Dt- 15/11/19

UNIT-7

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 Centigrade (°C)
MKS ——→	Kilo-Calorie (k·cal)	Degree Centigrade (°C)
SI ——→	Joule	Degree Kelvin (°K).

REALETION BETWEEN DIFFERENT UNITS of

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 hot or coldness.
(ii) Flows from hot body to cold body.	(ii) Temperature determines the flow 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

SPECIFICS 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 fee

as this heat does not rai

(increase) the temp of a bod

only State of body changes

(Solid, Liquid, gas)

(*) Sensible Heat → $\boxed{\text{Specific Heat}}$

(*) Hidden Heat → $\boxed{\text{Latent Heat}}$

(*) 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 (2)

(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
- 1lb (FPS)
- 1 gm (CGS)
- 1kg (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 → mass of a body (material).
Q → Heat ~~Sp~~ supplied to the body (material).
t → Rise (increase) in temp of the body (material)
s → Sp. heat of the body (material).

$\boxed{Q = mst}$ → Heat gained (Temp ↑)

And Let

m → mass of a body (material)
Q → Heat Lost by body (material).
t → Rise (increase) in temp. of the body (materi
s → Sp. heat of the body (material)

$\boxed{Q = mst}$ → Heat Lost (Temp ↓)

SI unit of SPECIFIC HEAT.

$Q = mst$ or $S = \frac{Q}{mt}$

FPS	C.G.S	MKS	SI
$\frac{BTU}{lb-°F}$	$\frac{Cal}{gm-°C}$	$\frac{k\text{-}cal}{kg-°C}$	$\frac{Joule}{kg-°K}$
$= \boxed{BTU-lb^{-1}-°F^{-1}}$	$\boxed{Cal-gm^{-1}-°C^{-1}}$	$= \frac{1000 Cal}{1000g-°C}$	$= \boxed{Joule-kg^{-1}-°K}$
		$= \boxed{\frac{Cal}{gm-°C}}$	

DIMENSIONAL FORMULA OF SPECIFIC HEAT

$Q = mst$ or $S = \frac{Q}{mt} \longrightarrow \left[\frac{ML^2T^{-2}}{M \times \theta}\right] = [L^2T^{-2}\theta^{-1}$

$$\boxed{(DIM)_{work} = (DIM)_{energy} = [ML^2T^{-2}]}$$

or $\frac{ML^2T^{-2}}{M \times K} = \boxed{[L^2T^{-2}K^{-1}]}$

NUMERICAL EXAMPLES ON SP. HEAT

06/11/19

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 with 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 becom liquid.

(*) Boiling point → Temp at which liquids becom gas or vapour.

$\boxed{\text{MP of ICE} = 0°C}$
$\boxed{\text{Boiling point of water} = 100°C}$

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DEFINE LATENT HEAT of a Substance

(Ans):- It is defined as the amount of heat requir to convert (change) unit mass of that substan into liquid/vapour (gas) at its melting point / boiling point (without change in temperature).

DEFINE LATENT HEAT of FUSION of a SUBSTA

(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.
↓
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 pt of ICE.

(*) 1 gm of ice ⟶ 1 gm of water $\frac{\text{at}}{\text{M.P}(0°C)}$, 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 = $\boxed{\text{Lice} = 80\ \text{cal/gm.}}$

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)

1gm Liquid $\xrightarrow[\text{Boiling point}]{\text{at}}$ 1 gm vapour → HR = LH of vapourisatio of that liqu

DEFINE LATENT HEAT of VAPOURISATION of WA

Ans)→ It is defined as the amount of heat require to convert (change) unit mass of WATER into VAPOUR (GAS) at 100 °C (without change in temp or at constant temperature).
Boiling point.

$$\begin{tikzcd} \text{(*) 1gm water at } 100^\circ C \arrow[r] \arrow[r, bend left, "\text{State changes}"] \arrow[r, bend right, "\text{temp - same}"'] & \text{1gm Vapour (steam) at } 100^\circ C \arrow[r] & \text{HR = 540 calo} \end{tikzcd}$$

(*) 1 gm water at 100°C + 540 Calorie of Heat → 1 gm steam at 100

(*) 1 gm stem at 100°C − 540 calorie of heat → 1gm water at 1

Latent Heat of Vaporisation of water = $\boxed{L_{water} = 540 \text{ Cal/gm}}$

This statement is ~~required~~ indicates tha 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

$$\begin{array}{ccccccccc} & & FPS & & CGS & & MKS & & SI \\ L = \frac{Q}{m} & \longrightarrow & \boxed{\frac{BTU}{lb}} & \longrightarrow & \boxed{\frac{Cal}{gm}} & \longrightarrow & \boxed{\frac{k.cal}{kg}} & \longrightarrow & \boxed{\frac{Joule}{kg}} \end{array}$$

$$\hookrightarrow \frac{1000\,cal}{1000\,gm} = \boxed{\frac{Cal}{gm}}$$

DIMENSION of LATENT HEAT (L)

$$L = \frac{Q}{m} \longrightarrow \frac{M^1L^2T^{-2}}{M} = \left[L^2T^{-2}\right]$$

SIMPLE NUEMERICAL FOR.

Dt:- 09/11/19

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

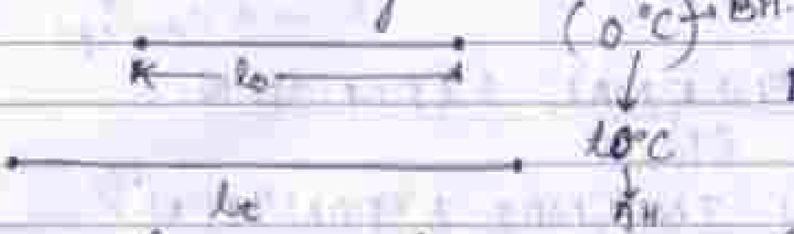
- 1 Dimensional Length
- 2 Dimensional Area (l×b)
- 3 Dimensional Volume (l×b×h).

EXPANSION of Solids.

- Linear EXpansion (1 Dimensional)
- Areal or Superficial Expansion (2-Dimensional)
- Cubical or volume EXpansion (3-dimensional)

LINEAR EXPANSION (Define / what is?).

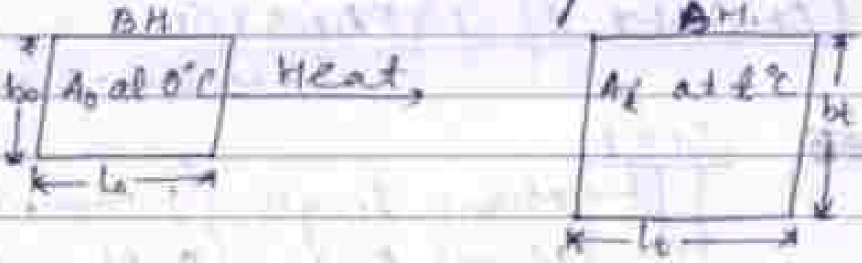
↳ It is the increase in length of soli
due to heating).



$LE = L_t - l_0$

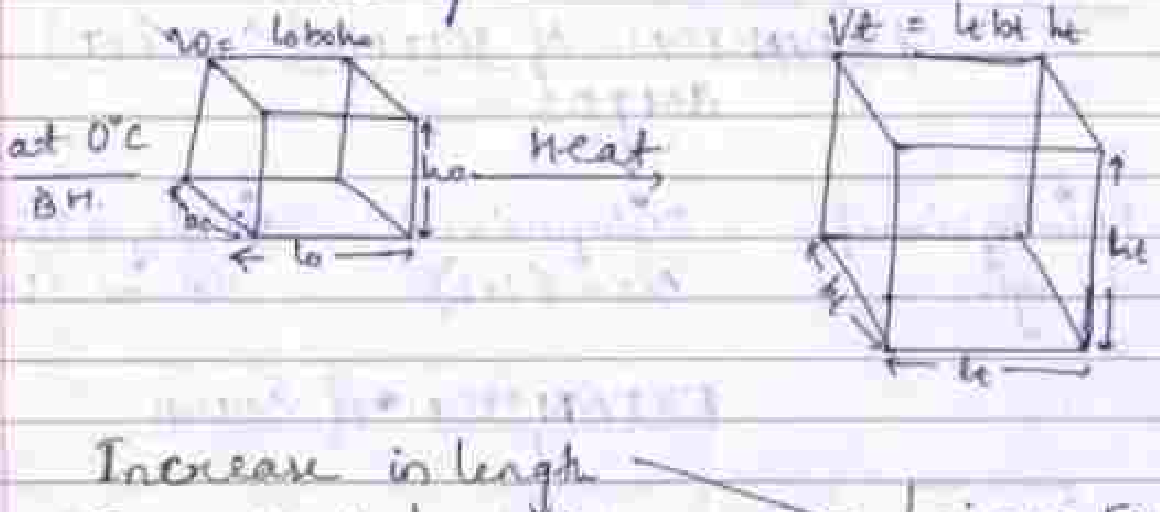
AREAL (Superficial) EXpansion (Define / what is?)

↳ 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 soli
due to heating).



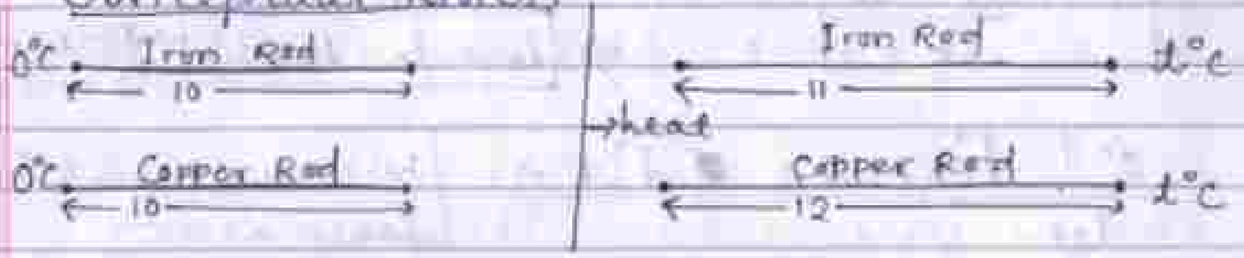
Increase in length
Increase in breadth → Linear Expansio
Increase in height

Dt : 11/11/19

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-efficient of expansion as their expanding abilities on being heated are not same.

FORMULA for COEFFICIENT of LINEAR EXPANSIO OF SOLID MATERIAL (α)

Let

Incr (l_0 → length of solid rod (material) at 0°C.
l_t → length of solid rod (material) at t°C.) inc

Increase in temp of solid rod = $t - 0 = t$°C

Increase in length of solid rod = $l_t - l_0$ → Linear Expans

Now,

Expression ($l_t - l_0 \propto t$ (Increase in temp) ⇒ t ↑ ⇒ l_t to ↑
$l_t - l_0 \propto l_0$ (Proportion) (original or Initial length)

Combining both expression.

$l_t - l_0 \propto l_0 t$ - (expression).

or $l_t - l_0 = \alpha\, l_0 t$

α → 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

$\boxed{l_t - l_0 = \alpha l_0 t}$

→ linear expansivity of the solid material

$\boxed{\alpha = \frac{l_t - l_0}{l_0 t}}$ or $l_t = l_0 + \alpha l_0 t$

$\Rightarrow \boxed{l_t = l_0 (1+\alpha t)}$ → Relation betw l_0 and l_t

2nd FORMULA FOR α

[When the original length taken at 0°C.

let

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

→ proportionally constant known as co-efficient of linear expantion of a solid material at t°C.

linear expansivity of the solid material at t°C.

$$\boxed{\alpha = \frac{l_2 - l_1}{l_1 (t_2 - t_1)}}$$

$l_2 = l_1 + \alpha l_1 (t_2 - t_1)$

$\Rightarrow \boxed{l_2 = l_1 [1 + \alpha (t_2 - l_1)]}$ → Relation between l_1 and l_2

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FORMULA FOR β (when original or initial area is measured at 0°C.

β → 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.

A_0 → BH. A_t → AH.

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).

β → (C. of AE or solid in nature).

$$\boxed{\beta = \frac{A_t - A_0}{A_0 t}}$$

or $A_t = A_0 + \beta A_0 t$

or $\boxed{A_t = A_0 (1 + \beta t)}$ → Relⁿ 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) I

A_2 → Area of a solid plate at t_2°C

Increase in Area = $A_2 - A_1$

Increase in Temp = $t_2 - t_1$

Now,

$A_2 - A_1 \propto A_1$ (O. 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 $\boxed{\beta = \dfrac{A_2 - A_1}{A_1 (t_2 - t_1)}}$

or $A_2 = A_1 + \beta A_1 (t_2 - t_1$

$\boxed{A_2 = A_1 [1 + \beta (t_2 - t_1}$

Relⁿ between A_2 and

FORMULA FOR 'γ' (when original or intial volum is taken at 0°C

→ Coefficient of volume (Cubical) expansion of a solid material.

(OR) Volume or (Cubical) expansion of the solid m

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 exp

$\boxed{\gamma = \dfrac{V_t - V_0}{V_0 t}}$

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

I $\left\{ \begin{array}{l} V_1 \rightarrow \text{volume of solid cube at } t_1°C. \\ V_2 \rightarrow \text{volume of solid cube at } t_2°C. \end{array} \right.$ I

$$\text{Increase in volume} = V_2 - V_1$$
$$\text{Increase in volume} = t_2 - t_1$$

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 $V_2 = V_1 + \gamma V_1 (t_2 - t_1)$

$$\boxed{V_2 = V_1 \left[1+\gamma (t_2 - t_1)\right]}$$

} Relation between V_2 and V_1

CONCEPTUAL NOTES on α, β and γ:

(1)

$\alpha = \frac{l_t - l_0}{l_0 t}$	$\rightarrow \frac{\text{Increase in length}}{\text{original or initial length at } 0°C \times \text{Rise in temp}}$
$\alpha = \frac{l_2 - l_1}{l_1 (t_2 - t_1)}$	$\rightarrow \frac{\text{Increase in length}}{\text{original original length at } t_1°C \times \text{Rise in temp}}$

DEFINE α (Coefficient of L-Exp^n of a solid material)

↳ 'α' of a solid material is defined as the <u>Increase in length</u> PER Unit original length PER unit degree rise in temp.

