Set-A

Group-B

1) a) ⇒ Two parallel forces of equal magnitude acting in opp. direction and separated by a distance i.e. diffⁿ lines of action.

eg: When we open a door, the rotation of the door is produced by a couple consisting of two forces; one the force which we exert at the handle of door and the other an equal and opposite force of rxⁿ at the hinge.

b)

2. b) $T \propto \frac{1}{\sqrt{g}}$

we have,

$T_e \propto \frac{1}{\sqrt{g_e}}$

$T_m \propto \frac{1}{\sqrt{g_m}}$

$\frac{T_m}{T_e} = \frac{1}{\sqrt{g_m}} \times \sqrt{g_e}$

$\frac{T_m}{T_e} = \sqrt{\frac{9.8}{3.71}}$

$T_m = 2.6s$

$h = \frac{2S}{r\rho g} = \frac{2S\cos\theta}{r\rho g}$

OR

a)

→ It is because cotton threads have large number of capillary in them and due to capillarity action, these capillarities help to absorb sweat from the surface of the body.

b)

$d = 3\,mm$

$r = 3/2\,mm = 1.5 \times 10^{-3}\,m$

$T = 0.545\,Nm^{-1}$

$\rho = 13.6 \times 10^{3}\,kgm^{-3}$

$\theta = 140^\circ$

$$\Delta h = \frac{2 \times T \times \cos\theta}{r\rho g}$$

$$= \frac{2 \times 0.545 \times \cos 140^\circ}{1.5 \times 10^{-3} \times 13.6 \times 10^{3} \times 10}$$

$$= -4.09 \times 10^{-3}$$

$|\Delta h| = 4.09 \times 10^{-3}\,m$

so, $\Delta h = 4.09 \times 10^{-3}\,m$ must be added to absorbed height. -ve sign shows downward movement

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3-a)

=> The air from our mouth is always. Of same temp
The feeling of cold and hot is because of our
surrounding. When we blow air with our
mouth narrow open, air from our mouth
reaches an object fast and a lot of envi-
ronment air is mixed with it, so we feel
cold but when the mouth is wide open, the
air from our mouth reaches to object slow
and we feel hot.

b)

=> In compression stroke and working stroke.

Set A

4. a)

Interference	Diffraction
i) Interference occurs betn two diffn source.	i) Interference occurs betn waves coming from diffn points of the same source.
ii) Fringe width of all fringes are equal.	ii) Fringe width of central maxima is more than other fringe width.
iii) Intensity of all bright fringes are same.	iii) Intensity of all bright fringes are diffn.

b)

$\Rightarrow \theta = 30^\circ$

$n = 2$

$N = ?$

$\lambda = 5 \times 10^{-5} cm$

$d \sin\theta = n\lambda$

$d = \frac{2 \times 5 \times 10^{-5}}{\sin 30^\circ}$

$= 20 \times 10^{-5}$

$= 2 \times 10^{-4} cm$

$$d = \frac{1}{N}$$

$$N = \frac{1}{d}$$

$$= 5000 \text{ lines/cm}.$$

5) b)

we have,

$$S = \frac{I_g G}{I - I_g}$$

To increase the range by n times

i.e. $I = n I_g$

$$S = \frac{I_g G}{(n-1) I_g}$$

$$S = \frac{G}{n-1}$$

a) ⇒ The value of shunt is so chosen that the desired current passes through the galvanometer and the rest of it through the shunt

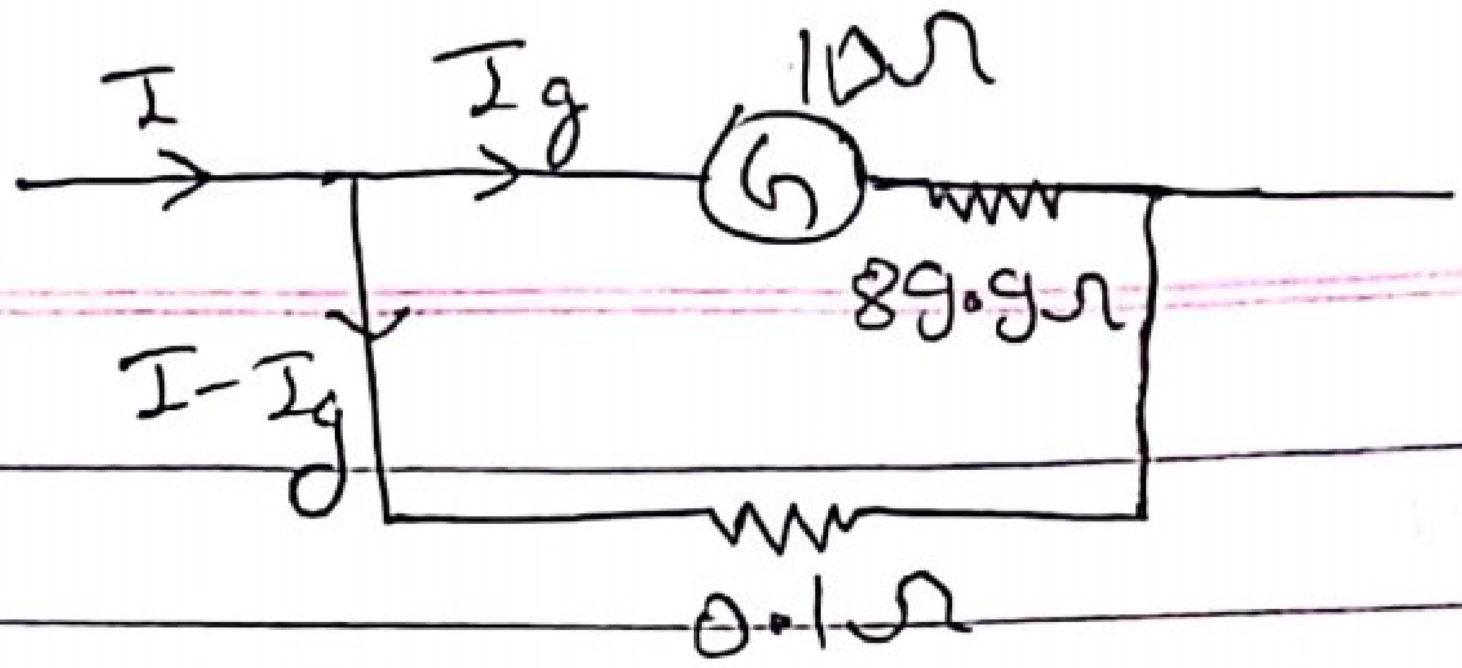
c)

