$

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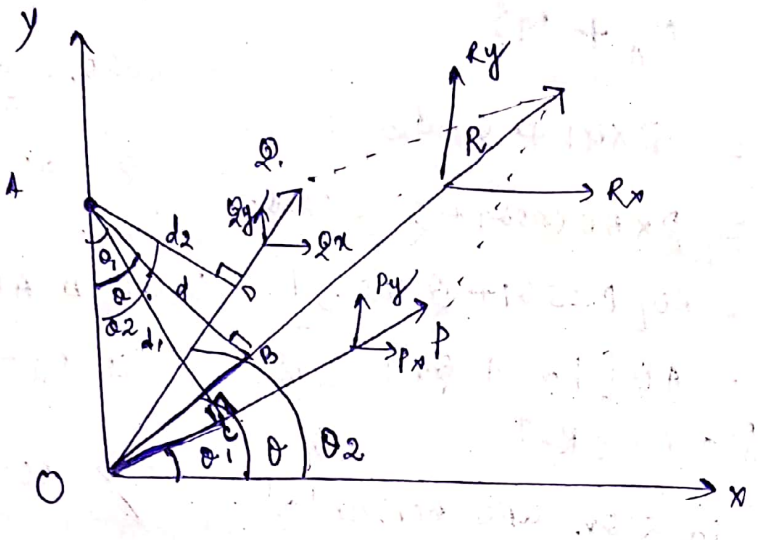

Let two forces P & Q are acting at a point O. Now by taking IInd gm law by projecting P & Q, we get a point, which is the resultant of P & Q.

Let angle of inclination of P with x axis = θ_1

R " " " = θ

Q " " " = θ_2

arbitary

- Now Let a point A on y axis, at which we will calculate the moment of P & Q.
- Now draw ⊥ line to P, Q & R from point A.

Acc to varignon theorem the moment by P & Q at A is equal to moment by R.

Moment of P at A = $M_A^P = P \times d_1$ ——①

" " Q " A = $M_A^Q = Q \times d_2$ ——②

" " R " A = $M_A^R = R \times d$

— — — — — = $R \times AO \cos\theta$

From ΔAOB $\cos\theta = \frac{d}{AO}$ = $AO \times R\cos\theta$

$\Rightarrow d = AO\cos\theta$ = $AO\,Rx$ ——③



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Adding equation ① & ②

$$\sum M_A^F = M_A^P + M_A^Q$$

$$= P \times d_1 + Q \times d_2$$

$$= P \times AO \cos\theta_1 + Q\, AO \cos\theta_2$$

$$= AO[P\cos\theta_1 + Q\cos\theta_2]$$

$$= AO[P_x + Q_x] \quad \text{—} ④$$

$$\sum M_A^P = AO[R_x] \quad \text{——} ⑤$$

P_x & Q_x are horizental component of P & Q.

Where $P_x + Q_x = R_x$ all the horizental components

From ΔAOC

$$\cos\theta_1 = \frac{d_1}{AO}$$

$$\Rightarrow d_1 = AO\cos\theta$$

From ΔAOD

$$\cos\theta_2 = \frac{d_2}{AO}$$

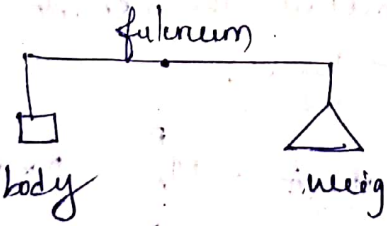
$$\Rightarrow AO\cos\theta_2 = d_2$$

From equation ③ & ⑤

$$\boxed{\sum M_A^P = M_A^R}$$

Levers

A lever is a riegid body (bar) (straight, curved or bent) and is hinged at one point (fulcrum). It is free to rotate about the fulcrum. Some common eg. of levers are scisor, weighing balance, tongue etc.



Eg

A uniform rectangular bar AB is placed over a fulcrum at a distance of 20cm from end A. A load of 30N is suspended at end B. what is the magnitude of force applied at end A. so the bar remains horizental?

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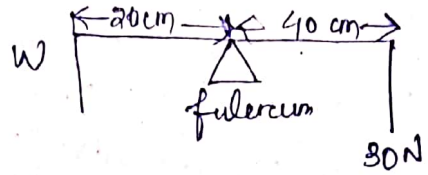
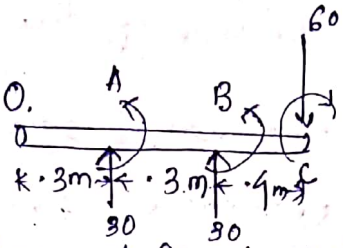
$W \times 20 = 30 \times 40$ cm

$\Rightarrow W = \frac{30 \times 40^{2}}{20} = 60$ N Ans



eg:2 A uniform rod OABC of length 1m is hinged at O. A force 30N at A & 30 N at B are applied at distances 0.3m & 0.6m from the end O. Another force of 60 N is applied at the end C. What is the moment of the forces about O.



Sol? pt A & B produces the moment while C produces -ve moment.

So $M = 30N \times 0.3m + 30N \times 0.6m - 60 \times 1m$

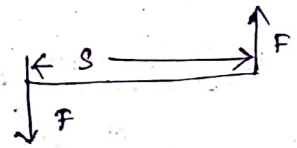
$= -33$ Nm Ans

clockwise moment of magnitude 33 Nm.

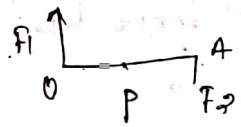
COUPLE

- A pair of equal and unlike parallel forces is known as a couple.

→ The perpendicular distance bet^{n} both forces called as arm of couple.



→ The plane to which the forces are acting are called plane of couple.



$F_1 \times OP + F_2 \times AP = 0$

$(\because F_1 = F_2 = F_1)$

Moment of couple

The magnitude of torque is given by $= F_1 \times OP + F_1 \times AP$

$= F_1 (OP + AP)$

$= F_1 \times OA$

$\tau = F \cdot S$

= Force x perpendicular distance. (Nm)

- It may be +ve or -ve depending upon direct^{n}.

(anticlock) (clockwise)

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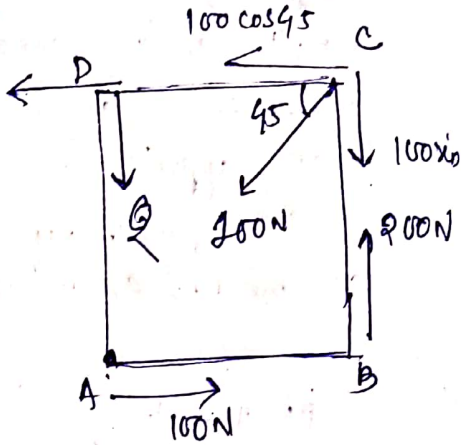
2) A square ABCD has forces acting as shown in fig. find values of P & Q. If the system reduces to a couple. Also find the magnitude of the couple. If the side of the square is 1m.



Sol) each side of square → 1m.

Resolving all horizontal forces.

$100 - 100\cos45' - P = 0$

$\Rightarrow P = 100 - 100\cos45'$

$= 100 - 70.71$

$= 29.28\ N$

Resolving all vertical forces

$200 - 100\sin45' - Q = 0$

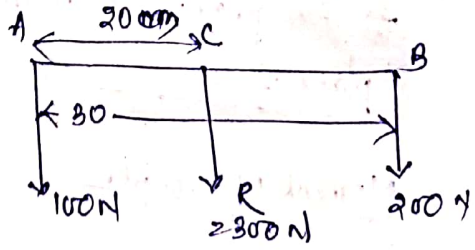
$\Rightarrow Q = 200 - 100\sin45'$

$= 129.3N$

By taking moments about A.

$200 \times 1 +$

2) Two like ||^{el} forces of 100N & 200N act as the ends of a rod of 30cm long. Find the magnitude of the resultant & the line of action.



Sol) Since both the ||^{el} forces has have same diren. of

$R = F_A + F_B$

$= 300N$

Let R acts at pt C.

Taking moment at A.

$200 \times AB + 0 = 300 \times AC$

$\Rightarrow 200 \times 30 = 300 \times AC$

$\Rightarrow AC = \frac{200 \times 30}{300} = 20\ cm$

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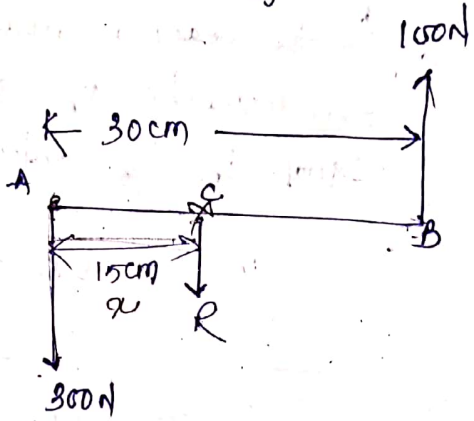
Resultant of parallel Forces

Q) Two unlike parallel forces of magnitude 300 N & 100 N are acting in such a way that their line of actions are 30 cm apart. Determine the magnitude & localation of the resultant.



Sol^n Both the forces are in opposite direc^n.

So $R = P - Q$

$= 300 - 100 = 200N$

Let R acts at pt. C.

By taking moment at A.

$100 \times BA + 0 = R \times AC$

$\Rightarrow 100 \times BA = 200 \times AC$

$\Rightarrow 100 \times 30 = 200 \times AC$

$\Rightarrow AC = 15cm$ Ans

~~$100 \times 30 = 300 \times x$~~

~~$\Rightarrow x = \frac{3000}{300}$~~

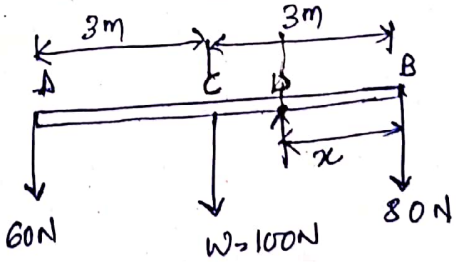
$100 \times (30 - x) = 300 \times x$

$\Rightarrow 3000 - 100x = 300x$

$\Rightarrow 3000 = 200x$

$\Rightarrow x = 15$ ✓

Q) A uniform beam AB of weight 100 N & 6m long has two bodies of weight 60N & 80N suspended from its two ends as shown in fig. Find at what point the beam should be supported so that it may rest horizontally



Sol^n Weight of rod AB = 100 N.

Length of the AB = 6m and weights of bodies suspended at A & B are 60N & 80N.

$80 \times x = 100 \times (3 - x) + 60 \times (6 - x)$

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Let x = distance between B & D., where the beam should be supported.

The force due to weight of the body, 100N, acts at the mid point of the beam at C.

As the beam is resting horizontally the clockwise -ve moments of the forces above D, should be equal to the anticlockwise moment of the forces.

So $80x = 60(6m - x) + 100(3m - x)$

$= 360m - 60x + 300 - 100x$

$\Rightarrow 240x = 660\,m$

$\Rightarrow x = \frac{660}{240} = 2.75m$ Ans

So, the beam can be balanced at a distance of 2.75m from the 80N force.

Properties of a couple

↳ The algebraic sum of the forces constituting the couple is zero.

↳ A couple can not be balanced by a single force.

↳ The algebraic sum of the moments of the force constituting the couple about any point is same and equal to moment of the couple itself.

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CHAPTER-02 EQUILIBRIUM OF FORCES

2.1 If a system of forces acting simultaneously on a body produces no change in the state of rest or the state of motion of the body, the system of forces is said to be in equilm.

A system of forces can be in equilm under two situations.

↳* If the resultant of a number of forces acting at a point is zero.

↳ When the resultant of a system of forces applied on a particle has a non-zero value, then the particle will remain at rest by applying a force equal in magnitude but opposite in dirn of the resultant.

Principles of Equilibrium

Two-force principle

When a body is acted upon by two, equal opposite collinear forces, the resultant force is zero. The system of forces is said to be in equilibrium.

Three Force principle

Three non-parallel forces will be in equilm when they lie in one plane, intersect at one point and their free vectors form a closed triangle.

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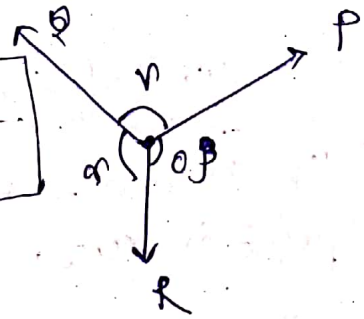
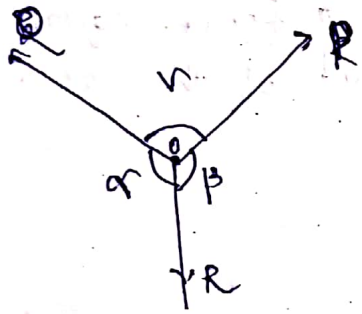
2.2 Lami's Theorem

If three coplanner concurrent forces are acting on a body kept in equilibrium, then each force is proportional to the sine angle between other two forces and the const. of proportionality is the same.

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma} = k = \text{const.}$$



proof

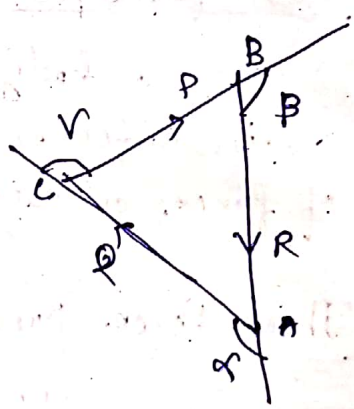


Let forces P, Q, R acting at point O.

since P, Q, R are in equilibrium the triangle of forces should be a closed one. (vector diagram)

Draw a line AB ∥ to force R.

From end A draw a line ∥ to Q. name it AC. From 'C' draw a line ∥ to P. It will intersect the line AB at B.



$\angle A = \pi - \alpha$

$\angle B = \pi - \beta$

$\angle C = \pi - \gamma$

Applying sine rule to the ΔABC.

$$\frac{P}{\sin(\pi-\alpha)} = \frac{Q}{\sin(\pi-\beta)} = \frac{R}{\sin(\pi-\gamma)}$$

$$\Rightarrow \boxed{\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}}$$

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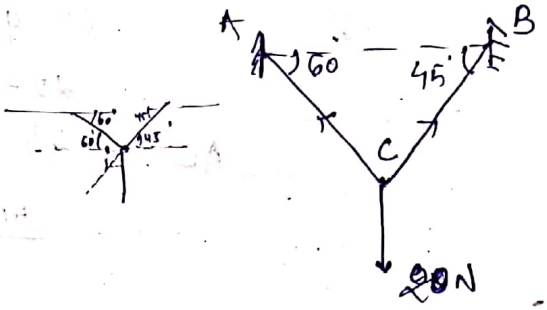
2) An electric lamp weighing 20N is suspended from a point C supported by 2 wire AC & BC. The point A, B are at same level. AC makes an angle 60° and BC makes 45° to horizontal as shown in fig. Determine the tension in the string AC & BC.



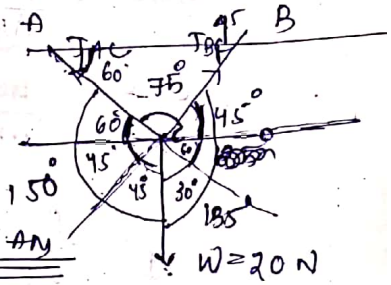
Soln W at C = 20

T_{AC} - tension in AC

T_{BC} = " " BC.

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$

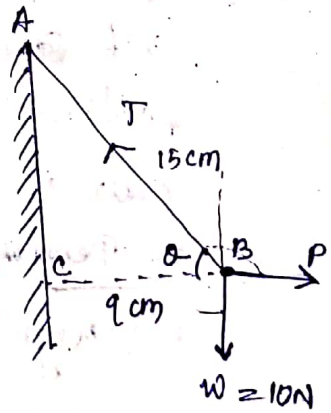
$$\Rightarrow \frac{20}{\sin 75^\circ} = \frac{T_{BC}}{\sin 150^\circ} = \frac{T_{AC}}{\sin 135^\circ}$$



$$T_{AC} = \frac{20 \times \sin 135}{\sin 75} = \frac{14.14}{\sin 75} = 14.95 \text{ N}$$

$$T_{BC} = \frac{20 \times \sin 150}{\sin 75^\circ} = \frac{10}{\sin 75^\circ} = \frac{10}{.965} = 10.35$$

3) Body weighing 10N is suspended from a fixed point by a string 15cm long & is kept at rest by a horizontal force P at a distance of 9 cm from the vertical line drawn through the point of suspension. What are the tension of the string & the value of P?



Soln Let tension T developed in the string AB. the point B is in equil^m, under the forces of T_{AB} & P.

Let $\angle ABC = \theta$

Applying Lami's theorem

$$\frac{P}{\sin(90+\theta)} = \frac{T_{AB}}{\sin 90} = \frac{10}{\sin(180-\theta)}$$

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$$\frac{P}{\cos\theta} = \frac{T}{1} = \frac{10}{\sin\theta}$$

From ΔABC

$$AB^2 = AC^2 + BC^2$$

$$\Rightarrow AC^2 = AB^2 - BC^2$$

$$= 15^2 - 9^2$$

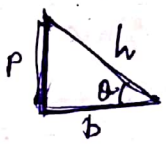
$$= 225 - 81$$

$$AC = \sqrt{144}$$

$$= 12 \text{ m Ans}$$

$$\sin\theta = \frac{AC}{AB} = \frac{12}{15} = 0.8$$

$$\cos\theta = \frac{BC}{AB} = \frac{9}{15} = 0.6$$



$\sin\theta = P/h$

$\cos\theta = b/h$

$\tan\theta = \frac{P}{b}$

$$\frac{T}{1} = \frac{P}{0.6} = \frac{10}{0.8}$$

$$\Rightarrow P = \frac{10 \times 0.6}{0.8} = \frac{60}{8} = 7.5 \text{ N Ans}$$

$$\Rightarrow T = \frac{10}{0.8} = 12.5 \text{ N Ans}$$

2) A fine light string ABCDE with one end A fixed, has weights W_1 & W_2 attached to it at B and C. The string passes round a smooth pulley D carrying wt 80N at free end E as shown in fig. If the position of equ^n, BC is horizontal with AB & CD makes an angle 150° & 120° with BC. Find

i) Tension in portion AB, BC, DE.

ii) Magnitude of W_1 & W_2

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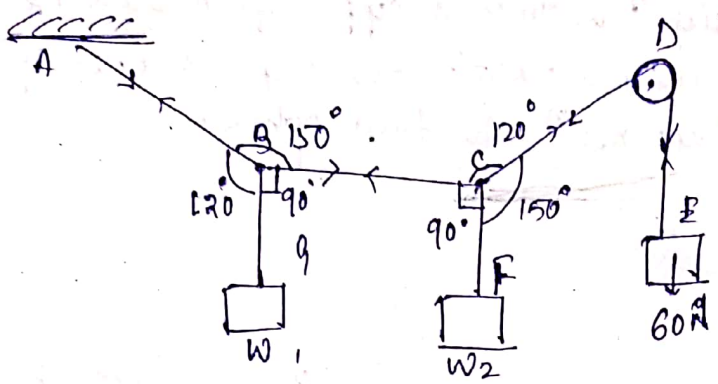


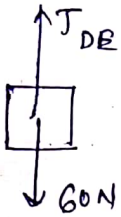
T_{AB} = tension in AB

T_{BC} = " " BC

T_{CD} = " " CD

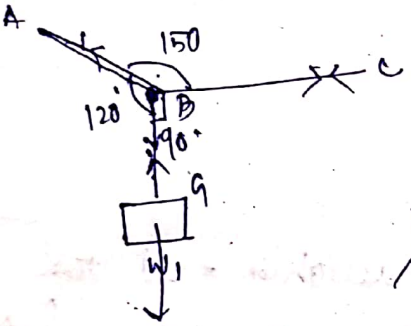
pulley is smooth no friction $T_{CD} = T_{DE}$

$T_{DE} = 60N = T_{CD}$



Apply Lami's Theorem at C & B.

(ii)



$$\frac{T_{AB}}{\sin 90} = \frac{T_{BC}}{\sin 120} = \frac{W_1}{\sin 150}$$

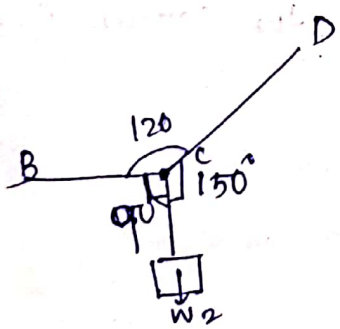
$$\Rightarrow T_{AB} = \frac{T_{BC} \times \sin 90}{\sin 120} = \frac{30 \times 1}{\sin 120}$$

$$= 34.63N$$

$$\Rightarrow W_1 = \frac{T_{BC} \times \sin 150}{\sin 120} = \frac{30 \times .5}{.866}$$

$$= 17.32N$$

(c)



$$\frac{T_{CD}}{\sin 90^\circ} = \frac{T_{BC}}{\sin 150} = \frac{W_2}{\sin 120^\circ}$$

$$\Rightarrow T_{BC} = \frac{T_{CD} \times \sin 150}{\sin 90} = \frac{60 \times .5}{1} = 30N$$

$$\Rightarrow W_2 = \frac{T_{CD} \times \sin 120}{\sin 90^\circ} = 51.96\ N$$

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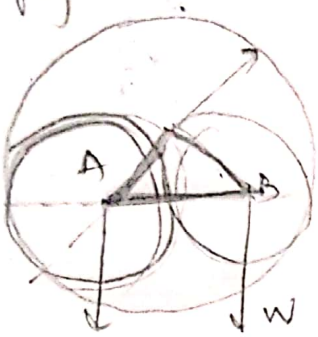
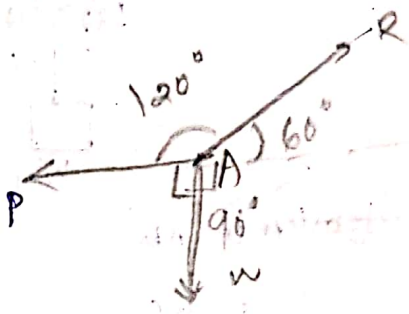
Q) Two equal and heavy spheres of 40 mm radius are in equilibrium within a cup of radius 120 mm. Find that the reaction between the cup & one sphere is double of that between the two spheres. As shown in the fig





$$\frac{R}{\sin 90^\circ} = \frac{W}{\sin 120} = \frac{P}{\sin 150^\circ}$$

Ans

$$\Rightarrow R = \frac{W}{\sqrt{3}/2} = \frac{P}{1/2}$$

$$\Rightarrow R = \frac{P}{1/2}$$

$$\Rightarrow R = 2P \quad \text{Ans}$$

Q) A uniform wheel 600 mm dia weighing 5 kN rest against a rigid rectangular block of 150mm height as shown in the fig. Find the min^m force resp. to turn the wheel over the corner A & find the reaction on the block.

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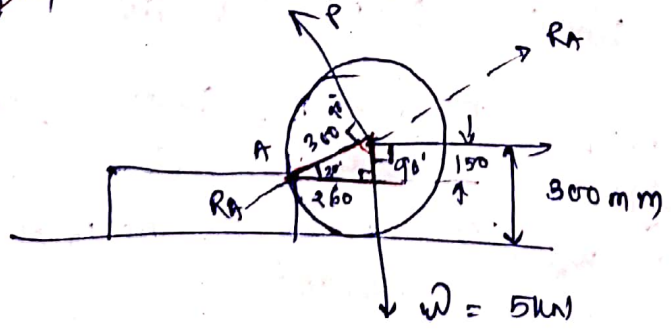

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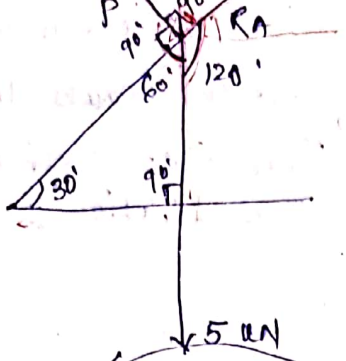
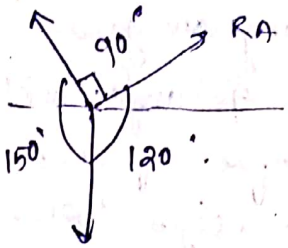




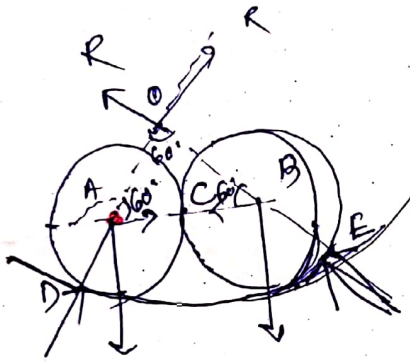
$$\frac{P}{\sin 120} = \frac{R_A}{\sin 150} = \frac{5000}{\sin 90^\circ}$$

$$\Rightarrow P = 4330\ N = 4.33\ kN$$

$$R_A = 2500\ N$$

$$= 2.5\ kN$$

Two spheres with centers A & B, lying in equilm, in cup with centers 'O', Let the 2 sphere contact at pt C. and sphere A with cup D & sphere B with cup E.



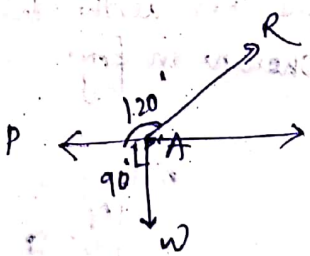
R → reqn at D & E

P → reqn at C.

From geometry. OD = 120 mm AD = 40 mm so AO = 120-40 = 80.

similarly OB = 80. AB = AC + CB = 40+40 = 80

OAB becomes equilateral Δ.



$$\frac{R}{\sin 90} = \frac{W}{\sin 120} = \frac{P}{\sin 150^\circ}$$

$$\Rightarrow R = \frac{W}{\sqrt{3}/2} = \frac{P}{1/2}$$

$$\Rightarrow R = P/1/2$$

$$\Rightarrow R = 2P$$

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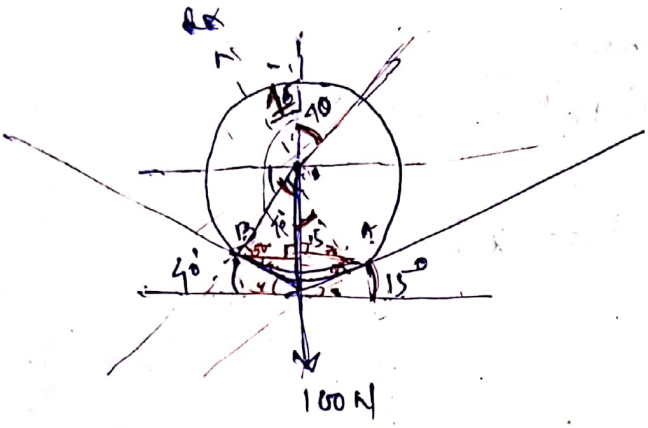
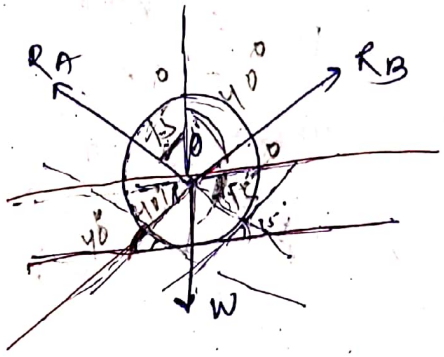
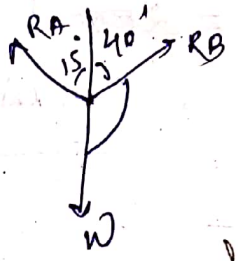
2) A smooth circular cylinder of radius 1.5 meter is laying in triangular groove. One side of which makes 15° angle & other 40° angle with horizontal. Find the reactions at the surface of contact. If there is no friction & the cylinder weighs 1000N.







R_A → Reaction of A

R_B → Reaction of B

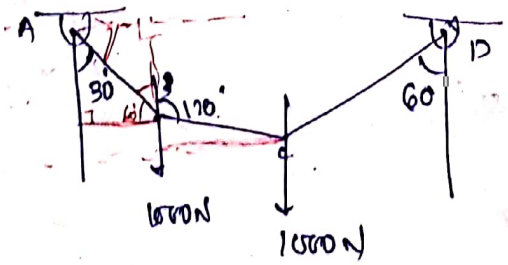
from friction form

$$\frac{R_A}{\sin(180-40)} = \frac{R_B}{\sin(180-15)} = \frac{1000}{\sin(15+45)}$$

$R_A = 78.5\,N$

$R_B = 81.6\,N$

3) A string ABCD attached to fixed points A & D has two equal weights of 1000N attached to B & C. The weights rest with the portions AB & CD inclined angle as shown in fig.



Find the tension in AB, BC & CD

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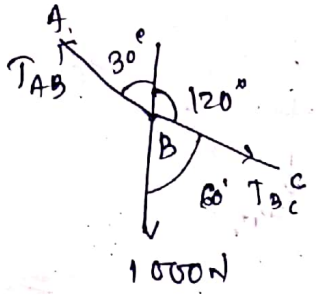
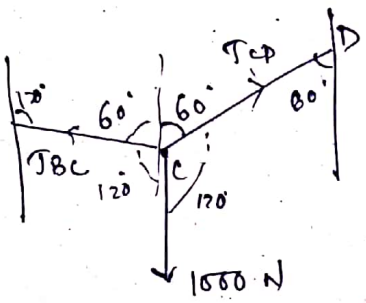
Soln Free body diagram.



$$\frac{T_{AB}}{\sin 60^\circ} = \frac{T_{BC}}{\sin(180-30)} = \frac{1000}{\sin 150^\circ}$$

$\Rightarrow T_{AB} = 1732\ N$

$\Rightarrow T_{BC} = 1000\ N$

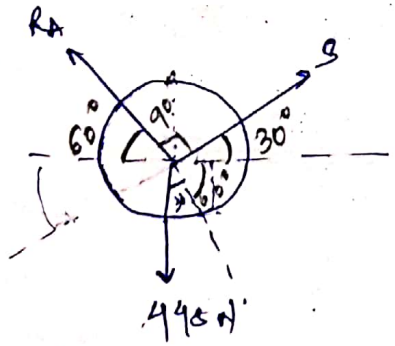


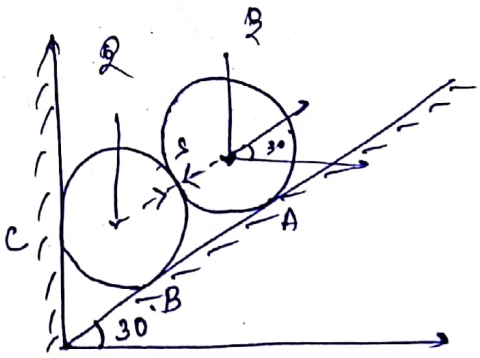
$$\frac{T_{BC}}{\sin 120^\circ} = \frac{T_{CD}}{\sin 120^\circ} = \frac{1000}{\sin 120^\circ}$$

$T_{CD} = 1000\ N$ Ans

Q) Two identical rollers each of weight $Q = 445\ N$ are supported by an inclined plane and a vertical wall as shown in the fig. Assuming smooth surface, find the reactions induced at the pt A, B, C

Soln





$$\frac{R_a}{\sin 120} = \frac{S}{\sin 150} = \frac{445}{\sin 90^\circ}$$

$\Rightarrow R_a = 385.38\ N$ $\quad S = 222.5\ N$

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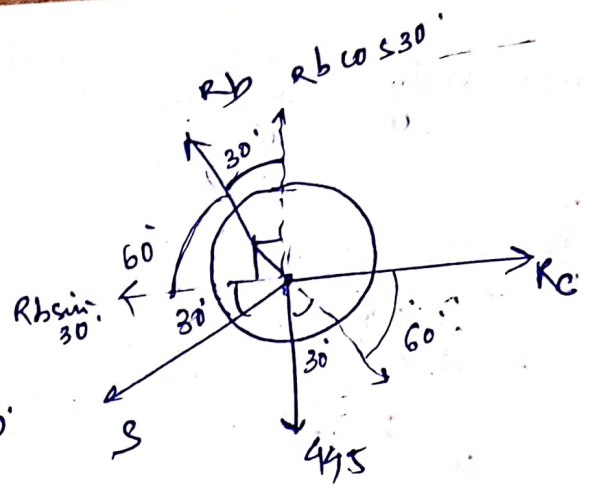
Resolving vertically

$\Sigma y = 0$



$Rb \cos 30 = 445 + S \sin 30°$

∴ $Rb =$ ( ) N

Resolving horizontally

$\Sigma x = 0$

$Rb \sin 30° + S \cos 30° = Rc$

∴ $Rc =$ ( ) N

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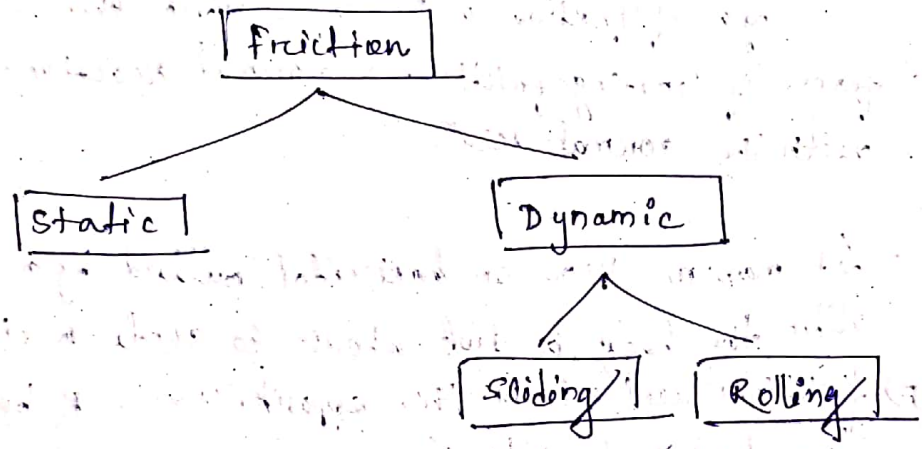
CHAPTER → 03 FRICTION

3.1 When a body slides or tends to slide over another surface, an opposing force, called as force of friction. It acts tangent to the surface and opposite to the direction the body is moving or tends to move.