(ii)

$\beta = \dfrac{A_t - A_0}{A_0 t}$ →	$\dfrac{\text{Increase in Area}}{\text{original or initial area at } 0^\circ C \times \text{Rise in temp}}$
$\beta = \dfrac{A_2 - A_1}{A_1 (t_2 - t_1)}$	$\dfrac{\text{Increase in Area}}{\text{original or initial area at } t_1^\circ C \times \text{Rise in temp}}$

DEFINE β (Coefficient of A. Expn of a solid material

'β' of a Solid material is defined as the Inc in Area per unit original AREA PER unit deg rise in temp.

(iii)

$\gamma = \dfrac{V_t - V_0}{V_0 t}$	$\dfrac{\text{Increase in volume}}{\text{original or initial volume at } 0^\circ C \times \text{Rise in temp}}$
$\gamma = \dfrac{V_2 - V_1}{V_1 (t_2 - t_1)}$	$\dfrac{\text{Increase in volume}}{\text{original or initial volume at } t_1^\circ C \times \text{Rise in temp}}$

DEFINE ~~β~~ 'γ' (Coefficient of V. Expn of a soli material

'γ' of a solid material is defined as the Inc in volume per unit original ~~A~~ volume PER un degree rise in temp..

UNITS of α, β, γ

(I)

$$\alpha = \frac{l_t - l_0}{l_0 t} \rightarrow \frac{cm}{cm \times {}^\circ C} = \frac{1}{{}^\circ C} = \boxed{{}^\circ C^{-1}}$$

$$\alpha = \frac{l_2 - l_1}{l_1 (t_2 - t_1)} \rightarrow \frac{cm}{cm \times {}^\circ C} = \frac{1}{{}^\circ C} = \boxed{{}^\circ C^{-1}}$$

(II) $\beta = \frac{A_t - A_0}{A_0 t} \rightarrow \frac{cm^2}{cm^2 \times °C} = \frac{1}{°C} = \boxed{°C^{-1}}$

$\beta = \frac{A_2 - A_1}{A_1 (t_2 - t_1)} \rightarrow \frac{cm^2}{cm^2 \times °C} = \frac{1}{°C} = \boxed{°C^{-1}}$

(III)

$\gamma = \frac{V_t - V_0}{V_0 \times t} \rightarrow \frac{cm^3}{cm^3 \times °C} = \frac{1}{°C} = \boxed{°C^{-1}}$

$\gamma = \frac{V_2 - V_1}{V_1 (t_2 - t_1)} \rightarrow \frac{cm^3}{cm^3 \times °C} = \frac{1}{°C} = \boxed{°C^{-1}}$

DIFFERENT UNITS of α, β and γ

	FPS	CGS	MKS	SI
α	$°F^{-1}$	$°C^{-1}$	$°C^{-1}$	$°K^{-1}$
β	$°F^{-1}$	$°C^{-1}$	$°C^{-1}$	$°K^{-1}$
γ	$°F^{-1}$	$°C^{-1}$	$°C^{-1}$	$°K^{-1}$

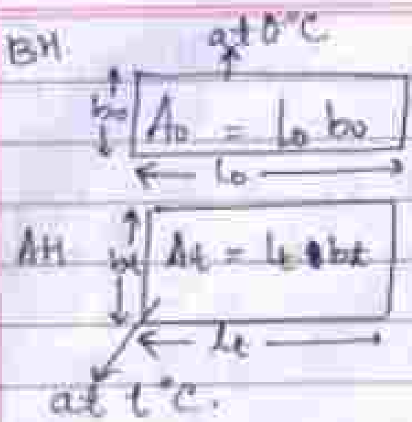
UNIT - 7 (CH-8) → 7·8

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 MATERIA



Consider a solid plate with original area A_0. It is heat 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 expansions along length and breadth.
(At the same time.)

$$A_t = A_0 (1+\beta t) \quad -(1)$$

$$\left[\begin{array}{l} l_t = l_0 (1+\alpha t). \\ b_t = b_0 (1+\alpha t). \end{array}\right]$$

$$l_t b_t = l_0 b_0 (1+\beta t)$$

$$l_0(1+\alpha t) b_0 (1+\alpha t) = l_0 b_0 (1+\beta t).$$

or

$$\cancel{l_0 b_0} (1+\alpha t)^2 = \cancel{l_0 b_0} (1+\beta t)$$

or $(1+\alpha t)^2 = (1+\beta t)$

or $(1+\beta t) = (1+\alpha t)^2$

$\Rightarrow 1+\beta t = 1+2\alpha t + \underbrace{\cancel{\alpha^2 t^2}}_{\text{neglected as it is very small compared to } \cancel{2} \, 2\alpha}$

$\Rightarrow$

$\alpha \rightarrow$ very small (

$\alpha^2 \rightarrow$ very very s

$\Rightarrow 1+\beta t = 1+2\alpha t$

Comparing coefficient of terms in both sides

$$\beta t = 2\alpha t$$

$$\boxed{\beta = 2\alpha}$$

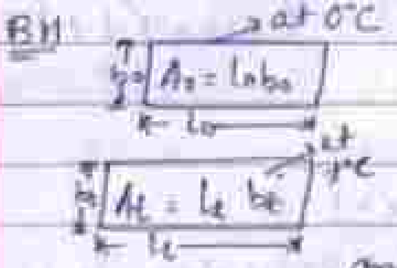
or $\boxed{\alpha = \frac{\beta}{2}}$

UNIT-7 (CH-8) → 7·8

RELATION BETWEEN α, β, γ

→ Between 'α' & 'β'
→ Between 'α' & 'γ'
} α, β, γ

RELATION BETWEEN 'α' and 'β' of a Solid material.



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.

$$A_t = A_0 (1 + \beta t) \text{———} ①$$

$$\left[\begin{array}{l} l_t = l_0 (1 + \alpha t). \\ b_t = b_0 (1 + \alpha t). \end{array}\right]$$

$$l_t b_t = l_0 b_0 (1 + \beta t)$$

$$\Rightarrow l_0 (1 + \alpha t) b_0 (1 + \alpha t) = l_0 b_0 (1 + \beta t).$$

$$\Rightarrow l_0 b_0 (1 + \alpha t)^2 = l_0 b_0 (1 + \beta t).$$

$$\Rightarrow (1 + \alpha t)^2 = 1 + \beta t \quad \Rightarrow 1 + \beta t = (1 + \alpha t)^2$$

$$\Rightarrow 1 + \beta t = 1 + 2\alpha t + \underbrace{\alpha^2 t^2}_{\text{neglected as it is very small compare to } 1+2\alpha t}$$

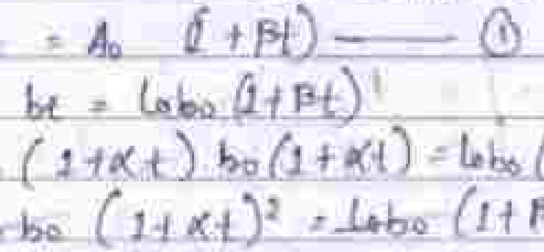
α → Very small in decimal
α^2 → very very small
let $\alpha = 0{\cdot}02$
$\alpha^2 = 0{\cdot}0004$.

$$\Rightarrow 1 + \beta t = 1 + 2\alpha t.$$

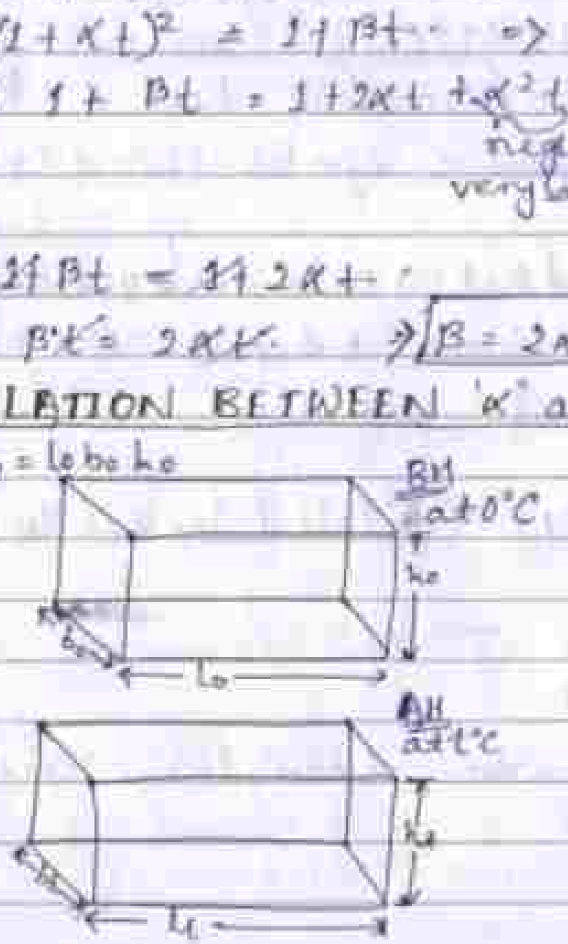
$$\Rightarrow \beta t = 2\alpha t. \quad \Rightarrow \boxed{\beta = 2\alpha} \text{ or } \boxed{\alpha = \beta/2}$$

(*) RELATION BETWEEN 'α' and 'γ' of a solid material.

$V_0 = l_0 b_0 h_0$



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 $V_t = V_0 (1 + \gamma t)$

$$l_t b_t h_t = l_0 h_0 b_0 (1 + \gamma t)$$

$$l_0 \to l_t \Rightarrow l_0 (1 + \alpha t)$$

$$b_0 \to b_t \Rightarrow b_0 (1 + \alpha t)$$

$$h_0 \to h_t \Rightarrow h_0 (1 + \alpha t).$$

→ volume or Cubical expansion is the result of 3 simu
linear expansion along, length, breadth and height

$l_t b_t h_t = l_0 b_0 h_0 (1+\gamma t)$

$\Rightarrow l_0(1+\alpha t) \cdot b_0(1+\alpha t)\, h_0(1+\alpha t) = l_0 b_0 h_0 (1+\gamma t)$.

$\Rightarrow (1+\alpha t)^3 = (1+\gamma t)$

$\Rightarrow (1+\alpha t) = (1+\alpha t)^3$.

$\Rightarrow (1+\gamma t) = 1+3\alpha t + \boxed{3\alpha^2 t^2 + \alpha^3 t^3}$

$\alpha \to$ very small
$\alpha^2 \to$ very very small
$\alpha^3 \to$ still smaller.
$\alpha^3 << \alpha^2 << \alpha$.

→ Neglect as they are ve
small compare to 1 and 3

Comparing Co-efficient in both side

$\Rightarrow 1+\gamma t = 1+3\alpha t$

$\Rightarrow \gamma t = 3\alpha t$.

$\Rightarrow \boxed{\gamma = 3\alpha.}$

RELATION BETWEEN
α, β, γ

(I) $\beta = 2\alpha$ or $\alpha = \frac{\beta}{2} \longrightarrow \boxed{\alpha = \beta/2 = \gamma/3}$

(II) $\gamma = 3\alpha$ or $\alpha = \gamma/3 \longrightarrow \boxed{\alpha : \beta : \gamma = 1:2:3}$

POSSIBLE LONG QUESTION (5/10m)

(*) Show that / Prove that / establish that $\alpha = \beta/2 = \gamma/$
or $\alpha : \beta : \gamma = 1:2:3$ where symbols used carry u
meaning.

(*) Declare / establish / find out a relation / equation / formu
between co-efficient of linear, superficial and cubic
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

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 ~~body~~ object doing work feels hot.

(*) Heat produced is directly proportional to the work done.

$W \propto H$ $(W\uparrow \Rightarrow H\uparrow)$ → Expression.

$\boxed{W = JH}$ → proportionality is known as mechanical Equivalent of Heat.

DI: 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)

→ 1kcal (MKS)

→ 1 Joule (SI)

→ 1BTU (FPS)

Expl^n:-

$W = JH$ or $\boxed{J = W/H}$

| H → heat produced
| W → Heat produced

'H' → W

1 → $\frac{W}{H}$ → Amt of work done to produce unit quantity of heat = J

unit quantity of heat.

$$\boxed{\frac{W}{H} = J}$$

VALUE of J (M. Eqv. of Heat).

$\boxed{J = 4.2 \text{ Joule/Calorie}}$ → Statement

↳ This statement indicates that 4.2 J of work has to be done to produce 1 calo of heat.