⇒ we know,

deflection of galvanometer is directly proportional to amount of current flowing through it, if it is out of range means max. current is passing. circuit is incorrectly arranged.

I -

d)



$V = IR$

$= \cancel{1} \times \frac{99.9 \times 0.1}{99.9 + 0.1}$

$= 0.0999\ V$

$I_g = \frac{V}{r}$

$= \frac{0.0999}{99.9}$

$= 1 \times 10^{-3} A$

6. a)

⇒ It states that the direction of induced current is such that it opposes the cause by which it has been produced.

explain from book

7. a)

$\Rightarrow$ No, because wavelength of x-Rays are very low and cannot be diffracted through ordinary grafting.

b) Case-I

$2d\sin\theta = n\lambda$

$2 \times 1.1 \times 10^{-10} \times \sin 5^{\circ} = 1 \times \lambda$

$\lambda = 1.92 \times 10^{-11} m$

Case-II

$2d\sin\theta = n\lambda$

$2 \times 1.1 \times 10^{-10} \sin\theta = 2 \times 1.92 \times 10^{-11}$

$\sin\theta = 0.17$

$\theta = 10^{\circ}$

(9) b) $\oint B\,dl = \mu_0 i_{in}$

$$\frac{3.38\times10^{-4}}{4\pi\times10^{-7}} = i$$

$$i = 268.97\ A$$

→ Yes, magnetic field charges.

c) $\mu_r = \frac{B_m}{B_0}$

$$= \frac{\mu_m H}{\mu_0 H}$$

$$= \frac{\mu_0(1+\chi)}{\mu_0}$$

$$\mu_r = 1+\chi$$

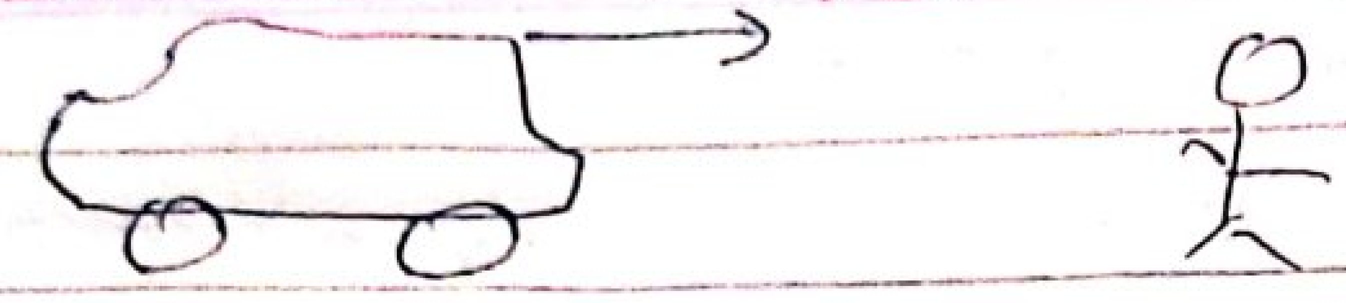
$(1+\chi)$ is the factor

d) $V_H = \frac{BI}{net}$

either I or B should be zero.

$v = f\lambda$

10(c) Case-I 20m/s



$f_s = 500 Hz$

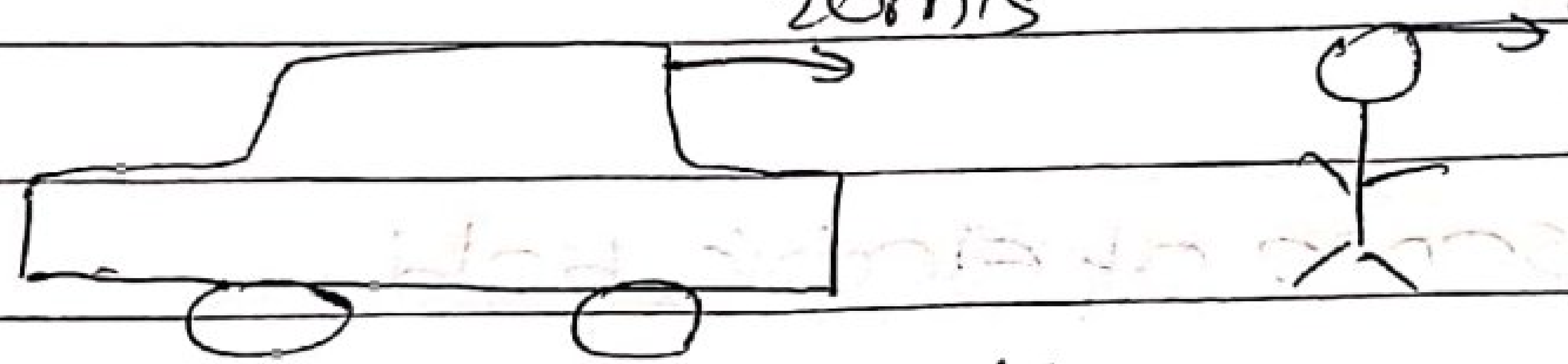
$$f_o = \left(\frac{v}{v - v_s}\right) f_s$$