↳ Static Friction

It is experienced by a body when it is at rest or when the body is tends to move.

↳ Sliding Friction

It is experienced when a body slides over another body.

↳ Rolling Friction

It is experienced when a body rolls over another body.

Limiting Friction

This is the maximum value of frictional force which comes in to play, when a body just begins to slide over another body, known as limiting friction.

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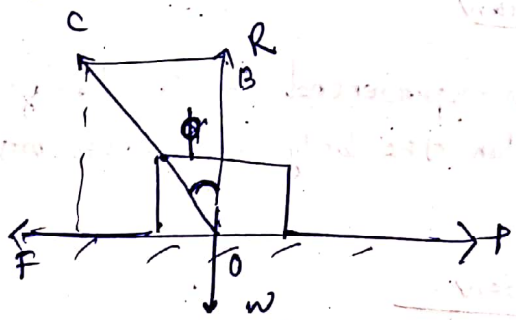
If the applied force is less than the limiting friction, the body remains at rest & the friction is called static friction, which may have any value betⁿ zero to limiting friction.

Angle of friction

Angle of friction is the angle which the resultant of force of limiting friction & normal reaction makes with the normal reaⁿ.

- Let mass m kept on horizontal. pulled by a force P. When the body is just about to slide a limiting friction will act on the opposite side. R be the normal reaⁿ of wt. W.



Let OC is the resultant betⁿ R & F, makes an angle ϕ with R.

$$\Delta OBC \quad \tan\phi = \frac{BC}{BO} = \frac{F}{R}$$

Coefficient of friction

It is the ratio of friction to the normal reaction betⁿ 2 bodies denoted by μ

$$\mu = \frac{F}{R} = \tan\phi \Rightarrow \boxed{F = \mu R}$$

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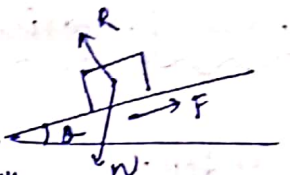
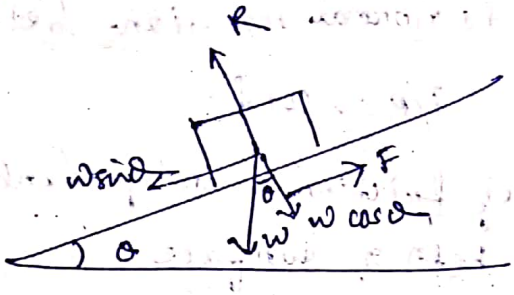
Angle of repose

Consider the block of weight W resting on an inclined plane which makes an angle θ with horizontal.



When θ is very small the block will rest on the plane. If θ increases gradually, a stage is reached at which the block will start to slide. That angle is called as angle of repose.





$\Sigma V = 0$

$R = W\cos\theta$ — (1)

$\Sigma H = 0 \quad F = W\sin\theta$ — (2)

$$\frac{W\sin\theta}{W\cos\theta} = \frac{F}{R}$$

$$\Rightarrow \boxed{\tan\theta = \frac{F}{R}}$$

$\therefore \tan\varphi = \tan\theta$

$\Rightarrow \varphi = \theta$

Angle of friction = Angle of repose.

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Laws of friction

↳ Laws of static friction

→ The force of friction always act opposite to the direct^n of applied force.

→ The magnitude of force of friction is exactly equal to the applied force, which tend to move the body.

→ The magnitude of the limiting friction bears a const ratio to normal reaction betn the two surface.

$$F/R = \text{const.}$$

→ The force of friction is independent of the area of contact betn 2 surface.

→ The force of friction depends upon the surface roughness.

↳ Laws of Dynamic friction

→ The forces of friction always act in a direction opposite in which the body is moving.

→ For moderate speed the force of friction remains const, but it decreases with increase of the speed.

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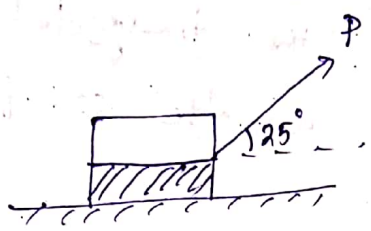
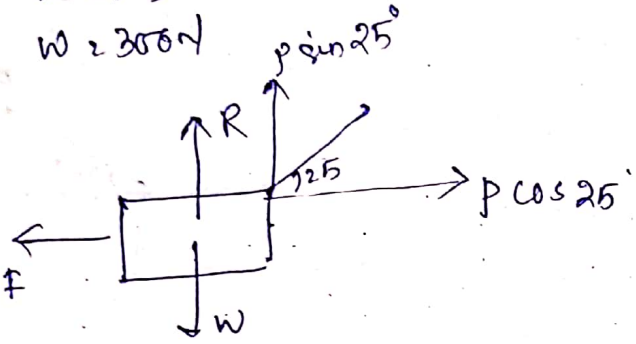
Q) A body of weight 300N is laying on a rough horizontal plane having a co-efficient of friction 0.3. Find the magnitude of the force, which can move the body, while acting at an angle of 25° with the horizontal.

Soln

$\mu = 0.3$

$W = 300N$





$\Sigma H = 0 \Rightarrow P\cos 25^\circ = F \Rightarrow F = 0.9063P$

$\Sigma V = 0 \Rightarrow R = W - P\sin 25^\circ$

We know that $F = \mu R$

$\Rightarrow 0.9063P = \mu [W - P \times .4226]$

$\Rightarrow 0.9063P = 0.3[300 - .4226P]$

$\Rightarrow 0.9063P = 90 - .1268P$

$\Rightarrow P = 87.1\ N.$ Ans

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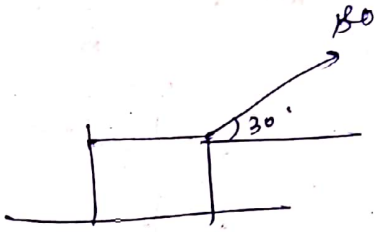
2015

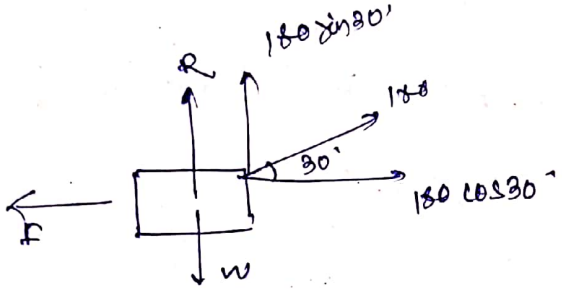
Q) A body resting on a rough horizontal plane required a pull of 180 N inclined at 30°, to the plane to move it. It was found that a push of 220 N inclined at 30° to the plane just moved the body. Determine the weight of the body and the co-efficient of friction.

Soln



(1)

FBD of fig 1



$\Sigma H = 0$

$F_1 = 180 \cos 30°$ N

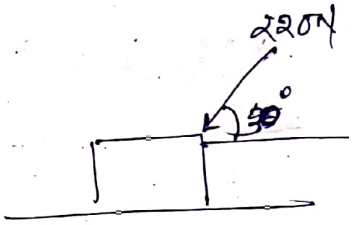
$\Sigma V = 0$

$R = W - 180 \sin 30°$

$\Rightarrow R = W - 90$

$F_1 = \mu R$

$\Rightarrow 155.88 = \mu (W - 90)$ ——— (1)



$\Sigma V = 0$

$R = W + 220 \sin 30°$

$\Rightarrow R = W + 110$

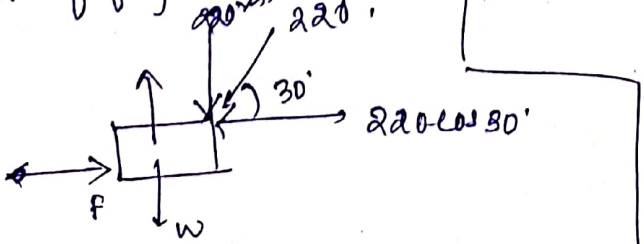
$F = \mu R$

$\Rightarrow 190.52 = \mu (W + 110)$ ——— (2)

Adding equn (1) & (2)

Substracting

FBD of fig 2



$\Sigma H = 0$

$F_2 = 220 \cos 30°$

$\Rightarrow F_2 = 190.52$ N

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$155.88 = \mu W - 90\mu$

$-190.52 = \mu W + 110\mu$

$+34.64 = +200\mu$

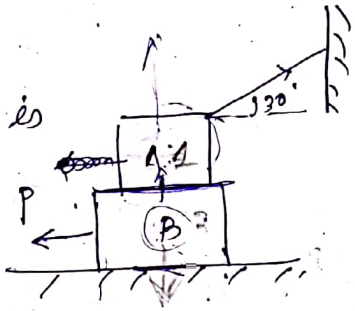
$\Rightarrow \mu = 0.1732$ Ans

putting value of μ in eqn (1)

we get $155.88 = 0.1732(W - 90)$

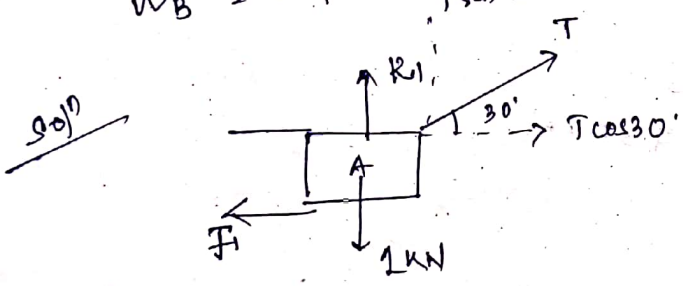
$W = 991.68N$

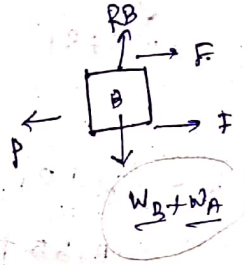
2) if co-efficient bet^n the 2 blocks is 0.3. Find force P req to move the block.



$W_A = 1KN$

$W_B = 2KN$





$R_1 + T \sin 30' = 1$ kN (vertically)

$\Rightarrow T \sin 30' = 1 - R_1$ —— (1)

Horizontally

$T \cos 30° = F_1$

$\Rightarrow T \cos 30' = \mu R_1$

$\Rightarrow T \cos 30' = 0.3 R_1$ —— (2)

Dividing eqn (1) & (2)

$$\frac{T \sin 30'}{T \cos 30'} = \frac{1 - R_1}{0.3 R_1} \Rightarrow \tan 30° = \frac{1 - R_1}{0.3 R_1}$$

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$$\Rightarrow 0.5774 = \frac{1-R_1}{0.3R_1}$$

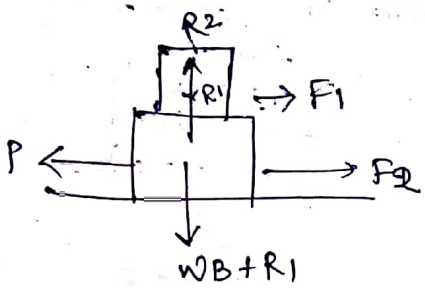
$$\Rightarrow 0.5774 \times 0.3R_1 = 1-R_1$$

$$\Rightarrow 0.173R_1 = 1-R_1$$

$$\Rightarrow R_1 = 0.85\ kN$$

$$f = \mu R_1 = 0.3 \times 0.85$$

$$= .255\ kN$$



$$R_2 = 2 + R_1$$

$$= 0.85 + 2 = 2.85\ kN$$

$$F_2 = \mu R_2$$

$$= 0.03 \times 2.85 = .855 kN$$

$$P = F_1 + F_2$$

$$= .255 + .855$$

$$= 1.11\ kN$$

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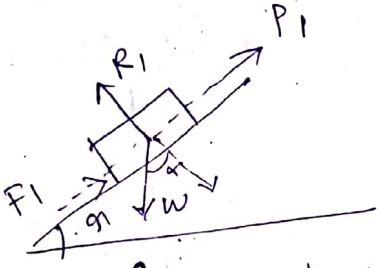
9.2 Equilm of a body on Rough Inclined plane

Consider a body laying on a rough inclined plane subjected to force P. as shown in fig

1. Minimum force (P_1) which will keep the body in equilm when it is sliding down ward.



(moving downward)

$F_1 = \mu R_1$

Net horizontal force.

$P_1 = W\sin\alpha - F_1$

$\Rightarrow P_1 = W\sin\alpha - \mu R_1$ —①

Net vertical force.

$W\cos\alpha = R_1$ —②

putting value of R_1 in equ ① we get

$P_1 = W\sin\alpha - \mu(W\cos\alpha)$

$= W(\sin\alpha - \mu\times\cos\alpha)$

$= W(\sin\alpha - \tan\phi\times\cos\alpha)$ $(\because \mu = \tan\phi$

$= W\left(\sin\alpha - \frac{\sin\phi}{\cos\phi}\times\cos\alpha\right)$ $\because \left(\tan\phi = \frac{\sin\phi}{\cos\phi}\right)$

$\Rightarrow P_1\cos\phi = W(\sin\alpha\times\cos\phi - \sin\phi\times\cos\alpha)$

$\Rightarrow P_1\cos\phi = W\sin(\alpha-\phi)$

$\Rightarrow \boxed{P_1 = \frac{W\sin\alpha(\alpha-\phi)}{\cos\phi}}$

2. Minimum force (P_1) which will keep the body in equm when moving upward.

$P_1 = W\sin\alpha + F_1$ —①

$R_1 = W\cos\alpha$

$\boxed{P_1 = \frac{W\sin(\alpha+\phi)}{\cos\phi}}$

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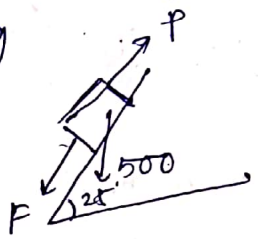
2) A body of wt 500 N is lying on a rough plane inclined at an angle of 25°. supported by horizontal force P as shown in fig Determine P for both upward & downward motion.

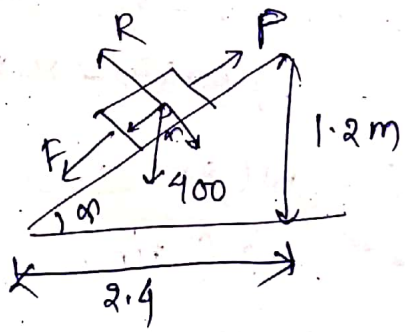


Soln

$$P_1 = \frac{W \sin(\alpha - \phi)}{\cos\phi} = 46.4\ N$$

$$P_2 = \frac{W \sin(\alpha + \phi)}{\cos\phi} = 376.2\ N$$

2) An inclined plane as shown in fig is used to unload a body of wt 400N. from a height 1.2 m. $\mu = 0.3$. (State weather it is necessary to push the body down the plane or hold it back from sliding down. What minm force is req. parallel for this purpose) Find (P) —



Soln $\tan\alpha = \frac{1.2}{2.4} = 0.5$

$\alpha = 26.5°$

& normal reaction

$R = W\cos\alpha$

$= 400 \times \cos 26.5°$

$= 357.9\ N$

$F = \mu R$

$A \sin\alpha + \mu R = P$

$\Rightarrow P = 400 \times \sin 26.5 + 0.3 \times 357.9$

$=$

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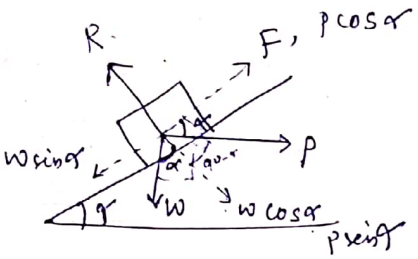
Equilibrium of a body on a rough inclined plane subjected to a force acting horizontally

Consider a body lying on a rough inclined plane subjected to a force acting horizontally.

1. Minimum force (P_1) which will keep the body in equilm, when it is at the point of sliding downward.



$F = \mu R$

$\Sigma H = 0$

$P\cos\alpha + F = W\sin\alpha$

$\Rightarrow P\cos\alpha = W\sin\alpha - F$

$\Rightarrow P\cos\alpha = W\sin\alpha - \mu R$ —①$(\because F = \mu R)$

$\Sigma V = 0$

$R = W\cos\alpha + P\sin\alpha$ —— ②

putting the value of R in eqn ①

$P_1\cos\alpha = W\sin\alpha - \mu(W\cos\alpha + P_1\sin\alpha)$

$\Rightarrow P_1\cos\alpha + \mu P_1\sin\alpha = W\sin\alpha - \mu W\cos\alpha$

$\Rightarrow P_1(\cos\alpha + \mu\sin\alpha) = W(\sin\alpha - \mu\cos\alpha)$

put $\mu = \tan\phi$

$\Rightarrow P_1 = W\dfrac{(\sin\alpha - \mu\cos\alpha)}{\cos\alpha + \mu\sin\alpha}$

$= W\dfrac{(\sin\alpha - \tan\phi\cdot\cos\alpha)}{(\cos\alpha + \tan\phi\cdot\sin\alpha)}$

$= W\dfrac{\left(\sin\alpha - \frac{\sin\phi}{\cos\phi}\cdot\cos\alpha\right)}{\left(\cos\alpha + \frac{\sin\phi}{\cos\phi}\cdot\sin\alpha\right)}$

$= W\left(\dfrac{\sin\alpha\cdot\cos\phi - \sin\phi\cdot\cos\alpha}{\cos\alpha\cdot\cos\phi + \sin\phi\cdot\sin\alpha}\right)$

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$$P_1 = W \frac{\sin(\alpha-\phi)}{\cos(\alpha-\phi)}$$

$$\Rightarrow \boxed{P_1 = W \tan(\alpha-\phi)}$$

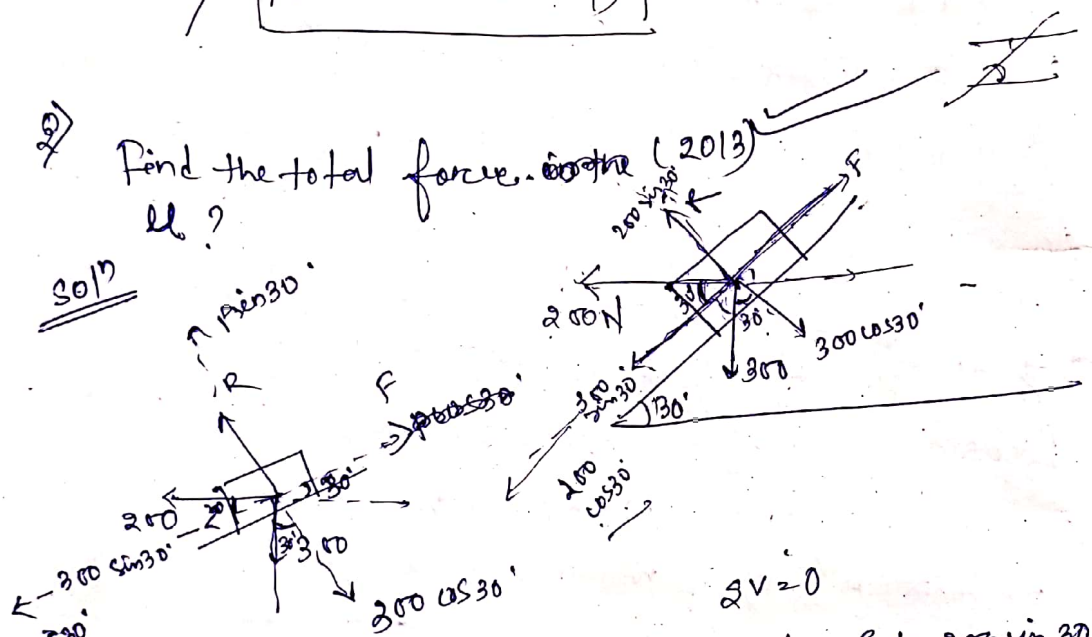
ii) Maximum force force (P_1), when the body is moving upward.

$$P_1 = W \frac{\sin(\alpha+\phi)}{\cos(\alpha+\phi)}$$

$$\Rightarrow \boxed{P_1 = W \tan(\alpha+\phi)}$$

Q) Find the total force. (2013)

Soln



$$\Sigma V = 0$$

$$300\cos30^\circ = R + 200\sin30^\circ$$

$$\Rightarrow R = 300\cos30^\circ - 200\sin30^\circ$$

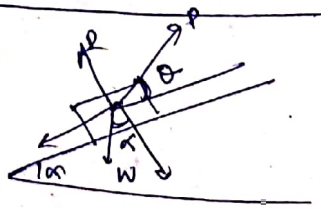
$$= (\quad)$$

$$\Sigma H = 0$$

$$200\cos30^\circ + 300\sin30^\circ = F$$

$$\Rightarrow F = 200\cos30^\circ + 300\sin30^\circ$$

Minimum force (P_1), keep the body in equm when sliding downward



$$P_1 = W \frac{\sin(\alpha-\phi)}{\cos(\theta+\phi)}$$

$$P_{max} = P_2 = \frac{W\sin(\alpha+\phi)}{\cos(\theta-\phi)}$$

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$$P_1 = W \frac{\sin(\alpha - \phi)}{\cos(\alpha - \phi)}$$

$$\Rightarrow \boxed{P_1 = W \tan(\alpha - \phi)}$$

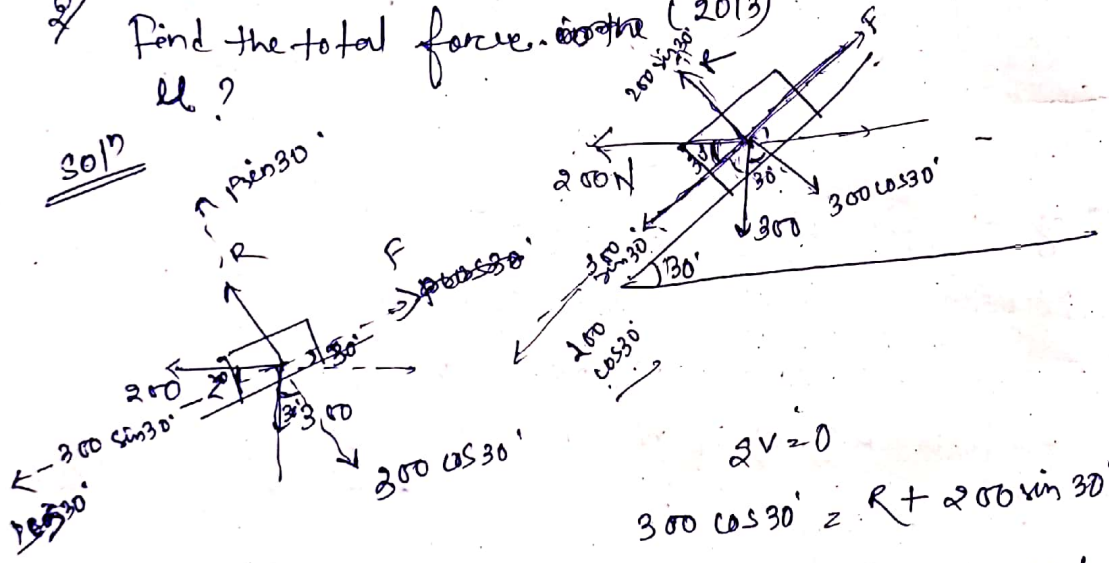
ii) Maximum force (P_1), when the body is moving upward.

$$P_1 = W \frac{\sin(\alpha + \phi)}{\cos(\alpha + \phi)}$$

$$\Rightarrow \boxed{P_1 = W \tan(\alpha + \phi)}$$

2) Find the total force. (2013)

soln



$\Sigma V = 0$

$300 \cos 30' = R + 200 \sin 30'$

$\Rightarrow R = 300 \cos 30' - 200 \sin 30'$

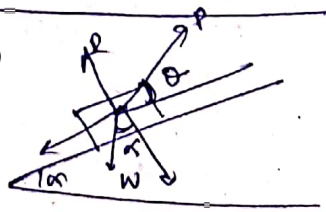
$= (\quad)$

$\Sigma H = 0$

$200 \cos 30' + 300 \sin 30' = F$

$\Rightarrow F = 200 \cos 30' + 300 \sin 30'$

Minimum force (P_1), keep the body in equilm when sliding downward



$$P_1 = W \frac{\sin(\alpha - \phi)}{\cos(\theta + \phi)}$$

$$P_{min} = P_2 = \frac{W \sin(\alpha + \phi)}{\cos(\theta - \phi)}$$

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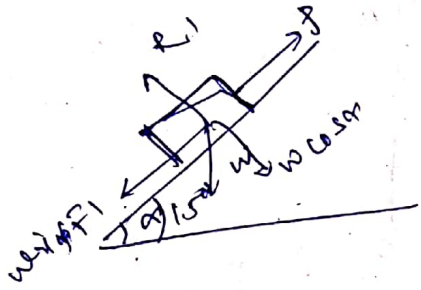
2) An effort of 200 N is required just to move certain body up an inclined plane at an angle 15° the forces acting ∥ to plane. If angle of friction is 20°, then the effort req. is found to be 230 N. Find weight of the body & R.

given $P_1 = 200\ N$ $P_2 = 230\ N$

$\alpha = 15°$ $\alpha = 20°$



$\Sigma F_H = 0$

$F + W \sin\alpha_1 = 200$

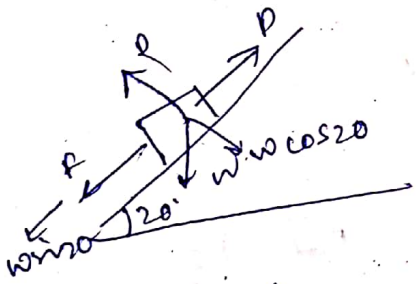
$\Rightarrow \mu R_1 + W \sin 15 = 200$

$\Rightarrow R W \cos\alpha + W \sin 15 = 200$

$\Rightarrow W(R \cos\alpha + \sin\alpha) = 200$ — (1)

$\Sigma F_V = 0$

$R_1 = W \cos\alpha$



$\Sigma F_H = 0$

$P = W \sin 20 + F$

$\Rightarrow \mu R + W \sin 20 = 230$

$\Rightarrow R W \cos 20 + W \sin 20 = 230$

$\Rightarrow W(R \cos 20 + \sin 20) = 230$ — (2)

$\Sigma F_V = 0$

$R_2 = W \cos 20°$

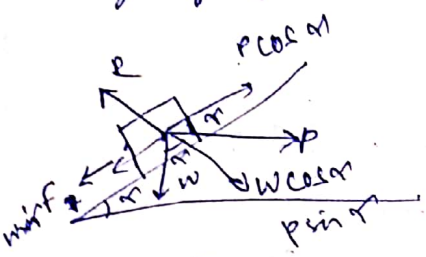
$$\frac{\text{eq (2)}}{\text{eq (1)}} = \frac{R \cos 20 + \sin 20}{R \cos 15 + \sin 15} \rightarrow \frac{230}{200}$$

$\Rightarrow R = 0.254$

eq (1) $\rightarrow W(.254 \times \cos 15 + \sin 15) = 200$

$\Rightarrow W = 392\ N$ Ans

Q) A load of 1.5kN resting on an inclined rough plane, can be moved up the plane by a force of 2kN applied horizontally & by a force of 1.25 kN applied ∥ to the plane. Find angle of inclination & μ.

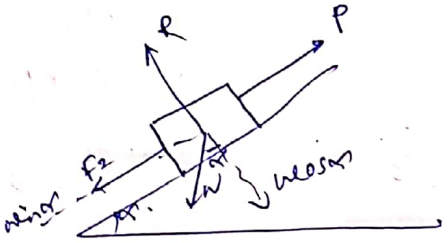


①

$P = W \tan(\alpha + \phi)$

$2 = 1.5 \tan(\alpha + \phi)$

$\alpha + \phi = 53.1°$



②

$P = W \frac{\sin(\alpha+\phi)}{\cos\phi}$

$1.25 = 1.5 \frac{\sin(53.1)}{\cos\phi}$

$\cos\phi = .96$

$\phi = 16.3°$

$\alpha = 53.1 - 16.3°$

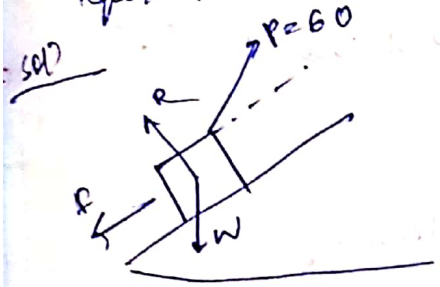
$= 36.8°$

$\mu = \tan\phi = \tan 16.3°$

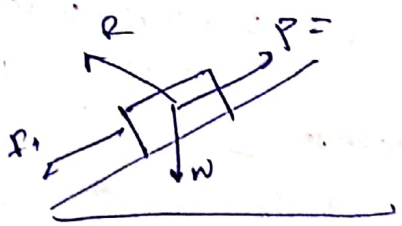
$= .292$

Q) Find the force req to move a load 3kN upon rough plane the force acting being ∥ to the plane. The inclination of the plane is such that when the same load is kept on a perfectly smooth plane inclined at same angle, a force 60N applied at an inclination of 30° to the plane, keep the same load in equilm. $\mu = 0.3$.

Sol)



Smooth



Rough.

For Smooth $\mu = 0 \therefore \phi = 0$

$P = W \frac{\sin(\alpha+\phi)}{\cos(\theta-\phi)} \Rightarrow 60 = \frac{3\alpha \sin\alpha}{\cos 30°} \Rightarrow \alpha = 10°$

For Rough $P = W \frac{\sin(\alpha+\phi)}{\cos\phi} \Rightarrow P = 140.7N$

$\mu = 0.3$

$\tan\phi = 0.3$

$\phi = \tan^{-1} 0.3$

$= 16.7°$

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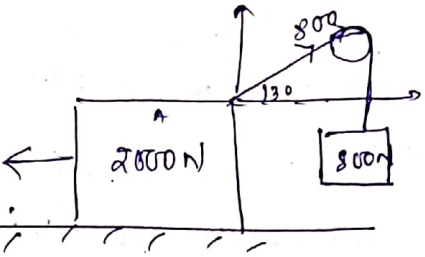
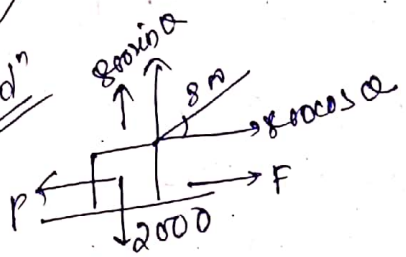
2) $\mu = 0.35$

Q) Determine value of P.

Consider the pulley is frictionless.



Sol^n



$\Rightarrow P = F + 800 \cos 30' \Rightarrow P = \mu R_n + 800 \cos 30'$

$2000 = R_n + 800 \sin 30'$

$\Rightarrow R_n = 2000 - 800 \sin 30'$

$\Rightarrow$ putting value of R_n.

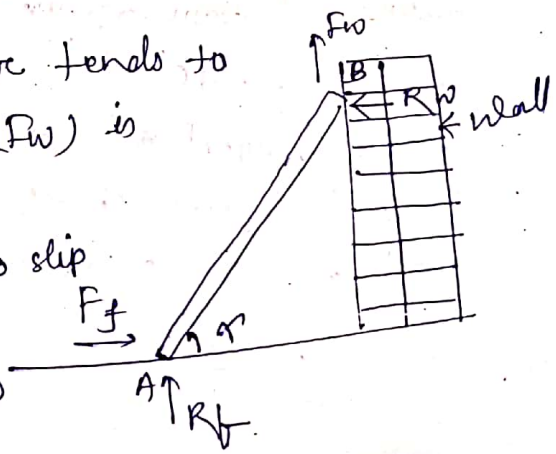
$P = \mu \times (2000 - 800 \sin 30') + 800 \cos 30'$

$= (1252.82)$ ✓

Application of friction

3.3 LADER FRICTION

A ladder is a device for climbing on walls.



- As upper end of the ladder tends to slip downward, friction (F_w) is upward.
- As the lower end tries to slip away from wall, friction (F_f) is towards the wall.
- Since the system is in equil^m, therefore the algebraic sum of horizontal & vertical components of the forces must also be equal to zero.