4.2 Joule work → 1 Cal Heat

42 Joule work → 10 Cal Heat

4200 Joule work → 100 Cal Heat

Or) Workdone → 4.2 Joule → 1 Calorie ← heat produce

4.2 Joule ↓ $\boxed{\text{Work equivelent of 1 Calorie}}$

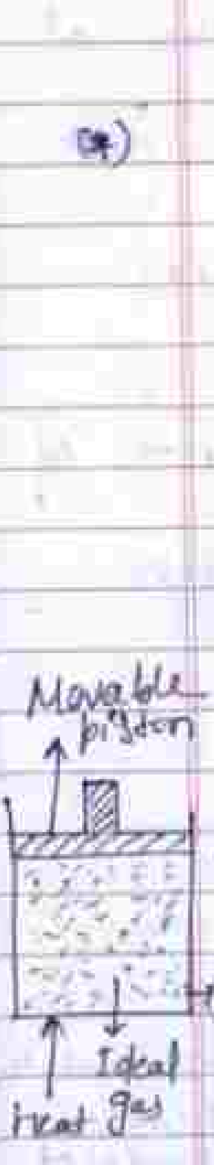
1 Calorie ↓ $\boxed{\text{heat equivelent of 4.2 Joule}}$

UNIT-7 (CH-11) → 7.11

⟨1st LAW OF TERMODYNAMICS⟩

↳ Statement

↳ Concept



Statement:

↳ When heat is supplied (given) to a sy it is utilised in 02 ways.

(I) A part of it is used to raise interna energy of the system.
Incre. 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.

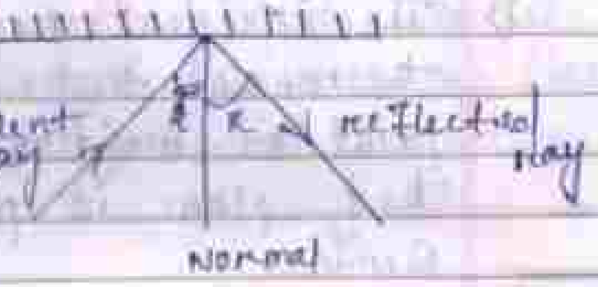
$$\boxed{dQ = dU + dW}$$

<UNIT-8> ①

OPTICS

31.01.19

Reflection :-



It is the properties of light by the vandue 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 into 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.

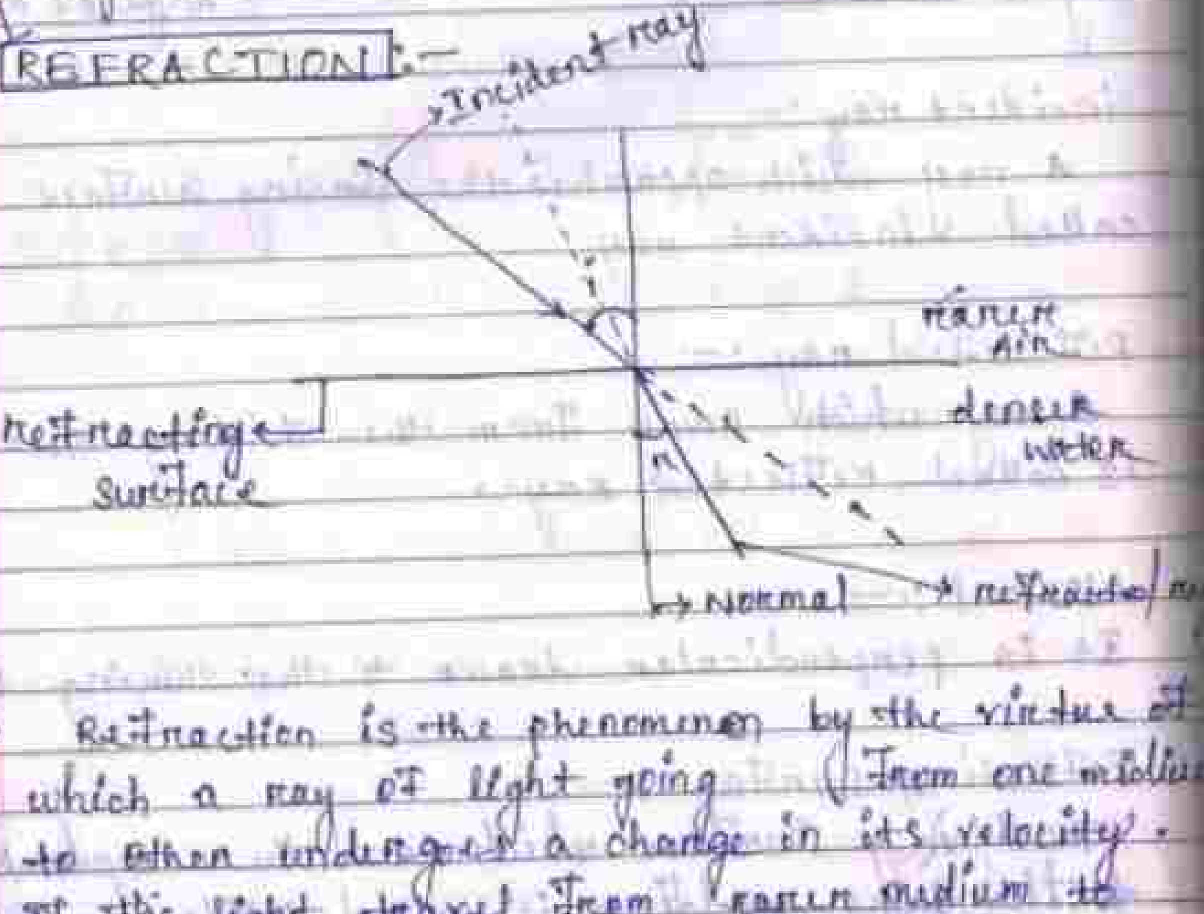
Laws of Reflection

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.

01/02/19

REFRACTION :-



→ Refraction is the phenomenon by the virtue of which a ray of light going from one mediu to other undergoes a change in its velocity.

→ If the light travel from rarer medium to danser medium it bends towards the normal

→ If the light travel from danser medium to rarer medium it bends away from the normal

Laws of Refraction:-

i) The sine of angle of incidence bears a constan ratio with the sine of angle of refraction

$\frac{\sin i}{\sin r}$ = constant. This law is called as Snell's

(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 $\frac{\sin i}{\sin r}$ = 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 vacuum then $\boxed{\mu = \frac{c}{v}}$ This μ is called as absolute refractive index

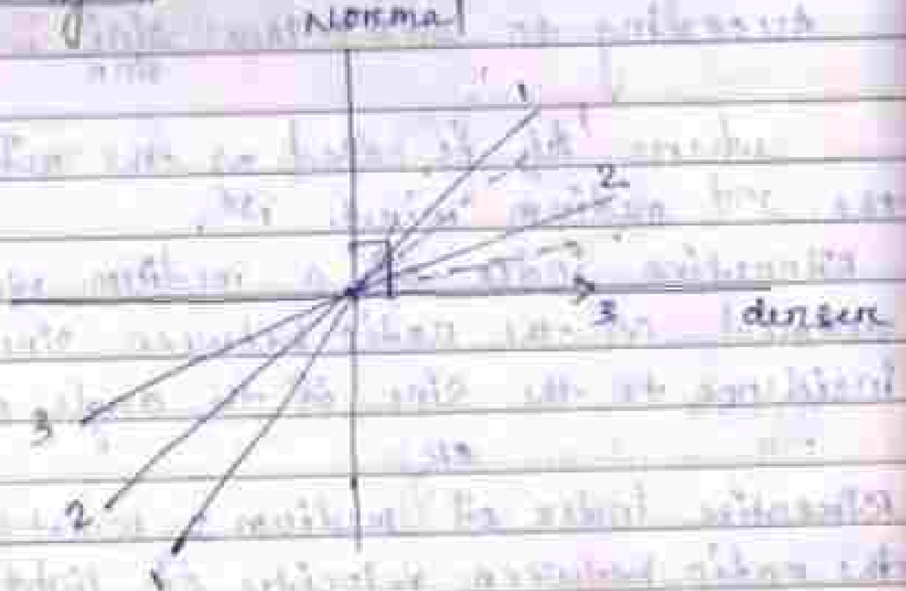
where c = velocity of light in vacuum or air.
v = velocity of light in medium.

$${}^1\mu_2 = \frac{v_1}{v_2} = \frac{v_1/c}{v_2/c} = \frac{1/\mu_1}{1/\mu_2} = \frac{\mu_2}{\mu_1}$$

$$\boxed{\therefore {}^1\mu_2 = \frac{\mu_2}{\mu_1}}$$

Refractive index of the 2nd medium w.r.t. 1st is defined as the ratio between absolute refractive index of the 2nd medium to the absolute refractive index of the 1st medium.

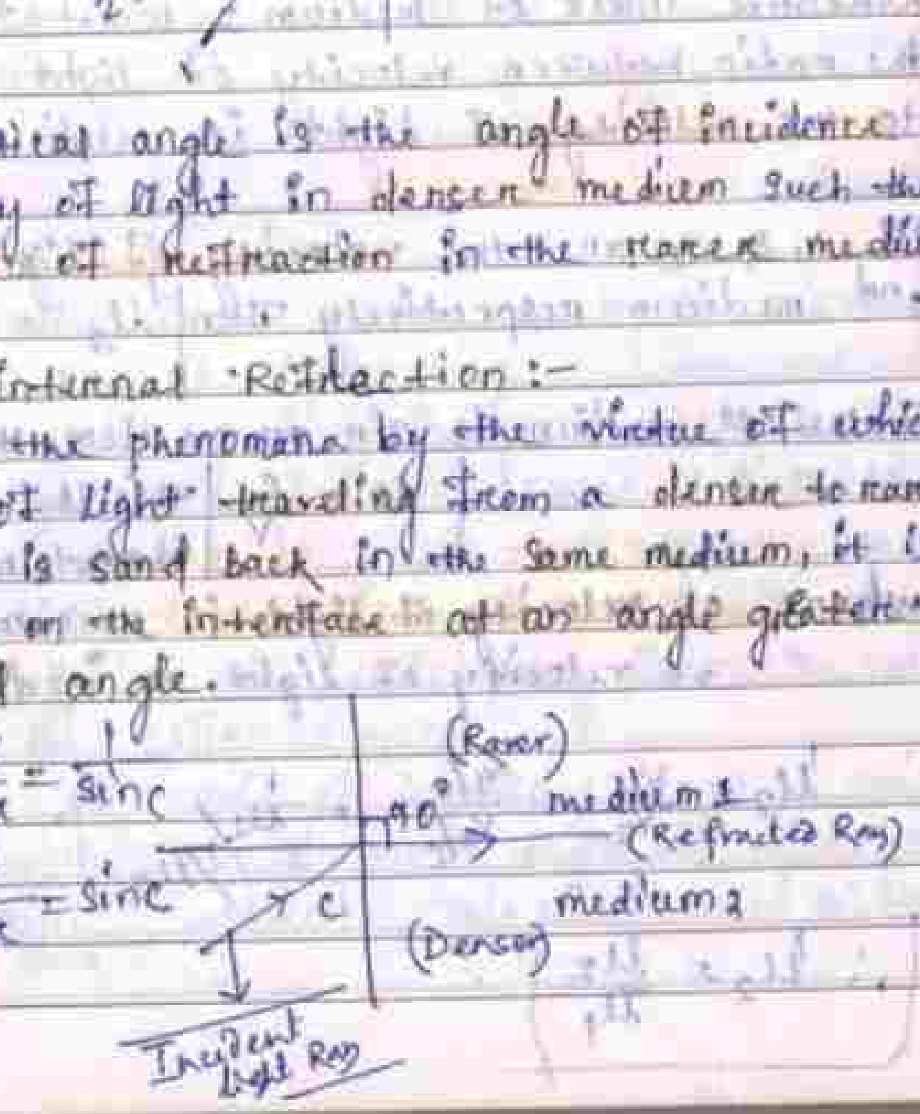
Critical Angle :-



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 Reflection :-

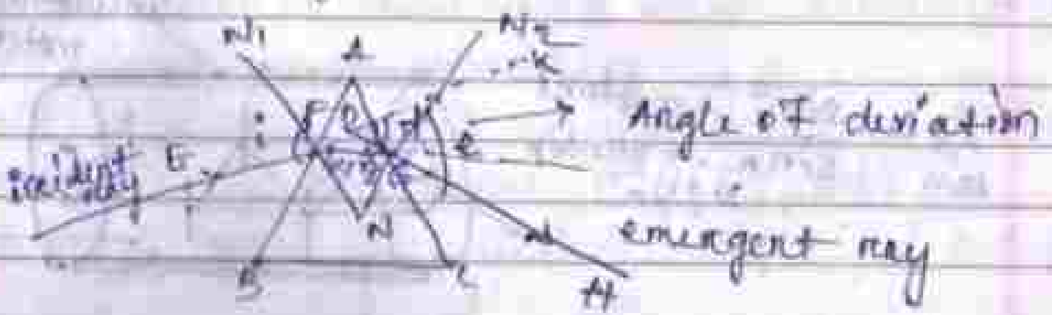
It is the phenomena by the virtue of which a ray of light travelling from a denser to rarer medium is send back in the same medium, it is incident on the interface at an angle greater than critical angle.



$${}^1\mu_2 = \frac{\sin i}{\sin r} = \frac{1}{\sin c}$$

$${}^2\mu_1 = \frac{\sin i}{\sin r} = \sin c$$

Refraction through prism :— 01.02.19



→ 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 takeplace 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 incident ray EF move in a straight line but due to refraction through the prism it changes it's 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 $\boxed{\mu = \frac{\sin\left(\frac{A+Dm}{2}\right)}{\sin (A/2}}$

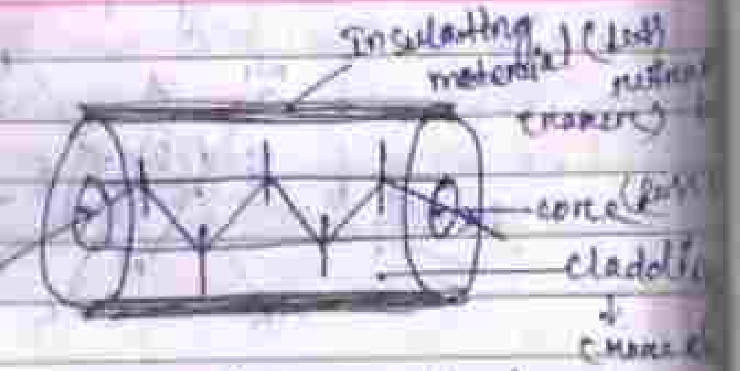
A = Angle of prism
Dm = Angle of minimum deviation.