$$= \frac{340}{320} \times 500$$

$$= 531.25 Hz$$

Case-II $\xrightarrow{v}$

20m/s 10m/s



$f_s = 500 Hz$

For source

$$f_s = \frac{v - 20}{\lambda}$$

$$\lambda = \frac{v - 20}{f_s}$$

For observer

$$f_o' = \frac{v - 10}{\lambda}$$

$$= \left(\frac{v - 10}{v - 20}\right) f_s$$

$$= \left(\frac{330}{320}\right) \times 500$$

$$= 515.625 Hz$$

$$f_o - f_o' = 15.625 Hz$$

11 a) i) $q = \pm ne$ $n = 0, 1, 2, 3$

charge always occurs in integral multiple of e.

b) ii)

because λ of visible light is greater, hence E is less $\left(E = \frac{hc}{\lambda}\right)$. because of which it cannot ionize the drops.

9 i) $m = 2\times10^{-15}\,kg$

$n = 2$

$V = 620\,V$

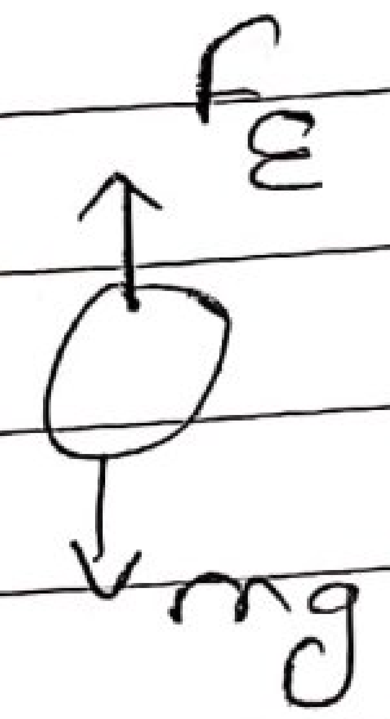
$mg = qE$

$mg = ne \times \frac{V}{d}$

$d = \frac{2\times1.6\times10^{-19}\times620}{2\times10^{-15}\times10}$

$= 0.009\,m$

$= 9.92\times10^{-3}\,m$

ii) 

$mg = F_e$

OR

a) i) $\phi = h\nu_0$

for photoelectric emission frequence of ~~photon~~ photon must be greater than ν_0

i.e. $\nu \geq \nu_0$.

ii)

⇒ 1) emission of electron is one to one phenomenon.

b) i) $\phi = 3.8 eV$

$\phi = h f_0$

$f_0 = \frac{3.8 \times 1.6 \times 10^{-19}}{6.62 \times 10^{-34}}$

$= 9.18 \times 10^{14}$

ii) $K.E = 4.5 \times 10^{-19} J$ [let work function be ϕeV]

$E = \phi + K.E$

$= \phi + \frac{4.5 \times 10^{-19}}{1.6 \times 10^{-19}}$

$E = (\phi + 2.8125) eV$

c)

⇒ i) Traffic controlling devices

ii) Fire alarm.

Set-C

1.a)

We know; For oscillatory Motion:

$F = -kx^n$ where $n = 1, 3, 5, 7$

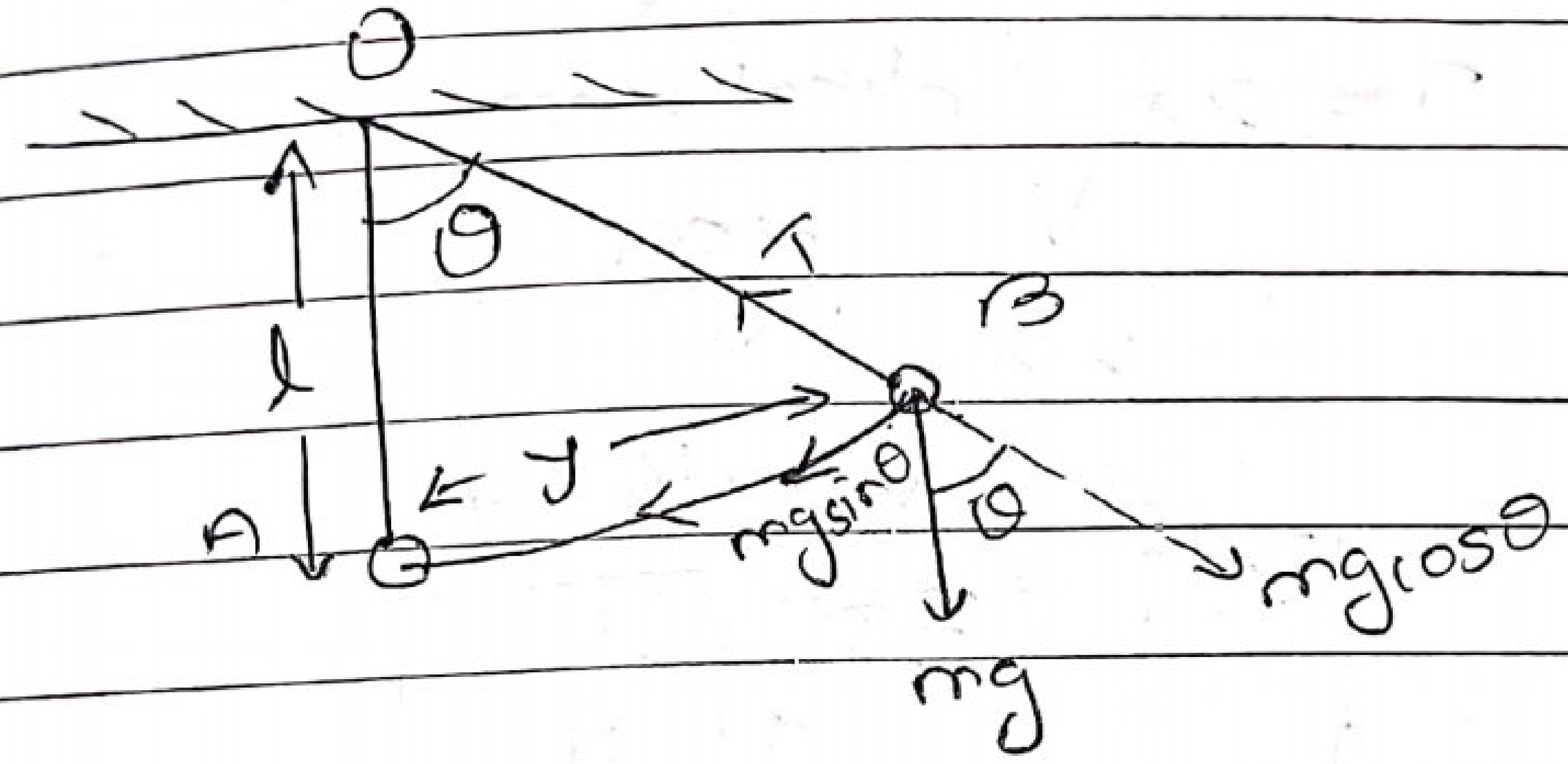
x is the distance from mean position.

For $n=1$

$\boxed{F = -kx}$; Simple Harmonic motion

i.e. the simplest case of oscillation is called Simple Harmonic motion.

b)



O → point of suspension

l → length of pendulum

y → displacement from mean position.

since, θ is very small;

~~sinθ θ =~~ $\theta = \frac{y}{l}$ $[\because \theta = l/r)$ — (i)

Also, $mg\cos\theta = T$

and $F = -mg\sin\theta$

$F \approx -mg\theta$ — (ii)

we know, $F = ma$ — (iii)

From eqns (ii) & (iii)

$-mg\theta = ma$

i.e. $a = -g\theta$

From eqn (i)

$a = -g\frac{y}{l}$

i.e. $a = -\left(\frac{g}{l}\right)y$ — (iv)

$$T = 2\pi\sqrt{\frac{\text{displacement}}{\text{accl}^n}}$$

$$= 2\pi\sqrt{\frac{y}{g/l \times y}}$$

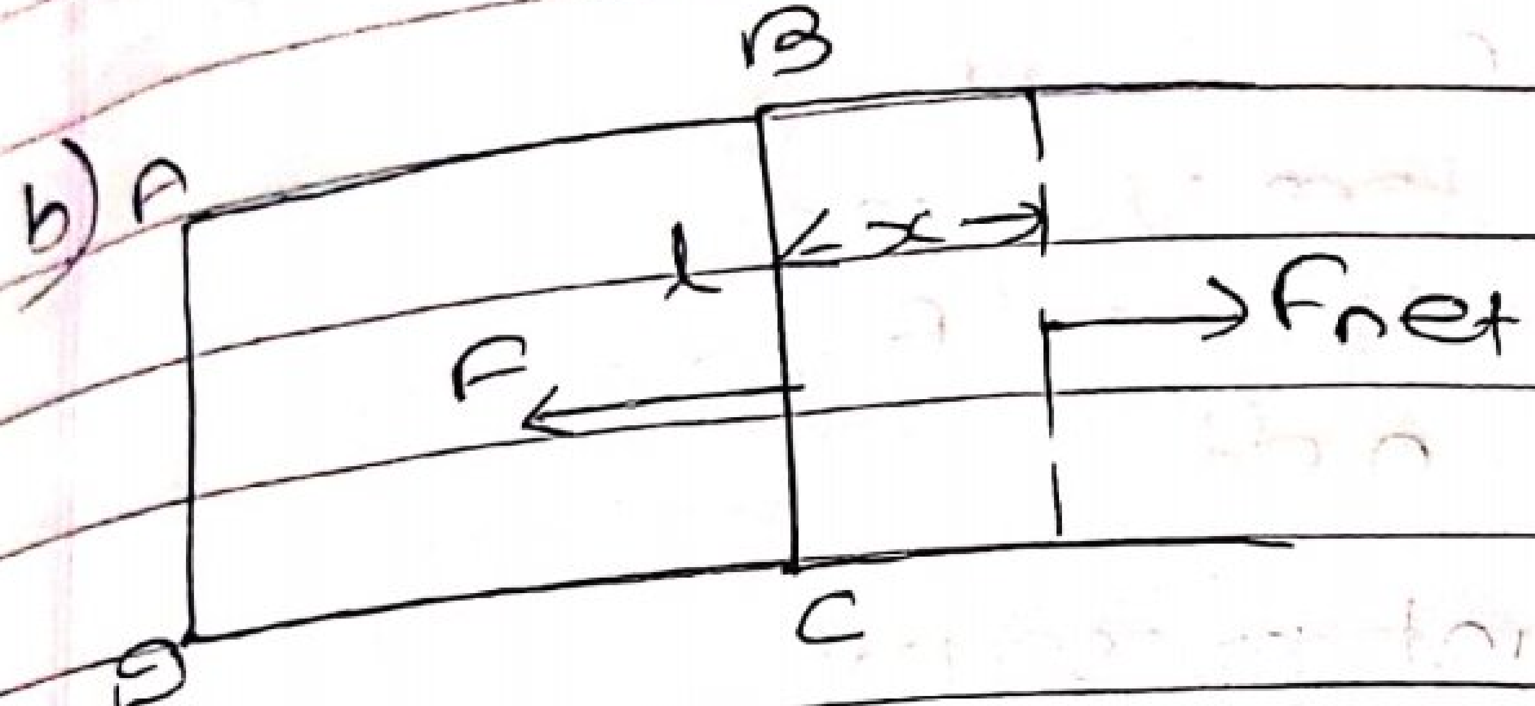
$$\boxed{\therefore T = 2\pi\sqrt{\frac{l}{g}}}$$