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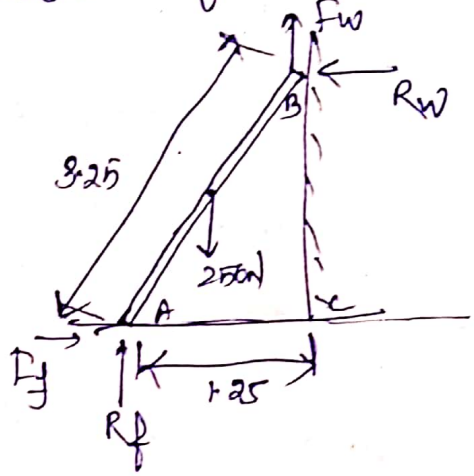
2) 2014 A uniform ladder of length 3.25m and weighing 250 N placed against a smooth vertical wall. It's lower end 1.15 m from the wall. the co-efficient of friction bet^n ladder & floor is 0.3. Determine the frictional force acting on ladder at point of contact bet^n ladder & floor.

Soln

$\Sigma V = 0$

$R_f = 250\ N$



from geometry

$BC^2 = \sqrt{AB^2 - AC^2}$

$= 3.0m$

Taking moments about O.

$$R_f \times 1.25 - 250 \times \left(\frac{1.25}{2}\right) = F_f \times 3$$

$$\Rightarrow R_f = 521.\ N$$

3) 2015 A ladder 5 meter long rest on on horizontal ground and leans against a smooth vertical wall at an angle 70° with horizontal. The weight of ladder is 900N and acts at it's middle. The ladder is at the point of sliding, when a man weighing 750N stands on the ladder 1.5m from bottom. calculate μ_f..

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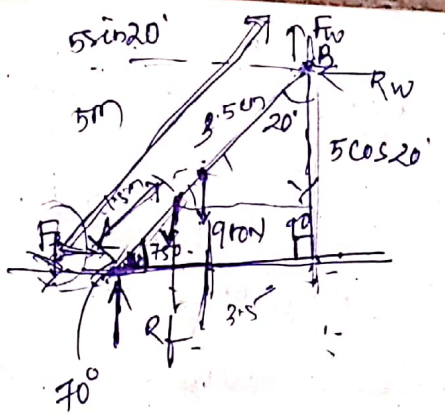
Sol^n $l = 5m$

$\alpha = 70°$

$W_1 = 900\,N$

$W_2 = 750\,N$



$Rf = 900 + 750 = 1650\,N$

$F_f = \mu \times R_f = \mu_f \times 1650\,N$ ✓

Taking moment about B

$R_f \times 5\cos 70 - 900 \times 2.5\cos 70 - 750 \times 3.5\cos 70 = F_f \times 5\sin 70$

$R_f \times 5\sin 20° = 900 \times 2.5\sin 20 - 750 \times 3.5 \sin 20°$

$= F_f \times 5\cos 20°$

put the value of F_f

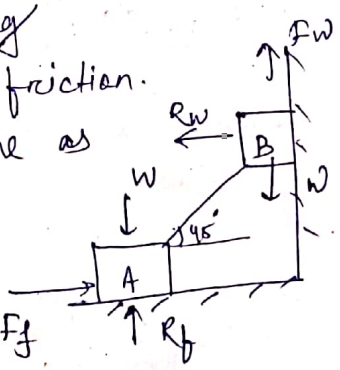
$R_f \times 5\sin 20 - 900 \times 2.5 \sin 20 - 750 \times 3.5 \sin 20 = \mu_f \times 1650 \times 5\cos 20°$

$\Rightarrow 1650 \times 5\sin 20° = (\mu_f \times 1650 \times 5\cos 20°) + 975$

$= 4533\mu_f + 975$

$\Rightarrow \mu_f = 0.15$ Ans

2) Two identical blocks of weight W are supported by a roof inclined at 45° with horizontal, as shown in fig. If both the blocks are limiting equilibrium, Find the coefficient of friction (μ) assuming it to be same as floor as well as at wall.



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Sol?

Resolving forces vertically.

$$F_W + R_f = 2W$$

$$\Rightarrow \mu R_W + R_f = 2W \quad \text{---} (1)$$

Now resolving the forces horizontally.

$$R_W = F_f$$

$$\Rightarrow R_W = \mu R_f \quad \text{---} (2)$$

Substituting R_W in equ^n (1).

$$\mu(\mu R_f) + R_f = 2W$$

$$\Rightarrow \mu^2 R_f + R_f = 2W$$

$$\Rightarrow R_f = \frac{2W}{(1+\mu^2)} \quad \text{---} (3)$$

putting value of R_f in equ^n (2)

$$R_W = \mu \times \frac{2W}{\mu^2+1}$$

Taking moment of the forces about block A

$$R_W \times l\cos 45^\circ + F_W \times l\cos 45^\circ = W \times l\cos 45^\circ.$$

$$R_W + F_W = W$$

$$\Rightarrow R_W + \mu R_W = W$$

$$\Rightarrow R_W(1+\mu) = W$$

putting value of R_W $\quad \frac{\mu \times 2W}{\mu^2+1}(1+\mu) = W$

$$\Rightarrow 2\mu(1+\mu) = \mu^2+1$$

$$\Rightarrow 2\mu + 2\mu^2 = \mu^2+1$$

$$\Rightarrow \mu^2 + 2\mu - 1 = 0$$

$$\mu = \frac{-2 \pm \sqrt{(2)^2+4}}{2} = 0.414 \quad \text{Ans}$$

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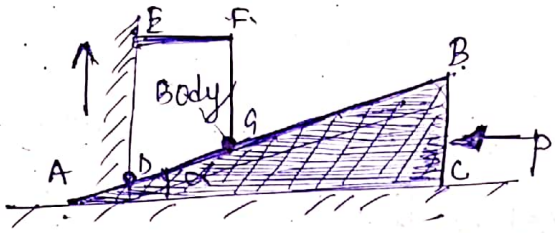
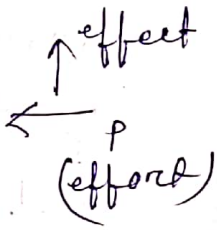
WEDGE FRICTION

A wedge is usually, of a triangular in cross-section it is generally, used for slight adjustments in the position of a body i.e for tightening fits or keys for shafts. Sometimes, a wedge is also used for lifting heavy weight. It is made of cup wood or metal.



Wedge ABC, used to lift the body DEFG.



W = weight of the body DEFG

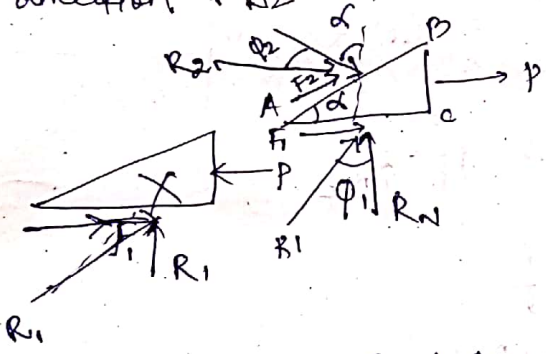
P = Force req. to lift the body

μ = co-efficient of friction = $\tan\phi$

W_{wedge} → Not considered.

due to horizontal movement we get vertical.

When force P is applied in, the body will lift in upward direction R_{N2}

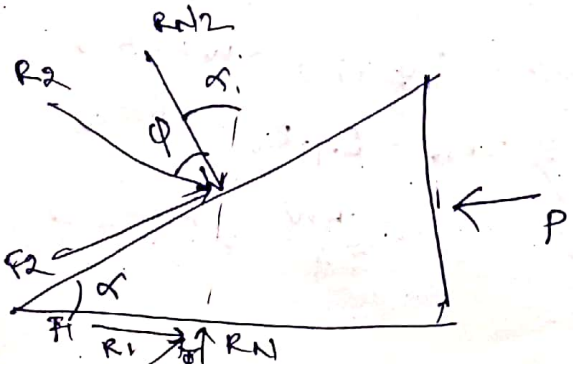


R_1 → resultant of frictional force & normal reaction betn floor & wedge. F_1 & R_N

ϕ_1 & ϕ_2 → angle of friction.

R_{N2} → normal reaction at AC, & frictional force F_2.

The resultant of both is R_2 making an angle ϕ_2.



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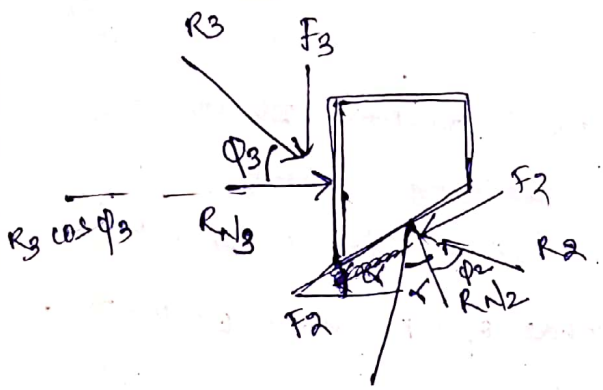
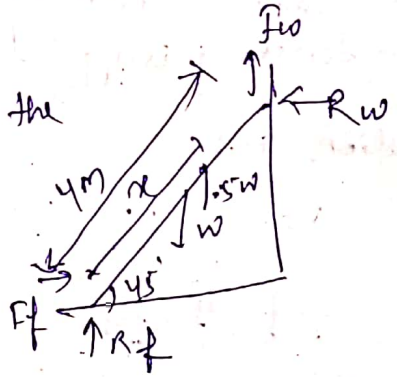


2) A uniform ladder of 4m length rests against a vertical wall with which it makes an angle of 45°. The co-effi of friction betⁿ ladder & wall 0.4 & that betⁿ ladder & floor 0.5. If a man whose weight is one-half of that ladder accesends it. how high it will be when the ladder slips?



Soln x → distance betⁿ A & the man.

weight of man = $\frac{W}{2}$ = .5W

$F_f = \mu_f R_f = 0.5 R_f$

$F_w = \mu_w R_w = 0.4 R_w$

$R_w = R_f = 0.5 R_f$

$R_f = 2R_w$

Resolving vertically $R_f + F_w = W + 0.5W$

$\Rightarrow 2R_w + 0.4 \cdot R_w = 1.5W$

$\Rightarrow R_w = \frac{1.5W}{2.4} = 0.625W$

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$F_W = .4 \times .625W$

$= 0.25W$

Taking moment about A.

$(W \times 2 \cos 45^\circ + .5W \times x \cos 45^\circ)$

$= R_W \times 4 \sin 45^\circ + F_W \times 4 \cos 45^\circ$

put value of R_W & F_W

$x = 3.0\ m.$

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CHAPTER → 04 Centre of Gravity

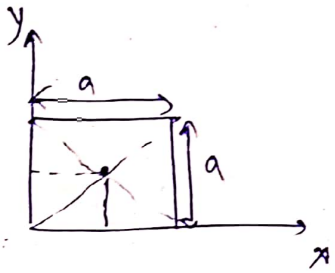
Centre of gravity can be defined as a point through which the whole weight of the body acts, irrespect of it's position. It may be noted that every body has one and only one centre of gravity.

4.1 Centroid

The plane figures like triangle, rectangle, circle etc have only area, but no mass. The centre of area of such fig is known as centroid.

Centroid of basic geometrical figures

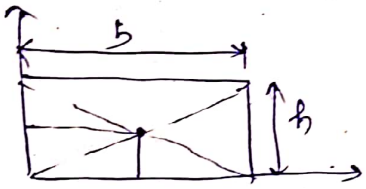
1)



$\bar{x} = a/2$

$\bar{y} = a/2$

2)



$\bar{x} = b/2$

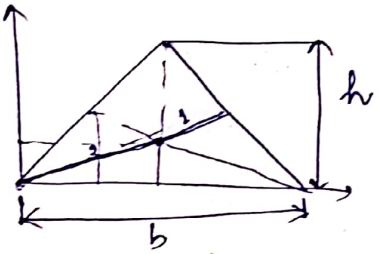
$\bar{y} = h/2$



$x = \frac{2b}{3}$

$y = h/3$

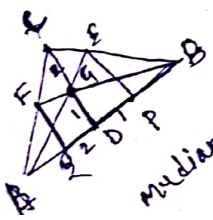
3)



(2:1)

$\bar{x} = b/2$

$\bar{y} = h/3$



median devided into 2:1 ratio.

draw a line FQ

BFQ & ΔACD.

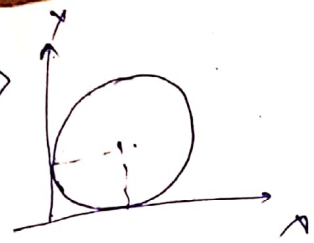
$\frac{AQ}{\ldots} = \frac{AF}{AC}$

DQBF & DDBG

$FG/GB = \frac{QD}{DB} = \frac{1}{2}$

QD:DB = 1:2

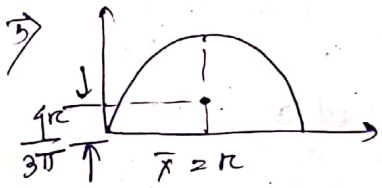
4)



$\bar{x} = r$

$\bar{y} = r$

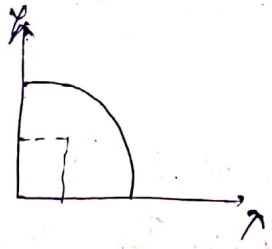
5)



$\bar{x} = r$

$\bar{y} = 4r/3\pi$

6)



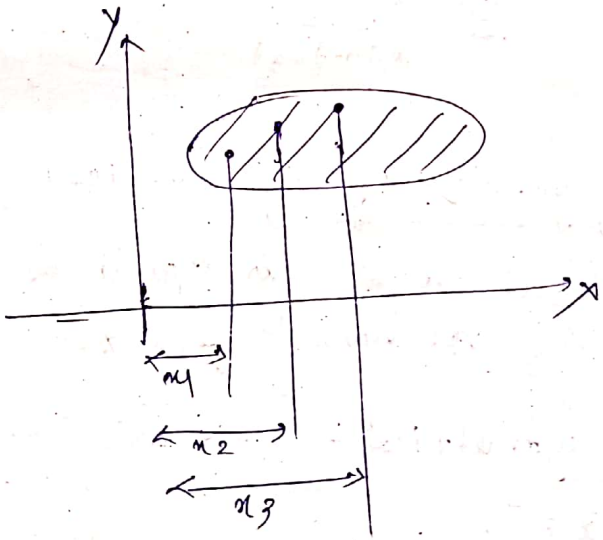
$\bar{x} = 4r/3\pi$

$\bar{y} = 4r/3\pi$

Where $\bar{x}$ & $\bar{y}$ is the co-ordinates of centroid

~~grav~~

Center of gravity by Moments



Consider a body of mass M whose centre of gravity is required to be found out. Let it is divided into small masses $m_1, m_2, m_3 \ldots$ & the co-ordinates are (x_1, y_1) (x_2, y_2) & $(x_3\ y_3)$

$$M\bar{x} = m_1x_1 + m_2x_2 + m_3x_2 \ldots$$

$$\bar{x} = \frac{\Sigma mx}{M}$$

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$$\bar{y} = \frac{\Sigma my}{M}$$

$$M = m_1 + m_2 + m_3 + \cdots$$

Axis of Reference

The centre of gravity of a body is always calculated with reference to some assumed axis known as axis of reference, called as axis of reference. from where $\bar{x}$ & $\bar{y}$ is calculated.

Centre of gravity of plane figure

The plane geometrical sections such as T, I, L sections only have area but no mass. For these the centroid & centre of gravity is same.

$$\bar{x} = \frac{a_1x_1 + a_2x_2 + a_3x_3 + \cdots}{a_1 + a_2 + a_3 + \cdots}$$

$$\bar{y} = \frac{a_1y_1 + a_2y_2 + a_3y_3 + \cdots}{a_1 + a_2 + a_3 + \cdots}$$

Center of gravity of Symmetrical Sections

- If the given section is symmetrical about x-x axis then we have to find $\bar{x}$.
- If it is symmetrical to y-y axis then we have to find $\bar{x}$ & $\bar{y}$.

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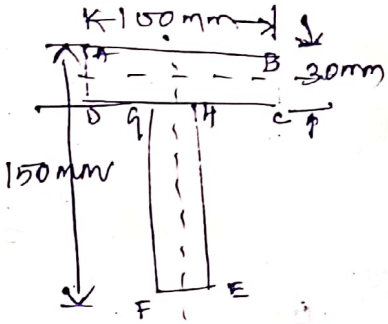
2) Find the centre of gravity of 100mm x 150mm x 30mm of T-section.



Sol:- This section is symmetrical about Y-Y axes.

Split the section in 2 section.

ABCD ; EFGH

For rectangle ABCD.

$a_1 = 100 \times 30 = 3000 mm^2$

$y_1 = (150 - \frac{30}{2}) = 135 mm$

rectangle EFGH $a_2 = (150-30) \times 30 = 120 \times 30$

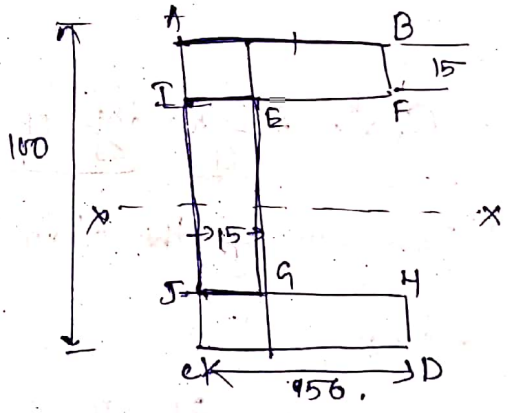
$= 3600 mm^2$

$y_2 = 120/2 = 60 mm.$

$\bar{y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2} = \frac{3000 \times 135 + 3600 \times 60}{3000 + 3600}$

$= 94.1 mm.$

2) Symmetrical about X-X axes.



1) Rectangle ABIF

$a_1 = 15 \times 50 = 750 mm^2$

$x_1 = 50/2 = 25 mm$

2) Rectangle CDHJ

$a_2 = 50 \times 15 = 750 mm^2$

$x_2 = 50/2 = 25 mm.$

3) rectangle IEJG

$a_3 = 15 \times (100 - 30)$

$= 1050 mm^2$

$x_3 = 15/2 = 7.5 mm$

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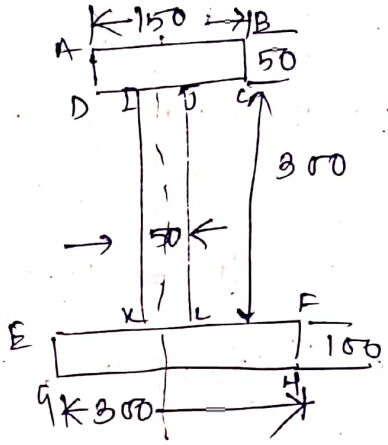
$$\bar{x} = \frac{a_1x_1 + a_2x_2 + a_3x_3}{a_1+a_2+a_3}$$

$$= \frac{750\times25 + 750\times25 + (1050\times7.5)}{750+1050+750}$$

$$= 17.8\,mm$$

Q)



$a_1 = 150\times50$

$y_1 = 100 + 300 + \frac{50}{2}$

$= 400 + 25 = 425\,mm$

$a_2 = 300\times100$

$y_2 = 100/2 = 50\,mm$

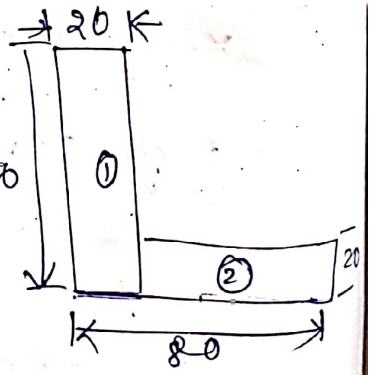
$a_3 = 300\times50$

$y_3 = 100 + \frac{300}{2} = 250\,mm$

$$\bar{y} = \frac{a_1y_1 + a_2y_2 + a_3y_3}{a_1+a_2+a_3}$$

Center of gravity of unsymmetrical section

Q) Find C.G of the given L section



Rectangle ①

$a_1 = 20\times100 = 2000\,mm^2$

$y_1 = 100/2 = 50\,mm$

$x_1 = 20/2 = 10\,mm$

Rectangle ②

$a_2 = (80-20)\times20 = 1200\,mm^2$

$y_2 = 20/2 = 10\,mm$ $\quad x_2 = 20 + \frac{(80-20)}{2}$

$= 50\,mm$

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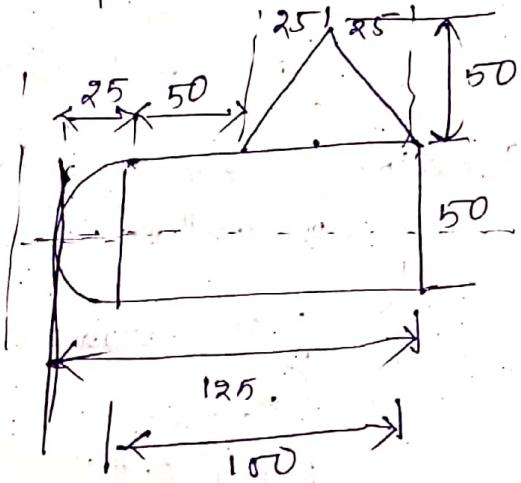
$$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2} = 25mm$$

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2} = 35mm$$

3) A uniform lamina is shown in fig. Determine the C.G of the lamina.



a) for the rectangle:

$$a_1 = 100 \times 50 = 5000\ mm^2$$

$$x_1 = 25 + 100/2 = 75mm$$

$$y_1 = 50/2 = 25mm$$

for semicircle:

$$a_2 = \frac{\pi r^2}{2} = \pi/2\,(25)^2 = 982mm^2$$

$$x_2 = 25 - 4r/3\pi = 14.4\ mm$$

$$y_2 = 50/2 = 25mm$$

for Δ:

$$a_3 = \frac{1}{2} \times b \times h = \frac{1}{2} 50 \times 50 = 1250\ mm^2$$

$$x_3 = 25 + 50 + 25 = 100mm$$

$$y_3 = 50 + 50/3 = 66.7mm$$

$$\bar{x} = \frac{a_1x_1 + a_2x_2 + a_3x_3}{a_1 + a_2 + a_3} = 71.1\ mm$$

$$\bar{y} = \frac{a_2y_1 + a_2y_2 + a_3y_3}{a_1 + a_2 + a_3} = 32.2mm$$

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4.2 MOMENT OF INERTIA

Moment of force = F × ⊥ distance. (1st moment of force.

If F × ⊥ distance × ⊥ distance (2nd moment of force)

M.M.O.F / Second moment of force. or moment, moment of force)

Sometime Area & mass can be found out by above methode.

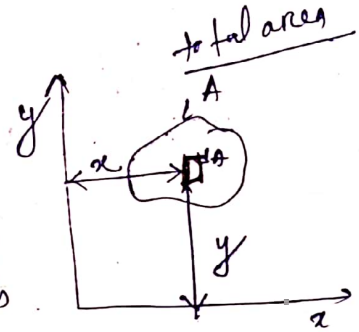
⇒ also known as Moment of inertia.

- M.M.O.A
- M.M.O.M

$I_{yy} = \sum dA \cdot x$ (M.I about yy)

$= \sum dA \cdot x \cdot x$

$\boxed{I_{yy} = \sum dA \cdot x^2}$ — MI about yy axis



$\boxed{I_{yy} = \int dA \cdot x^2}$

$\boxed{I_{xx} = \int dA \cdot y^2}$ — M.I about xx axis

$\boxed{\text{Moment of inertia} = \text{Force} \times (\text{perpendicular distance})^2}$

$\boxed{\text{unit} = N\,m^2}$

Moment of inertia of a rectangular section.

consider a rectangular section ABCD.

b → Width of the section

d → Depth of the section

Consider a small strip PQ of thickness dy // to X-X axis, at a distance y from the centre axis.

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Area of small strip = $dA = b \times dy$

M.O.I of strip about x-x axis

$= \text{Area} \times y^2$

$= dA \cdot y^2$

$= b \times dy \cdot dy^2$

$$I_{x-x} = \int_{-d/2}^{d/2} dA \cdot y^2$$

$$= \int_{-d/2}^{d/2} b \cdot dy \cdot y^2$$

$$= b \int_{-d/2}^{d/2} y^2 \cdot dy = b \left[\frac{y^3}{3}\right]_{-d/2}^{d/2}$$

$$= b \left[\frac{(d/2)^3}{3} - \frac{(-d/2)^3}{3}\right]$$

$$= b \left[\frac{d^3/8 - (-d^3/8)}{3}\right]$$

$$= b \left[\frac{2d^3}{8 \times 3}\right]$$

$$I_{xx} = bd^3/12.$$

for hollow

$$I_{xx} = \frac{bd^3}{12} - \frac{b_1 d^3}{12}$$

$= db^3/12 - d_1 b_1^3/12$

By similarly $I_{yy} = \frac{db^3}{12}$.

$\frac{bd^3}{12} + \frac{db^3}{12}$

$= \frac{bd^3 + db^3}{12}$

M.I of a circular section

- Consider a circle ABCD with centre O.
- Consider a ring of radius x and thickness dx.

area of the ring $da = 2\pi x \cdot dx$

M.O.I about xx axis = area x distance^2

or & yy axis $= 2\pi x \cdot dx \times x^2$

$= 2\pi x^3 dx.$

Now M.I about the central axis let it be I_{xx}.

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$I_{zz} = \int_0^r 2\pi x^3 \cdot dx = 2\pi \int_0^r x^3 \, dx$

$= 2\pi \left[\frac{x^4}{4}\right]_0^r$

$= \frac{\pi}{2} \times r^4 = \frac{\pi}{32} d^4 \quad (r = d/2)$

$\therefore I_{xx} = I_{yy} = \frac{I_{zz}}{2} = \frac{\pi}{64} d^4$

for hollow $I_{xx} = \frac{\pi}{64}(D^4 - d^4) = I_{yy}$

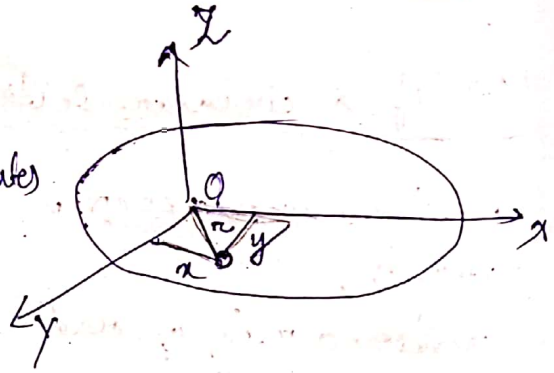
Theorem of perpendicular Axis

If I_{xx} & I_{yy} be the moment of inertia of a plane section about 2 perpendicular axis meeting at O, the moment of inertia about I_{zz} about the zz axis perpendicular to the plane and passing through intersection of x-x & y-y is given by

$$I_{zz} = I_{xx} + I_{yy}$$

Proof

consider a lamina 'p' of area da having co-ordinates x & y as shown in fig along ox & oy axis as shown in fig.



consider a plane oz ⊥ to ox & oy. Let r be the distance of lamina p from zz axis. op = r

from geometry $r^2 = x^2 + y^2$

M.I about XX $I_{xx} = da \cdot y^2$

YY $I_{yy} = da \cdot x^2$

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$$I_{zz} = da \cdot r^2$$
$$= da(x^2+y^2)$$
$$= da\,x^2 + da \cdot y^2$$
$$\boxed{I_{zz} = I_{xx} + I_{yy}}$$

Theorem of parallel axes

It states that if the M.I of a plane area about an axis through it's centre of gravity is denoted by I_G, then moment of inertia of the area about any other axis AB, parallel to the 1st, and at a distance h from the C.G is given by

$$\boxed{I_{AB} = I_G + ah^2}$$

I_{AB} → M.I of the area about axis AB.

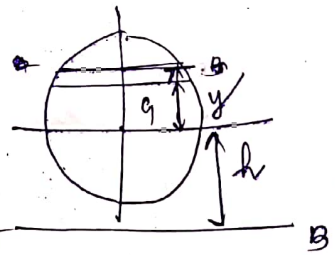
I_G → M.I ... about C.G

a → area of section

h → distance bet^n C.G & sec^n AB.

proof

consider a strip of a circle, where M.I required to be found out



let δa = area of strip

y = distance of strip from C.G.

h = distance of CG from axis AB

M.I of whole section about an axis passing through

$CG = \delta a \cdot y^2$

$I_G = \Sigma \delta a \cdot y^2$ · MI of whole sec^n passing through C.G.

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M.I of section about AB

$$I_{AB} = \sum sa(h+y)^2$$

$$= \sum sa(h^2+y^2+2hy)$$

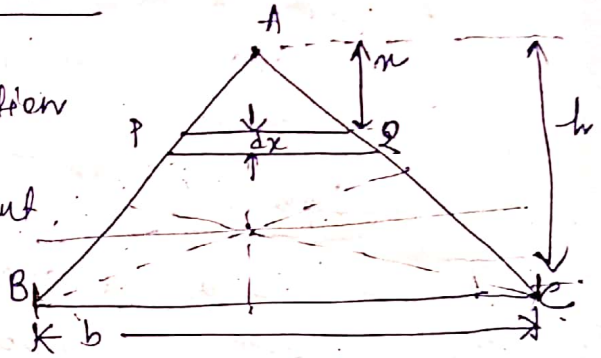
$$= (\sum h^2 sa) + (\sum y^2 . sa) + (\sum 2hy\, sa)$$

$$\boxed{I_{AB} = ah^2 + I_G .}$$

$\sum h^2 sa = ah^2$ sum of moments

$\sum y^2 sa = I_G$

M.I of a triangular section



(BC = base = b)

Consider a triangular section ABC whose M.I is required to be found out.

b → base

h → height

Consider a small sec^n PQ of thickness dx at a distance from vertex A.

for ΔAPQ, ΔABC

$$\frac{PQ}{BC} = \frac{x}{h}$$

$$\Rightarrow PQ = \frac{BC \cdot x}{h} = \frac{b \cdot x}{h}$$

Small area of PQ $= \frac{b \cdot x}{h} \times dx$

M.I of strip about BC = Area $\times$ (distance)^2

$$= \frac{bx}{h} . dx \times (h-x)^2$$

$$= \frac{bx}{h} \cdot (h-x)^2 . dx$$

M.I of whole Δ can be found out by integrating the above from 0 to h

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$$I_{BC} = \int_0^h \frac{bx}{h}(h-x)^2 dx$$

$$= \frac{b}{h}\int_0^h x\cdot(h^2+x^2-2hx)\,dx$$

$$= \frac{b}{h}\int_0^h (xh^2+x^3-2hx^2)\,dx$$

$$= \frac{b}{h}\left[\frac{x^2h^2}{2}+\frac{x^4}{4}-\frac{2hx^3}{3}\right]_0^h$$

$$= \frac{b}{h}\left[\frac{h^4}{2}+\frac{h^4}{4}-\frac{2h^4}{3}\right] = \frac{b}{h}\left[\frac{2h^4+h^4}{2\,4}-\frac{2h^4}{3}\right]$$

$$= \frac{b}{h}\left[\frac{3h^4}{4}-\frac{2h^4}{3}\right] = \frac{b}{h}\left[\frac{9h^4-8h^4}{12}\right] = \frac{bh^3}{12}$$

M.I. of triangular section through axis of the centre of gravity, parallel to X-axis

$$I_G = I_{BC} - ad^2$$

$$= \frac{bh^3}{12} - \frac{bh}{2}\times\left(\frac{h}{3}\right)^2$$

$$\boxed{I_G = \frac{bh^3}{36}}$$

$d = h/3$

$I_{BC} = I_G + ah^2$

Moment of Inertia of a Composite Section.

Steps

↳ 1st split up the given section into plane areas.

↳ Find M.I of these areas about their respective C.G.

↳ Apply parallel axis theorem.

↳ Obtain the M.I.

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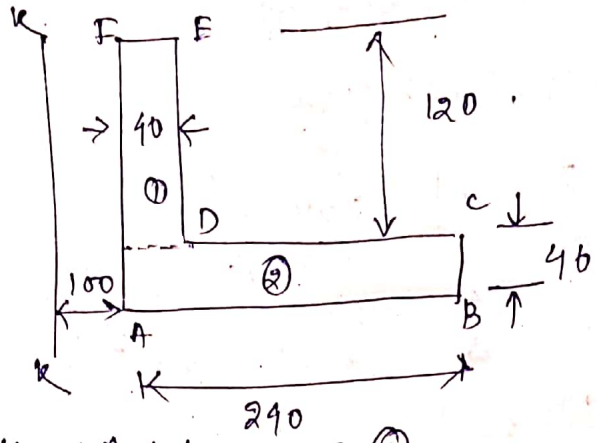
2) Find M.I about axis K-K



Split up the section into ① & ②.