⑥

04-5/19

Fibre optics :-

$\underset{\text{less}}{\mu} = \frac{\sin i}{\sin r}$ ← constant
→ greater
> i > r



(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 opticaly denser (high refractive index). outer part i.e cladding surrounding the core is opticaly rarer (lesser refracting index)

→ Each fibre is opticaly 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

04.02.19

Uses of optical fibre :—

i) Optical Fibre can be used as a medium For tele communication & comp. networking.

ii) In some building optical fibre rout sunlight from the roof to the other part of the building.

iii) Optical Fibre lamps are used in decorative purpose.

Dt: 18/11/19

UNIT-9 ①

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 (ELECTRO

(*)

Parameter of charge.
- polarity
  - +ve or
  - -ve
- Value (manitude
  - measured in Coulomb

(*) Charge of a proton = q_p = $1 \cdot 6 \times 10^{-19}$ Coul
(*) Charge of a electron = q_e = $1 \cdot 6 \times 10^{-19}$ Coulomb.

(Value of charges or magnitude of charge

Symbol for Charge.
↳ Q
OR
↳ q

$\boxed{\text{Charge means} \rightarrow \text{Electric charge.}}$

Law of Charges (statement).
↳ Like (similar) charges REPEL but Unlike (dissimilar) charge ATTRACT.

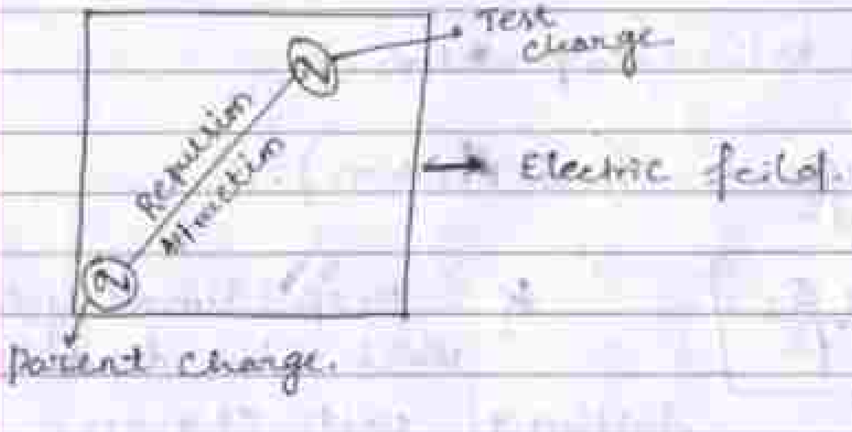
Same polarity	Opposite polarity

Expl^n:-
Like charge
⊕ ⊕ → Relpulsion.
⊖ ⊖ → Relpulsion.

unlike charge.
⊕ ⊖ → Attraction
⊖ ⊕ → Attraction

(※) SI unit of Electric charge → $\boxed{\text{Coulomb}}$

$\boxed{\text{Electric charge} \xrightarrow[\text{produces}]{\text{creates}} \text{Electric feild.}}$
↳ Specified Area.



CH-2 → (9.2) → UNIT-9

→ COULOBM'S LAW
  ↳ Statement
  ↳ EXplanation.

→ Defiriion of unit charge

COULOMB'S LAW OF ELECTROSTATICS:-

Statement

↳ The force of attraction OR: rep
between 02 [redacted] electric chargesis:

(i) Directly proportional to the product of their charges.

(ii) Inversely proportional to the square of distance between them.

EXplanation :-

Q_1 → 1st Charge
Q_2 → 2nd charge
d → Distance betw Q_1 and Q_2.
F → Force of attract or replusion betw the charges.

According to statement:

Expression

(i) $F \propto Q_1 Q_2$ $\left(Q_1 Q_2 \uparrow \Rightarrow F \uparrow \text{ or } Q_1 Q_2 \downarrow \Rightarrow F \downarrow \right)$

(ii) $F \propto \frac{1}{d^2}$ $\left(d \uparrow \Rightarrow F \uparrow \text{ OR } d \downarrow \Rightarrow F \uparrow \right)$

Combining both expression

$$F \propto \frac{Q_1 Q_2}{d^2} \quad (\text{Expression}).$$

$$\boxed{F = K \frac{Q_1 Q_2}{d^2}}$$

K = proportionality const which value depends on system of units changes.

$$\boxed{K = \frac{1}{4\pi \epsilon}}$$ (SI system).

[where $\epsilon \rightarrow$ Permittivity of medium between the charge]

$$F = k\frac{Q_1 Q_2}{d^2} \Rightarrow \boxed{F = \frac{1}{4\pi \epsilon}\frac{Q_1 Q_2}{d^2}}$$

Mathemetical from of coulombs law in electrostatics.

FOR AIR MEDIUM:

$$k = \frac{1}{4\pi \epsilon_0}$$

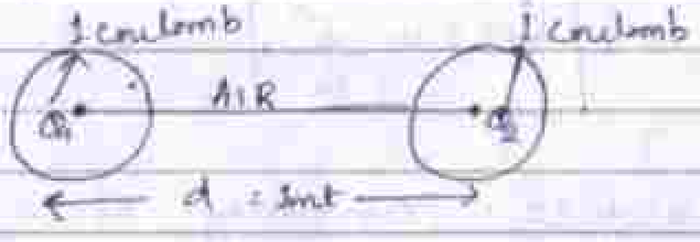
$\epsilon_0 \rightarrow$ permittivity of free Space (AIR).

$$\boxed{F = \frac{1}{4\pi \epsilon_0}\frac{Q_1 Q_2}{d^2}}$$

($\frac{2m}{5m}$) **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^n 03 mark)



$Q_1 = Q_2 = 1$ coul (unit charge)
$d = 1$mt (unit distance).
Medium → AIR.

$$\boxed{F = \frac{1}{4\pi \epsilon_0}\frac{Q_1 Q_2}{d^2}} \rightarrow \text{Air medium.}$$

$$F = \frac{1}{4\pi \epsilon_0}\frac{1\times1}{1^2} \Rightarrow \boxed{F = \frac{1}{4\pi \epsilon_0}\text{ Newton}}$$

UNIT - 9 (CH-3) → 9·3

Absolute and Relative permitivity.

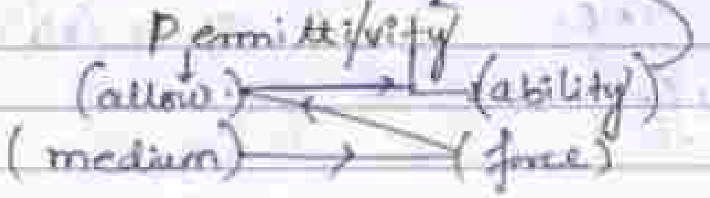
→ Definition.
→ Relation
→ unit.

Medium

Absolute Permitivity (ϵ) → No comparision.

Relative Permitivity (ϵ_r). → Get by comparis

Note:-



[2m] **DEFINE RELATIVE PERMITTIVITY of a Mediu**

(Ans):- It is the ratio of permittivity of that mediu to the permitivity of free space or Air.

$$\left[\text{Relative permitivity}\right]_{\text{medium}} = \frac{\text{Permitivity of that medi}}{\text{Permitivity of free space/}}$$

reference

$$\boxed{\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}}$$

[2m] **DEFINE Absolute Permittivity of a medium :-**

(Ans) :- It is the product of relative permittivity (ε_r) of that medium and the permittivity of free spac

$$\boxed{\epsilon = \epsilon_0 \epsilon_r}$$

~~Relation~~

Relative permittivity (ϵ_r) = 1
of free Space (AIR)

SI UNIT of ϵ, ϵ_0 and ϵ_r

$\epsilon \xrightarrow[\text{permittivity}]{\text{Absolute}} \frac{(Coul)^2}{Nt - mt^2}$

$\epsilon_0 \xrightarrow[\text{permittivity}]{\text{Absolute}} \frac{(Coul)^2}{Nt - mt^2}$

$\epsilon_r \longrightarrow \epsilon_r = \frac{\epsilon}{\epsilon_0}$

$\Rightarrow \epsilon_r = \frac{\frac{(Coul)^2}{Nt - mt}}{\frac{(Coul)^2}{Nt - mt}}$

$\Rightarrow \epsilon_r = \frac{x_1}{x_2}$ = Number

$\epsilon_r \xrightarrow{\text{Relative}}$ No unit.

$F = \frac{1}{4\pi\epsilon} \frac{Q_1 Q_2}{d^2}$

$\epsilon = \underbrace{\boxed{\frac{1}{4\pi}}}_{\text{no unit}} \frac{Q_1 Q_2}{F \times d^2}$

$\epsilon = \frac{Coul \times Coul}{Nt \times mt^2}$

$\epsilon = \frac{(Coul)^2}{Nt - mt^2}$

$F = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{d^2}$

$\epsilon_0 = \frac{1}{4\pi} \frac{Q_1 Q_2}{F \times d^2}$

$\epsilon_0 = \frac{Coul \times Coul}{Nt \times mt^2}$

$\epsilon_0 = \frac{(Coul)^2}{Nt - mt^2}$

$F = \frac{1}{4\pi\epsilon_r} \frac{Q_1 Q_2}{d^2}$

$\epsilon_r = \frac{1}{4\pi\epsilon_r}$

Dt-21/11/19

UNIT-9

⑦

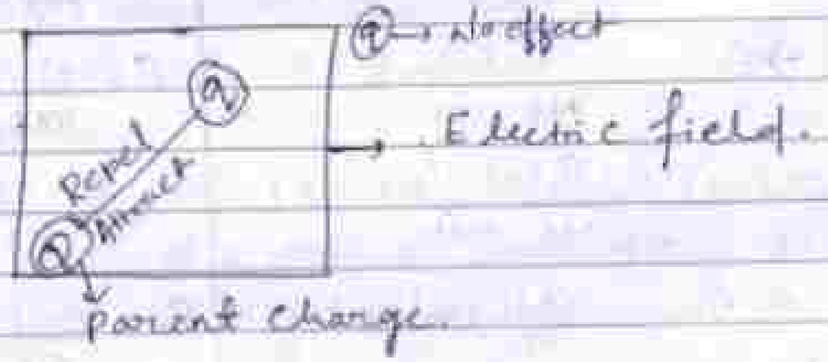
UNIT-9 (CH-5) → 9.5

Qualitative concept ← Electric field.

Quantitative concept ← Electric feild and Intensity
- → Definition
- → FORMULA
- → UNIT

WHAT is ELECTRIC FIELD?
OR.
DEFINE ELECTRIC FIELD.

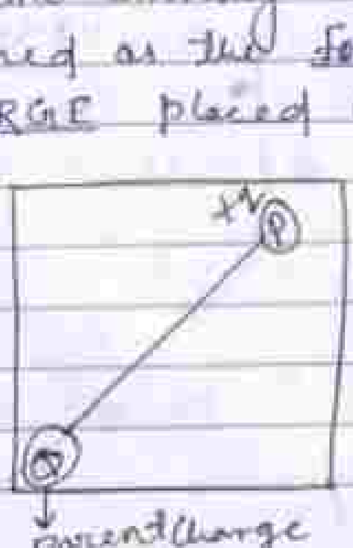
(Ans): It is the SPACE or AREA surrounding an
electric charge within which its influence (effe
is experienced (felt).



Qualitative
DEFINE ELECTRIC FIELD INTENSITY
OR.
DEFINE ELECTRIC INTENSITY ($\vec{E}$)

(Ans):

Electric intensity at any point of an electric field i
defined as the FORCE acting on an UNIT POSITIV
CHARGE placed at the point.



FORMULA FOR ELECTRIC INTENSITY:

$$|\vec{E}| = E$$

$$q(+) \xrightarrow{\text{at pt 'P'}} F \text{ (due to parent charge).}$$

$$1(+) \xrightarrow{\text{at pt 'P'}} \frac{F}{q} = E \cdot I \text{ at pt P.}$$

unit +ve charge

$$\boxed{E = \frac{F}{q}}$$

SI UNIT of 'E'

$$\boxed{E = \frac{F}{q}} \begin{matrix} \to \\ \to \end{matrix} \boxed{\frac{\text{Newton}}{\text{Coulomb}}} \text{ or } \boxed{\text{Nt/coul}}$$

DIMENSION of 'E'

$$E = \frac{F}{q} \begin{matrix} \longrightarrow \\ \longrightarrow \end{matrix} \frac{MLT^{-2}}{Q} = [MLT^{-2}Q^{-1}]$$

NATURE of 'E·I':

$$\boxed{\text{Vector qty}}$$

$$\boxed{\text{Dt. 29/11/19}}$$

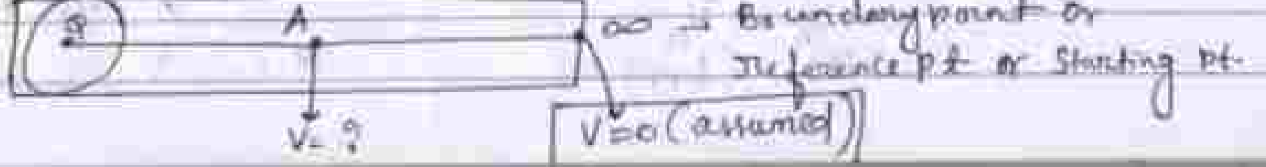
UNIT - 9 (Ch-4) → 9.4

Electric potential
Electric potential difference } → Definition / formula / 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) upto 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.