2. a)

⇒ Force of attraction between the molecules of different substance is called adhesive force.

Force of attraction between the molecule of same substance is called cohesive force eg: Capillary action is because of adhesive force between water molecules & molecules of solid.

Cohesive force is the reason for the formation of water droplets.



$l \rightarrow$ length of movable slides

$x \rightarrow$ displacement

$F \rightarrow$ force due to surface tension

$S \rightarrow$ surface tension

we have,

$$S = \frac{F}{2l}$$

$$F = 2l \times S$$

$$\therefore W = F \times x$$

$$= S \times 2l \times x$$

Change in area $= 2l \times x$

So, surface energy $= \frac{\text{work done}}{\text{change in Area}}$

$$(\sigma) = \frac{S \times 2l \times x}{2l \times x}$$

$$\therefore \boxed{\sigma = S}$$

$Q = msd$

3) a)

⇒ When a solid or a liquid is heated, its pressure and volume is not changed. But in case of gas both pressure & volume changes on heating. So, specific heat of a gas is defined at a constant ~~temp~~ volume or at a constant pressure.

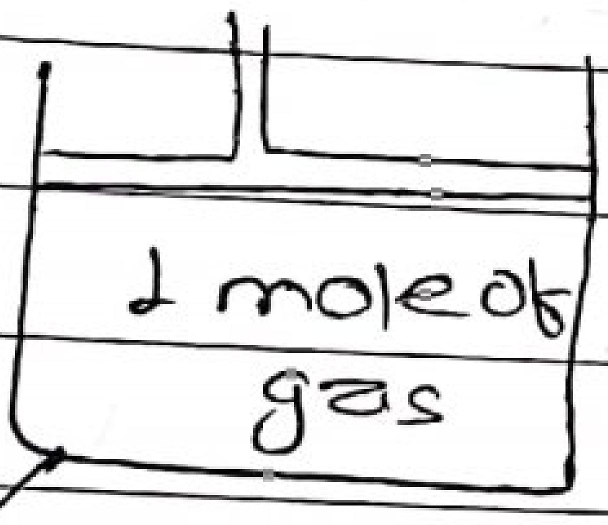
At constant ~~tem~~ volume

$$C_v = \frac{Q}{n\,dt} \quad \text{(for n moles)}$$

At constant pressure

$$C_p = \frac{Q}{n\,dt}$$

b)



→ Piston → immovable, constant volume.

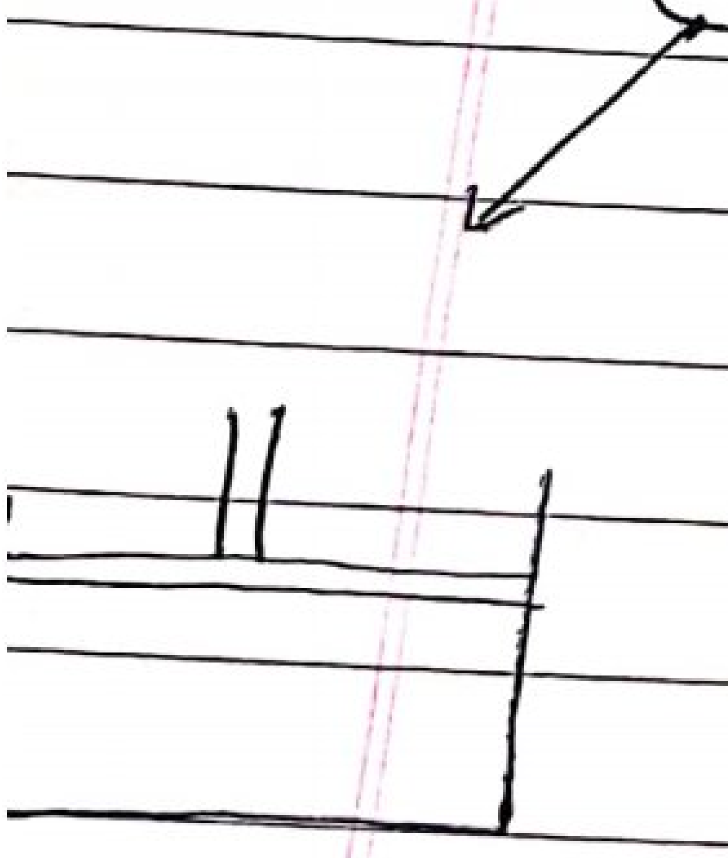
At constant volume;