For section ①. I_{G1} = M.I about c.G about the axis K-K.

$$I_{G1} = \frac{db^3}{12} = \frac{120 \times 40^3}{12} = 640 \times 10^3 \text{ mm}^4$$

$h_1 = 100 + \frac{40}{2} = 120$ mm. (distance betn c.G of section ① & axis K-K)

M.I of section ① axis K-K.

$$I_{KK} = I_{G1} + a_1 h_1^2$$
$$= [(640 \times 10^3) + (120 \times 40) \times (120)^2]$$
$$= 69.76 \times 10^6 \text{ mm}^4$$

Similarly M.I of section ② above. it's c.G ∥ parallel to axis K-K.

$$I_{G2} = \frac{db^3}{12} = 46.08 \times 10^6 \text{ mm}^4$$

$$h_2 = 100 + \frac{240}{2} = 220 \text{ mm}$$

$$I_{G2} + a_2 h_2^2$$
$$= [(46.08 \times 10^6) + (240 \times 40) \times (220)^2]$$
$$= 510.72 \times 10^6 \text{ mm}^4$$

$$I_{KK} = 69.76 \times 10^6 + 510.72 \times 10^6$$
$$= 580.48 \times 10^6 \text{ mm}^4$$

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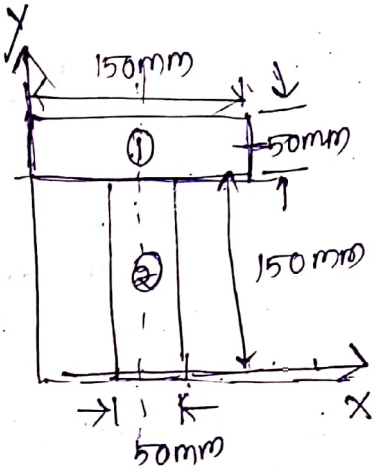
2) Find the M.I of a T-section with as 150 mm × 50 mm and web 150 mm × 50 mm about x-x & y-y axis through the centre of gravity of the section.



Sol^n Rectangle ①

$a_1 = 150 \times 50 = 7500\ mm^2$

$y_1 = 150 + \frac{50}{2} = 175mm$

Rectangle ②

$a_2 = 150 \times 50 = 7500\ mm^2$

$y_2 = \frac{150}{2} = 75\ mm$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2} = \frac{(7500 \times 175) + (7500 \times 75)}{7500 + 7500} = 125mm$$

M.I of ① about X-X axis

$I_{G1} = \frac{bd^3}{12} = \frac{150 \times 50^3}{12} = 1.5625 \times 10^6 mm^4$

$h_1 = \underbrace{150 + \frac{50}{2}}_{y_1} - \underbrace{125}_{\bar{y}} = 50mm$

y → distance from c.g

M.I about x-x axis $I_{G1} + a_1 h_1^2$

$= 1.5625 \times 10^6 + 7500 \times (50)^2$

$= 20.3125 \times 10^6 mm^4$

Similarly M.I of ② about x-x axis

$I_{G2} = \frac{bd^3}{12} = \frac{50 \times (150)^3}{12} = 14.06 \times 10^6\ mm^4$

$h_2 = 125 - \frac{150}{2} = 50\ mm$

M.I about X-X axis $I_{G2} + a_2 h_2^2$

$= 14.06 \times 10^6 + 7500 \times 50^2$

$= 32.8125 \times 10^6\ mm^4$

$I_{XX} = 20.3125 \times 10^6 + 32.8125 \times 10^6$

$= 53.125 \times 10^6\ mm^4$ Ans

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Moment about y-y axis of

$$I_{G_1} = \frac{db^3}{12} = \frac{50 \times 150^3}{12} = 14.0625 \times 10^6 \, mm^4$$

$$I_{G_2} = \frac{db^3}{12} = \frac{150 \times 50^3}{12} = 1.5625 \times 10^6 \, mm^4$$

From y axis the distance is zero.

M.I about Y-Y axis ①.

$$I_{G_1} + \cancel{a_1 h_1^2}^{\,0} = 14.0625 \times 10^6 \, mm^4$$

M.I about Y-Y axis ②

$$I_{G_2} + \cancel{a_1 h_1^2}^{\,0} = 1.5625 \times 10^6 \, mm^4$$

$$I_{YY} = 14.0625 \times 10^6 + 1.5625 \times 10^6$$

$$= 15.625 \times 10^6 \, mm^4 \quad \underline{\text{Ans}}$$

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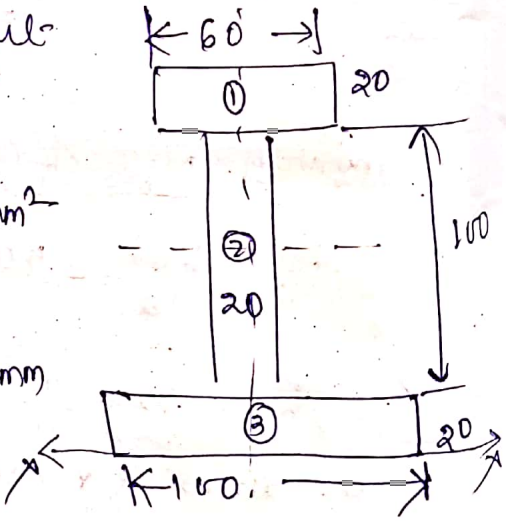
2) Find the M.I of the given section about horizontal axis passing through C.G. Find M.I about X-X axis



Soln This secn is symmetric about y axis. CG pass

Rect ① $a_1 = 60 \times 20 = 1200 \, mm^2$

$x_1 = 60/2 = 30$

$y_1 = 120 + \frac{20}{2} = 130 \, mm$

② $a_2 = 100 \times 20 = 2000$

$y_2 = 20 + \frac{100}{2} = 70 \, mm$

③ $a_3 = 100 \times 20 = 2000$

$y_3 = 20/2 = 10 \, mm$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3} = 60.8 \, mm$$

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$I_{G_1} = \frac{bd^3}{12} = \frac{60 \times 20^3}{12} = 40 \times 10^3 \text{ mm}^4$

$h_1 = y_1 - \bar{y} = 130 - 60.8 = 69.2 \text{ mm}$

M.I of rectangle ① about X-X

$I_{G_1} + a_1 h_1^2 = 40 \times 10^3 + [1200 \times (69.2)^2]$

$= 5786 \times 10^3 \text{ mm}^4$

for ②

$I_{G_2} = \frac{bd^3}{12} = \frac{20 \times 100^3}{12} = 1666.7 \times 10^3 \text{ mm}^4$

$h_2 = y_2 - \bar{y} = 70 - 60.8 = 9.2 \text{ mm}$

$I_{XX(2)} = I_{G_2} + a_2 h_2^2 = 1836 \times 10^3 \text{ mm}^4$

for ③ $I_{G_3} = \frac{100 \times 20^3}{12} = 66.7 \times 10^3 \text{ mm}^4$

$h_3 = \bar{y} - y_3 = 60.8 - 10 = 50.8 \text{ mm}$.

$I_{XX(3)} = I_{G_3} + a_3 h_3^2 = 5228 \times 10^3 \text{ mm}^4$

$I_{XX} = (5786 \times 10^3) + (1836 \times 10^3) + (5228 \times 10^3)$

$= 12850 \times 10^3 \text{ mm}^4$

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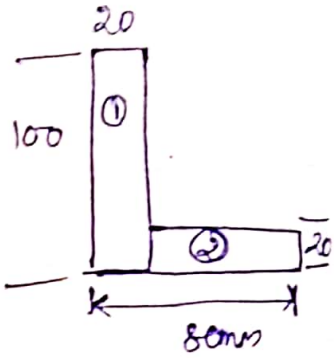
20/8/25)

Find the M.I about the centroidal x-x & y-y axis of the angle section.

Soln This section is not symmetrical about x or y axis.



Rectangle (1)

$$a_1 = 100 \times 20 = 2000 \text{ mm}^2$$

$$y_1 = 100/2 = 50 \text{ mm}$$

(2) $$a_2 = 80 \times 20 = 1600 \text{ mm}^2$$

$$y_2 = \frac{20}{2} = 10 \text{ mm}$$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2} = \frac{2000 \times 50 + 1600 \times 10}{2000 + 1600} = 35 \text{mm}$$

M.I of ① about x-x axis.

$$I_{G1} = \frac{bd^3}{12} = \frac{20 \times (100)^3}{12} = 1.667 \times 10^6 \text{ mm}^4$$

$$h_1 = y_1 - \bar{y} = 50 - 35 = 15 \text{mm}$$

$$I_{xx(1)} = I_{G1} + a_1 h_1^2 = 1.667 \times 10^6 + 2000 \times (15)^2$$

$$= 2.117 \times 10^6 \text{ mm}^4$$

M.I of ② about x-x-axis

$$I_{G2} = \frac{bd^3}{12} = \frac{60 \times 20^3}{12} = 0.04 \times 10^6 \text{ mm}^4$$

$$h_2 = \bar{y}_2 - \bar{y} = 35 - 10 = 25 \text{ mm}$$

$$I_{xx(2)} = I_{G1} + a_2 h_2^2 = 0.74 \times 10^6 \text{ mm}^4$$

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$I_{X-X} = I_{XX(1)} + I_{XX(2)} = 2.407 \times 10^6 \text{ mm}^4$

M.I about y axis

$x_1 = 20/2 = 10 \text{ mm}$

$x_2 = 20 + 60/2 = 50 \text{ mm}$

$\bar{x} = \frac{a_1 x_1 + a_2 x_2}{a_1 + a_2} = 25 \text{mm}.$

M.I of ① about Y-Y axis

$I_{G_1} = \frac{db^3}{12} = \frac{100 \times 20^3}{12} = 0.06 \times 10^6 \text{ mm}^4$

$h_1 = \bar{x} - x_1 = 25 - 10 = 15 \text{mm}$

$I_{yy(1)} = I_{G_1} + a_1 h_1^2 = 0.06 \times 10^6 + 2000 \times 15^2$

$= 0.517 \times 10^6 \text{ mm}^4$

M.I of ② Y-Y

$I_{G_2} = \frac{db^3}{12} = \frac{20 \times 80^3}{12} = 0.36 \times 10^6 \text{ mm}^4$

$h_2 = x_2 - \bar{x} = 50 - 25 = 25 \text{mm}$

$I_{yy(2)} = I_{G_2} + a_2 h_2^2 = 1.11 \times 10^6 \text{ mm}^4$

$I_{YY} = I_{yy(1)} + I_{yy(2)}$

$= 1.627 \times 10^6 \text{ mm}^4$

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CHAPTER – 05 Principle of Lifting Machines.

5.1

↳ Machine :- It is an assembly of interconnected components arrranged to transmit or modify forces in order to perform useful works.

↳ Simple machine :- It is defined as a machine which helps to do some work at some point when effort of force is applied to it.

↳ Compound machine :- It can be defined as a device which consist of no. of simple machine which enable us to do some work at a faster speed with less effort as compare to semple machine.

↳ Lifting Machine :- The machine which are use to lift heavily load are called lifting machine. In a lifting machine a force or load (W) applied at one point by means of another force called effort (P) applied at another point.

1) Mechanical Advantage (M.A)

$$M.A = \frac{\text{Weight load lifted}}{\text{effort applied}} = \frac{W}{P}$$

$$M.A = \frac{W}{P}$$

2) Velocity Ratio (V.R)

$$V.R = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}} = \frac{y}{x}$$

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3) **Input** :- It can be defined as work done on the machine. It is measured by the product of effort applied & the distance covered by the effort.

$i/p = P \times y$ or effort x effort distance.

4) **output** :- It is defined as the work done by the machine. It is the product of load lifted & distance covered by the load.

output = $W \times x$ Load x load distance.

Efficiency (η) / Relation bet^n η, M.A, V.R

Ratio of $\frac{\text{work done by the machine.}}{\text{work done on the m/c}}$

$$= \frac{W \times x}{P \times y} = \frac{W}{P} \times \frac{x}{y}$$

$$= \frac{W}{P} \times \frac{1}{y/x} = \frac{M.A}{V.R} \times \frac{1}{V.R}$$

$$\boxed{\eta = \frac{M.A}{V.R}} < 1.$$

Ideal Machine

$$\eta = \frac{M.A}{V.R} = 100\%$$

i.e $\boxed{o/p = i/p.}$

2) In a certain weight lifting m/c a weight of 1 kN is lifted by an effort of 25 N. While wt. moves by 100mm, the point of application of effort moves by 8 m. Find MA, VR & η.

Soln

$W = 1 kN$
$P = 25 N$
$x = 100mm = .1 m$
$y = 8$

$MA = W/P = 40$

$V.R = y/x = 80$

$\eta = MA/VR = 0.5 = 50\%$

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2) Effort = 50 N (P)

Load (W) = 500 N

Effort distance = (y) = 55 cm = 0.55 m

Load distance = (x) = 5 cm = 0.05 m

$VR = y/x = \frac{.55}{.05} = 11$

$M.A = \frac{500}{50} = 10$

$\eta = \frac{10}{11} = 0.9 = 90\%$

3) M.R = 50 Determine W & P = 60

$\eta = 70\%$

$VR = y/x$ $\eta = \frac{MA}{VR}$

$MA = \frac{W}{P}$ $\Rightarrow .70 = \frac{MA}{50}$

$\Rightarrow W = 2100$ N. $\Rightarrow MA = 35$

Reversibility of a Machine

Sometimes, a machine is also capable of doing some work in the reversed direction, after effort is removed. Such a m/c is called a reversible m/c & known as reversibility of a machine.

Condition for Reversibility of a m/c

W → load lifted by the m/e

P → effort req to lift the load

y → distance moved by effort

x → distance moved by load.

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i/p = p x y

o/p = w x x

We know that- m/c friction = i/p - o/p

= p x y - w x x

If the m/c is reversible then the o/p of the machine. should be more than friction.

$$w \times x > p \times y - w \times x$$

$$\Rightarrow 2w \times x > p \times y$$

$$\Rightarrow \frac{w \times x}{p \times y} > \frac{1}{2}.$$

$$\Rightarrow \frac{w/p}{y/x} > 1/2$$

$$\left.\begin{array}{l} \frac{M.A}{V.A} > \frac{1}{2} \\ \frac{M.A}{V.R} > 50\% \\ \eta > 50\% \end{array}\right\}$$

So the condition is if the machine is reversible the efficiency is more than 50%.

Self locking m/c

Some time a machine is not capable of doing any work when the effort is removed. Such machine is called as self locking machine. Here the efficiency should not be more than 50%.

Law of Machine.

Law of machine may be defined as the relationship between effort applied & load lifted.

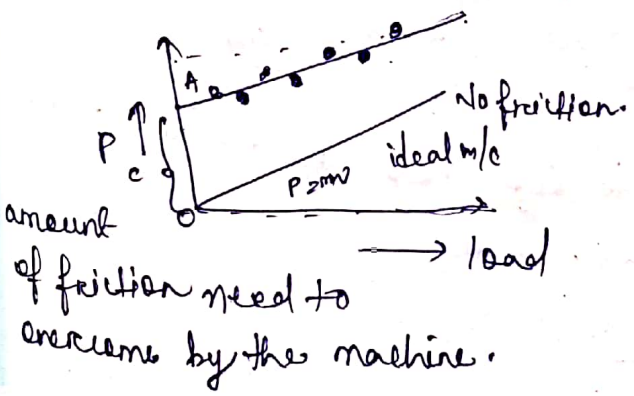
Mathmetically it is $p = mw + c$

p → effort

w → Load lifted

(Slope) m → constant

c → Another constant. represent m/c friction.



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2) What load can be lifted by an effort of 120N, if the velo. ratio is 18 & $\eta = 60\%$. Determine the load of the machine, if it is observed that an effort of 200N is req to lift a load of 2000N & find the effort req to run the m/c at a load of 3.5kN.

Sol^n V.R = $y/x = 18$ $P = 120$

$\eta = .6$

$\frac{W/P}{V/R} = .6 \Rightarrow \frac{W}{P} = V.R \times .6$

$= 18 \times .6$

$= 10.8$

$\Rightarrow W = 120 \times 10.8$

$= 1296 N$

Laws of m/c $P = 200$, $W = 2600$

$P = mW + c$

$120 = m \times 1296 + c$ — (1)

$200 = m \times 2600 + c$ — (2)

$-80 = -1304m$

$\Rightarrow m = 0.061$

put the value of m in equ^n (2)

$120 = 0.061 \times 1296 + C$ $\quad 200 = 0.061 \times 2600 + c$

$\Rightarrow C = 1.15$ $\quad \Rightarrow C = 44$

Now effort req. to lift a load of $3.5kN = 3.5 \times 10^3 N$

$P = .061 \times 3.5 \times 10^3 + 44$

$P = 257 N$ Ans

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6) In a lifting m/c, an effort of 40N raised a load of 1KN. If efficiency of the m/c is 0.5. What is its velocity ratio? If on this m/c, an effort of 74 N raised a load of 2KN. What is max efficiency? What will be the effort req: to raise a load of 5KN.

Sol) $P = 40N$ $\eta = 0.5$

$W = 1kN = 1000N$ $P = 74N$ $W = 2kN = 2000N$.

velocity ratio when effi is 0.5

$M.A = \frac{W}{P} = \frac{1000}{40} = 25$

$\eta = \frac{M.A}{V.R} = \frac{25}{V.R} \Rightarrow V.R = \frac{25}{0.5} = 50$

Effi when P is 74 & W = 2000N

$M.A = \frac{W}{P} = \frac{2000}{74} = 27$

$\eta = \frac{M.A}{V.R} = \frac{27}{50} = 54\%$

effort req. to raise a load of 5KN or 5000N

$P = mW + C$

$40 = m \times 1000 + C$

$74 = m \times 2000 + C$

$\Rightarrow 34 = 1000m$

$\Rightarrow m = 0.034$

value of C.

$40 = m \times 1000 + C$

$\Rightarrow 40 = 0.034 \times 1000 + C$

$\Rightarrow C = 6$

$P = 0.034W + 6$

$\Rightarrow P = 0.034 \times 5000 + 6 = 176N$

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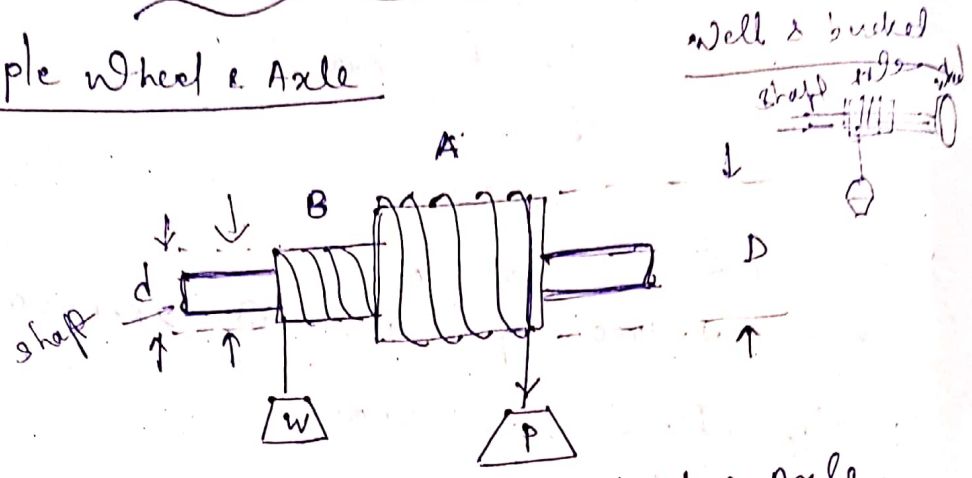
5.2 Simple Lifting Machine

Simple Wheel & Axle



The above is the fig of simple wheel & Axle.

↳ The wheel A & axle B are keyed to the same shaft. The shaft is mounted on ball bearing, to reduce the frictional resistance minimum.

↳ A string is wound round the axle B, which carries the load to be lifted. A second string is wound round the wheel A in the opposite direction to that of the string on B.

D → Dia of effort wheel W → Load lifted
d → " " " load axle P → effort applied

↳ one end of the string is fixed to the wheel, while the other is free & the effort is applied to this end.

↳ Since the two strings are wound in opposite directions, therefore a downward motion of the effort (P) will raise the load (W)

$$M.A = \frac{W}{P}$$

Distance/Displacement by the wheel = πD

" " " Axle = πd

$$V.R = \frac{\pi D}{\pi d} \Rightarrow V.R = \frac{D}{d}$$

$$\eta = \frac{M.A}{V.R}$$

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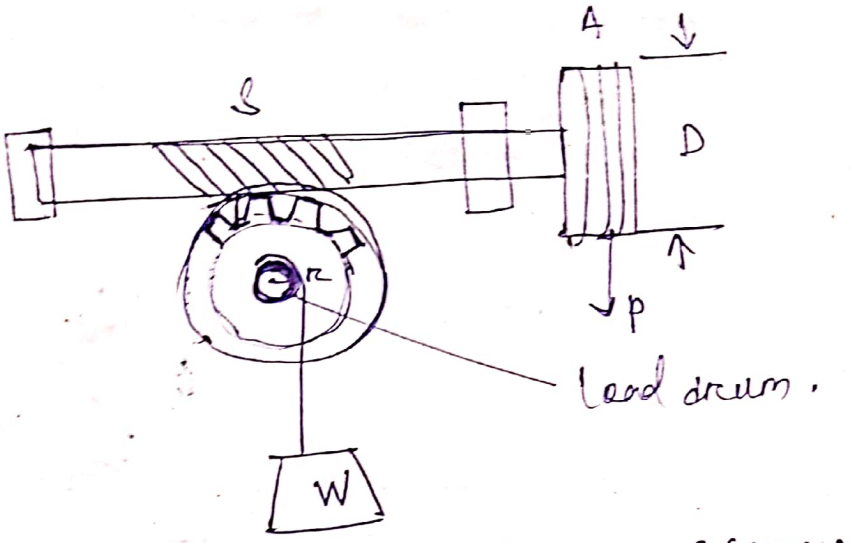
Worm & Worm wheel



↳ It consist of a square threaded screw. S (known as worm) & a toothed wheel (known as worm wheel) geared to each other..

↳ A wheel A is attached to the worm, over which passes a rope as shown in fig.

D → Dia of effort wheel

R → radius of the load drum.

W → load

P → Effort applied

T → No. of teeth on the worm wheel.

$\pi D = 2\pi \times \frac{d}{2}$

$M.A = \frac{W}{P}$

~~Displace~~ Distance moved by wheel = πD

" " " Load drum = $\frac{2\pi R}{T}$

$V.R = \frac{\pi D}{2\pi R/T} = \frac{DT}{2R}$ =

∴ if the there is thread of n no.

then $V.R = \frac{DT}{n \times 2 \times R}$

$\eta = \frac{M.A}{V.R}$

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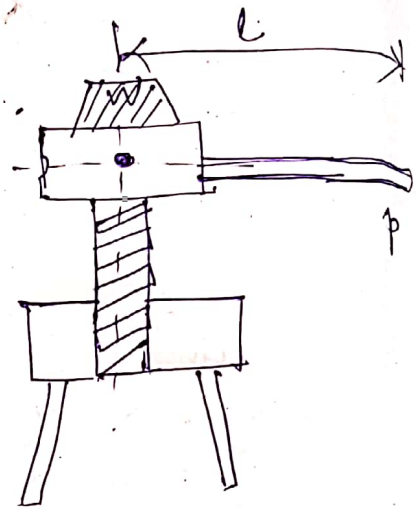
Simple Screw Jack

It consist of a screw, fitted in a nut, which forms the body of the Jack. The principle on which a screw works, is similar to that of an inclied plane.

↳ The fig shows a simple screw Jack.

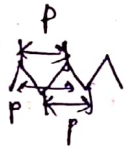


↳ l → length of effort arm

P → effort

W → load

p → pitch of the screw



The distance moved by the effort in one revolution = $2\pi l$

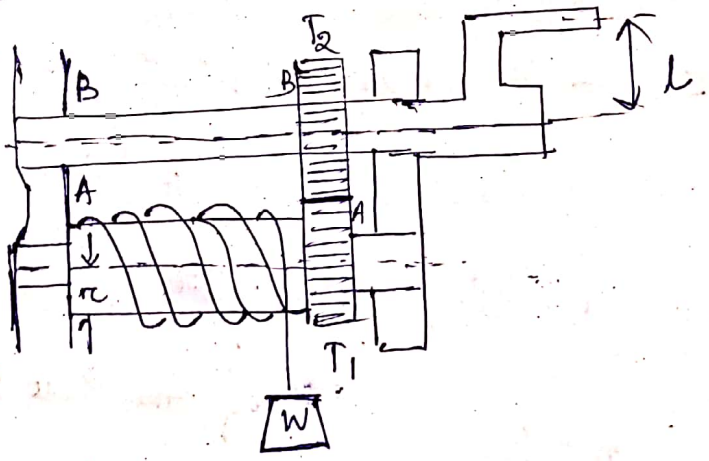
Distance moved by the load = p

$$V.R = \frac{2\pi l}{p}$$

$$M.A = \frac{W}{P}$$

$$\boxed{\eta = \frac{M.A}{V.R}}$$

Single purchase Crab winch



In a single purchase crab winch, a rope is fixed to the drum & is wound a few turns arround it.

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The free end of the rope carries a load W.
↳ A toothed wheel A is rigidly mounted on the load drum
↳ Another toothed wheel B called pinion is geared with wheel A.

T_1 → no. of teeth in wheel / gear A.
T_2 → " " " " / " B.
l → length of handle
r → radius of load drum
W → Load
P → effort.

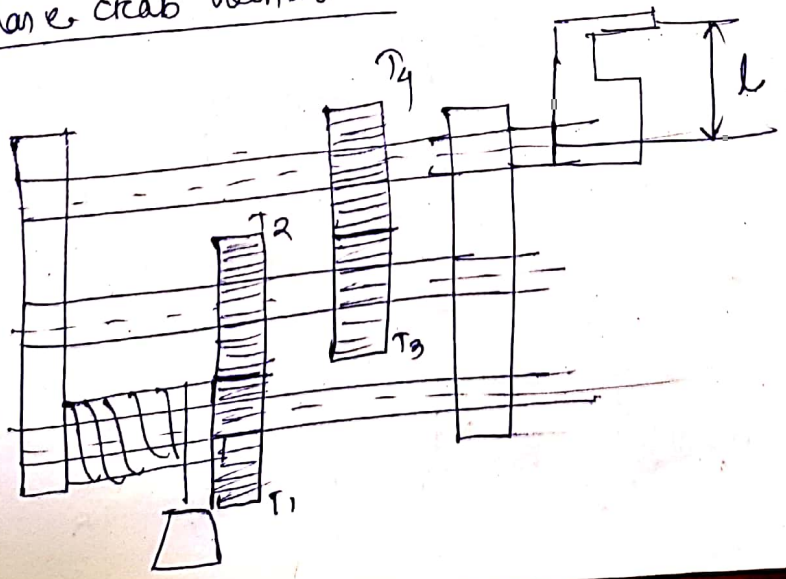
Distance moved by the effort in one revolution of handle
$= 2\pi l$
no. of revol^n made by pinion B = 1
" " " " A = $\frac{T_2}{T_1}$
" " " " load drum = T_2/T_1

distance moved by load = $2\pi r \times T_2/T_1$

$$V.R = \frac{2\pi l}{2\pi r \times T_2/T_1} = \frac{T_1 \times l}{T_2 \times r}$$

$$M.A = \frac{W}{P} \qquad \boxed{\eta = \frac{M.A}{V.R}}$$

Double purchase crab winch



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It is the improved version of single purchase crab winch. Here there are 2 spur wheel & 2 pinion.

T_1 meshed with T_2 (pinion)

T_3 " " T_4 (pinion)

l = length of the handle.

T_1 & T_3 = No. of teeth in spur wheels

T_2 & T_4 = " " " pinion "

r = radius of drum

W = load

P = effort

Distance moved by effort in one revolution of handle

$= 2\pi l$

No. of revol^n made by pinion 4 = 1

" " " " spur 3 = T_4/T_3

" " " " pinion 2 = T_4/T_3

" " " spur 1 = $\frac{T_2}{T_1} \times \frac{T_4}{T_3}$

Distance moved by load = $2\pi r \times \frac{T_2}{T_1} \times \frac{T_4}{T_3}$

$$V.R = \frac{2\pi l}{2\pi r (T_2/T_1)(T_3/T_4)} = \frac{1}{r}\left(T_1/T_2 \times T_4/T_3\right)$$

$$M.A = W/P$$

$$\boxed{\eta = \frac{M.A}{V.R}}$$

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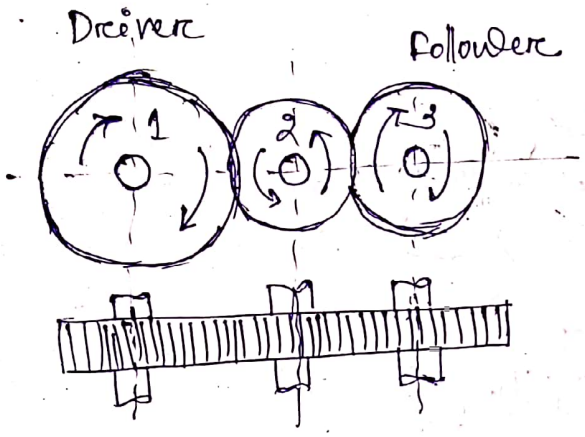
Gears

A gear may be defined as a pulley or wheel having projections on its rim known as teeth. It is also used for power transmission.

Gear train

Sometimes two or more gears are made to mesh with each other, so as to operate as a single system, to transmit power from one shaft to another. Such a combination is called gear train or train of wheels.

1) simple gear train



The above fig shows a simple gear train.

N_1 → speed of driver

T_1 → No. of teeth on the driver

N_2 → Speed of intermediate

T_2 → No. of teeth on "

N_3 → Speed of follower

T_3 → No. of teeth " "

Velocity ratio of gear 1 & 2

$$\frac{N_2}{N_1} = \frac{T_1}{T_2} \quad \text{——— (1)}$$

Velocity ratio of gear 2 & 3

$$\frac{N_3}{N_2} = \frac{T_2}{T_3} \quad \text{——— (2)}$$

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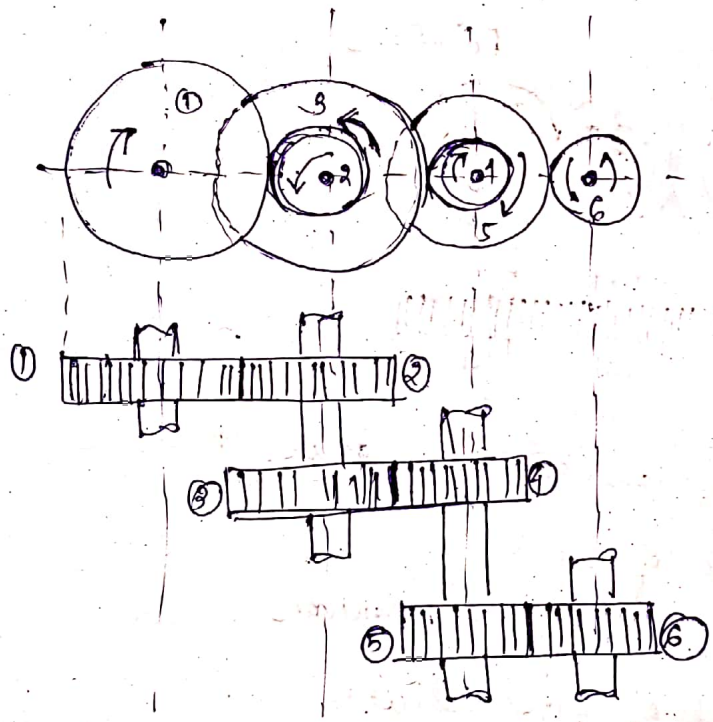
Multiplying eqn ① & ②

$$\frac{N_3}{N_2} \times \frac{N_2}{N_1} = \frac{T_2}{T_3} \times \frac{T_1}{T_2}$$

$$\Rightarrow \boxed{\frac{N_3}{N_1} = \frac{T_1}{T_3}}$$

Compound gear train

When more than one gear is mounted on same shaft it is known as compound gear train.



$N_1, N_2, N_3, N_4, N_5, N_6$ → Speed of respective wheel

$T_1, T_2, T_3, T_4, T_5, T_6$ → No. of teeth of " "

$$\frac{N_2}{N_1} = \frac{T_1}{T_2} \quad \text{(for 1 \& 2)}$$

$$\frac{N_4}{N_3} = \frac{T_3}{T_3} \quad \text{(" 3 \& 4)}$$

$$\frac{N_6}{N_5} = \frac{T_5}{T_6} \quad \text{(" 5 \& 6)}$$

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Multiplying ① ② ③.

$$\frac{N_2}{N_1} \times \frac{N_4}{N_3} \times \frac{N_6}{N_5} = \frac{T_1}{T_2} \times \frac{T_3}{T_4} \times \frac{T_5}{T_6}$$

$$\Rightarrow \boxed{\frac{N_6}{N_1} = \frac{T_1}{T_2} \times \frac{T_3}{T_4} \times \frac{T_5}{T_6}}$$

$$\left\{ N_2 = N_3 \right\} \quad \left\{ N_4 = N_5 \right\}$$

5.3 Derrick

A derrick is a lifting device. These are used to lift heavy loads. Normally used in building construction, portete, marine sector.