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

→ Work Done
→ Charged moved

El potential at the pt.

SI UNIT OF EL POTENTIAL

$V = \frac{W}{q} \xrightarrow{} \frac{\text{Joule}}{\text{Coulomb}} = \boxed{\text{VOLT}}$

DIMENSION OF EL·POTENTIAL :-

$V = \frac{W}{q} \longrightarrow \frac{ML^2T^{-2}}{Q} = [ML^2T^{-2}Q^{-1}]$

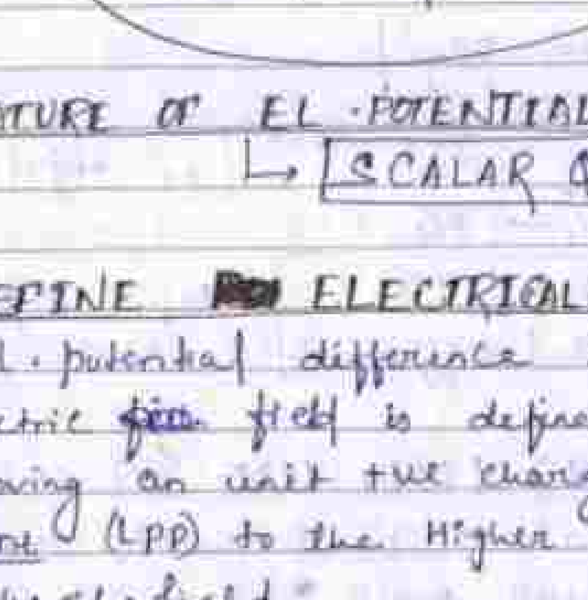
NATURE OF EL·POTENTIAL :-

↳ $\boxed{\text{SCALAR Qty}}$ (because it is defi
in terms of work done

DEFINE ELECTRICAL POTENTIAL DIFFERENCE·

(Ans): El· potential difference between 2 point within
electric field is defined as the WORK DONE in
moving an unit +ve charge from the lower poten
point (LPP) to the Higher potential point (HPP) again
the el·field.

Explanation and Formula for El· potential difference



$V_A - V_B$ = El· potential difference bet 'A' and 'B'.

= V

Q(+) $\xrightarrow{\text{'B' to 'A'}}$ W

1(+) $\xrightarrow{\text{'B' to A}}$ $\frac{W}{q}$ = El. P.D between 'A' and 'B'

= V

↓ unit +ve charge

P.D ← $\boxed{V = \frac{W}{q}}$ → Work Done, q → Test charged measured

SI unit → VOLT

DIMENSION → $[ML^2T^{-2}Q^{-1}]$

NATURE → Scalar qty.

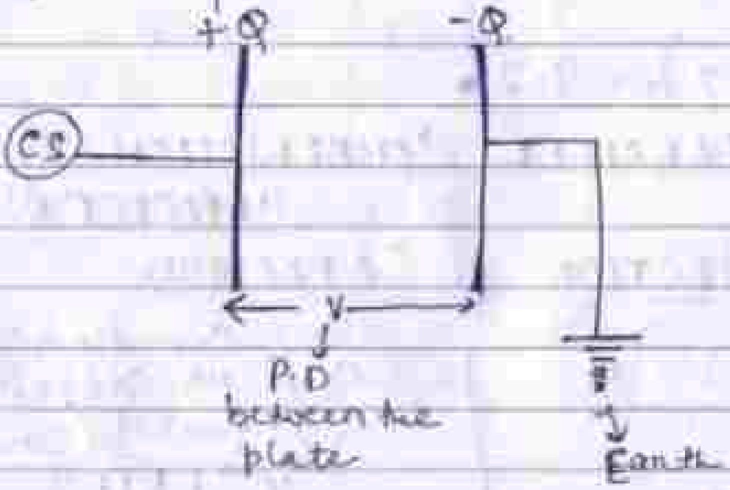
UNIT - 9 (CH - 6) → 9.6

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

$V(PD) \longrightarrow Q$

$1(PD) \longrightarrow \frac{Q}{V} = \text{Capacitance} = C$

Capacitance $\boxed{C = \frac{Q}{V}}$ → charge supplied / → P·D between plates.

SI UNIT

$C = \frac{Q}{V} \xrightarrow{} \frac{\text{coul}}{\text{volt}} = \boxed{\text{Farad}}$

[Dt:- 23/11/19]

DEFINE FARAD.

(Ans) :- The Capacitance of capacitor is said to be 1farad i 1coulomb of charge required to maintain a potential difference of 1volt between the plate

NOTE :-

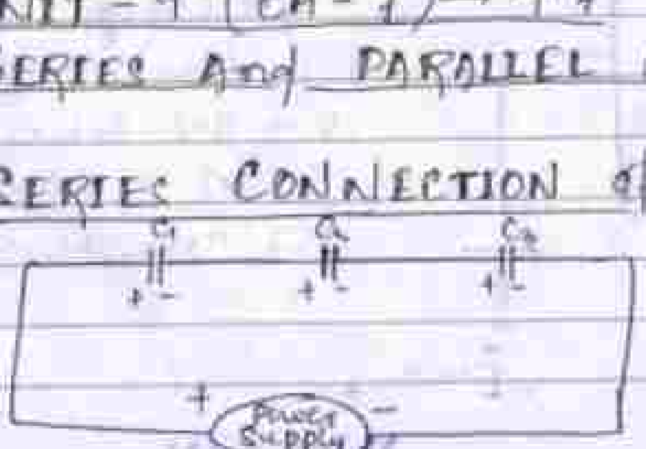
↳ Farad is a very large unit for practical u Hence, smaller units are prefered.

millifarad (mf).	1mf = 10^{-3} farad	1F = 10^{3} mf
microfarad (μf).	1μf = 10^{-6} farad	1F = 10^{6} μf
picofarad (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



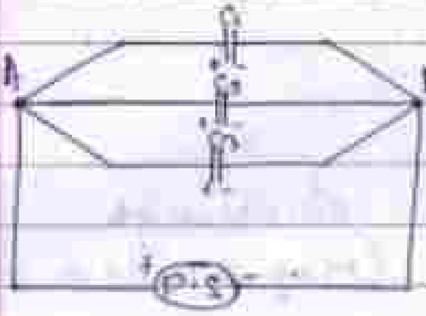
C1, C2, C3 } Capacitance of 3 Capacitor joined (Connect in SERIES.

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 $$\boxed{C = \frac{C_1C_2C_3}{C_1C_2 + C_2C_3 + C_1C_3}}$$

PARALLEL COMBINATION of CAPACICTOR:



C_1, C_2, C_3 } Capacitance of the 3 capacitor 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 (W_b).
→ 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 mag~~

~~Properties :~~
~~└→ Any magnet has 02 pole (NP- SP)~~
~~→ A magnet can be attract or repel.~~
~~→ like poles repels and unlike poles att~~

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 :-

m1 → poles strength of 1st pole.

m2 → pole strength 2nd pole.

d → distance between poles m1 and m2.

F → force acting between the 02 poles.

Now,

(i) $F \propto m_1 m_2$ $(m_1 m_2 \uparrow \Rightarrow F \uparrow)$

(ii) $F \propto \frac{1}{d^2}$ $(d\uparrow \Rightarrow F\downarrow$ OR $d\downarrow \Rightarrow F\uparrow)$.

Combining both expression.

$$F \propto \frac{m_1 m_2}{d^2}$$ (Expression).

or $$\boxed{F = k \frac{m_1 m_2}{d^2}}$$

k = proportionality constant whose value depends upon the system of units chosen

In SI System:

$\rightarrow k = \frac{\mu}{4\pi}$ (any medium)

$\rightarrow k = \frac{\mu_0}{4\pi}$ (Air medium).

$$\boxed{F = \frac{\mu}{4\pi} \frac{m_1 m_2}{d^2}} \longrightarrow \text{any medium.}$$

$$\boxed{F = \frac{\mu_0}{4\pi} \frac{m_1 m_2}{d^2}} \longrightarrow \text{Air medium.}$$

$\mu \rightarrow$ permeability of the medium between the pol

$\mu_0 \rightarrow$ permeability of free space between the pol

$$\boxed{\mu_0 = 4\pi \times 10^{-7} \text{ henery / metre}}$$

$$\boxed{\varepsilon_0 = 8 \cdot 854 \times 10^{-12} \frac{(\text{Coul})^2}{\text{Nt} - \text{mt}^2}}$$

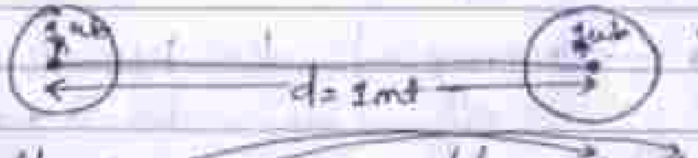
UNIT POLE.

↳ Any magnetic pole of pole strength 1 web

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.

Expⁿ:



$m_1 = m_2 = 1$ Wb { uni

$d = 1$mt (unit dis

$$F = \frac{\mu_0}{4\pi} \frac{m_1 m_2}{d^2} = \frac{\mu_0}{4\pi} \frac{1 \times 1}{1^2} = \boxed{\frac{\mu_0}{4\pi} \text{ Nt}} = \frac{4\pi \times}{4\pi}$$

$$= \boxed{10^{-7} \text{ Nt}}$$

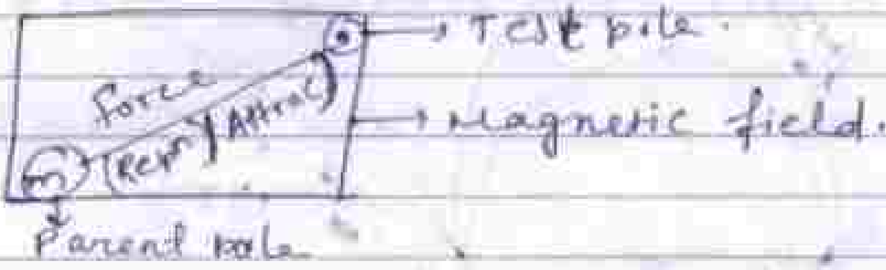
UNIT - 9 (CH-20) → 9.10

Magnetic field
Magnetic Field Intensity ($\vec{H}$).
→ Definition
→ Formula
→ Unit.

DEFINE MAGNETIC FIELD.
OR.
WHAT is MAGNETIC FIELD?

qualitative concept.

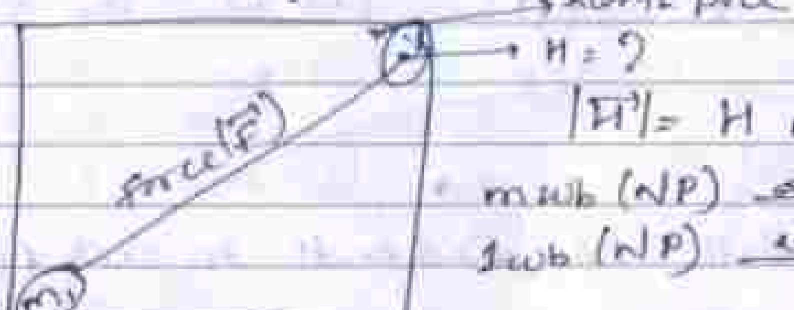
(Ans):- It is the AREA surrounding a magnetic pole with in which its effect or influence is experienced (felt).



DEFINE MAGNENTIC FIELD INTENSITY ($\vec{H}$)

(Ans):- Magnetic intensity at any point with in a magnetic field is defined as the FORCE experienced by an UNIT NORTH POLE placed at that point.