$$W = P\Delta V = 0$$

$$\text{so, } dQ = dW + dU$$

$$\text{or } dQ = dU$$

$$nC_v dt = dU \quad \text{— (i)}$$



piston is made movable, constant pressure

$$dW = PdV$$

$$dQ = dW + dU$$

$$nC_p dt = PdV + nC_v dt \quad \text{— (ii)}$$

Also,

$pdv = Rdt$

Using in eqn (ii)

$nC_p dt = Rdt + nC_v dt$

$$\boxed{C_p - C_v = R}$$

OR

a) $\cancel{\eta = 1 - \frac{T_2}{T_1}}$

$\cancel{\eta = 0}$

we have

$PV = nR\Delta T$

$P\Delta V = nR\Delta T$

$W = P\Delta V$

since ΔV is related to change in T and if no. temp diffn exists i.e. $\Delta T = 0$

so, $W = P\Delta V$

$= P \times 0$

$= 0$

4)a)

=) When two waves of same frequency moving with same speed in opposite ~~dire~~ directions superposeon each other, stationary waves are formed.

b) We have,

the equation of stationary waves is;

$y = 2a\cos kx \sin\omega t$

when $2a\cos kx$ is the amplitude.

For node

$2a\cos kx = 0$

$\cos kx = 0$

$\cos \frac{2\pi}{\lambda} x = 0$

$\cos \frac{2\pi}{\lambda} x = \cos\left(\frac{2n+1}{2}\right)\pi$

i.e. $\frac{2\pi}{\lambda} x = \left(\frac{2n+1}{2}\right)\pi$

$x = \left(\frac{2n+1}{2}\right) \times \frac{\lambda}{2}$

For $n = 1$ For $n = 2$

$x = \frac{3\lambda}{4}$ $x = 5\lambda/4$

$\therefore$ distance $= 5\lambda/4 - 3\lambda/4 = 2\lambda/4 = \lambda/2$

5 (a)

i) OA = proton

OB = neutron

OC = electron

ii) Neutron is not attracted or repelled in magnetic field.

b) We have

$F = Bqv\sin\theta$ —— (i)

Suppose there are N no. of electron per a unit volume

$N = nV = n \times Al$ —— (ii)

$F_{net} = nAl \times Bqv_d \sin\theta$ —— (iii)

$I = v_d enA$

$v_d = \frac{I}{qnA}$

Using in eq^n (iii)

$F_{net} = nAl \times Bq \times \frac{I}{qnA} \sin\theta$

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

~~emf is produced~~

b) when current is passed in primary coil, emf is induced

a) ⇒ into the page

b) ⇒ when current is passed in primary coil, magnetic field is produced and the magnetic field linked with secondary coil changes. This change induce an alternating emf in secondary coil.

c)

$E = 3.6 \times 10^6 J$

$i = 200A$

we have,

$$U = \frac{1}{2} L I^2$$

$$\frac{2U}{I^2} = L$$

$$\text{or } L = \frac{2 \times 3.6 \times 10^6}{(200)^2}$$

$$= 180 \text{ Henry.}$$

7) a)
⇒ No because the interaction of photon and emission of electron is one to one. i.e. a photon carrying sufficient energy can only eject a electron at a time.

b)
$\phi_{Cu} = 4.5eV$
$\phi_{Na} = 2.0eV$
$\lambda = 4000A^{\circ} = 4 \times 10^{3} \times 10^{-10} = 4 \times 10^{-7}m$

For Copper

$$\phi_{Cu} = \frac{hc}{\lambda_0}$$

$$4.5 \times 1.6 \times 10^{-19} = \frac{hc}{\lambda_0}$$

$$\lambda_0 = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{4.5 \times 1.6 \times 10^{-19}}$$

$$= 2.75 \times 10^{-7} m$$

Since $\lambda > \lambda_0$ (No photoelectric emission)

For sodium

$$\lambda_0 = 6.2 \times 10^{-7} m$$

$\lambda < \lambda_0$ (photoelectric emission)

7 a)

=) It aims a light source into a sensing chamber at an angle away from the sensor. Smoke enters the chamber reflecting light into the light sensor; triggering the alarm.

OR

(8) b)

i) 27 = At no. & 60 = mass no.

ii) $\lambda = \frac{0.693}{T_{1/2}} = 0.13$ per year

iii)

60 gram $\Rightarrow 6.023 \times 10^{23}$ atoms

1 gm $\Rightarrow 10^{22}$ atoms

$A = A_0 e^{-\lambda T}$

$R = \frac{dN}{dt} - \lambda N = 1.3 \times 10^{21}$ per year.