↳ These are also known as stationary cranes.

↳ The most basic type of derrick is controlled by 3 or 4 lines connected to the top of the mast/column which allow it to move lateral direct^n & upsdown motion.

↳ Normally the height of a derrick is 265 ft (80 m).

* Shaft is a live member & axle is a dead member, shaft is used to transmit power from one mechanical member to another, while axle is used to only support the load/transmit motion.

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CHAPTER-06 | DYNAMICS

6.1 Dynamics :- It is the study of motion of rigid body and their relation with the forces causing them.

The entire system of dynamics is based on 3 laws of motion. Also known as newton law's of motion.

Newton's 1st law

It states that " Every body continues in its state of rest or of uniform motion, in a straight line, unless it is acted up on by some external force.
It is also called as law of inertia.

↳ A body at rest has a tendency to remain at rest called inertia of rest.

↳ A body in uniform motion in a straight line has a tendency to preserve its motion. known as inertia of motion. * I

Newton's 2nd Law

" The rate of change of momentum is directly proportional to the impressed force and takes place, in the same dirⁿ in which the force acts".

m = mass of a body
u = initial velo. of the body
v = final velo of the body
a = const. accⁿ
t = time. in seconds req. to change the velo u to v.
F = Force req to change velo from u to v ab initio.

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initial momentum = mu

final " = mv

Rate of change of momentum = $\frac{mv - mu}{t} = \frac{m(v-u)}{t}$

$= ma$

Acc to 2nd law $F \propto ma$

$\Rightarrow F = kma$ $\left(\because \frac{v-u}{t} = a\right)$

$k \rightarrow$ const.

For convenience, the unit of forces adopted in such that it produces unit acc^n in unit mass.

$F = ma$ = mass x acc^n

In S.I system unit of force is Newton $\rightarrow$ N.

A Newton may be defined as the force while acting upon a mass of 1 kg, produces an acc^n of 1 m/s^2 in the dirc^n of which it acts.

Also known as Law of dynamics.

if acc^n is due to gravity $a = 9.8$ m/s^2 = 1 kg.wt

$F = ma$

$\Rightarrow F = 9.8$ N $\quad (1$ kg.wt $= 9.8$ N$)$

$= 1$ kg.wt $\quad (1$ kg.f $= 9.8$ N$)$

$= 1$ kg.F

b) body has 50 kg mass on earth. Find a where $g = 9.8$ N/kg

b) on moon $g = 1.7$ m/s^2

c) " ever. $g = 270$ m/s^2

$F_1 = 50 \times 9.8$

$F_2 = 50 \times 1.7$

$F_3 = 50 \times 270$

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Kinetic equations

1) $v = u + at$

2) $s = ut + \frac{1}{2}at^2$

3) $v^2 = u^2 + 2as$

2) A particle of mass 500gm starts from rest & moves under the influence of a const force. It acquires a speed of 6 m/s after 12s.

i) Find force on the particle

ii) Find speed at $t = 16s$

iii) Find distance covered by the particle in 1st 10s.

iv) Find " " " during time interval 5 to 15s.

Sol)

m = mass of the particle = 500g = 0.05 kg

$u = 0$

$v = 6$ m/s

$t = 12$.

i) $v = u + at$

$F = ma$

$\Rightarrow 6 = 0 + a \times 12$

$\Rightarrow a = 6/12 = 0.5$ m/s^2

i) $F = m \times a$

$= .05 \times 0.5 = 0.025$ N

ii) $v = u + at$

$= 0 + (0.5 \times 16) = 8.0$ m/s

iii) $s = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2} \times 0.5 \times 10^2 = 25$ m

iv) $s_2 - s_1 = \left(ut_2 + \frac{1}{2}at_2^2\right) - \left(ut_1 + \frac{1}{2}at_1^2\right)$

$= (\quad)$ m

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Newton 3rd law of Motion

To every action there is an equal & opposite reaction.

Momentum :- It is the product of mass with velocity.

$m \times v$

Force :- Any external agent which produce are tends to produce, destroys are tends to destroy the motion of any body. known as Force. unit N.

$F = m \times a$

Inertia :- The property which offers resistance to change state of rest- are motion is known as inertia.

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Newton 3rd law for recoil of gun

When bullet is fired from a gun, the opposite reaction of the bullet is known as recoil of gun.

M → Mass of gun.
m → Mass of bullet.
V → velo. of gun
v → velo of bullet after being fired.

momentum ~~before~~ of the gun = MV
" " , bullet = mV

$$MV = mv$$

Law of conservation of Momentum.

D'alembert's principle

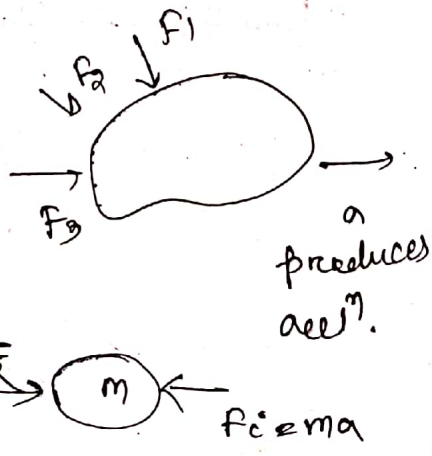
A system of forces acting on a body in motion is in dynamic equilm with inertia force of the body.

Inertia → Resist motion
→ Resist to be at rest

The resultant of F_1, F_2, F_3 let R.

Let a mass m.

If resultant to bring the body at rest, we have to apply a force in opposite dirn whose value is equal to ma.



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known as inertia force, to bring the body in static equilm.

$$\Sigma F = 0$$

$$F\hat{R} - ma = 0$$

$$\Rightarrow F\hat{R} = ma \Rightarrow \boxed{F_i = ma}$$

$-ma \rightarrow$ inertia force. $= F_i$, Also known as reversed force.

6.2 Work, power, Energy

Work

When force acts on a body, the body undergoes a displacement, work is said to be done on the body by the force.

$$W = F \cdot S$$

unit

$$W = F \cdot S$$

$$= N\text{-}m = 1 \text{ Joule (SI)}$$

$$1 \text{ erg} = \text{CGS} = 1 \text{ dyne} = 10^{-7} \text{ Joule}$$

power

It is the rate of doing work.

$$\text{unit} = \text{Watt} = J/s = N\text{-}m/s$$

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Energy

It is the capacity to do work.
It exists in many forms, mechanical, electrical Chemical, heat, light etc.

unit

Same as work = Joule = J

Mechanical Energy
- Kinetic = $\frac{1}{2}mv^2$
- potential = mgh

Kinetic Energy

Energy posed by a body, by virtue of its mass & velocity.

PE

Energy posed by a body, by vertue of its position.

2) A truck of mass 15 tonnes travelling at 1.6 m/s. impact with a spring

Law of conservation of Energy

It states that "Energy can neither be created nor destroyed, though it can transformed from one form to another form.

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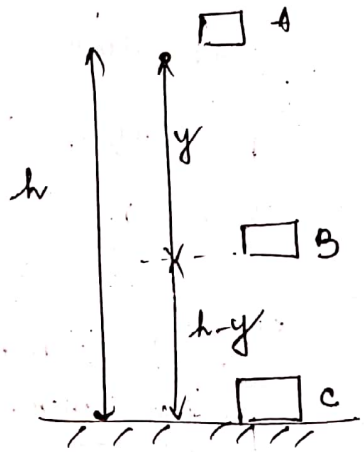
Transformation of Energy

Consider a body of mass m which is released from rest from height h above the ground.

m = mass of the body

h = height of



Energy at A

Since at A body has 0 velocity

$KE = 0$

$PE = mgh$

total energy = $PE + KE = mgh$

Energy at B

The body travelled y distance from A to B. So

$v = \sqrt{2gy}$

$KE \text{ at } B = \frac{mv^2}{2} = \frac{m \times (\sqrt{2gy})^2}{2} = mgy$

$PE = mg(h-y) = mgh - mgy$

total energy = $KE + PE = mgy + mgh - mgy$

$= mgh$

Energy at C

At C body has fallen a height h.

$v = \sqrt{2gh}$

$KE = \frac{mv^2}{2} = \frac{m(\sqrt{2gh})^2}{2} = mgh$

$PE = 0$

total energy = $KE + PE = mgh$

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Q) A 100gm ball is released from rest from the top of 20m high building. Find the change in P.E & K.E when it is at a height of 10 from the ground.

Soln

$m = 100gm = 0.1kg$

$h_1 = 20m$

$P.E_1 = mgh_1 =$

$K.E_1 = 0$

Impulse → When a const. force F acts on a body for a time interval, t. known as impulse.

$$\boxed{I = F \times t}$$ unit N-s

Linear momentum -

Law of conservation of linear momentum

Acc to newton's 2nd law, the net external force acting on a body is equal to rate of change of linear momentum / momentum.

This leads to the law of conservation of linear momentum for a body.

which states that the linear momentum of a body remains const. if the external force on a body is zero.

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6.3 Collision of Elastic Bodies

When two bodies strikes with each other with certain velocity it is known as collision.

↳ If one body is in rest and even if another body strikes to it (wall or floor) also known as collision.

↳ Let any ball strikes to the floor, it rises certain height or rebounded.

↳ This property of bodies by virtue of which, they rebounded after impact is called elasticity.

↳ But if a body does not rebound at all, after impact called as inelastic collision.

Phenomenon of collision

- The bodies, immediately after collision, come momentarily to rest.
- The two bodies tend to compress each other, so long as they are compressed to the maxim value called as time of compression. (t_c)
- The process of regaining of original shape from the deformed shape of the bodies called restitution. Time taken for that called as time of restitution (t_R)

Time of collision = Time of compression + Time of restitution

Law of conservation of Momentum

It states that the total momentum of two bodies remains const. after their collision.

$$m_1v_1 + m_2v_2 = m_1V_1 + m_2V_2$$

m_1 = mass of 1st body

m_2 = " " 2nd body

v_1, v_2 = initial velocity of mass m_1 & m_2 respectively

V_1, V_2 = final " " " m_1 & m_2 "

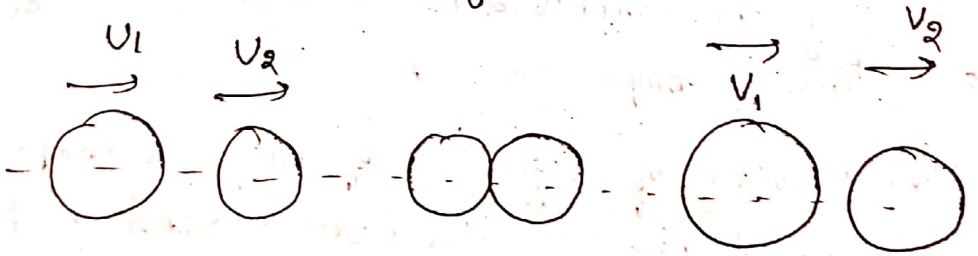
Newtons Law of collision of elastic bodies

It states when two moving bodies collide with each other, their velo. of separation bears a const ratio to their velo. of approach.

$$(V_2 - V_1) = e(v_1 - v_2)$$

$$e = \frac{v_1 - v_2}{V_2 - V_1}$$

e = co-efficient of restitution.



$v_1 > v_2$ → collision takes place.

$V_2 > V_1$ → separation takes place.

Two Types of collision

→ Direct collision

→ Indirect "

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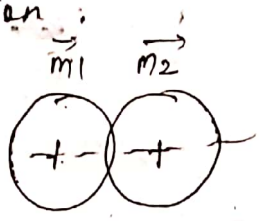
Direct collision

The line of impact of the two colliding bodies, is in the line joining the centers of the 2 bodies, known as point of contact or point of collision.



$m_1u_1 + m_2u_2 = m_2v_1 + m_2v_2$.

The value of e is in bet^n 0 to 1

if $e = 0$ collision is inelastic

$e = 1$ " " elastic.

2016

8) A ball of mass 2 kg moving with a velocity 2m/sec hit another ball of mass 4 kg at rest, after impact the 1st ball comes to rest. Cal. velo. of the 2nd ball after impact & coeffi of restitution.



$m_1 = 2$kg $u_1 = 2$ m/s

$m_2 = 4$ kg $v_1 =$

$v_2 =$

$u_2 =$

$e =$

$v_1 = 0$ (comes to rest m_1)

$u_2 = 0$ at rest (m_2)

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$\Rightarrow 2 \times 2 = 4 \times v_2$

$\Rightarrow v_2 = 1$ m/s

$(v_2 - v_1) = e(u_1 - u_2)$

$\Rightarrow e = \frac{1-0}{2-0} = \frac{1}{2} = 0.5$ Ans

2015, 2018

9) Two balls of masses 2kg & 3kg are moving with velo 2m/s & 3m/s towards each other. If $e = 0.5$. find velocity of the two balls after collision.

Sol^n

$m_1 = 2$ $u_1 = 2$

$m_2 = 3$ $u_2 = 3$

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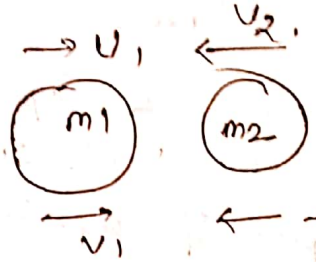
$$e = \frac{v_2 - v_1}{u_1 - u_2}$$



$$\Rightarrow \frac{1}{2} = \frac{v_2 - v_1}{2 - (-3)}$$

$$\Rightarrow v_2 - v_1 = 1 \times \frac{1}{2} = \frac{1}{2}.$$

$$\Rightarrow \frac{1}{2} = \frac{-v_2 - v_1}{5}$$

$$\Rightarrow -v_2 - v_1 = 5/2. \quad \text{---------- (2)}$$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$\Rightarrow 2 \times 2 + 3(-3) = 2v_1 + (-3v_2)$$

$$\Rightarrow 2v_1 - 3v_2 = -5 \quad \text{---------- (1)}$$

multiply 2 in eqn (1) (2×2)

$$2v_1 - 3v_2 = -5$$
$$-2v_1 - 2v_2 = 5$$
$$-5v_2 = 0$$

$$v_2 = 0 \text{ m/s}$$

$$\Rightarrow v_2 + v_1 = -5/2$$

$$\Rightarrow v_2 = -5/2 + v_1$$

put the value of eqn (2)

$$2v_1 - 3(-5/2 - v_1) = -5$$

$$\Rightarrow 2v_1 + 15/2 + 3v_1 = -5$$

$$\Rightarrow v_1 = -2.5 \text{ m/s}$$

Now $v_1 = -5/2 = -2.5$ m/s

$v_2 = 0$

② A ball is dropped from a height of 10m on a smooth floor and it rebound to a height of 5m. Determine the coefficient of restitution between the ball & the floor & also determine the expected height of the 2nd rebound.

$u \rightarrow$ velo before impact

$v \rightarrow$ " after "

$h \rightarrow$ hight before " 10m

$h_1 \rightarrow$ " after 1st rebound 5m

$h_2 \rightarrow$ " " 2nd , ?

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$U = \sqrt{2gh}$ (when the body is at a height 10m $V_2 0$)

$V = \sqrt{2gh_1}$

$e = \frac{V}{U} = \frac{\sqrt{2gh_1}}{\sqrt{2gh}}$

$\Rightarrow e = \sqrt{h_1/h}$

$\Rightarrow e = 0.7$

similarly

$e = \sqrt{h_2/h_1}$

$\Rightarrow (0.7)^2 = \frac{h_2}{5}$

$\Rightarrow h_2 = 2.5m$

GOVERNMENT POLYTECHNIC
Date 28/04/2020
SAMBALPUR (RENGALI), ODISHA

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UNIT-7

GOVERNMENT POLYTECHNIC
SAMBALPUR (RENGALI), ODISHA
Date 28/04/2020

UNIT-7 (HEAT and THERMODYNAMICS)

7.1 (CH-1) – Heat and Temperature

↳ Definition and Difference.

[SQ 2m] DEFINE HEAT.

OR

WHAT is HEAT?

(Ans):→ It is a form of energy whose flow from one body to another depends on the temperature of the two bodies.

Heat or Heat energy always flows from hot body to cold body.

[SQ 2m] DEFINE TEMPERATURE.

OR

WHAT is TEMPERATURE?

(Ans)→ Temperature measures or indicates the degree of hotness or coldness of a body.

Temperature of a body determines the flow of heat. Heat always flows from one body at higher temperature to a body at lower temperature.

(CH-2) UNIT-7 → 7.2

UNITS of HEAT.

SYSTEM	UNIT OF HEAT	UNIT OF TEMPERATURE
FPS	British Thermal unit (BTU)	Degree Fahrenheit (°F)
CGS	Calorie	Degree Centigrate (°C)
MKS	Kilo-Calorie (k·cal)	Degree Centigrate (°C)
SI	Joule	Degree Kelvin (°k).

RELATION BETWEEN DIFFERENT UNITS of H

- 1 B.T.U = 252 calories
  1-k-cal = 1000 calories.

DIFFERENCE BETWEEN HEAT and TEMPERATURE.

HEAT	TEMPERATURE
(i) It is a form of energy.	(i) Measures the degree of hotn or coldness.
(ii) Flows from hot body to cold body.	(ii) Temperature determines the flows of heat.
(iii) Units of heat are :- BTU – FPS; Cal – CGS; k·cal – MKS; Joule – SI	(iii) Units of temperature are °F → FPS; °C → CGS; °C → MKS; °k → SI

UNIT-7 (CH-3) → 7.3

SPECIFIES HEAT.

- Concept
- Definition
- Unit
- Dimension
- Simple Numerical.

Dt: 06/11/19

CONCEPT of SPECIFIC HEAT

HEAT

- Sensible Heat.
  - Specific Heat
  - Sense (feel).
  - raises the temp of a body.
- Hidden Heat.
  - we cannot sense or feel as this heat does not raise (increase) the temp of a body only State of body changes. (solid, liquid, gas)

(*) Sensible Heat → Specific Heat

(*) Hidden Heat → Latent Heat

(*) Specific Heat → Raises (increases) the temperature of a body but State doesn't change.

(*) Latent Heat → State changes but temp of the body doesn't changes.

(*) Body gains Heat → Temp increases (rises)

(*) Body loses Heat → Temp decreases (falls).

DEFINE SPECIFIC HEAT (S)

(Ans) → Specific heat of a body (material / substance) is defined as the amount of heat required to raise (increase) the temperature of unit mass of that substance or material by unit degree.

unit mass
- 1 lb (FPS)
- 1 gm (CGS)
- 1 kg (MKS/SI)

unit degree
- °F (FPS)
- °C (CGS/MKS)
- °K (SI).

(*) Copper
→ 1 gm (unit mass) — 1°C ↑ (unit degree) — Heat Req — x cal (SH) copper

(*) Iron
→ 1 gm (unit mass) Temp — 1°C ↑ (unit degree) — Heat Req — y cal (SH) Iron

FORMULA FOR SPECIFIC HEAT.

Let

$m \rightarrow$ mass of a body (material).
$Q \rightarrow$ Heat supplied to the body (material).
$t \rightarrow$ Rise (increase) in temp of the body (material)
$s \rightarrow$ Sp. heat of the body (material).

$$\boxed{Q = mst} \rightarrow \text{Heat gained (Temp}\uparrow\text{)}$$

And Let

$m \rightarrow$ mass of a body (material)
$Q \rightarrow$ Heat Lost by body (Material).
$t \rightarrow$ Rise (increase) in temp. of the body (material)
$s \rightarrow$ Sp. heat of the body (material)

$$\boxed{Q = mst} \rightarrow \text{Heat lost (Temp}\downarrow\text{)}$$

SI unit of SPECIFIC HEAT:

$Q = mst$ or $S = \frac{Q}{mt}$

FPS	CGS	MKS	SI
$\frac{BTU}{lb-°F}$	$\frac{Cal}{gm-°C}$	$\frac{k\text{-}cal}{kg-°C}$	$\frac{Joule}{kg-°k}$
$= \boxed{BTU-lb^{-1}-°F^{-1}}$	$\boxed{Cal-gm^{-1}-°C^{-1}}$	$= \frac{1000\,Cal}{1000\,g-°C}$	$= \boxed{Joule-kg^{-1}-°k^{-1}}$
		$= \boxed{\frac{Cal}{gm-°C}}$	

DIMENSIONAL FORMULA Of SPECIFIC HEAT.

$Q = mst$ or $S = \frac{Q}{mt} \rightarrow \frac{ML^2T^{-2}}{M\times\theta} = \boxed{L^2T^{-2}\theta^{-1}}$

$$\boxed{(DIM)_{work} = (DIM)_{Energy} = [ML^2T^{-2}]}$$

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Or $\frac{M L^2 T^{-2}}{M \times K} = \boxed{[L^2 T^{-2} K^{-1}]}$

NUMERICAL EXAMPLES ON SP. HEAT

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UNIT-7 (CH-4) → 7.4

LATENT HEAT

- Concept
- Definition.
- Unit
- Dimension.
- Numerical.

WHAT is LATENT HEAT?

(Ans) → The heat which changes the state of a body without changes in temperature is called Latent heat of that body (Material).

Important Concepts

(*) Solid → Liquid → (Fusion / melting).

(*) Liquid → gas (vapour) → (Vaporisation)

(*) Melting point → Temp at which Solid becomes Liquid.

(*) Boiling point → Temp at which Liquids becomes gas or vapour.

MP of ICE = 0°C

Boiling point of water = 100°C.

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DEFINE LATENT HEAT of a Substance.

(Ans):- It is defined as the amount of heat required to convert (change) unit mass of that substance into liquid / vapour (gas) at its melting point / boiling point (without change in temperature).

DEFINE LATENT HEAT of FUSION of a SUBSTANCE

(Ans) → It is defined as the amount of heat required to convert (change) unit mass of that Solid in

liquid at its melting point (without change in temperature).

(*) 1gm solid ⟶ 1gm liquid $\xrightarrow{\text{at M. point}}$ HR.

HR ↓ LH of fusion of that solid (Material/substance)

DEFINE LATENT HEAT OF FUSION OF ICE.

(Ans)→ It is defined as the amount of heat required to convert (change) unit mass of ICE into WATER at 0°C (without change in temp or at constant temperature).

0°C → is the melting p of ICE.

(*) 1gm of ice ⟶ 1gm of water $\xrightarrow{\text{at M·P (0°C)}}$ HR = 80 cal.

State change

(*) 1gm ice at 0°C + 80 calorie of heat ⟶ 1gm of water at 0°C.

temp same

(*) 1gm water at 0°C — 80 calorie of heat → 1gm of ice at 0°C.

Latent heat of fusion of ice = $\boxed{L_{ice} = 80 \text{ cal/gm.}}$

This statement means 80 calorie of heat is required to convert 1gm of ice at 0°C to 1gm water at 0°C.

DEFINE LATENT HEAT of VAPOURISATION OF A LIQUID (SUBSTANCE/MATERIAL).

(Ans):- It is defined as the amount of heat required to convert (change) unit mass of Liquid into VAPOUR (GAS) at BOILING point (without change in temp or constant temp).

1 gm Liquid $\xrightarrow[\text{Boiling point}]{\text{at}}$ 1 gm Vapour $\longrightarrow$ HR = LH of Vapourisation of that liqui

DEFINE LATENT HEAT of VAPOURISATION of WAT

(Ans) → It is defined as the amount of heat required to convert (change) unit mass of WATER into VAPOUR (GAS) at 100°C (without change in temp or at constant temperature).
Boiling point.

(*) 1 gm water at 100°C $\longrightarrow$ 1 gm Vapour (steam) at 100°C $\longrightarrow$ HR = 540 Calori

State changes

temp - same

(*) 1 gm water at 100°C + 540 Calorie of Heat $\longrightarrow$ 1 gm steam at 100

(*) 1 gm stem at 100°C — 540 calorie of Heat $\longrightarrow$ 1 gm water at 10

Latent Heat of Vapourisation of water = $\boxed{L_{water} = 540 \text{ cal/gm.}}$

This statement is ~~required~~ indicates that 540 calories of heat is required to convert 1gm water into steam at 100°C.

FORMULA FOR LATENT HEAT.

If m → mass of a substance.
L → Latent Heat of Fusion or Vapourisation.

Q → Heat Supplied to the substance then

$$\boxed{Q = mL}$$

UNITS of LATENT HEAT (L)

$Q = mL$ or $L = \frac{Q}{m}$

FPS	CGS	MKS	SI
$\frac{BTU}{lb}$	$\frac{Cal}{gm}$	$\frac{K \cdot cal}{kg}$	$\frac{Joule}{kg}$

$\frac{1000\ cal}{1000\ gm}$

$= \boxed{\frac{Cal}{gm}}$

DIMENSION of LATENT HEAT (L)

$$L = \frac{Q}{m} \longrightarrow \frac{ML^2T^{-2}}{M} = \boxed{L^2T^{-2}}$$

SIMPLE NUMERICAL FOR.

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UNIT-7 (CH-5) → 7.5

THERMAL EXPASSION.

- Definition
- Concept

DEFINE THERMAL EXPANSION.

OR.

WHAT IS THERMAL EXPANSION?

(Ans)→ Expansion (increase in size) of any substance (solid - liquid - Gas) due to HEAT is called Thermal Expansion.

CONCEPT of EXPANSION

→ Means increase in size of a body.

SIZE

- → Means length (1 Dimensional body).
- → Means Area (2 Dimensional body)
- → Means Volume (3 Dimensional body)

UNIT-7 (CH-6) → 7.6

EXPANSION of SOLIDS (CONCEPT)

SOLIDS

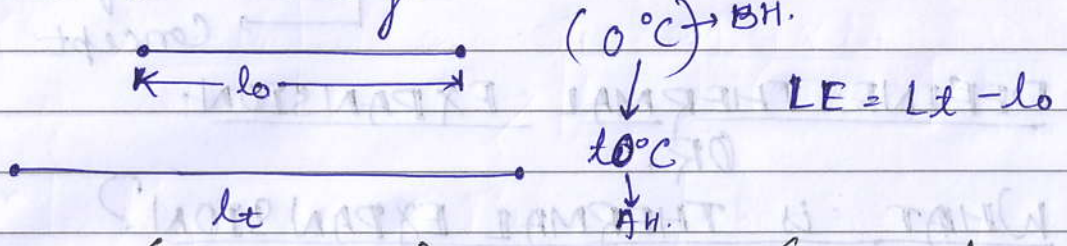
- 1 Dimensional → Length
- 2 Dimensional → Area (l x b)
- 3 Dimensional → Volume (l x b x h).

EXPANSION of Solids.

- Linear Expansion (1 Dimensional)
- Areal or Superficial Expansion (2 Dimensional)
- Cubical or volume Expansion. (3 dimensional)

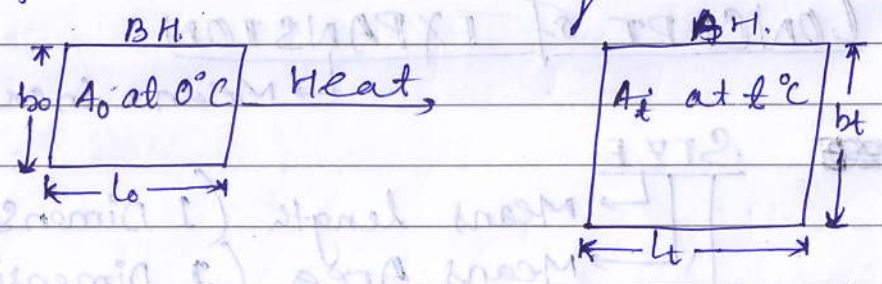
LINEAR EXPANSION (Define / What is?).

↳ It is the increase in length of solid due to heating.



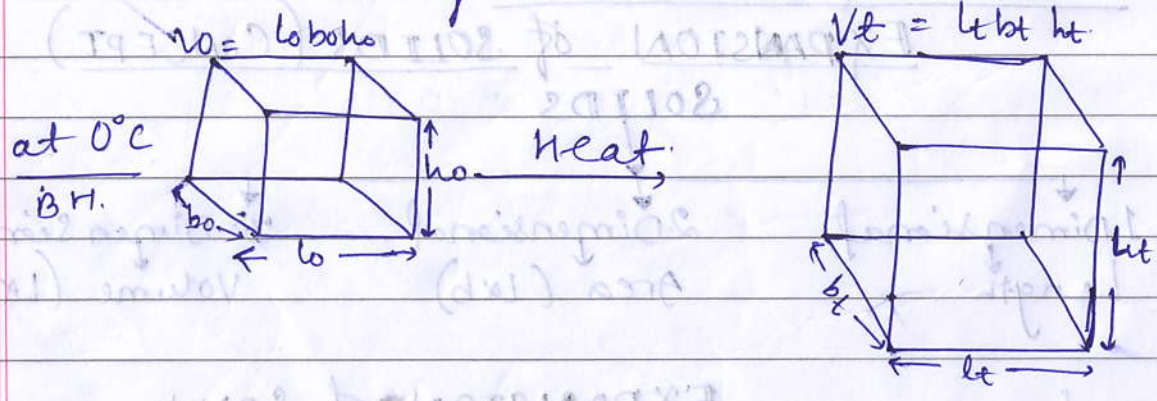
AREAL (Superficial) EXPANSION: (Define / what is?)

↳ It is the increase in Area of a solid due to heating.



VOLUME (Cubical) EXPANSION: (Define / what is?).

↳ It is the increase in volume of a solid due to heating.



Increase in length
Increase in breadth → Linear Expansion
Increase in height

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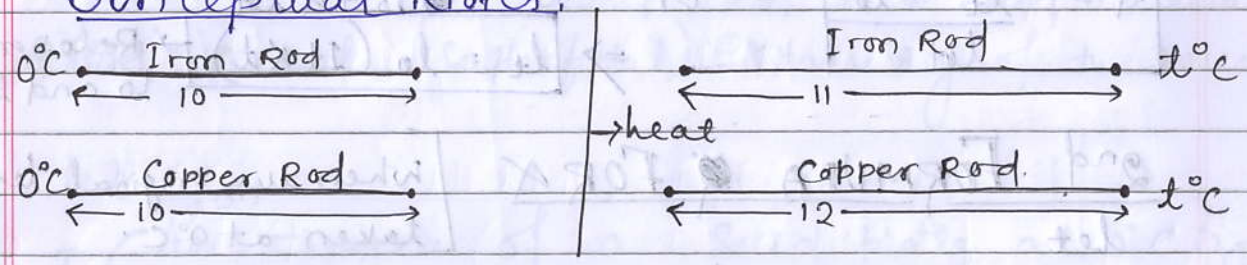
UNIT-7 (CH-7) – 7.7

COEFFICIENT OF → LINEAR EXPASION(α)
→ AREAL EXPANSION(β)
→ VOLUME EXPANSION(γ).

Conceptual Notes:



COEFFICIENT → Expanding ability of a meterial due to heating.

(*) Different material have different Co-effecient of expansion as their expanding abilities on being heated are not same.

FORMULA for COEFFICIENT of LINEAR EXPANSION OF SOLID MATERIAL (α)

Let
Increase → l_o → length of solid rod (material) at 0°C.
→ l_t → length of solid rod (material) at t°C.
Increase

Increase in temp of solid rod = $t - 0 = t°C$
Increase in length of solid rod = $l_t - l_o$ → Linear Expansion

Now,
Expression: $l_t - l_o \propto t$ (Increase in temp) $\Rightarrow t \uparrow \Rightarrow l_t$ to ↑
$l_t - l_o \propto l_o$ (Proportion) (original or Initial length)

Combining both expression.
$l_t - l_o \propto l_o t$ – (expression).
or $l_t - l_o = \alpha l_o t$
→ proportionality constant
Known as coefficient of linear Expression of the solid material.

10cm → Cu Rod
↓ 0 – 20°C
11cm → I in length = 1cm

20cm → Cu Rod
↓ 0 – 20°C
22cm → I in length = 2cm

$$l_t - l_0 = \alpha l_0 t$$

→ linear expansivity of the solid material a

$$\alpha = \frac{l_t - l_0}{l_0 t} \quad \text{or} \quad l_t = l_0 + \alpha l_0 t$$

$$\Rightarrow \boxed{l_t = l_0(1 + \alpha t)} \rightarrow \text{Relation betw } l_0 \text{ and } l_t.$$

2nd FORMULA FOR α

[When the original length is taken at 0°C.

let

I (l_1 → length of solid rod at t_1°C.
l_2 → length of solid rod at t_2°C.

Increase in length = $l_2 - l_1$
Increase in Temp = $t_2 - t_1$

Now,

$l_2 - l_1 \propto l_1$ (original length)
$l_2 - l_1 \propto t_2 - t_1$ (Increase in temp).

Combining both expression.

$l_2 - l_1 \propto l_1 (t_2 - t_1)$. → (Expression)

or $l_2 - l_1 = \alpha l_1 (t_2 - t_1)$ → Equation

→ Propertionally constant. Known as co-efficient of linear expansion of a solid material at t°C.

Linear expansivity of the solid material at t°C.

$$\alpha = \frac{l_2 - l_1}{l_1 (t_2 - t_1)}$$

$$l_2 = l_1 + \alpha l_1 (t_2 - t_1)$$

$$\Rightarrow \boxed{l_2 = l_1 [1 + \alpha (t_2 - t_1)]} \rightarrow \text{Relation between } l_1 \text{ and } l_2$$

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FORMULA FOR β (when original or initial area is measured at 0°C.)