EXPⁿ and FORMULA :-



$|\vec{H}|$ = H magnitude.

m wb (NP) $\xrightarrow{\text{at Pt A}}$ F

1 wb (NP) $\xrightarrow{\text{at Pt A}}$ $\frac{F}{m}$ = (M.I.) at Pt A
= H.

$$\boxed{H = f/m}$$

SI unit of H :-

$$H = \frac{F}{m} \begin{matrix} \rightarrow \\ \rightarrow \end{matrix} \boxed{\frac{\text{Newton}}{\text{Weber}}} = \boxed{Nt/wb}$$

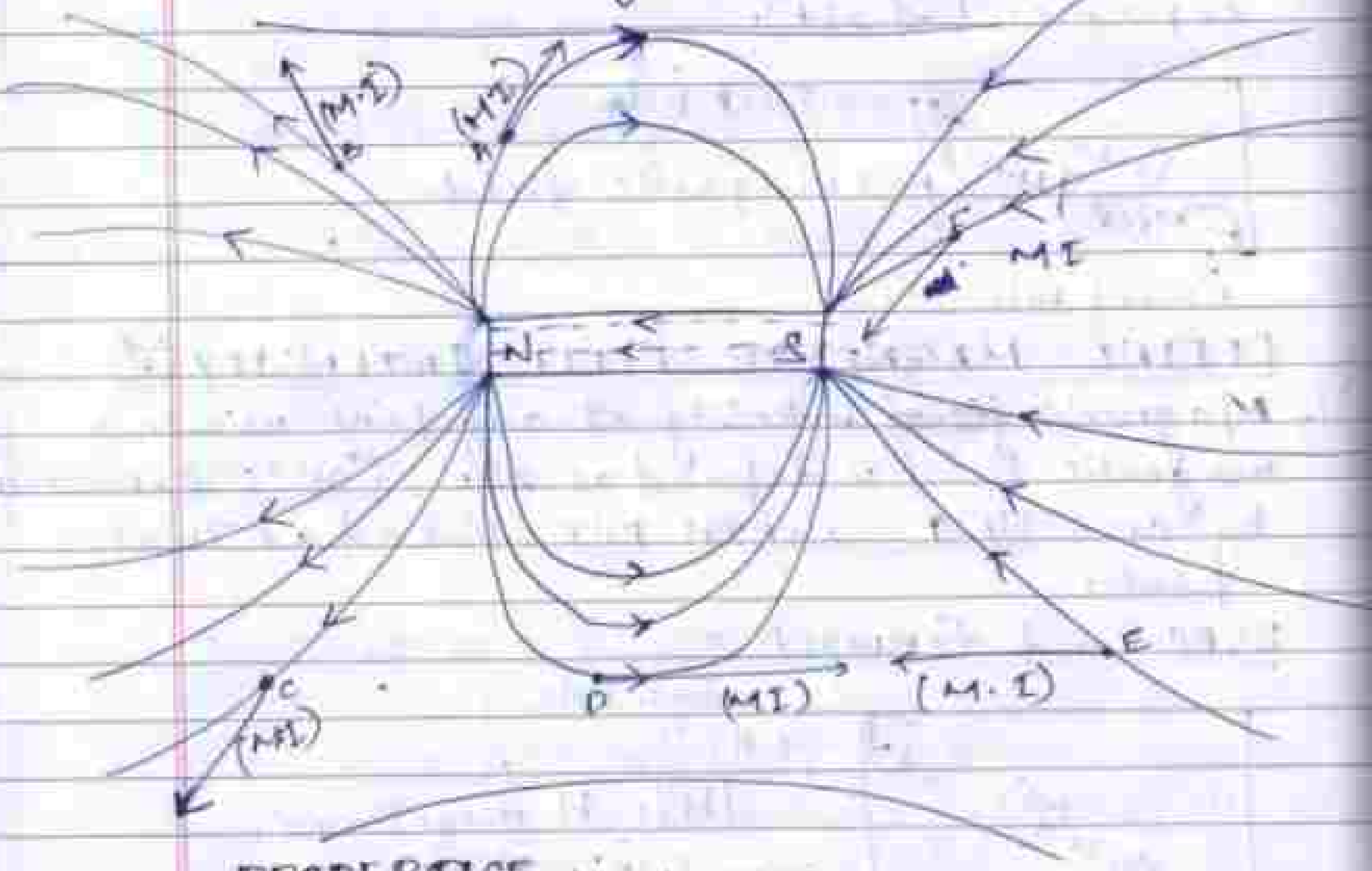
Nature of H → It is a vector qty

UNIT - 9 (CH - 11) → 9.11

Magnetic lines of force (Definition & Proper

DEFINE MAGNETIC LINES of FORCE :

(ans): They are imarginary 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 pole.

(*) Inside the magnetic, they run from Sout 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 ($\vec{A}$).

$\boxed{\phi = \vec{B}\cdot\vec{A}}$ or $\boxed{\phi = B\cdot A\cos\theta}$

↓ 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
→ 1mt² (MKS/SI)
→ 1cm² (CGS)
→ 1ft (FPS)

EXPLⁿ and FORMULA for 'B'. [$|\vec{B}| = B$]

A → Area of surface within the magnetic field.
ϕ → Magnetic flux normally crossing that area.
B → Magnetic flux Density.

$A \xrightarrow{\text{normally}} \phi$

$1 \xrightarrow{\text{normally}} \frac{\phi}{A} = B$ $\boxed{B = \frac{\phi}{A}}$

SI UNIT of B :-

$$B = \frac{\phi}{A} \frac{\to \text{weber}}{\to (\text{meter})^2} = \frac{wb}{mt^2} = \boxed{\text{Tesla}}$$

Nature

B → vector qty.

END

UNIT-10

UNIT-10

1. ELECTRIC CURRENT

↳ (Study about Elect. charges in motion)

→ Definition, Formula, units.

DEFINE ELECTRIC CURRENT (I)

(Ans): New: It is time rate of flow of electric charges through a conductor.

OR.

Old: It is the charges flowing through a conductor per unit time.

EXPLⁿ and FORMULA for 'I':

$Q \rightarrow$ Charge flow

$t \rightarrow$ time taken

$I \rightarrow$ Electric current

$I = ?$

$$'t' \longrightarrow Q$$

$$1 \longrightarrow \frac{Q}{t} = \text{El. current} = I$$

$$\boxed{I = \frac{Q}{t}}$$

SI. unit of El. current

$$I = \frac{Q}{t} \longrightarrow \frac{\text{Coul}}{\text{Sec}} = \boxed{\text{Ampere}}$$

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 t ends provided temp remain constant.

EXPLANATION :-

$V \propto I$

or $\boxed{V = RI}$ [R → Proportionality constant known as Resistance of the co (material)]

→ (Mathematical form of Ohm's law)

3Q
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.

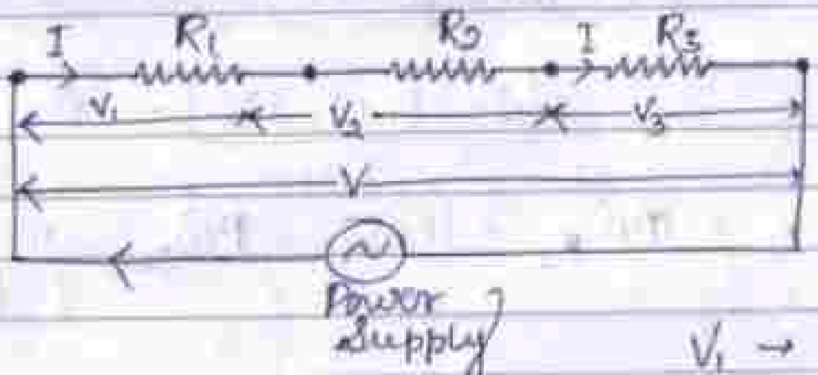
UNIT -10 (CH-3) → 10.3

Series and Parallel Combination of Resistors.

Capacitor $\xrightarrow{has}$ Capacitance
Resistor $\xrightarrow{has}$ Resistance
> property (value)

element

→ SERIES CONNECTION.



R_1, R_2, R_3 } 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.

$V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$.

$V = IR$

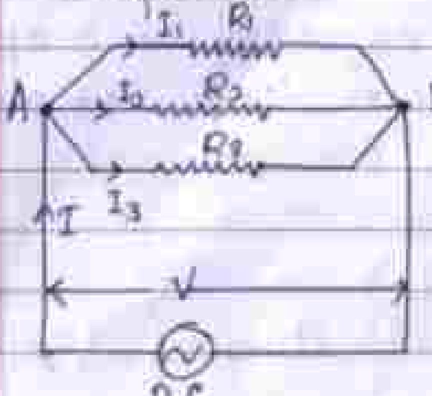
Here $V = V_1 + V_2 + V_3$. (P.D is a scalar qty).

$\Rightarrow IR = IR_3 + IR_2 + IR_3$

$\Rightarrow IR = \cancel{I}(R_1 + R_2 + R_3)$

$\Rightarrow \boxed{R = R_1 + R_2 + R_3}$

PARALLEL COMBINATION of RESISTORS.



R_1, R_2, R_3 } Resistance of the 03 resis in PARALLEL.

$R \rightarrow$ Effective / total / Combined / Resultant resistance of the Combination.

→ All the 03 have been connecte across terminal 'A' and 'B'.

$I_1 \rightarrow$ current through R_1
$I_2 \rightarrow$ current through R_2
$I_3 \rightarrow$ current through R_3
] $I \rightarrow$ Total current the ckt

$$\boxed{I = I_1 + I_2 + I_3} \quad \text{— ①}$$

Here,

$$\boxed{(PD)_{R_1} = (PD)_{R_2} = (PD)_{R_3} = (PD)_{ckt} = V.}$$

$$\left.\begin{aligned} V &= I_1 R_1 \Rightarrow I_1 = \frac{V}{R_1} \\ V &= I_2 R_2 \Rightarrow I_2 = \frac{V}{R_2} \\ V &= I_3 R_3 \Rightarrow I_3 = \frac{V}{R_3} \end{aligned}\right\} \text{—(2)}$$

$$I = I_1 + I_2 + I_3.$$

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

$$\Rightarrow V \times \frac{1}{R} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\Rightarrow \boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$\frac{1}{R} = \frac{R_2 R_3 + R_1 R_3 + R_1 R_2}{R_1 R_2 R_3} \text{ or } \boxed{R = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3}}$$

UNIT - 10 (CH-4) → 10.4

KIRCHOFF'S LAWS

KCL (1st law)
Kirchoff's current law

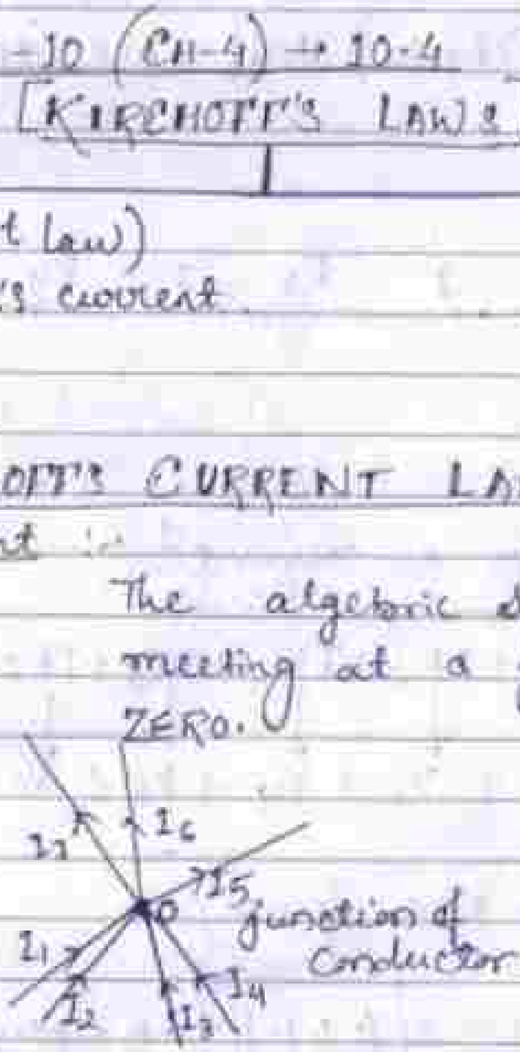
KVL (2nd law)
Kirchoff's voltages law.

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, I_3 } Incoming current (+ve)

Junction → Common meeting point

I_5, I_6, I_7 } outgoing current (-ve)

$$I_1 + I_2 + I_3 + I_4 + (-I_5) + (-I_6) + (-I_7) = 0$$

or

$$\boxed{I_1 + I_2 + I_3 + I_4 = I_5 + I_6 + I_7}$$

$I_1 + I_2 + I_3 + I_4$ ↓ Sum of incoming current

$I_5 + I_6 + I_7$ ↓ Sum of outgoing current

there is no charge accumulation at junction

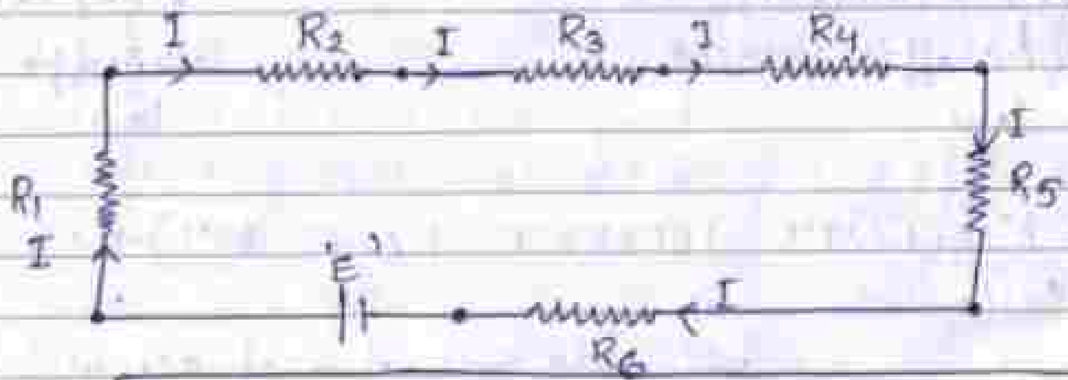
KIRCHOFF'S VOLTAGE LAW (2nd law).

Statement :

The algebric sum of voltage in each p of an closed Ckt is equal to the total emf of the Ckt.

Voltage → Potential Difference (IR)
↳ I × R

EXPl^n.