9, a)

=) A plane transmission is a transparent plate or surface made of glass or of similar material on which a very large number of equidistant parallel lines very near to each other ~~are set~~ scratched by a sharp diamon point. It consists a large no. of narrow slits placed side by side. The slits are separated by opaque spaces.

b)
i)

$(a+b) = \frac{1}{500}$ mm

$\lambda = 600$ nm
$= 600 \times 10^{-9} \times 10^{3}$
$= 600 \times 10^{-6}$ mm

$\theta = 90^\circ$

$(a+b) \sin\theta = n\lambda$

$\left(\frac{1}{500}\right) \sin 90^\circ = n \times 600 \times 10^{-6}$

$\therefore n = \frac{1}{500 \times 600 \times 10^{-6}}$

$n = 3.33$

$n \approx 3$

OR

c) $l^o = 0.3$ m

$l^c = 0.23$ m

1st overtone of closed organ pipe = 1st overtone of open organ pipe

$\frac{3\cancel{v}}{4(l^c+e)} = \frac{\cancel{2}\cancel{v}}{\cancel{2}(l^o+2e)}$

or $\frac{3}{4(0.23+e)} = \frac{1}{0.3+2e}$

$l = \lambda/_4 + \lambda/_4$

$\lambda/_2$ $\lambda = 2l$

$v = f\lambda$

$(\frac{v}{2l} = f)$

$or, 0.3 \times 3 + 6e = 0.92 + 4e$

$or, 2e = 0.92 - 0.9$

$e = 0.01m$

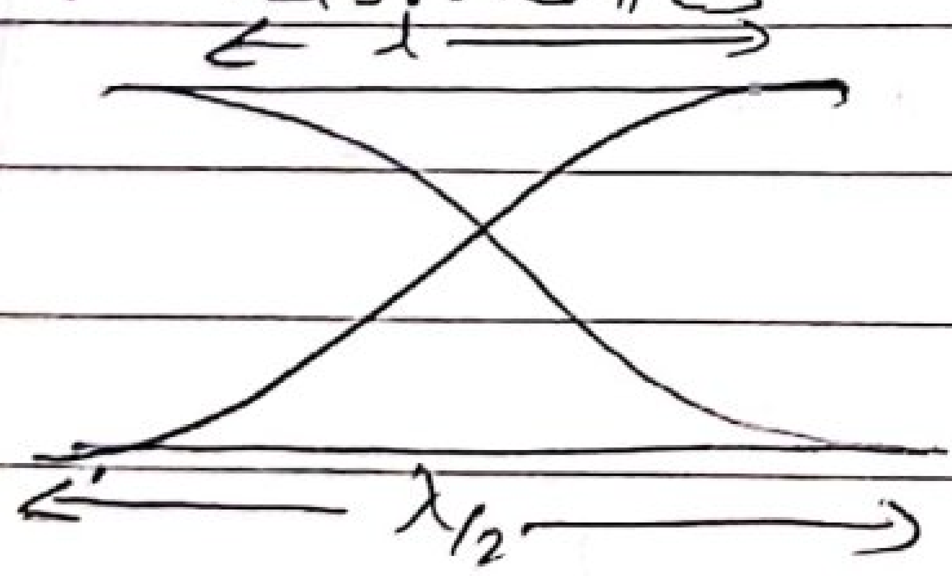
$= 1cm$

a)

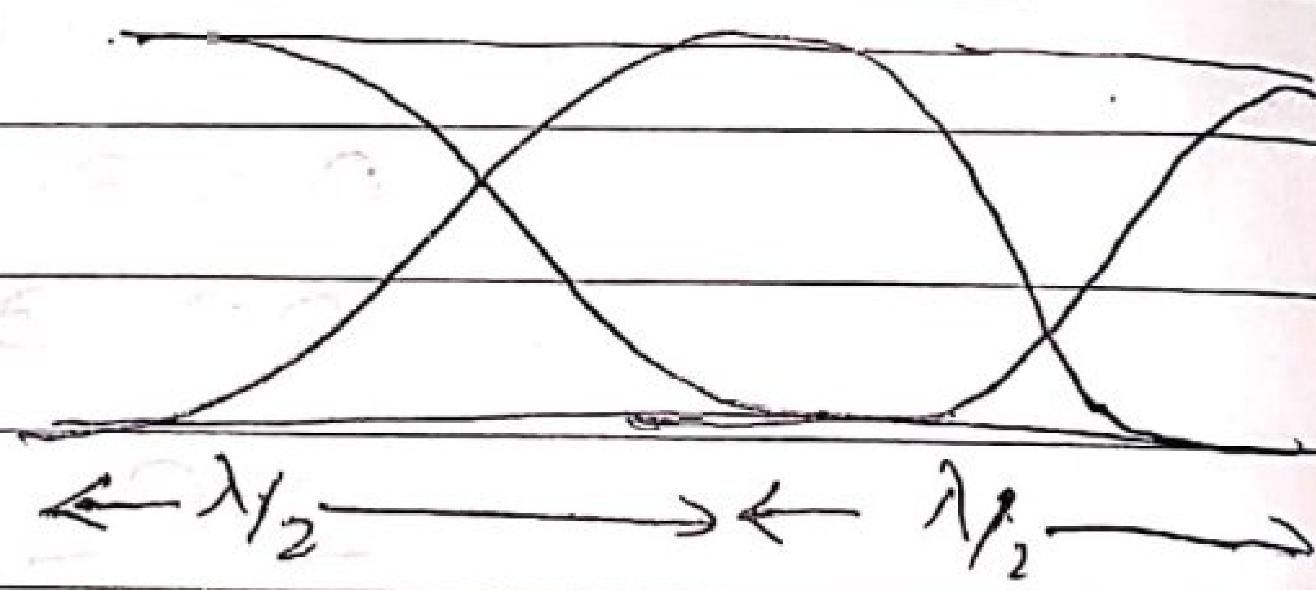
⇒ When air is blown from one end having mouth piece, the longitudinal wave travels to the another end which is reflected back from that end which can be regarded as the reflection from rarer medium. Hence, it produces a stationary sound wave.