→ Coefficient of Areal (superficial) expansion of a solid material.

(OR) Areal (Superficial) Expansivity of the solid material

Let,

I (A_0 → Area of a solid plate at 0°C.) I
(A_t → Area of a solid plate at t°C.)

Increase in Area = $A_t - A_0$.

Increase in Temp = $t - 0$.

Now,

$A_t - A_0 \propto A_0$ (original or initial Area at 0°C).

$A_t - A_0 \propto t$ (Rise or increase in temp).

Combining both expression:

$A_t - A_0 \propto A_0 t$ (Expression).

or $A_t - A_0 = \beta A_0 t$ (Equation).

→ (C. of AE or solid in nature).

$$\beta = \frac{A_t - A_0}{A_0 t}$$

or $A_t = A_0 + \beta A_0 t$

or $A_t = A_0 (1 + \beta t)$ → Rel^n between A_t and A_0.

2nd FORMULA FOR β (when the original area is measured at t°C.)

Let

I (A_1 → Area of a solid plate at t_1°C)
(A_2 → Area of a solid plate at t_2°C) I

Increase in Area = $A_2 - A_1$

Increase in Temp = $t_2 - t_1$

Now,

$A_2 - A_1 \propto A_1$ (0. Area or I Area at $t_1°C$).
$A_2 - A_1 \propto t_2 - t_1$ (Rise or increase in temp).

$A_2 - A_1 \propto A_1 (t_2 - t_1)$
or $A_2 - A_1 = \beta A_1 (t_2 - t_1)$.

or $\boxed{\beta = \frac{A_2 - A_1}{A_1 (t_2 - t_1)}}$

or $A_2 = A_1 + \beta A_1 (t_2 - t_1)$
$\boxed{A_2 = A_1 [1 + \beta (t_2 - t_1)]}$
↓
Rel^n between A_2 and A_1

FORMULA FOR 'γ' (when original or intial volume is taken at 0°C)

↳ Coefficient of volume (Cubical) expansion of a solid material.

(OR) Volume or (Cubical) expansion of the solid mat

Let,
I (V_0 → volume of solid cube at 0°C (BH))
(V_t → volume of solid cube at t°C (AH))

Increase in volume = $V_t - V_0$
Increase in Temp = $t - 0$

Now,
$V_t - V_0 \propto V_0$ (original or intial volume at 0°
$V_t - V_0 \propto t$ (Rise or Increase in temp).

Combining both expression.
$V_t - V_0 \propto V_0 t$ (Expression).
or $V_t - V_0 = \gamma V_0 t$ (equation)
↳ (C. of volume or cubical expan

$\boxed{\gamma = \frac{V_t - V_0}{V_0 t}}$

or $V_t = V_0 + \gamma V_0 t$

or $\boxed{V_t = V_0 (1 + \gamma t)}$

2nd FORMULA FOR γ (when the original volume is measured at 0°C.)

Let
$V_1 \rightarrow$ volume of solid cube at t_1°C.
$V_2 \rightarrow$ volume of solid cube at t_2°C.

Increase in volume = $V_2 - V_1$
Increase in volume = $t_2 - t_1$

Now,

$V_2 - V_1 \propto V_1$ (O. volume or I. volume at t_1°C).
$V_2 - V_1 \propto t_2 - t_1$ (Rise or increase in temp).

$V_2 - V_1 \propto V_1 (t_2 - t_1)$

or $V_2 - V_1 = \gamma V_1 (t_2 - t_1)$.

or $\boxed{\gamma = \frac{V_2 - V_1}{V_1 (t_2 - t_1)}}$

or $V_2 = V_1 + \gamma V_1 (t_2 - t_1)$

$\boxed{V_2 = V_1 [1 + \gamma (t_2 - t_1)]}$

→ Relation between V_2 and V_1

CONCEPTUAL NOTES on α, β and γ:

(1) $\boxed{\alpha = \frac{l_t - l_0}{l_0 t}}$ → $\boxed{\frac{\text{Increase in length}}{\text{original or initial length at 0°C}} \times \text{Rise in temp}}$

$\boxed{\alpha = \frac{l_2 - l_1}{l_1 (t_2 - t_1)}}$ → $\boxed{\frac{\text{Increase in length}}{\text{original or initial length at } t_1\text{°C}} \times \text{Rise in temp}}$

DEFINE α (Coefficient of L. Expn of a solid material)

↳ 'α' of a solid material is defined as the Increase in length PER unit original length PER unit degree rise in temp.

(II)

$\beta = \frac{A_t - A_0}{A_0 t}$	Increase in Area / original or intial area at 0°C × Rise in temp
$\beta = \frac{A_2 - A_1}{A_1 (t_2 - t_1)}$	Increase in Area / original or intial area at t_1°C × Rise in temp

DEFINE β (Coefficient of A. Expn of a solid material)

'β' of a solid material is defined as the Increase in Area per unit original AREA PER unit deg rise in temp.

(III)

$\gamma = \frac{V_t - V_0}{V_0 t}$	Increase in volume / original or intial volume at 0°C × Rise in temp
$\gamma = \frac{V_2 - V_1}{V_1 (t_2 - t_1)}$	Increase in volume / original or intial volume at t_1°C × Rise in temp

DEFINE 'γ' (Coefficient of V. Expn of a solid material)

'γ' of a solid material is defined as the Increase in volume per unit original volume PER unit degree rise in temp.

UNITS of α, β, γ

(I)

$$\alpha = \frac{l_t - l_0}{l_0 t} \rightarrow \frac{cm}{cm \times °C} = \frac{1}{°C} = \boxed{°C^{-1}}$$

$$\alpha = \frac{l_2 - l_1}{l_1 (t_2 - t_1)} \rightarrow \frac{cm}{cm \times °C} = \frac{1}{°C} = \boxed{°C^{-1}}$$

(II) $\beta = \frac{A_t - A_0}{A_0 t} \longrightarrow \frac{cm^2}{cm^2 \times {}^\circ C} = \frac{1}{{}^\circ C} = \boxed{{}^\circ C^{-1}}$

$\beta = \frac{A_2 - A_1}{A_1 (t_2 - t_1)} \longrightarrow \frac{cm^2}{cm^2 \times {}^\circ C} = \frac{1}{{}^\circ C} = \boxed{{}^\circ C^{-1}}$

(III) $\gamma = \frac{V_t - V_0}{V_0 \times t} \longrightarrow \frac{cm^3}{cm^3 \times {}^\circ C} = \frac{1}{{}^\circ C} = \boxed{{}^\circ C^{-1}}$

$\gamma = \frac{V_2 - V_1}{V_1 (t_2 - t_1)} \longrightarrow \frac{cm^3}{cm^3 \times {}^\circ C} = \frac{1}{{}^\circ C} = \boxed{{}^\circ C^{-1}}$

DIFFERENT UNITS of α, β and γ

	FPS	CGS	MKS	SI
α	${}^\circ F^{-1}$	${}^\circ C^{-1}$	${}^\circ C^{-1}$	${}^\circ K^{-1}$
β	${}^\circ F^{-1}$	${}^\circ C^{-1}$	${}^\circ C^{-1}$	${}^\circ K^{-1}$
γ	${}^\circ F^{-1}$	${}^\circ C^{-1}$	${}^\circ C^{-1}$	${}^\circ K^{-1}$

UNIT - 7 (CH-8) → 7.8

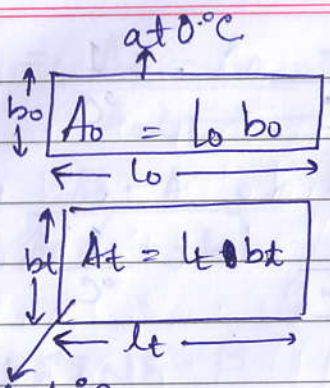
RELATION BETWEEN α, β and γ

- Between 'α' and 'β'.
- Between 'α' and 'γ'

α, β and γ

RELATION BETWEEN 'α' and 'β' of a SOLID MATERIAL

BH.



Consider a solid plate with original area A_0. It is heated upto $t°C$.

$A_0 \rightarrow$ Area of solid plate at 0°C

$A_t \rightarrow$ Area of solid plate at $t°C$

on heating

$l_0 \xrightarrow{I} l_t$ (LE)

$b_0 \xrightarrow{I} b_t$ (LE)

Areal (superficial) Expansion is the combination of 02 simultaneous linear expansion along length and breadth.

↳ (At the same time.)

$$A_t = A_0 (1 + \beta t) \quad -(1)$$

$$l_t b_t = l_0 b_0 (1 + \beta t)$$

$$\boxed{\begin{aligned} l_t &= l_0 (1 + \alpha t) \\ b_t &= b_0 (1 + \alpha t) \end{aligned}}$$

$$l_0 (1+\alpha t)\, b_0 (1+\alpha t) = l_0 b_0 (1+\beta t)$$

or

$$l_0 b_0 (1+\alpha t)^2 = l_0 b_0 (1+\beta t)$$

or $(1+\alpha t)^2 = (1+\beta t)$

or $(1+\beta t) = (1+\alpha t)^2$

$\Rightarrow 1 + \beta t = 1 + 2\alpha t + \alpha^2 t^2$

$\Rightarrow$

$\alpha^2 t^2$ neglected as it is very small compared to 2α

$\alpha \rightarrow$ Very small (ind

$\alpha^2 \rightarrow$ Very very s m

$\Rightarrow 1 + \beta t = 1 + 2\alpha t$

Comparing coefficient of terms in both sides

$$\beta t = 2\alpha t$$

$$\boxed{\beta = 2\alpha}$$

or $$\boxed{\alpha = \frac{\beta}{2}}$$

RELATION BETWEEN α, β, γ

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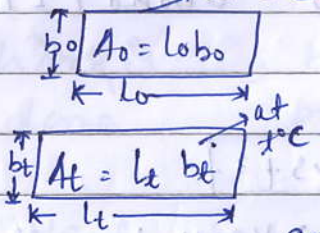
→ Between 'α' & 'β'
→ Between 'α' & 'γ'
} α, β, γ

RELATION BETWEEN 'α' and 'β' of a Solid material.

BH



Consider a solid plate with original Area A_0. It is heated upto $t°C$.

A_0 → Area of solid plate at $0°C$.

A_t → Area of solid plate at $t°C$.

on heating,

$l_0 \xrightarrow{I} l_t$ (LE).

$b_0 \xrightarrow{I} b_t$ (LE)

Areal (Superficial) expansion is the combination of 02 simultaneous linear expansions along length and breadth.
↳ at the same time.

$A_t = A_0 (1+\beta t)$ —— ①

$l_t b_t = l_0 b_0 (1+\beta t)$

$\Rightarrow l_0 (1+\alpha t)\, b_0 (1+\alpha t) = l_0 b_0 (1+\beta t)$.

$\Rightarrow (1+\alpha t)^2 = 1+\beta t$. $\Rightarrow 1+\beta t = (1+\alpha t)^2$

$\Rightarrow 1+\beta t = 1+2\alpha t + \alpha^2 t^2$

($\alpha^2 t^2$ neglected as it is very small compare to 1 & $2\alpha t$)

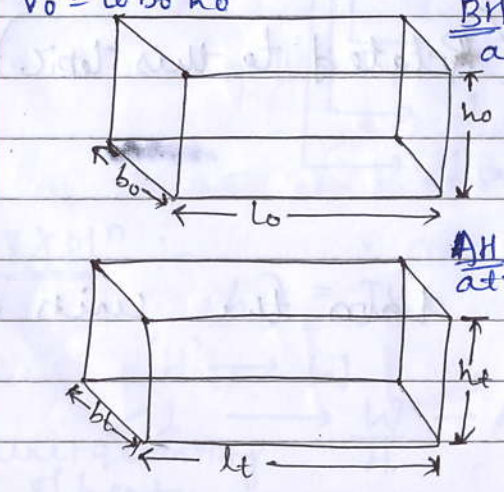
$\Rightarrow \beta t = 2\alpha t$.

$\Rightarrow \boxed{\beta = 2\alpha}$ or $\boxed{\alpha = \beta/2}$

$l_t = l_0 (1+\alpha t)$.
$b_t = b_0 (1+\alpha t)$.

α → very small in decimal.
α^2 → very very small.
let $\alpha = 0.02$
$\alpha^2 = 0.0004$.

(*) RELATION BETWEEN 'α' and 'γ' of a solid material.



Consider a solid cube at $0°C$. It is heated upto $t°C$ due to which its volume increase from $V_0 \xrightarrow{I} V_t$.

we know that $V_t = V_0 (1+\gamma t)$

$l_t b_t h_t = l_0 h_0 b_0 (1+\gamma t)$.

$l_0 \rightarrow l_t \Rightarrow l_0 (1+\alpha t)$

$b_0 \rightarrow b_t \Rightarrow b_0 (1+\alpha t)$

$h_0 \rightarrow h_t \Rightarrow h_0 (1+\alpha t)$.

→ Volume or Cubical expansion is the result of 03 simul linear expansion along, length, breadth and height.

$l_t\, b_t\, h_t = l_0 b_0 h_0 (1+\gamma t)$.

$\Rightarrow l_0(1+\alpha t) \cdot b_0(1+\alpha t)\, h_0(1+\alpha t) = l_0 b_0 h_0 (1+\gamma t)$.

$\Rightarrow (1+\alpha t)^3 = (1+\gamma t)$

$\Rightarrow (1+\alpha t) = (1+\alpha t)^3$.

$\Rightarrow (1+\gamma t) = 1+3\alpha t + \boxed{3\alpha^2 t^2 + \alpha^3 t^3}$.

Comparing Co-efficient in both side

$\Rightarrow 1+\gamma t = 1+3\alpha t$

$\Rightarrow \gamma t = 3\alpha t$.

$\Rightarrow \boxed{\gamma = 3\alpha}$.

$\alpha \rightarrow$ very small

$\alpha^2 \rightarrow$ very very small

$\alpha^3 \rightarrow$ still smaller.

$\alpha^3 << \alpha^2 << \alpha$.

→ Neglect as they are very small compared to 1 and 3α

RELATION BETWEEN α, β, γ

(i) $\beta = 2\alpha$ or $\alpha = \frac{\beta}{2}$ ⟶ $\boxed{\alpha = \beta/2 = \gamma/3}$

(ii) $\gamma = 3\alpha$ or $\alpha = \frac{\gamma}{3}$ ⟶ $\boxed{\alpha : \beta : \gamma = 1:2:3}$

POSSIBLE LONG QUESTION: (5/10m)

(*) Show that / Prove that / establish that $\alpha = \beta/2 = \gamma/3$ or $\alpha : \beta : \gamma = 1:2:3$ where symbols used carry usu meaning.

(*) Declare / establish / find out a relation / equation / formul between co-efficient of linear, superficial and cubica expression of a solid.

SHORT QUESTION: (Related to this topic).

(1) Define α.

(2) Define β.

(3) Define γ

(4) State or maintain or write down the units of α, β, γ.

UNIT-7 (CH-9) → 7.9.
WORK AND HEAT

classmate
Date
Page

Important points (Salient points).

(*) When work is done heat is produced.

(*) More the work done, more is the heat produced.

(*) Work is done → Heat is produced → The body or object doing work feels hot.

(*) Heat produced is directly proportional to the work done.

$W \propto H$ $(W \uparrow \Rightarrow H \uparrow)$ → Expression.

$W = JH$ → proportionality is known as mechanical Equivalent of Heat.

DL:- 15/11/19

UNIT-7 (CH-10) → 7.10
JOLE'S MECHANICAL EQUIVELENT OF HEAT.

→ Definition
→ units

DEFINITION OF MECHANICAL EQUIVELENT OF HEAT (J)

(Ans):- It is the amount of work done to produce unit quantity of Heat.

- 1 Cal (CGS)
- 1 Kcal (MKS)
- 1 Joule (SI)
- 1 BTU (FPS)

Expln:-

$W = JH$ or $\boxed{J = W/H}$

'H' → W

1 unit quantity of heat. → $\frac{W}{H}$ → Amt of work done to produce unit quantity of heat = J

H → heat produced
W → Heat produced.

$$\frac{W}{H} = J$$

VALUE of J (M. Eqv of Heat).

$J = 4.2$ Joule/Calorie → Statement

↳ This statement indicates that 4.2 J of work has to be done to produce 1 calorie of heat.

4.2 Joule Work ⟶ 1 Cal Heat

42 Joule Work ⟶ 10 Cal Heat

4200 Joule Work ⟶ 100 Cal Heat

(*) Workdone ↑ 4.2 Joule ⟶ 1 Calorie ↑ Heat produce

↓ Work equivelent of 1 calorie

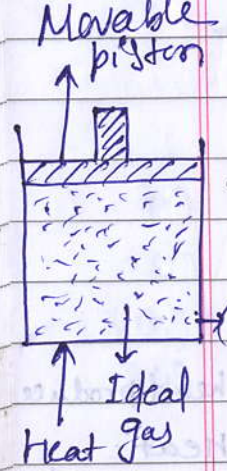
↓ Heat equivelent of 4.2 Joule

UNIT-7 (CH-11) → 7.11

1st LAW OF TERMODYNAMICS

↳ Statement

↳ Concept



Statement:

↳ When heat is supplied (given) to a syst it is utilised in 02 ways.

(I) A part of it is used to raise internal energy of the system. (Incr. Temp)

(II) Rest heat is used for doing work.

END

Expl^n (Concept)

If dQ → Heat supplied to a system.
dU → Increase in Internal Energy.
dW → Work done.

$$\boxed{dQ = dU + dW}$$

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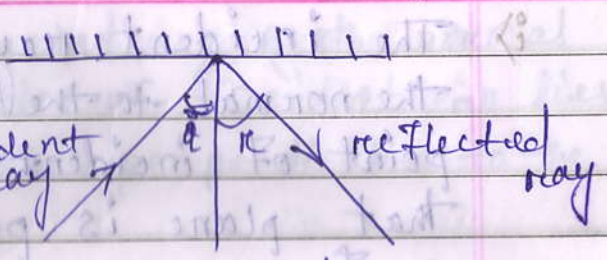
OPTICS

Reflection :-

It is the properties of light by the varitue of which light is sand back into the same medium from which it is coming after being reflected by a surface.



i = Angle of incident

r = Angle of reflection

incident ray :-

A ray which approches the shining surface is called incident ray.

Reflected ray :-

A ray which away from the shining surface is called reflected ray.

Normal :-

It is perpendicular drawn to the shining surface

Reflecting surface :-

The shining surface which sand the ray back in to the same medium is called reflecting surface.

Angle of incident :-

It is the angle between incident ray & normal,

Angle of Reflection :-

It is the angle between the reflected ray & normal.

Laws of Reflection

i) The incident ray, the reflected ray & the normal to the reflecting surface at the point of incident, all lies in one plane & that plane is perpendicular to the reflecting surface.

ii) The angle of incidence is equal to the angle of reflection.

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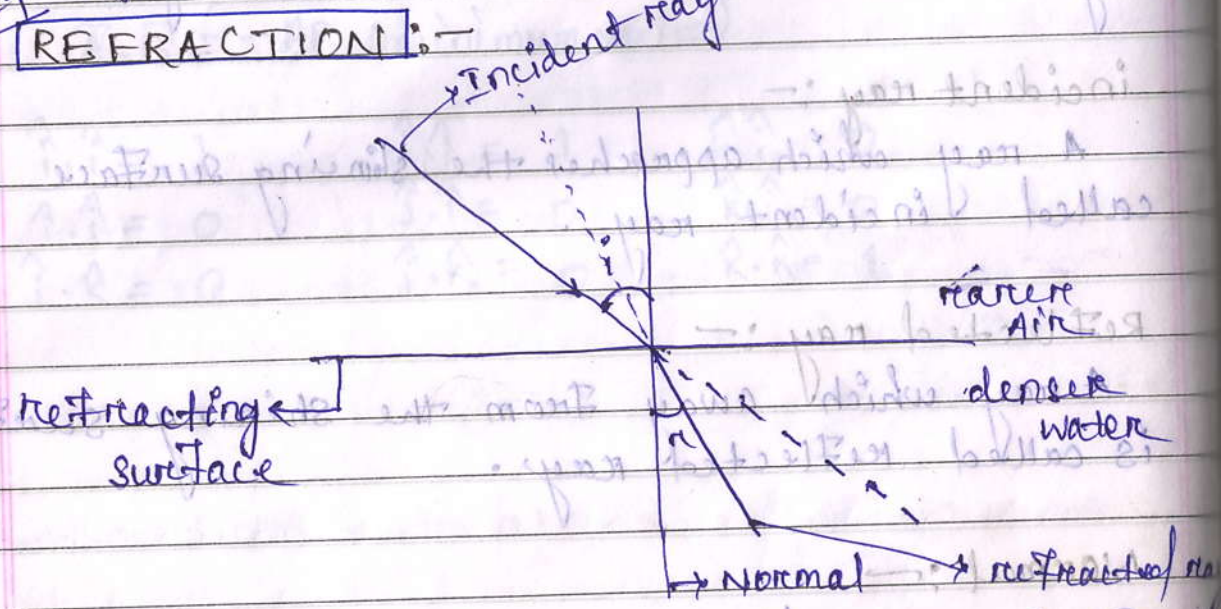
REFRACTION :-



→ Refraction is the phenomenon by the virtue of which a ray of light going from one medium to other undergoes a change in its velocity.

→ If the light travel from rarer medium to denser medium it bends towards the normal

→ If the light travel from denser medium to rarer medium it bends away from the normal

Laws of Refraction :-

i) The sine of angle of incidence bears a constant ratio with the sine of angle of refraction

$\frac{\sin i}{\sin r}$ = constant. This law is called as Snell's

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ii) The incident ray, the refracted ray & the normal to the interface at the point of incident, all lies in one plane & that plane is perpendicular to the refracting surface.

Refractive Index :- 'μ'

→ According to Snell's law $\frac{\sin i}{\sin r} = \text{constant} = {}^1\mu_2$

where ${}^1\mu_2$ is called as the refractive index of the 2nd medium w.r.t. 1st.

→ Refractive index of a medium w.r.t another is defined as the ratio between sine of the angle of incidence to the sine of the angle of refraction

OR

Refractive index of medium 2 w.r.t 1 is defined as the ratio between velocity of light in medium 1 to the velocity of light in medium 2.

→ If v_1 & v_2 are the velocity of light in 1st & 2nd medium respectively then $\boxed{{}^1\mu_2 = \frac{v_1}{v_2}}$

→ If the 1st medium is air or vaccum then $\boxed{\mu = \frac{c}{v}}$ this μ is called as absolute refractive index

where, c = velocity of light in vaccum or Air.
v = velocity of light in medium.

$${}^1\mu_2 = \frac{v_1}{v_2} = \frac{v_1/c}{v_2/c} = \frac{1}{\mu_1} \Big/ \frac{1}{\mu_2} = \frac{\mu_2}{\mu_1}$$

$$\therefore {}^1\mu_2 = \frac{\mu_2}{\mu_1}$$

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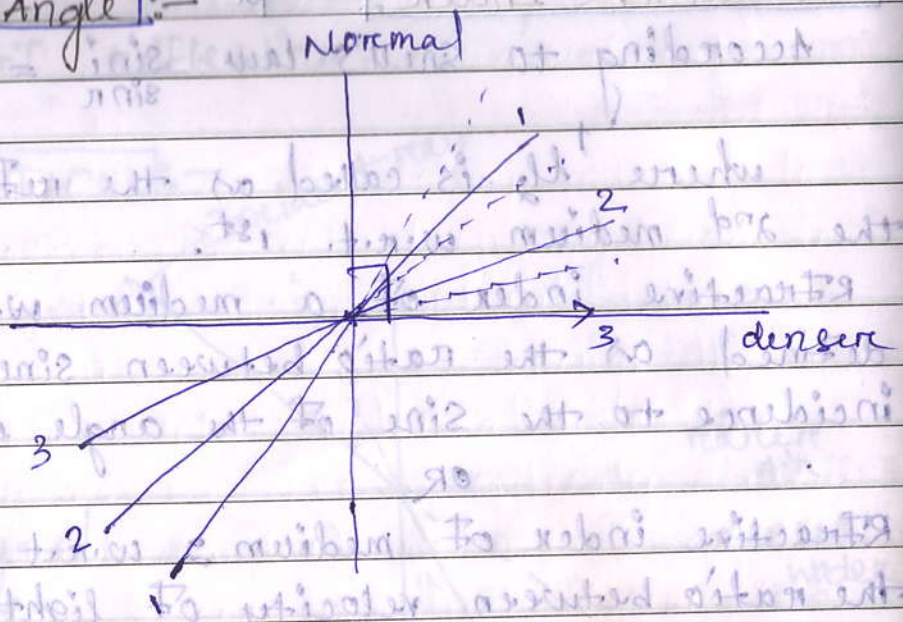
Refractive index of the 2nd medium w.r.t. 1st is defined as the ratio between absolute refractive index of the 2nd medicem to the absolute refractive index of the 1st medicem.

Critical Angle :-



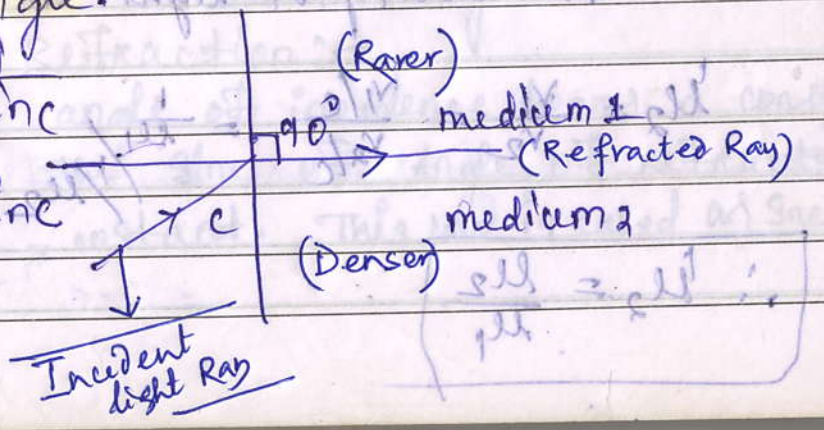
The critical angle is the angle of incidence of a ray of light in denser medium such that its angle of refraction in the rarer medium is 90°.

Total internal Refraction :-

It is the phenomana by the virtue of which a ray of light traveling from a denser to rarer medium is send back in the same medium, it is incident on the interface at an angle greater than critical angle.

$$^1\mu_2 = \frac{\sin i}{\sin r} = \frac{1}{\sin c}$$

$$^2\mu_1 = \frac{\sin i}{\sin r} = \sin c$$



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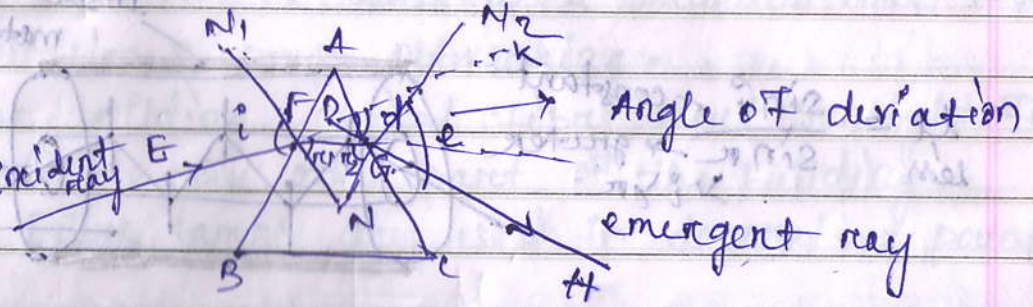
Refraction through prism :—



→ A ray EF incident of the ~~phase~~ Face AB at the point F where N1FN is the Normal & ∠i is the angle of incidence. Since the refraction take place from air to glass therefore, the refracted ray FG Bends towards the Normal such that ~~ang~~ ∠r1 is the angle of refraction.

→ The Refracted ray FG incident on the ~~phase~~ face AC at the point G. where N2GN is the Normal & ~~angle~~ ∠r2 is the angle of incidence. Since the refraction NOW take place from denser to rarer medium therefore the Emergent ray GH bends away from the normal & goes along GH such that ∠e is the angle of emergent.

→ In the absence of prism the insident ray EF move in a straight line but due to refraction through the prism it changes its path along the direction DHG. Thus ∠KDH gives the angle of deviation i.e the angle through which the incident ray get deviated in passing through the prism.

→ The minimum value of the angle of deviation when a ray of light passing through the prism is called angle of minimum deviation.

Refractive index of prism $\mu = \dfrac{\sin\left(\frac{A+D_m}{2}\right)}{\sin(A/2)}$

A = Angle of prism
Dm = Angle of minimum deviation.

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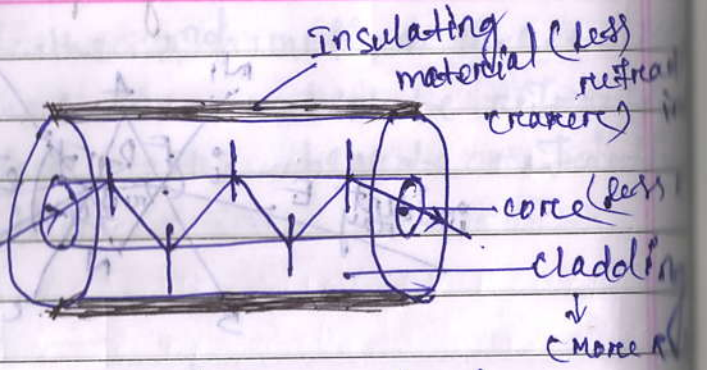
Fibre optics :-

$\mu = \frac{\sin i}{\sin r}$ → constant
less → greater



(core, cladding, insulating material)

→ Fibre optics is a technology related to transportation of optical energy (light energy) through a specialy design optical fibres.

→ Light energy propagates through the fibre by multiple total internal reflection. The inner part i.e core is optically denser (high refractive index). outer part i.e cladding surrounding the core is optically rarer (lesser refracting index)

→ Each fibre is optically insulated by coating with a material having less refractive index then the fibre.

→ Light ray entering at one end of the fibre undergoes multiple total internal reflection because the angle of incidence is allways greater then the critical angle.

→ Consequently light is transmitted to the other end without loss of energy.

(7) END

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Uses of optical fibre :—

i) Optical Fibre can be used as a meddium Fore tele communication & comp. networking...

ii) In some building optical fibre rout sunlight from the roof to the other paret of the building.

iii) Optical Fibre lamps are used in dacerative pourepose.

Dt: 18/11/19

UNIT-9

UNIT-9 | ELECTROSTATICS AND MAGNETOSTATICS

UNIT-9 (CH-1) → 9.1

ELECTROSTATICS

→ Definition
→ Concept.

DEFINE ELECTROSTATICS

OR.

WHAT is ELECTROSTATICS?

(Ans):- It is study about electric charges at rest

Electro / statics
↓ ↓
electric charge, at rest

Conceptual Notes:-

Electric charge
- +ve charge (PROTON)
- -ve charge (ELECTRON)

(*) Parameter of charge.
- polarity
  - +ve or -ve
- value (manitude)
  - measured in coulomb

(*) Charge of a proton = q_p = 1.6×10^{-19} Coulo

(*) Charge of a electron = q_e = 1.6×10^{-19} Coulomb.

(Value of charger or magnitude of charge

Symbol for Charge.
↳ Q
OR
↳ q

Charge means → Electric charge.

Law of Charges (statement).
↳ Like (similar) charges REPEL
but Unlike (dissimilar) charge ATTRACT.

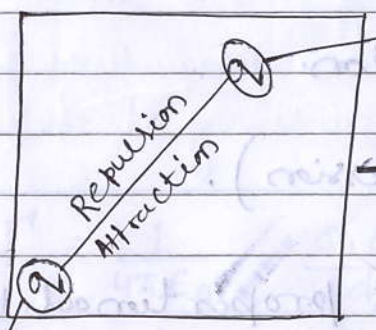
Same polarity | Opposite polarity

Expl^n:-
Like charge { ⊕ ⊕ → Relpulsion.
⊖ ⊖ → Relpulsion.

unlike charge. { ⊕ ⊖ → Attraction
⊖ ⊕ → Attraction

(*) SI unit of Electric charge → Coulomb

Electric charge $\xrightarrow[\text{produces}]{\text{creates}}$ Electric feild.
↓
Specified Area.



CH-2 → (9.2) → UNIT-9

→ COULOMB'S LAW
- Statement
- Explanation

→ Definition of unit charge

COULOMB'S LAW OF ELECTROSTATICS:-

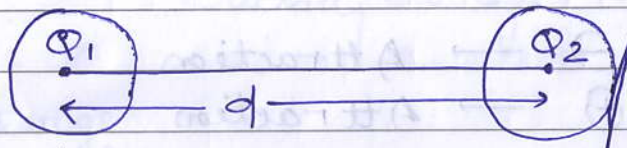
Statement

→ The force of attraction OR repu between 02 electric charges is:

(i) Directly proportional to the product of their charges.

(ii) Inversely proportional to the square of distance between them.