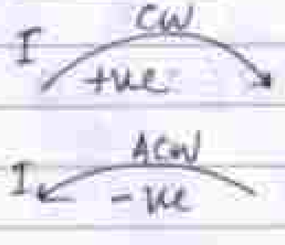


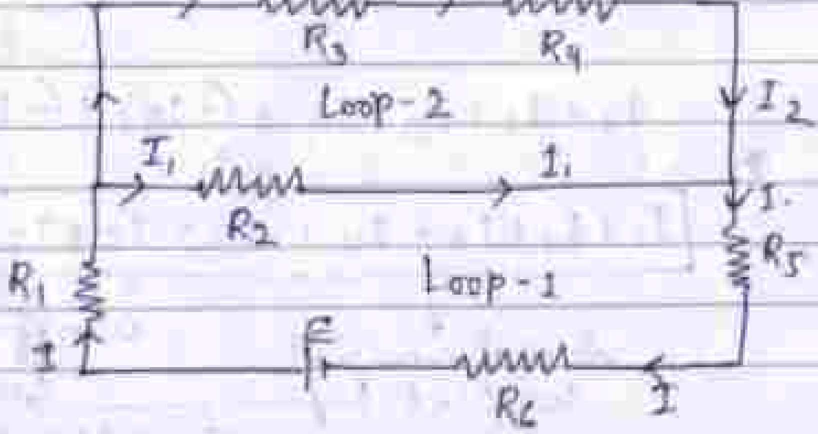
$$\boxed{\begin{array}{l} IR_1 + IR_2 + IR_3 + IR_4 + IR_5 + IR_6 = E \text{ (emf)} \\ \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \\ V_1 + V_2 + V_3 + V_4 + V_5 + V_6 = E \end{array}}$$

emf → (electro motive force).

| ⊣⊢ – cell | | ⊣⊢⊣⊢⊣⊢⊣⊢⊣⊢ → Battery (5cells)

Case – II :





KVL (Loop-1)

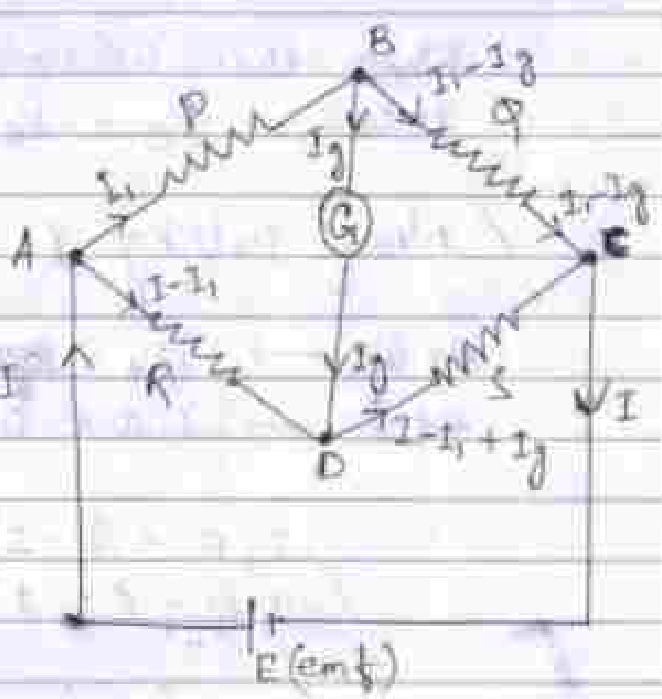
$\boxed{IR_1 + I_1R_2 + IR_5 + IR_6 = E}$

KVL (loop-2)

$\boxed{I_2R_3 + IR_4 - I_1R_2 = 0}$ (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
} Resistor in the 04 arms of the W.B

Ⓖ → 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'.

Applying KVL to loop ABDA.

$I_1 P + I_g g - (I - I_1) R = 0$ (n/o source of emf). ——①

Applying KVL to loop BCDB.

$(I_1 - I_g) Q - I_g g - (I - I_1 + I_g) S = 0$ (n/o source of emf) ——(2)

When the Wheatstone Bridge is in balance Condi
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 → $I_1 P + 0 \times g - (I - I_1) R = 0$

eq ② → $I_1 Q - 0 \times g - (I - I_1 + 0) S = 0$

$I_1 P - (I - I_1) R = 0$

$I_1 Q - (I - I_1) S = 0$

$\Rightarrow I_1 P = (I - I_1) R$ ——(3)

$\Rightarrow I_1 Q = (I - I_1) S$ ——(4)

Divide eq (3) by (4)

$$\frac{I_1 P}{I_1 Q} = \frac{(I - I_1) R}{(I - I_1) S}$$

$$\Rightarrow \boxed{\frac{P}{Q} = \frac{R}{S}} \longrightarrow$$ (Condition of Balance)

Dt:- 29/11/19

UNIT-11

①

UNIT-11 [ELECTROMAGNETISM AND ELECTROMAGNETIC INDUCTION]

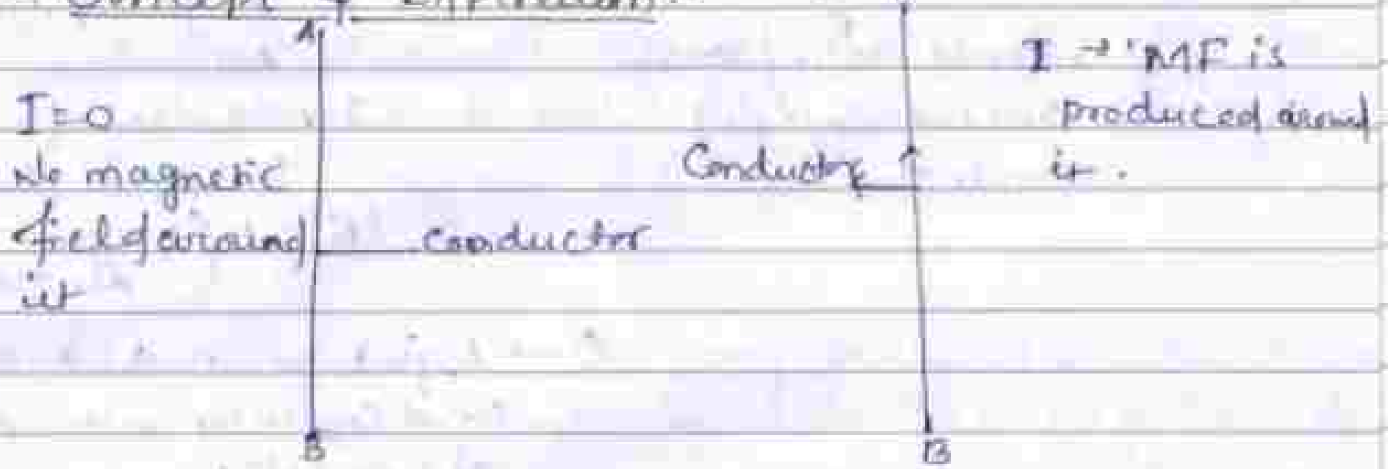
(CH-1) → 1.1

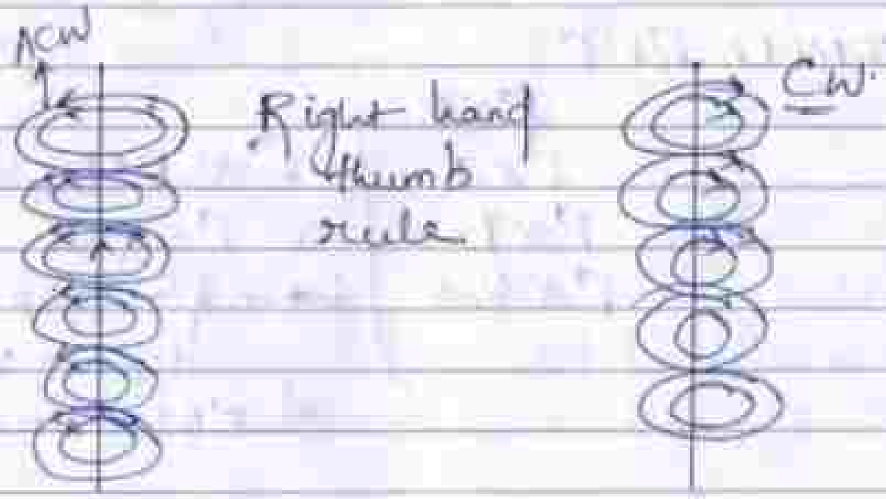
Electromagnetism.
→ Definition
→ Concept.
(New name)
(Old name - magnetic effect of electric current)

DEFINE ELECTROMAGNETISM?

(Ans):- It is the phenomena (process) in which magnetic field is produced around a conductor when electric current flows through it.

Concept & Explnation:



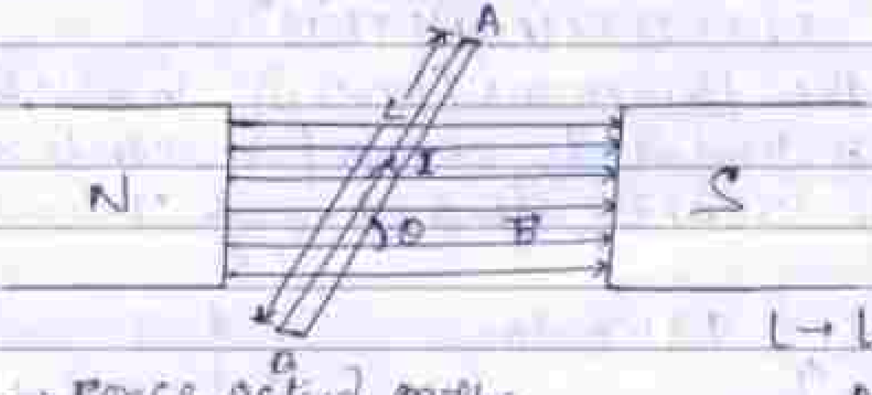


②

UNIT-11 (CH-2) → 11·2·

(iv) FORCE acting on current carrying Condu
placed in an uniform magnetic field
(v) Fleming left hand rule

FORMULA FOR FORCE(F) ACTING ON CURRENT CARRYING CONDUCTOR PLACED I AN UNIFORM MAGNENTIC FIELD.



F → Force acting on the current carrying conductor.

L → length of Conduc AB.

I → Current flowing the conductor.

$|\vec{B}| = B$ (magnetic flu density

θ → Angle between the M·Fiel and conductor in the direc of current.

FORMULA FOR F:

$F \propto B$
$F \propto I$
$F \propto L$
$F \propto \sin\theta$

$\Rightarrow F \propto BIL\sin\theta$
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 cho that $K = 1$.

$$\boxed{F = BIL\sin\theta}$$

UNIT-11 (CH-3) → 11·3

Faraday's Law of Electromagnetic Induction:-

M·Field (Cause) → Reverse of Electromagnetism
Electric current (effect)

→ 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.

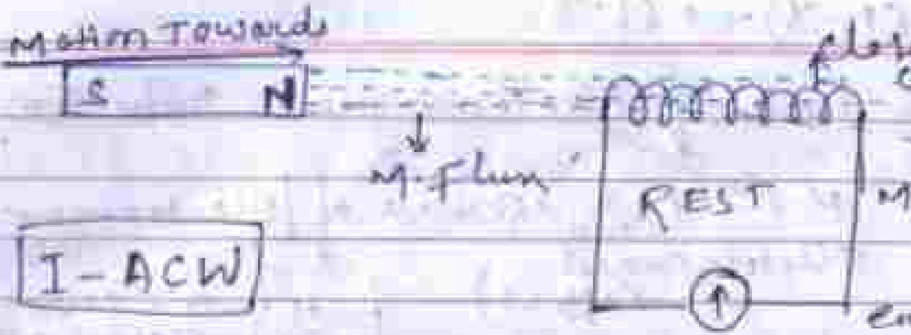
2nd Law (Statement): The emf (E) induced in the closed coil is directly proportional to the number of turns (N) in the coil.

$$\boxed{e \propto N}$$

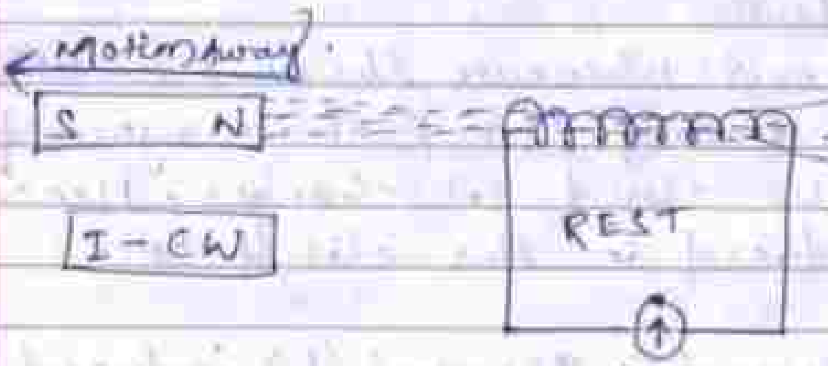
3rd Law (Statement):- The emf induced in the closed coil is directly proportional to the negative of time rate of change of magnetic flux linkage $\left(\frac{d\phi}{dt}\right)$.

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 → oc
↓
M·Flux linkage ch
(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 $\qquad$ $\phi_2 \longrightarrow \phi_2 - \phi_1 = d\phi$ → c in

t_1 $\qquad$ $t_2 \longrightarrow t_2 - t_1 = dt$ → c in Tim

$e \propto N$ ——— (1) $\qquad$ $e \propto -\frac{d\phi}{dt}$ — (2).

Combine

$$e \propto -N\frac{d\phi}{dt}$$

Or $\boxed{e = -kN\frac{d\phi}{dt}}$

K = proportionality const. whose value depends upon the v
of e, N, $\frac{d\phi}{dt}$.

The value of K, N, & $\frac{d\phi}{dt}$ are so choosen that K = 1.

$$\boxed{e = -N\frac{d\phi}{dt}} \longrightarrow$$ 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 oppos 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 → +ve
$\frac{d\phi}{dt}$ → -ve

e → -ve
$\frac{d\phi}{dt}$ → +ve

UNIT - 11 (CH-2) → 112

(*) [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 in an uniform magnetic field.