Explanation :-



According to statement:

Expression:

(i) $F \propto Q_1 Q_2$ ($Q_1, Q_2 \uparrow \Rightarrow F \uparrow$ or $Q_1 Q_2 \downarrow \Rightarrow F \downarrow$)

(ii) $F \propto \frac{1}{d^2}$ ($d \uparrow \Rightarrow F \uparrow$ OR $d \downarrow \Rightarrow F \uparrow$)

Q_1 → 1st Charge

Q_2 → 2nd charge

d → Distance betwe Q_1 and Q_2.

F → Force of attracti or repulsion betwe the charges.

Combining both expressions.

$$F \propto \frac{Q_1 Q_2}{d^2} \quad \text{(Expression)}.$$

$$\boxed{F = k \frac{Q_1 Q_2}{d^2}}$$

k = proportionality constant which value depends on system of units charges.

$$K = \frac{1}{4\pi\epsilon}$$ (SI system).

where ϵ → Permitivity of medium between the charge.

$$F = k\,\frac{Q_1 Q_2}{d^2} \Rightarrow \boxed{F = \frac{1}{4\pi\epsilon}\,\frac{Q_1 Q_2}{d^2}}$$

Mathematical form of coulombs law in electrostatics.

FOR AIR MEDIUM:-

$$k = \frac{1}{4\pi\epsilon_0}$$

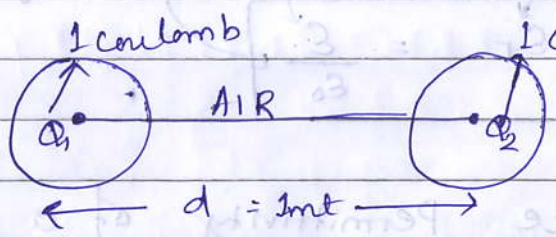
ϵ_0 → permitivity of free space (AIR).

$$\boxed{F = \frac{1}{4\pi\epsilon_0}\,\frac{Q_1 Q_2}{d^2}}$$

(2m/5m) **DEFINE UNIT CHARGE (1 coulomb)** (Coulomb's Law)

(Ans):- unit charge is that charge which placed at UNIT DISTANCE in AIR from a similar and equal charge is REPELLED by a force of $\frac{1}{4\pi\epsilon_0}$ Newton.

EXPL:- (03 mark)



$Q_1 = Q_2 = 1$ coul (unit charge)

$d = 1$mt (unit distance).

Medium → AIR.

$$\boxed{F = \frac{1}{4\pi\epsilon_0}\,\frac{Q_1 Q_2}{d^2}} \rightarrow \text{Air medium.}$$

$$F = \frac{1}{4\pi\epsilon_0}\,\frac{1\times 1}{1^2} \Rightarrow \boxed{F = \frac{1}{4\pi\epsilon_0}\ \text{Newton}}$$

UNIT - 9 (CH-3) → 9-3

Absolute and Relative permitivity.

- Definition.
- Relation
- Unit.

Medium

- Absolute Permitivity (ϵ) → No comparision.
- Relative Permitivity (ϵ_r). → Get by comparision

Note:- Permittivity (allow) → (ability) (medium) → (force)

[2m] **DEFINE RELATIVE PERMITTIVITY of a Medium**

(Ans):- It is the ratio of permittivity of that medium to the permittivity of free space or Air.

[Relative permitivity of medium] = Permittivity of that medium / Permittivity of free space (reference)

$$\epsilon_r = \frac{\epsilon}{\epsilon_0}$$

[2m] **DEFINE Absolute Permittivity of a medium :-**

(Ans) :- It is the product of relative permitivity (ϵ_r) of that medium and the permittivity of free space

$$\epsilon = \epsilon_0 \epsilon_r$$

Relationship

classmate
Date
Page

Relative permittivity (ϵ_r) = 1 of free space (AIR)

SI UNIT of ϵ, ϵ_0 and ϵ_r

$\epsilon \xrightarrow{\text{Absolute permittivity}} \frac{(Coul)^2}{Nt - mt^2}$

$\epsilon_0 \xrightarrow{\text{Absolute permittivity}} \frac{(Coul)^2}{Nt - mt^2}$

$\epsilon_r \longrightarrow \epsilon_r = \frac{\epsilon}{\epsilon_0}$

$\Rightarrow \epsilon_r = \frac{\frac{(Coul)^2}{Nt - mt}}{\frac{(Coul)^2}{Nt - mt}}$

$\Rightarrow \epsilon_r = \frac{x_1}{x_2} = \text{Number}$

$\epsilon_r \xrightarrow{\text{Relative}}$ No unit.

$F = \frac{1}{4\pi\epsilon} \frac{Q_1 Q_2}{d^2}$

$\epsilon = \left(\frac{1}{4\pi}\right) \frac{Q_1 Q_2}{F \times d^2}$

↓ no unit

$\epsilon = \frac{Coul \times Coul}{Nt \times mt^2}$

$\epsilon = \frac{(Coul)^2}{Nt - mt^2}$

$F = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{d^2}$

$\epsilon_0 = \frac{1}{4\pi} \frac{Q_1 Q_2}{F \times d^2}$

$\epsilon_0 = \frac{Coul \times Coul}{Nt \times mt^2}$

$\epsilon_0 = \frac{(Coul)^2}{Nt - mt^2}$

$F = \frac{1}{4\pi\epsilon_r} \frac{Q_1 Q_2}{d^2}$

$\epsilon_r = \frac{1}{4\pi\epsilon_r}$

Dt:- 21/11/19

UNIT-9

UNIT-9 (CH-5) → 9.5

Qualitative Concept ← Electric field.

Quantitative Concept ← Electric field and Intensity.
- → Definition.
- → FORMULA
- → UNIT

WHAT is ELECTRIC FIELD?
OR.
DEFINE ELECTRIC FIELD.

(Ans):- It is the SPACE or AREA surrounding an electric charge within which its influence (effect) is experienced (felt).



q → No effect

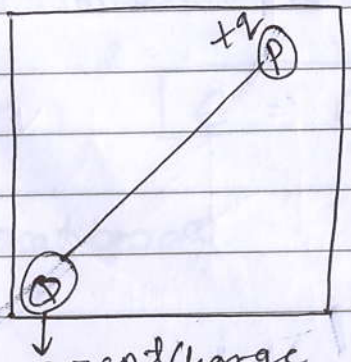
→ Electric field.

Qualitative

DEFINE ELECTRIC FIELD INTENSITY ($\vec{E}$)
OR.
DEFINE ELECTRIC INTENSITY ($\vec{E}$)

(Ans):-

Electric intensity at any point of an electric field is defined as the FORCE acting on an UNIT POSITIVE CHARGE placed at the point.



FORMULA FOR ELECTRIC INTENSITY:

$|\vec{E}| = E$

$q(+)$ at pt 'P' → F (due to parent charge).

$1(+)$ at pt 'P' → $\frac{F}{q} = E \cdot I$ at pt P.

(unit +ve charge)

$$E = \frac{F}{q}$$

SI UNIT of 'E'

$E = \frac{F}{q}$ → Newton / Coulomb or Nt/coul

DIMENSION of 'E'

$E = \frac{F}{q} \longrightarrow \frac{MLT^{-2}}{Q} = [MLT^{-2}Q^{-1}]$

NATURE of 'E': I:

Vector qty

Dt:- 22/11/19

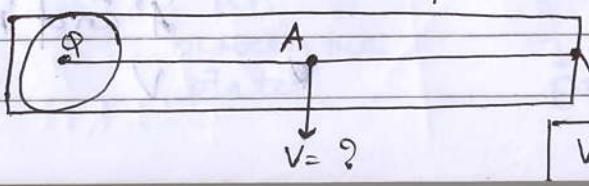
UNIT - 9 (CH-4) → 9.4

Electric potential
Electric potential difference → Definition & formulas & unit.

DEFINE ELECTRIC POTENTIAL (V)

(Ans):- Electric potential at a point within the electric field is defined as the WORK DONE in moving an UNIT +ve CHARGE from ∞ (infinity) up to that point against the electric field.

Explanation and Formula for Electric Potential:-



$q(+) \xrightarrow{\text{'}\infty\text{' to 'A'}} W$ (Work Done)

$1(+) \xrightarrow{\text{'}\infty\text{' to 'A'}} \frac{W}{q}$ = El potential at pt 'A' = V

↓ unit +ve charge.

$$\boxed{V = \frac{W}{q}}$$

W → Work Done

q → Charged moved.

V → El potential at the pt.

SI UNIT OF EL POTENTIAL

$$V = \frac{W}{q} \quad \frac{W \rightarrow \text{Joule}}{q \rightarrow \text{Coulomb}} = \boxed{\text{VOLT}}$$

DIMENSION OF EL. POTENTIAL :-

$$V = \frac{W}{q} \quad \frac{W \rightarrow ML^2T^{-2}}{q \rightarrow Q} = [ML^2T^{-2}Q^{-1}]$$

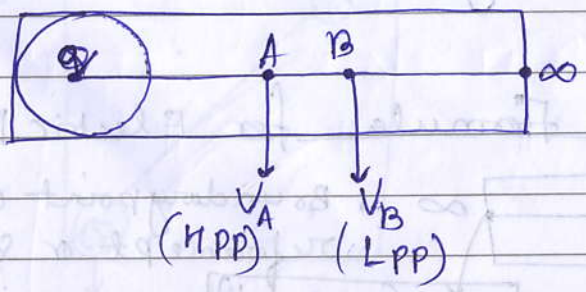
NATURE OF EL. POTENTIAL :-

↳ $\boxed{\text{SCALAR Qty}}$ (because it is defined in terms of work done

DEFINE ELECTRICAL POTENTIAL DIFFERENCE.

(Ans) :- El. potential difference between 02 point within an electric field is defined as the WORK DONE in moving an unit +ve charge from the lower potential point (LPP) to the Higher potential point (HPP) against the el. field.

Explanation and Formula for El. potential Difference



$V_A - V_B$ = El. potential difference betw 'A' and 'B'.

= V

Q(+) 'B' to 'A' W

1(+) 'B' to A $\frac{W}{Q}$ = EL. P.D between 'A' and 'B'

$= V$

↓

unit +ve charge.

P.D ← $V = \frac{W}{Q}$ → Work Done

→ Test charged measured

SI unit → VOLT

DIMENSION → $[ML^2T^{-3}Q^{-1}]$

NATURE → Scalar qty

UNIT - 9 (CH-6) → 9.6

CAPCITANCE

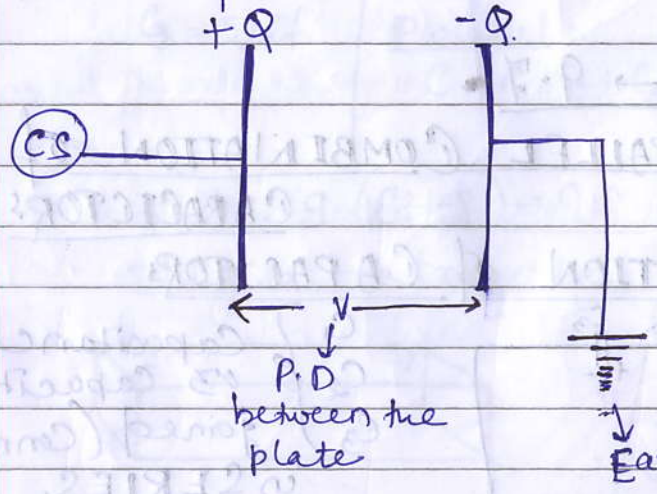
- Definition.
- Formula
- Unit.

DEFINITION OF CAPACITANCE

OR.

DEFINE CAPACTY OF A CAPACTANCE

(Ans):- It is defined as the CHARGE REQUIRED to maintain UNIT POTENTIAL DIFFERENCE between the plates of a capacitor.



Q → Charge supplied to the capacitor.

V → P.D between the plates of capacitor.

C → Capacitance (Capacity of a capacitor)

Formula For CAPACITANCE

V(PD) — Q

1(PD) — $\frac{Q}{V}$ = Capacitance = C

Capacitance $C = \frac{Q}{V}$ → charge supplied.
→ P.D between plates.

SI UNIT

$C = \frac{Q}{V} \rightarrow \frac{coul}{volt} = $ Farad.

Dt:- 23/11/19

DEFINE FARAD.

(Ans):- The Capacitance of capacitor is said to be 1Farad if 1 coulomb of charge required to maintain a potential difference of 1volt between the plates

NOTE :-

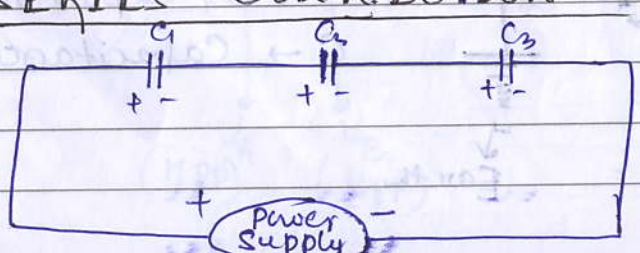
↳ Farad is a very large unit for practical use. Hence, smaller units are prefered.

millifarad (mf).	$1mf = 10^{-3}$ farad	$1F = 10^3 mf$
microfaraid (μf).	$1\mu f = 10^{-6}$ farad	$1F = 10^6 \mu f$
picofaraid (pf).	$1pf = 10^{-12}$ farad	$1F = 10^{12} pf$

UNIT - 9 (CH - 7) → 9.7

SERIES And PARALLEL COMBINATION of CAPACICTORS

SERIES CONNECTION of CAPACITORS



C_1, C_2, C_3 } Capacitance of 3 Capacitor joined (Connected) in SERIES.

Let,

C → Combined or Total or Effective or Resultant Capacitor of the combination.

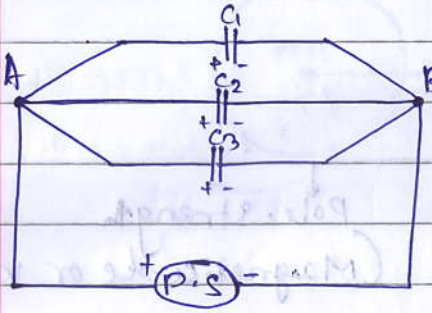
Then,

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \text{or} \quad \frac{C_2C_3 + C_1C_3 + C_1C_2}{C_1 \cdot C_2 \cdot C_3}$$

or

$$\boxed{C = \frac{C_1 C_2 C_3}{C_1C_2 + C_2C_3 + C_1C_3}}$$

PARALLEL COMBINATION of CAPACICTOR:



C_1, C_2, C_3 } Capacitance of the 03 Capaciter joined in parallel.

C → Total / combined / Effective Resultant capacity of the combination.

A and B → Common terminal of the circuit

Then,

$$\boxed{C = C_1 + C_2 + C_3}$$

Suppose:

$C_1 = 2\mu f$

$C_2 = 3\mu f$

$C_3 = 5\mu f$

Series:-

$$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{2} + \frac{1}{3} + \frac{1}{5} = \frac{15 + 10 + 6}{30} \Rightarrow \boxed{C = \frac{31}{30}\mu f}$$

less

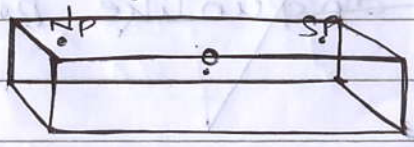
Parallel:-

$$C = C_1 + C_2 + C_3 = 2 + 3 + 5 \Rightarrow \boxed{C = 10\mu f}$$

More

UNIT-9 (CH-8) → 9.8

Magnet — properties of a magnet:



NP → North pole
SP → South pole
O → Centre of the Magnet.

Properties :-

→ Any magnet has 02 poles (NP-SP).
→ A magnet can Attract or Repel.
→ like poles Repel and unlike pole attract.

NP NP → Repel.
SP SP

SP NP → Attract.
NP SP

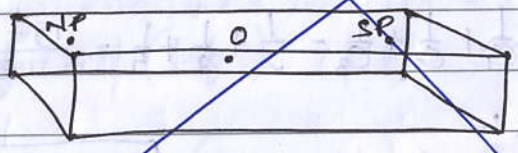
Pole parameter:

Polarity
NP SP

Pole Strength
(Magnetic de or valu

→ SI unit of pole Strength is WEBER (Wb).
→ NP (+m)
→ SP (-m).

~~UNIT-9 (CH-8) → 9.8~~
~~MAGNETOSTATICS~~
~~magnet — properties of magnet.~~



NP → North pole
SP → South pole
O → centre of the mage

Properties :-

→ ~~Any magnet has 02 pole (NP-SP)~~
→ ~~A magnet can attract or repel.~~
→ ~~like poles repels and unlike poles attr~~

UNIT-9 (CH-9) → 9.9.

⟨Coulomb's Law in magnetism⟩

UNIT POLE → Definition.

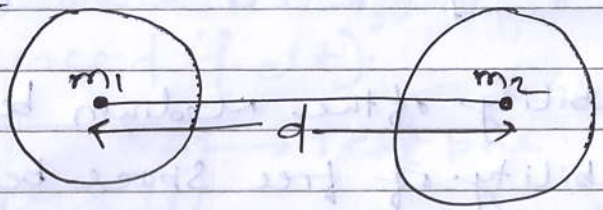
COULOMB'S LAW in MAGNETISM.

Statement :- The force of attraction or Repulsion between two magnetic poles is :-

(i) Directly proportional to the product of their pole strength.

(ii) And inversely proportional to their Square of distance between them.

Expl^n :-



m_1 → poles strength of 1st pole.

m_2 → pole strength 2nd pole.

d → distance between poles m_1 and m_2.

F → force acting between the 02 poles.

Now,

(i) $F \propto m_1 m_2$ $\left(m_1 m_2 \uparrow \Rightarrow F \uparrow \right)$

(ii) $F \propto \frac{1}{d^2}$ $\left(d \uparrow \Rightarrow F \downarrow \text{ OR } d \downarrow \Rightarrow F \uparrow \right)$.

Combining both expression.

$$F \propto \frac{m_1 m_2}{d^2} \quad (\text{Expression}).$$

or $$\boxed{F = k \frac{m_1 m_2}{d^2}}$$

k = proper sonality constant whose value depends upon the system of units chosen.

In SI System:-

→ $k = \frac{\mu}{4\pi}$ (any medium)

→ $k = \frac{\mu_0}{4\pi}$ (Air medium).

$$F = \frac{\mu}{4\pi} \frac{m_1 m_2}{d^2} \longrightarrow \text{any medium.}$$

$$F = \frac{\mu_0}{4\pi} \frac{m_1 m_2}{d^2} \longrightarrow \text{Air medium.}$$

μ → permeability of the medium between the pole

μ_0 → permeability of free space between the pole

$$\mu_0 = 4\pi \times 10^{-7} \text{ Henery/Metre}$$

$$\varepsilon_0 = 8.854 \times 10^{-12} \frac{(\text{Coul})^2}{\text{Nt} - \text{mt}^2}$$

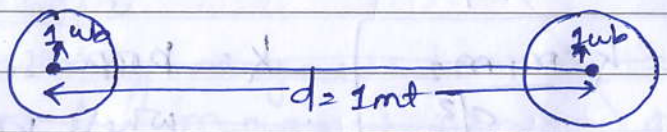
UNIT POLE.

→ Any magnetic pole of pole Strength 1 weber

DEFINITION OF UNIT POLE.

→ Unit pole is that pole which when plac at UNIT DISTANCE in AIR from a similar a equal pole is repeled by force of $\frac{\mu_0}{4\pi}$ Nt or 10^{-7} Nt.

EXPLN :-



$m_1 = m_2 = 1$ Wb (unit
$d = 1$ mt (unit dista

$$F = \frac{\mu_0}{4\pi} \frac{m_1 m_2}{d^2} = \frac{\mu_0}{4\pi} \frac{1 \times 1}{1^2} = \frac{\mu_0}{4\pi} \text{Nt} = \frac{4\pi \times 1}{4\pi}$$

$$= 10^{-7} \text{ Nt}$$

UNIT - 9 (CH-10) → 9-10

Magnetic field

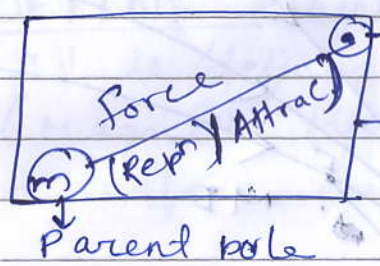
Magnetic Field Intensity ($\vec{H}$).

↳ Definition
→ Formula
→ Unit.

DEFINE MAGNETIC FIELD.
OR.
WHAT is MAGNETIC FIELD ?

Qualitative concept.

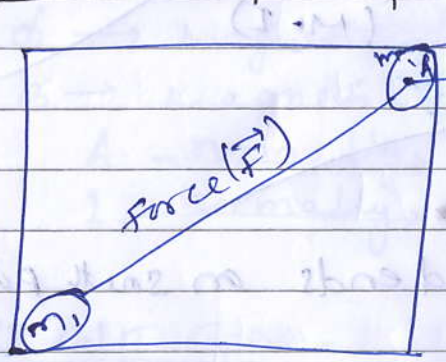
(Ans):- It is the AREA surrounding a magnetic pole within which its effect or influence is experienced (felt).



DEFINE MAGNENTIC FIELD INTENSITY ($\vec{H}$)

(Ans):- Magnetic intensity at any point within a magnetic field is defined as the FORCE experienced by an UNIT NORTH POLE placed at that point.

EXPln and FORMULA :-



$|\vec{H}|$ = H magnitude.

m Wb (NP) at pt A, F

1 Wb (NP) at pt A, $\frac{F}{m}$ = (N.I) at pt A

= H.

$$H = F/m$$

SI unit of H :-

$$H = \frac{F}{m} \rightarrow \frac{\text{Newton}}{\text{Weber}} = N/wb$$

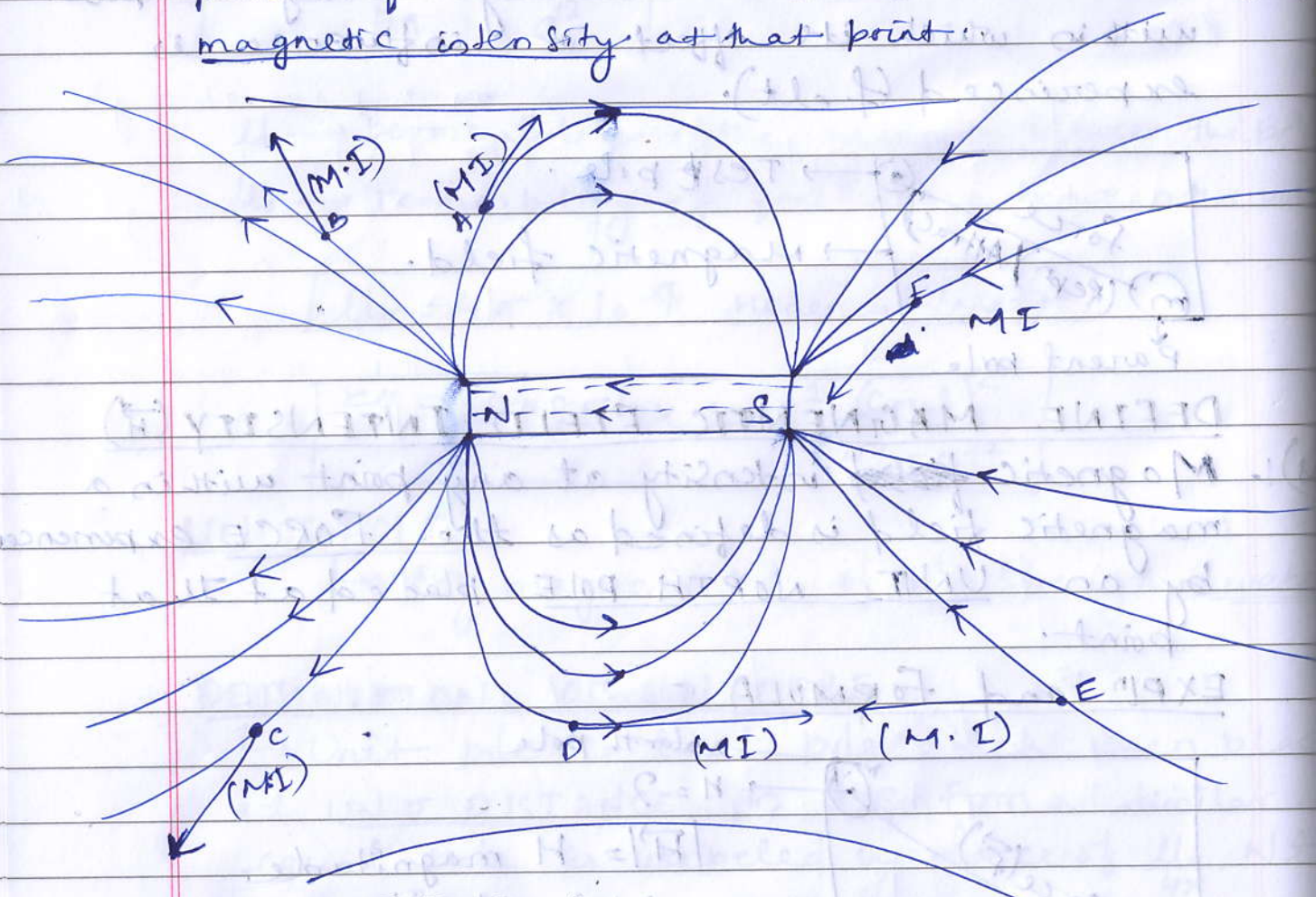
Nature of H → It is a vector qty

UNIT - 9 (CH - 11) → 9.11

Magnetic lines of force (Definition & Properti

DEFINE MAGNETIC LINES of FORCE.

(ans): They are imaginary closed curves drawn in a magnetic field, the tangent at any point of which indicates the direction of magnetic intensity at that point.



PROPERTISE :-

(*) Starts from North pole and ends on south poles.

(*) Inside the magnetic, they run from South poles to North pole.

(*) 02 lines of force never intersect each oth

UNIT-9 (CH-12) → 9.12

Magnetic flux (ϕ). → Definition
Magnetic flux Density ($\vec{B}$) → Formula, unit

DEFINE MAGNETIC FLUX (ϕ)

It is defined as the dot product of magnetic Flux Density ($\vec{B}$) and Area ($\vec{A}$).

$$\phi = \vec{B} \cdot \vec{A} \quad \text{or} \quad \phi = B \cdot A \cos\theta$$

ϕ → scalar qty
→ (SI unit) weber.

θ → Angle between $\vec{B}$ and $\vec{A}$.

DEFINE MAGNETIC FLUX DENSITY ($\vec{B}$).

(ans):- It is defined as the magnetic lines of force (magnetic flux) normally crossing unit area of a surface within the magnetic field, perpendicularly.

unit area
- → $1 mt^2$ (MKS/SI)
- → $1 cm^2$ (CGS)
- → $1 ft$ (FPS)

EXPLN and FORMULA for 'B'. $[|\vec{B}| = B]$

A → Area of surface within the magnetic field.
ϕ → Magnetic flux normally crossing ther area.
B → Magnetic flux Density.

A — normally → ϕ
1 — normally → $\frac{\phi}{A} = B$

$$\boxed{B = \frac{\phi}{A}}$$

SI UNIT of B :-

$$B = \frac{\phi}{A} \rightarrow \frac{\text{weber}}{(\text{meter})^2} = \frac{wb}{mt^2} = \boxed{\text{Tesla}}$$

Nature

B → vector qty.

END

UNIT-10

UNIT-10 [ELECTRIC CURRENT]

→ (Study about Elect. Charges in motion)

→ Definition, Formula, units.

DEFINE ELECTRIC CURRENT (I)

(Ans): It is time rate of flow of electric charges through a conductor.

New

OR.

Old It is the charges flowing through a conductor per unit time.

Expl^n and FORMULA for 'I'.

A —— Q coul. —— B

't' sec

Q → charge flow

t → time taken

I → electric current

I = ?

't' → Q

1 → $\frac{Q}{t}$ = El. current = I

$$\boxed{I = \frac{Q}{t}}$$

SI. unit of El. current

$$I = \frac{Q}{t} \rightarrow \frac{\text{Coul}}{\text{sec}} = \boxed{\text{Ampere}}$$

UNIT - 10 (CH-2) → (10.2)

OHM'S LAW and application :-

Statement :-

The electric current flowing thro a Conductor is directly proportional to the POTENTIAL DIFFERENCE applied across it ends provided temp remain constant.

EXPLANATION :-



$V \propto I$

or $\boxed{V = RI}$. [R → Proportionality constant known as Resistance of the (Material)]

→ (Mathematical form of Ohm's law.)

SQ 2m

UNDER what Condition does ohm's Law hold good?

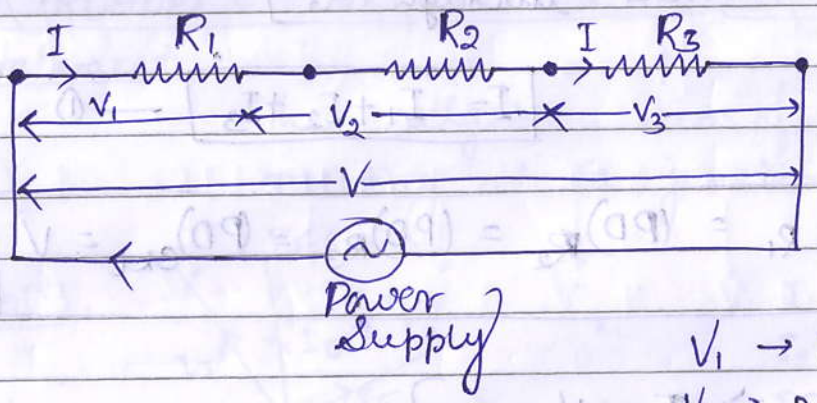
(Ans):- Ohm's law holds good or valid or is applicable in electric circuits where temp remains Constant.

UNIT - 10 (CH-3) → 10.3

Series and Parallel Combination of Resistors.

Capacitor has → Capacitance
Resistor has → Resistance
→ property (value)
→ element

SERIES CONNECTION:



R1, R2, R3 → Resistance of the 03 resistor Connected in SERIES.

V_1 → P.D across R_1

V_2 → P.D across R_2

V_3 → P.D across R_3.

V → P.D across the Ckt (Circuit)

Let R → Combined or effective or total or resultant resistance of the Combination.

$V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$.

$V = IR$.

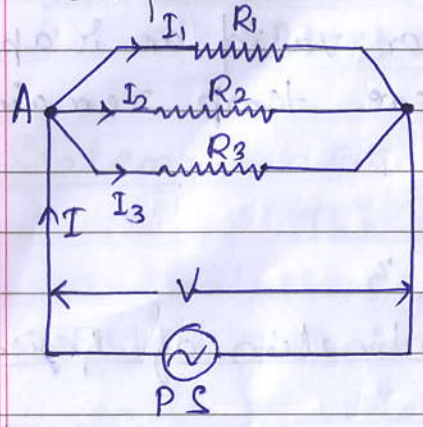
Here $V = V_1 + V_2 + V_3$. (P.D is a scalar qty).

$\Rightarrow IR = IR_1 + IR_2 + IR_3$

$\Rightarrow IR = I(R_1 + R_2 + R_3)$

$\Rightarrow \boxed{R = R_1 + R_2 + R_3}$

PARALLEL COMBINATION of RESISTORS.



R_1, R_2, R_3 } Resistance of the 03 resistors in PARALLEL.

R → Effective / total / Combined / Resultant resistance of the Combination.

→ All the 03 have been connected across terminal 'A' and 'B'.

I_1 → Current through R_1
I_2 → Current through R_2
I_3 → Current through R_3
. I → Total Current in the ckt.

$$I = I_1 + I_2 + I_3 \quad \text{---} (1)$$

Here,

$$(PD)_{R_1} = (PD)_{R_2} = (PD)_{R_3} = (PD)_{ckt} = V.$$

$$V = I_1 R_1 \Rightarrow I_1 = \frac{V}{R_1}$$

$$V = I_2 R_2 \Rightarrow I_2 = \frac{V}{R_2}$$

$$V = I_3 R_3 \Rightarrow I_3 = \frac{V}{R_3} \quad \text{---} (2).$$

$$I = I_1 + I_2 + I_3.$$

$$\Rightarrow \frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\Rightarrow V \times \frac{1}{R} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

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$$\Rightarrow \boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$\frac{1}{R} = \frac{R_2 R_3 + R_1 R_3 + R_1 R_2}{R_1 R_2 R_3} \quad \text{or} \quad \boxed{R = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3}}$$

UNIT - 10 (CH-4) → 10.4

[KIRCHOFF'S LAWS]

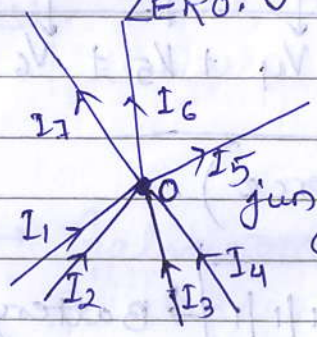
- KCL (1st law) — Kirchoff's current law
- KVL (2nd law) — Kirchoff's voltages law.