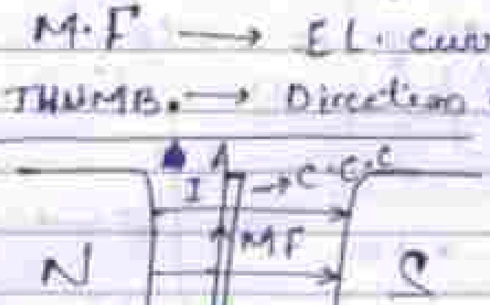
Statement →

Strech the fore finger - middle finger - thumb of the left hand mutually perpendicul to each other.

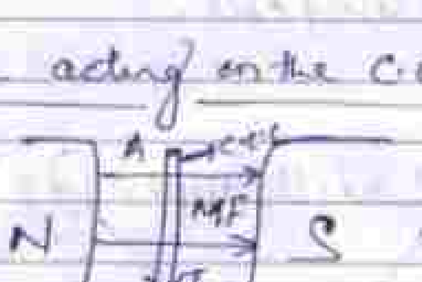
If the fore finger indicates the direction of magn field, middle finger indicates direction of electric curr then the thumb indicates the force acting on the C.C. conductor placed in the U.M. field.

F.F → M. Field.
M.F → El. current
THUMB. → Direction of force acting on the C.C.C

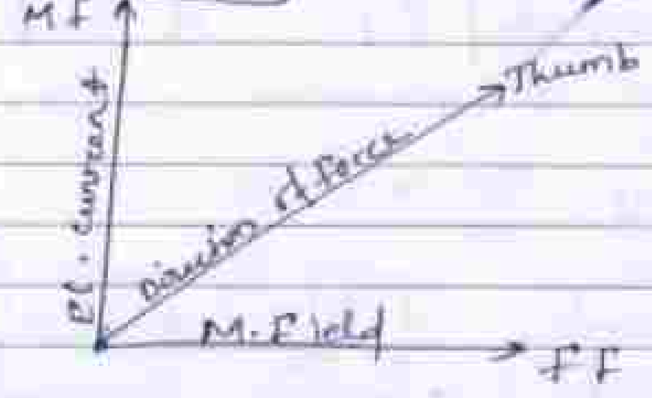
Expl^n.



F on C.C.C → I inward



Force C.C → I outwar



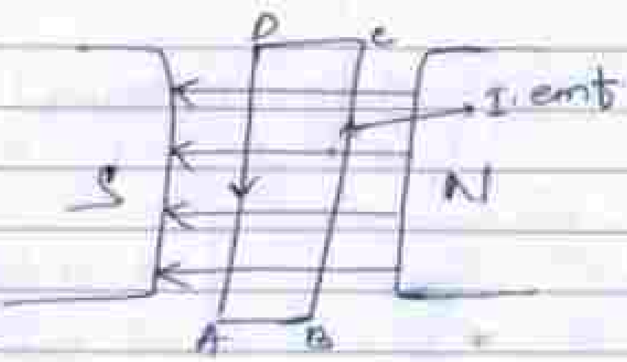
UNIT-11 (CH-5) → 11.5

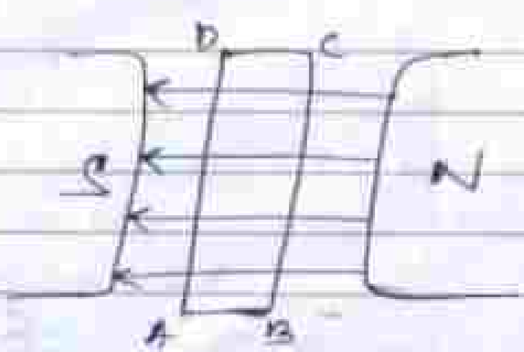
[FLEMING'S RIGHT HAND RULE (LAW)]

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 conductor / coil, then MIDDLE FINGER indicates direction of Induced emf (I current).

FF → M. Field
Thumb → Motion of coil.
M.F → Direction of I.emf (I.current)





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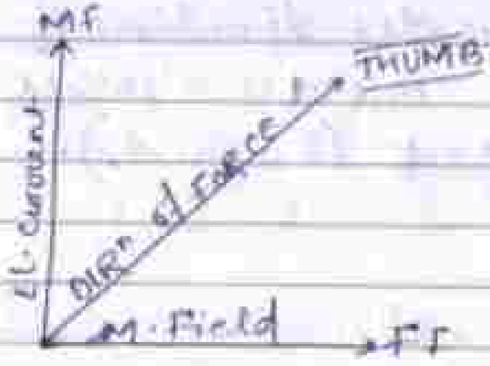
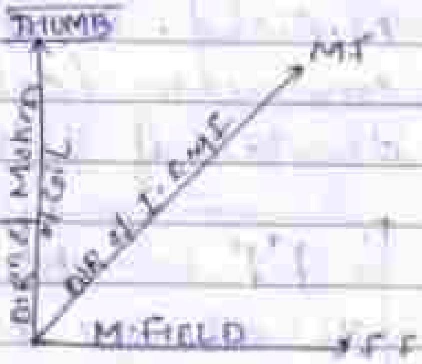
UNIT-11 (CH-6) → 11.6

COMPARISION BETWEEN F.L.H Rule and F.R.H 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 the M. Field.	(1) It helps to find out th direction of induced emf produced in the phenomen em 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).
	

Dt → 02/12/19

UNIT-12

'MODERN PHYSICS'

'CH-1' → 12·1

'LASER and LASER BEAM'

SQ 2m

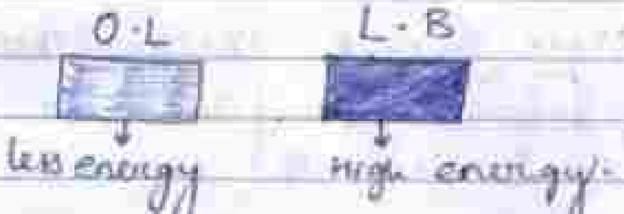
DEFINE LASER.
OR
WHAT is LASER?

(Ans)→ A Laser is a device which produces Laser Beam.

SQ 2m

DEFINE LASER BEAM.
OR
WHAT is LASER BEAM?

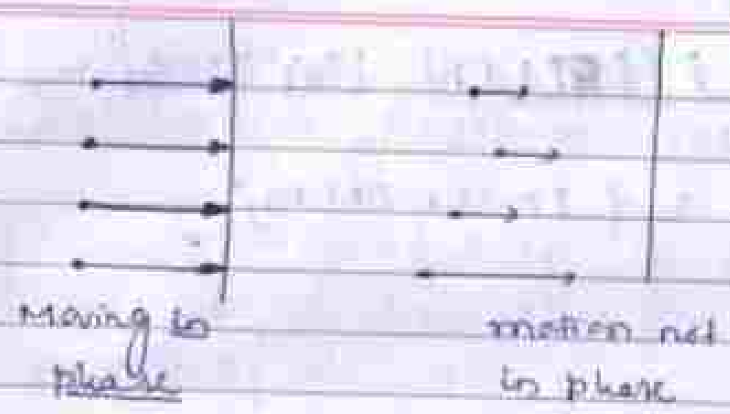
(Ans)→ Laser Beam is a very high energy light beam which is Intense – Collimated – monochromatic – Coherent.



CHARACTERISTICS (Properties) of LASER BEAM.

(i) It is intense (Has very high energy).
(ii) It is Collimated (Moves in a Coloumn) = unidirectionally)
(iii) It is monochromatic (light of one Colour).
(iv) It is Coherent (has photons of same energy value which are in phase).

$$(\text{Energy})_{\text{photon}} = \underset{\substack{\downarrow \\ \text{Planck's} \\ \text{constant}}}{h}\,\nu \rightarrow \text{frequency of light.}$$



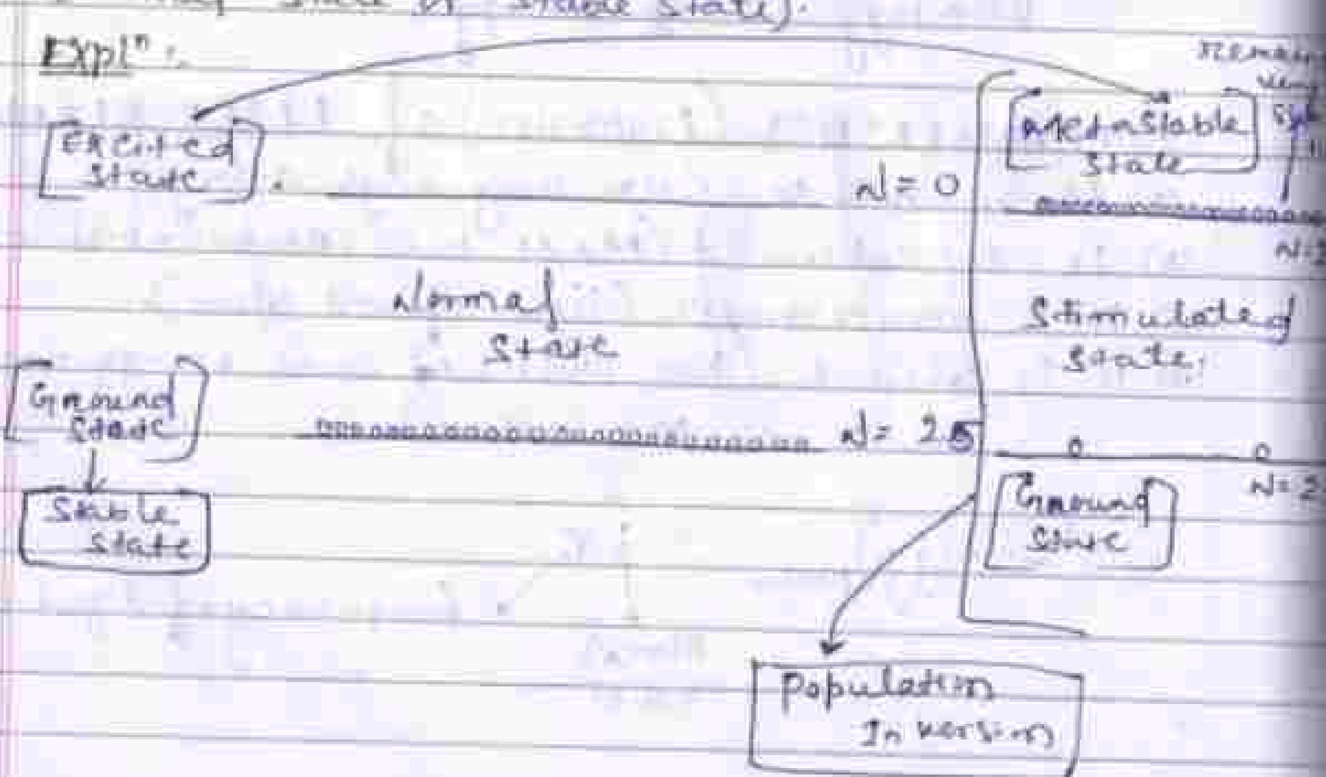
UNIT-12 (CH-2) → 12·2

Principle of LASER
→ Population Inversion
→ optical pumping.

[LASER] What does laser stands for?
→ Light Amplification by Stimulated Emission of
Of Radition.

POPULATION INVERSION (Define /what is?)
→ It is a state where the number of atoms
the EXCITED STATE (higher energy STATE) is very les
than number of atoms found in the GROUND STA
(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 destroy enemy aeroplanes.
- → Laser beams are used for underwater Communication between submarines.

UNIT - 12 (CH-4)

Wireless Transmission.

- → Ground waves
- → Sky wave.
- → Space wave

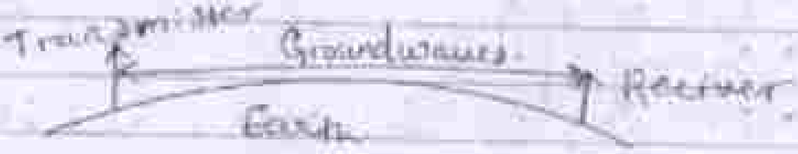
} Definition and Concept.

④ END

GROUND WAVES :

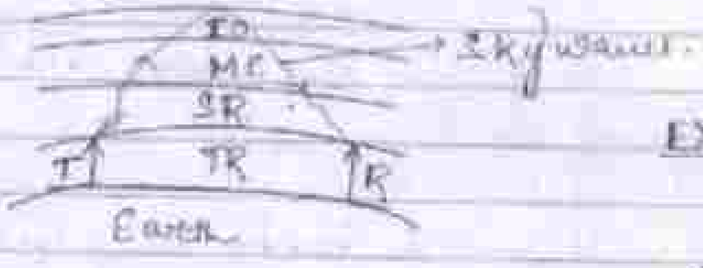
↳ They are radio wave (electromagnetic waves) which progress along the surface of the earth and are influenced by the electrical properties of the ground.

Ex → AM Radio.
(Amplitude modulated wave)



SKY WAVES →

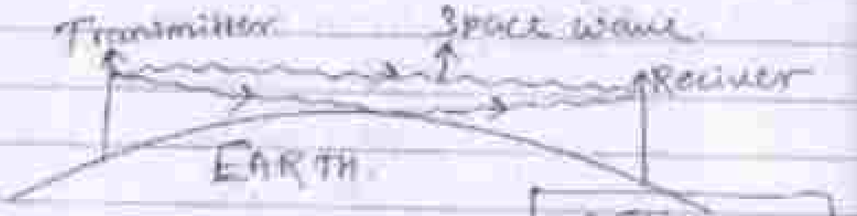
↳ They are the radio waves (electromagnetic w which after emission from transmitter reach the reciver by reflection from ionosphere



Ex → BBC Radio.
(British Broadcasting
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.



→ TV
→ Radar