KIRCHOFF'S CURRENT LAW (KCL) → 1st law

Statement :-

The algebric sum of electric current meeting at a junction of conductor is ZERO.

EXPL^{N} :-



I_1, I_2, I_3, I_4 — Incoming current (+ve)

I_5, I_6, I_7 — outgoing current (-ve)

junction → Common meeting point

$$I_1 + I_2 + I_3 + I_4 + (-I_5) + (-I_6) + (-I_7) = 0$$

or

$$\boxed{I_1 + I_2 + I_3 + I_4 = I_5 + I_6 + I_7}$$

Sum of incoming current = Sum of outgoing current

There is no charge accumulation at junction

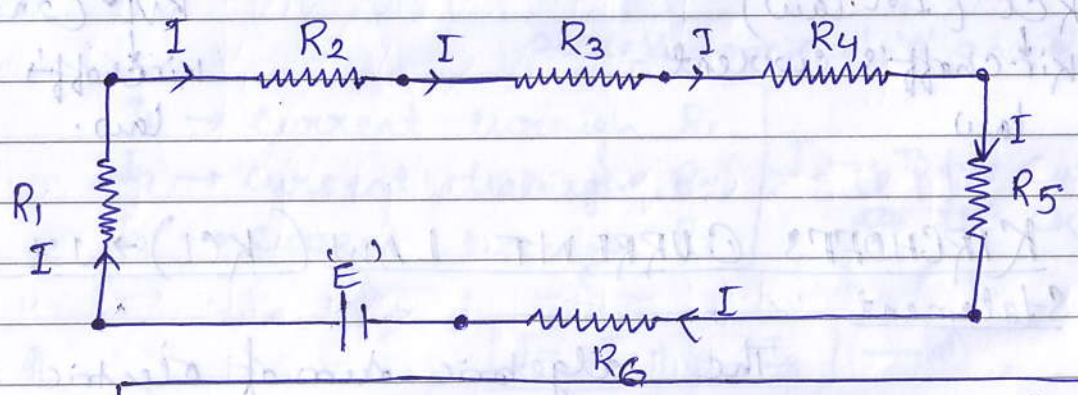
KIRCHOFF'S VOLTAGE LAW (2nd Law).

Statement :-

The algebric sum of voltage in each pa of an closed ckt is equal to the total emf of the ckt.

Voltage → Potential Difference (IR)
→ I × R

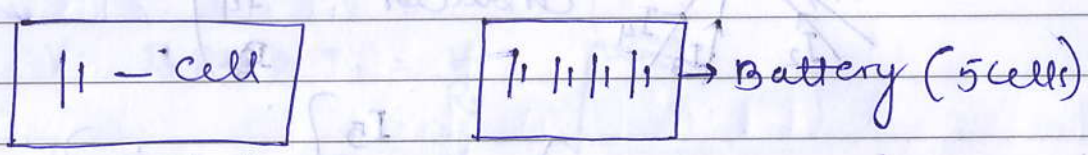
Expl^n :-



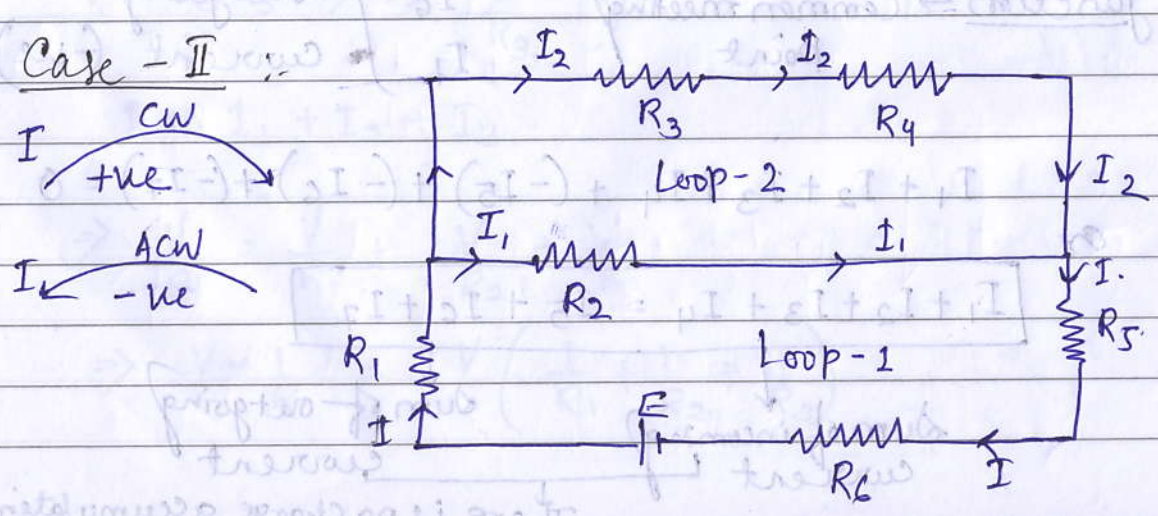
$$IR_1 + IR_2 + IR_3 + IR_4 + IR_5 + IR_6 = E \text{ (emf)}$$

$$V_1 + V_2 + V_3 + V_4 + V_5 + V_6 = E$$

emf → (electro motive force).



Case – II :-



KVL (Loop-1)

$$I R_1 + I_1 R_2 + I R_5 + I R_6 = E$$

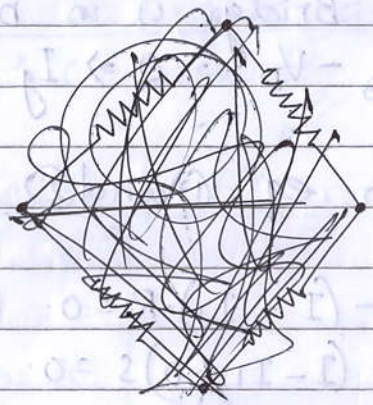
KVL (Loop-2)

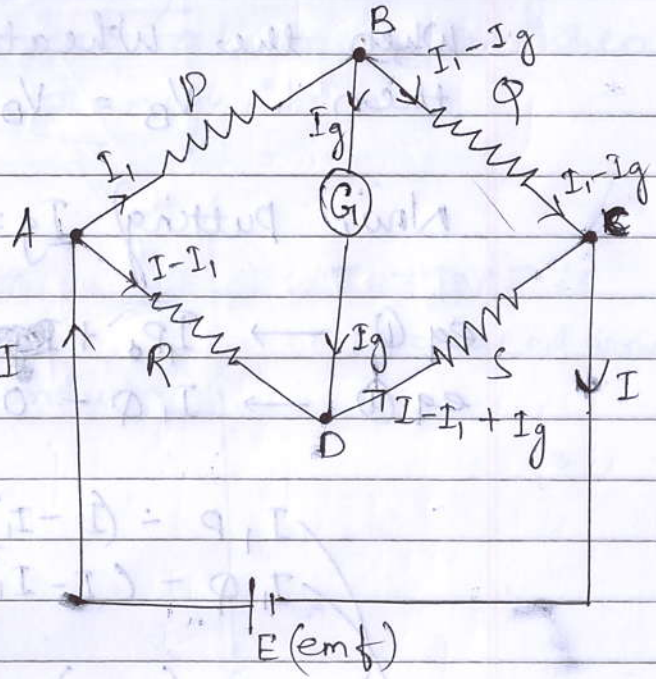
$$I_2 R_3 + I_2 R_4 - I_1 R_2 = 0$$

(No source of emf in this loop.)

UNIT-10 (CH-5) - 10.5

Appln of Kirchoff's law to Wheatstone Bridge





P
Q
R
S
} Resister in the 04 arms of the W.B

(G) → Galvanometer (detects small current)

g → Resistance of the galvanometer.

I → Total current in the ckt.

I_1 → current through 'P'.

$I - I_1$ → current through 'R'

I_g → Current through galvanometer

$I_1 - I_g$ → current through 'Q'

$I - I_1 + I_g$ → current through 'S'.

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Applying KVL to loop ABDA.

$$I_1 P + I_g g - (I - I_1) R = 0 \quad (\text{No source of emf}). \quad \text{——— (1)}$$

Applying KVL to loop BCDB.

$$(I_1 - I_g) Q - I_g g - (I - I_1 + I_g) S = 0 \quad (\text{No source of emf}) \quad \text{——— (2)}$$

When the Wheatstone Bridge is in balance condition then: $V_B = V_D \Rightarrow V_B - V_D = 0 \Rightarrow I_g = 0$.

Now, putting $I_g = 0$ in eq (1) and (2).

eq (1) $\longrightarrow$ $I_1 P + 0 \times g - (I - I_1) R = 0$.

eq (2) $\longrightarrow$ $I_1 Q - 0 \times g - (I - I_1 + 0) S = 0$.

$$I_1 P - (I - I_1) R = 0$$
$$I_1 Q - (I - I_1) S = 0.$$

$$\Rightarrow I_1 P = (I - I_1) R. \quad \text{——— (3)}$$
$$\Rightarrow I_1 Q = (I - I_1) S. \quad \text{——— (4)}$$

Divide eq (3) by (4)

$$\frac{I_1 P}{I_1 Q} = \frac{(I - I_1) R}{(I - I_1) S}$$

$$\Rightarrow \boxed{\frac{P}{Q} = \frac{R}{S}} \longrightarrow (\text{Condition of Balance})$$

Dt:- 29/11/19

UNIT-11

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UNIT-11 / [ELECTROMAGNETISM AND ELECTROMAGNETIC INDUCTION]

(CH-1) → 1.1

Electromagnetism.

→ Definition

→ Concept

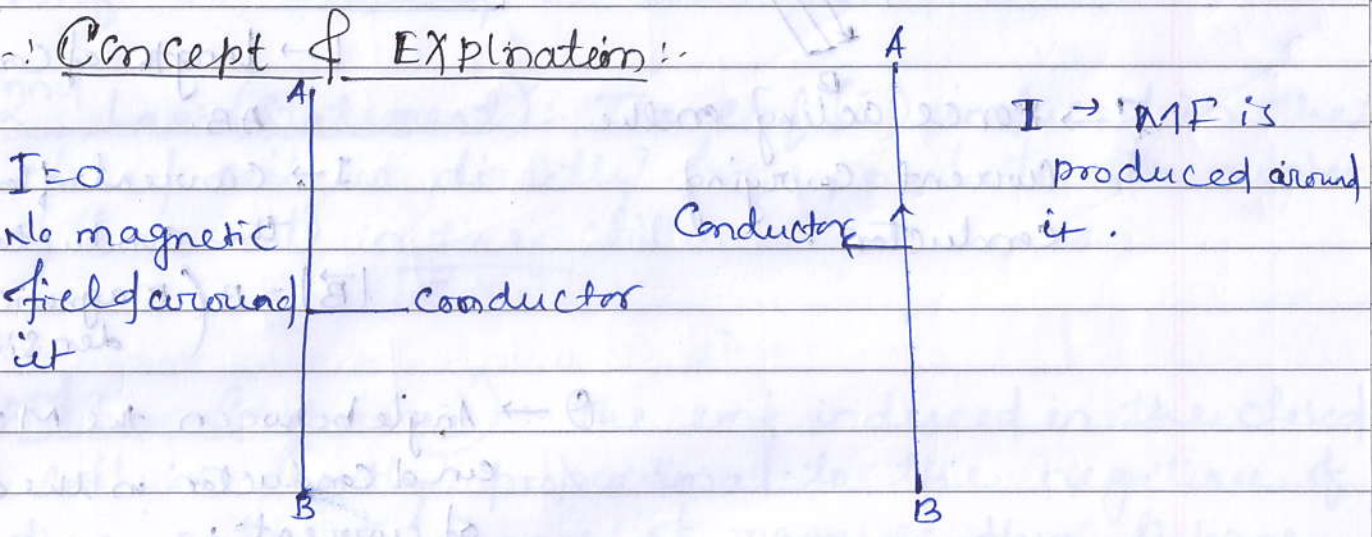
(New name)

(Old name - magnetic effect of electric current)

DEFINE ELECTROMAGNETISM?

(Ans):- It is the phenomena (process) in which magnetic field is produced around a conductor when electric current flows through it.

:- Concept & Explanation :-

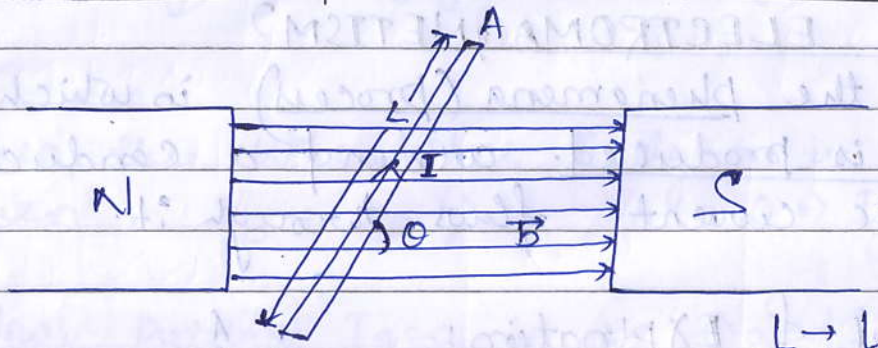




UNIT-11 (CH-2) → 11.2.

(*) FORCE acting on current carrying Conduc placed in an uniform magnetic field
(*) Fleming left hand Rule

FORMULA FOR FORCE(F) ACTING ON CURRENT CARRYING CONDUCTOR PLACED I AN UNIFORM MAGNENITIC FIELD.



F → Force acting on the current carrying conductor.

L → length of Conduct AB.

I → Current flowing the conductor.

|B| = B (magnetic flux density

θ → Angle between the M.Fiel and conductor in the direct of current.

FORMULA FOR 'F':

$F \propto B$
$F \propto I$
$F \propto L$
$F \propto \sin\theta$

$F \propto BIL \sin\theta$
or $F = KBIL \sin\theta$
where K → prop Const whose v depends upon the value of F, B, I, L and $\sin\theta$.

The Values of F, B, I, L and $\sin\theta$ are so chos that K = 1.

$$F = BIL \sin\theta$$

UNIT-11 (CH-3) → 11.3

Faraday's Law of Electromagnetic Induction :-

M. Field (cause) → Reverse of Electromagnetism
Electric current (effect)

Electromagnetism → Electric current (cause)
M. Field (Effect).

FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION.

Faraday's 1st Law :-

Statement :- Whenever there is relative motion between magnet and closed coil, magnetic flux linked with the closed coil changes. Hence an emf is induced in the closed coil.

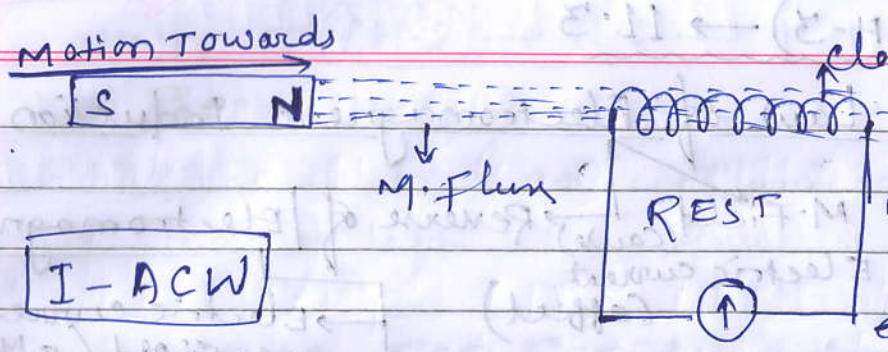
2nd Law (Statement) :- The emf (E) induced in the closed coil is directly proportional to the number of turns (N) in the coil.

$E \propto N$

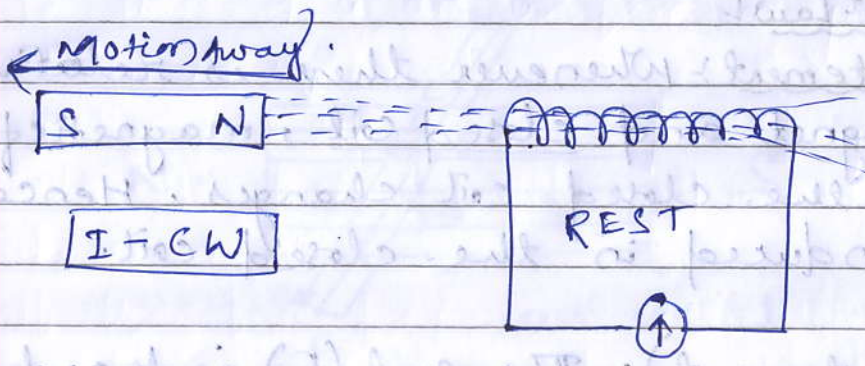
3rd Law (Statement) :- The emf induced in the closed coil is directly proportional to the negative of time rate of change of magnetic flux linkage $\left(\frac{d\phi}{dt}\right)$.

4th Law (Statement) :-

The emf (E) induced in the closed coil as long as the is relative motion between magnet and closed coil i.e., emf lasts as long as magnetic flux linkage changes.



R. Motion → occ
M. flux linkage cha
(Incre
emf is induced in th
coil.
current flows in the
closed coil.



R. Motion → occurs
M. Flux changes (decreases)
↓
emf is induced in the closed coil.
↓
Current flows in the closed coil.
↓
Induction → changes without contact

Initial	Final
ϕ_1	$\phi_2 \longrightarrow \phi_2 - \phi_1 = d\phi \rightarrow$ c in M
t_1	$t_2 \longrightarrow t_2 - t_1 = dt \rightarrow$ c in T in
$e \propto N$ — (1)	$e \propto \frac{d\phi}{dt}$ — (2).

Combine

$$e \propto -N\frac{d\phi}{dt}$$

K = proportionality const. whose valu depends upon the va of e, N, $\frac{d\phi}{dt}$.

Or $$\boxed{e = -KN\frac{d\phi}{dt}}$$

The value of K, N, & $\frac{d\phi}{dt}$ are so choosen that K = 1.

$$\boxed{e = -N\frac{d\phi}{dt}}$$ → Mathematical form of faraday's Law of E.M.I.

UNIT-11 (CH-4) → 11.4

[LENZ'S LAW]

Statement: The direction of induced emf is such that opposes the very cause which produced it.

emf → scalar
induced → vector
current → scalar.
induced current → vector.

Expln:- Relative motion between magnet & closed coil. → M.Flux linkage with closed coil chages → emf is induced in the closed coil.

$\left[\frac{d\phi}{dt}\right]$ ← opposes. [e]

e will oppose $\left[\frac{d\phi}{dt}\right]$

have opposite sign

$e \rightarrow +ve$

$\frac{d\phi}{dt} \rightarrow -ve$

$e \rightarrow -ve$

$\frac{d\phi}{dt} \rightarrow +ve$

UNIT-11 (CH-2) → 11.2

(*) [FLEMING'S LEFT HAND RULE] (LAW).

Aim → This rule (law) helps us to find out the direction of the force acting on a C.C.C placed is an uniform magnetic field.

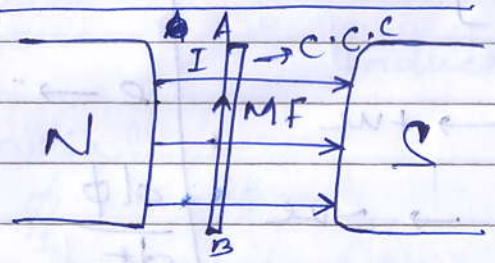
Statement →

Strech the fore finger - middle finger - thumb of the left hand mutually perpendicular to each other.

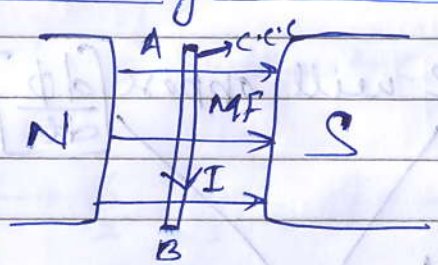
If the fore finger indicates the direction of magn field, middle finger indicates direction of electric curr then the thumb indicates the force acting on the C.C. conductor placed is the U.M. field.

F.F → M.Field.
M.F → El. current
THUMB → Direction of force acting on the C.C.C

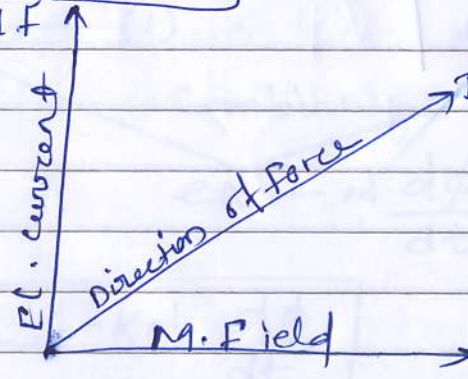
Expl:-



F on C.C.C → I inward



F on C.C.C → I outward



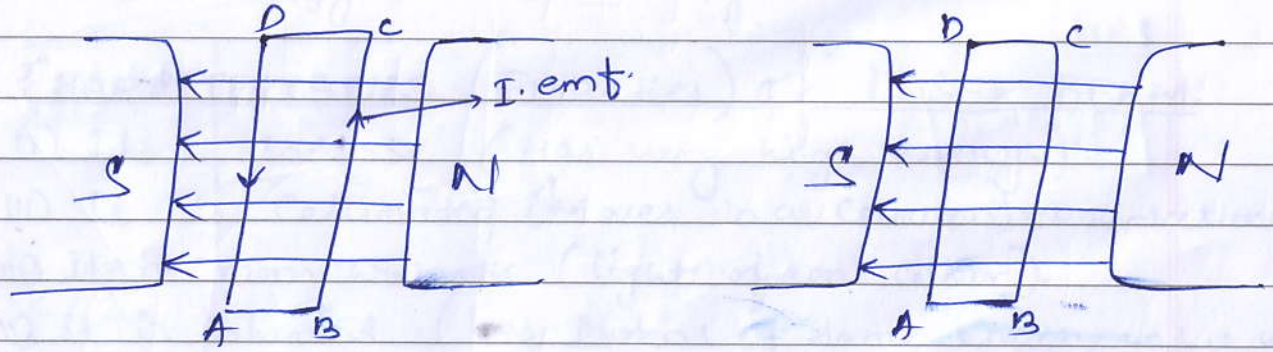
UNIT-11 (CH-5) → 11.5

[FLEMING'S RIGHT HAND RULE (LAW)]

Aim → This Law helps us to find out the direction of I.emf (I.current) in the closed coil during EMI.

Statement → Strech the fore finger - middle finger - Thumb of the right hand mutually perpendicular to each other.
If the fore finger indicates the direction of M.Field, thumb indicates direction of Motion of conductors / coil, then MIDDLE FINGER indicates direction of induced emf (I current).

F.F	→ M. field.
Thumb	→ Motion of coil.
M.F	→ Direction of I.emf (I.current)



Date → 02/12/19

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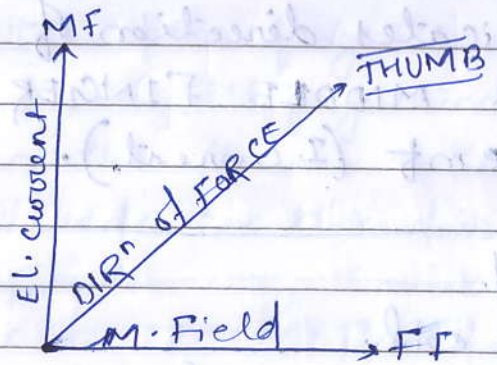
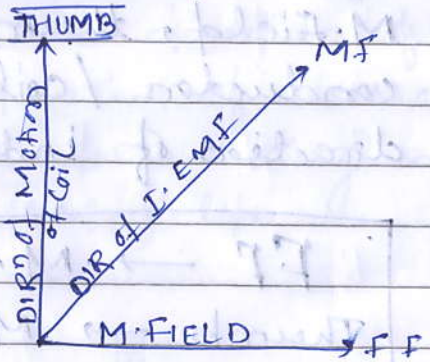
UNIT-11 (CH-6) → 11.6

COMPARISION BETWEEN F.L.H Rule and F.R.I Rule.

Fleming's left hand Rule	Fleming's Right hand Rule
(1) It helps to find out the direction of force acting on a c.c conductor placed in M.F.	(1) It helps to find out the direction of induced emf produced in the phenomena of induction.
(2) Fore F → M. Field. Middle Finger → El. current. Thumb → Direction of force.	(2) Fore Finger → M. Field. THUMB → Direction of motion of Middle Finger → Direction of Induced emf (I. current).
	

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UNIT-12

MODERN PHYSICS

CH-1 → 12.1

LASER and LASER BAEM

SQ 2m

DEFINE LASER.

OR

WHAT is LASER?

(Ans)→ A Laser is a device which produces Laser Beam.

ordinary light → Laser → Laser Beam. (amplified) → energy multiplication.

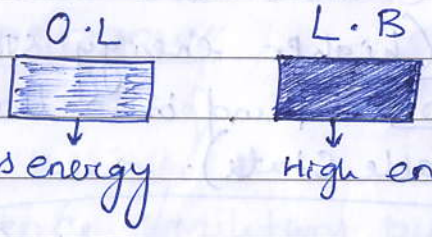
SQ 2m

DEFINE LASER BEAM.

OR

WHAT is LASER BEAM?

(Ans)→ Laser Beam is a very high energy light beam which is Intense – Collimated – monochromatic – Coherent.

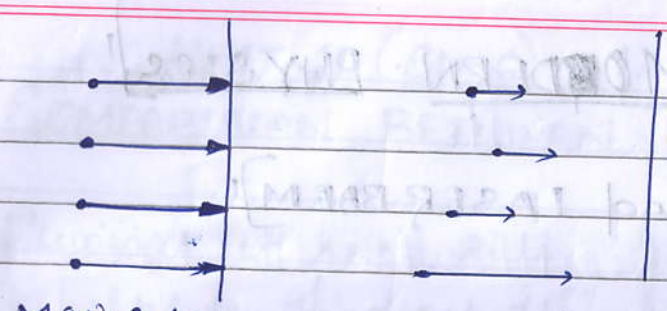


CHARACTERISTICS (Properties) of LASER BEAM.

(i) It is intense (Has very high energy).
(ii) It is Collimated (Moves in a Columns) - unidirectionally
(iii) It is monochromatic (light of one colour).
(iv) It is Coherent (has photons of same energy value which are in phase).

$$(Energy)_{photon} = h\nu$$

h → Planck's Constant
ν → frequency of light.



UNIT-12 (CH-2) → 12.2

Principle of LASER.

- → Population Inversion.
- → Optical pumping.

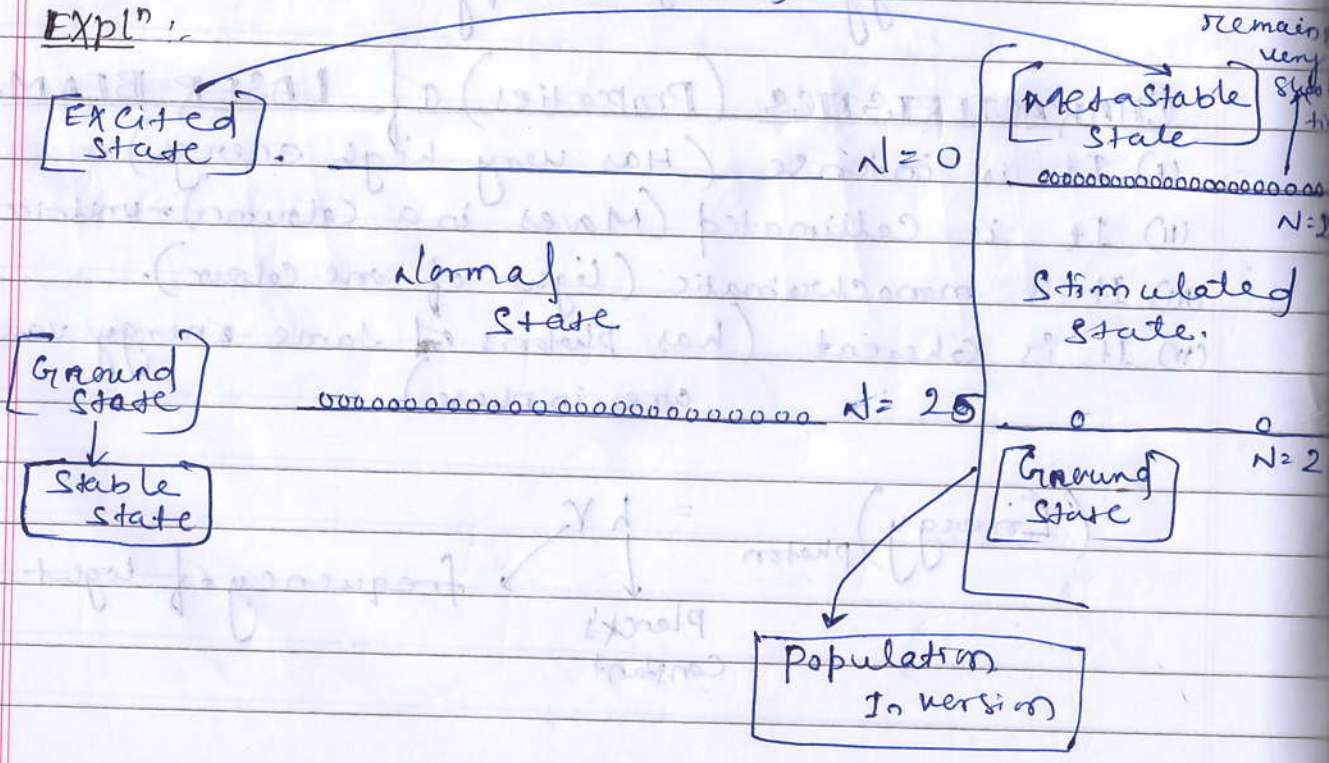
[LASER] What does Laser stands for?

↳ Light Amplification by Stimulated Emission of Radiation.

POPULATION INVERSION (Define / what is?)

↳ It is a state where the number of atoms in the EXCITED STATE (higher energy STATE) is very less than number of [atoms] found in the GROUND STATE (Normal State or Stable State).

Expl^n:



Optical Pumping (What is? / Define):-
↳ The process or method by which population Inversion is achieved is called optical pumping.

CH-3 → 12.3

APPLICATIONS (USES) of LASER BEAM:

Medical Application:
- ↳ Cancer treatment
- ↳ Tooth drilling.
- ↳ Eye Surgery.
- ↳ Cutting of Bones.
- ↳ Breaking up Gall Blader and kidney stone

Welding and cutting
- ↳ used for Spot welding of electronic Components.
- ↳ Precision cutting of diamond.
  - ↳ accurately

In HOLOGRAPHY
- ↳ Taking 3D-image of an object using Laser Beam.

In Defence / Military purpose.
- ↳ Laser guided bombs are used for precision bombing.
- ↳ Laser guided missile are used to destory emey aeroplanes.
- ↳ Laser beams are used for underwater Communication between submarines.

UNIT - 12 (CH-4)

Wireless Transmission.
- ↳ Ground waves
- ↳ Sky wave
- ↳ Space wave

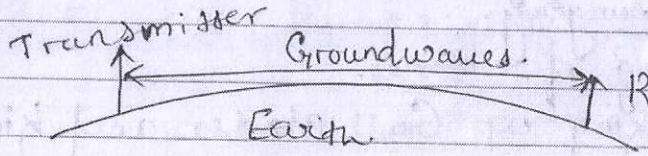
} Definition and Concept.

(4) END

GROUND WAVES :-

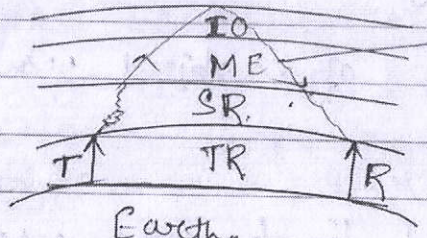
→ They are radio wave (electromagnetic waves) which progress along the the surface of the earth and are influenced by the electrical properties of the ground.

EX :→ AM. Radio.
(Amplitude modulated wave)



SKY WAVES :-

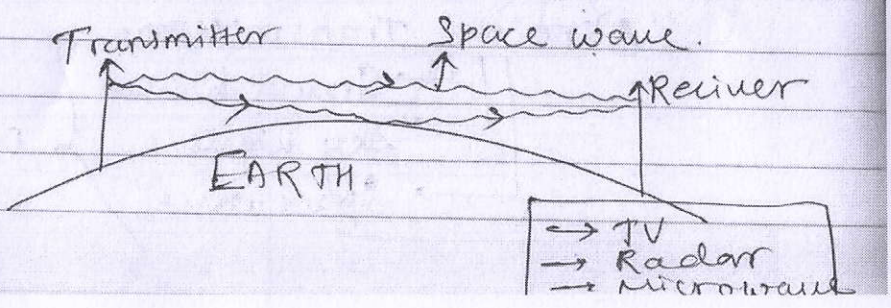
→ They are the radio waves (electromagnetic wa which after emission from transmitter reach the reciver by reflection from ionosphere



EX→ BBC Radio.
(British Broadcasting wave
VOA
(Voice of America).

SPACE WAVE →

→ They are the radio waves (electromagnetic waves) which after emission from Transmitter reach the reciver directly or by reflection of ground.



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