b)

1st harmonics



2nd Harmonics



$l = \lambda/_2$ $\lambda = 2l$

$f_0 = \frac{v}{\lambda}$

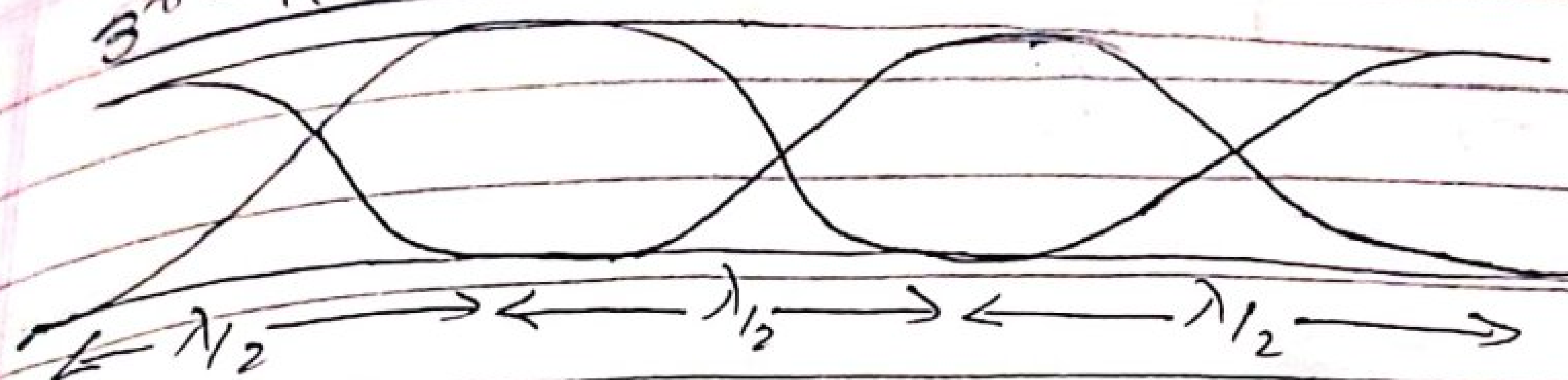
$= \frac{v}{2l}$

$l = \lambda$

$f_1 = \frac{v}{\lambda}$

$= \frac{v}{l}$

3rd Harmonics



$l = 3\lambda/2$

$\lambda = 2l/3$

$v = f\lambda$

$f_2 = \frac{3v}{2l}$

Hence, the frequence of n^{th} Harmonics is given by $f = \frac{nv}{2l}$

which shows all harmonics are present.

10) a) i)

we have,

$V = IR$

$= I\frac{\rho l}{A}$

For potentiometer $V \propto l$; it occurs only when ρ, I & A are constant. If A is not constant V will not be directly proportional to l.

ii)

$$\frac{\mathcal{E}_1}{\mathcal{E}_2} = \frac{l_1 + l_2}{l_1 - l_2}$$

b)

=> ~~If~~ I will use OX because $V \propto l$

c)

let $\mathcal{E}_1$ & $\mathcal{E}_2$ be the emfs of two cells, l_1 & l_2 be balancing lengths obtained.

when the cells support each other

$$\mathcal{E}_1 + \mathcal{E}_2 = l_1 + l_2 \quad \text{— (i)}$$
$$= 4$$

when cells oppose each other.

$$\mathcal{E}_1 - \mathcal{E}_2 = l_1 - l_2 \quad \text{— (ii)}$$
$$= 1$$

$l_1 + l_2 = 4$

$l_1 - l_2 = 1$

$2l_1 = 5$

$l_1 = 5/2 \quad l_2 = 3/2$

$\therefore \frac{\mathcal{E}_1}{\mathcal{E}_2} = \frac{l_1}{l_2} = 5/3$

d)

=> A potentiometer at balance, does not draw any current from the cell; so the cell remains in open circuit. Hence ii)

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1 + l_2}{l_1 - l_2}$$

b)

⇒ ~~It~~ I will use OX because $V \propto L$

c)

let ε_1 & ε_2 be the emfs of two cells, l_1 & l_2 be balancing lengths obtained.

when the cells support each other

$$\varepsilon_1 + \varepsilon_2 = l_1 + l_2 \quad -(i)$$
$$= 4$$

when cells oppose each other:

$$\varepsilon_1 - \varepsilon_2 = l_1 - l_2 \quad -(ii)$$
$$= 1$$

$l_1 + l_2 = 4$

$l_1 - l_2 = 1$

$2l_1 = 5$

$l_1 = 5/2 \quad l_2 = 3/2$

$\therefore \frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = 5/3$

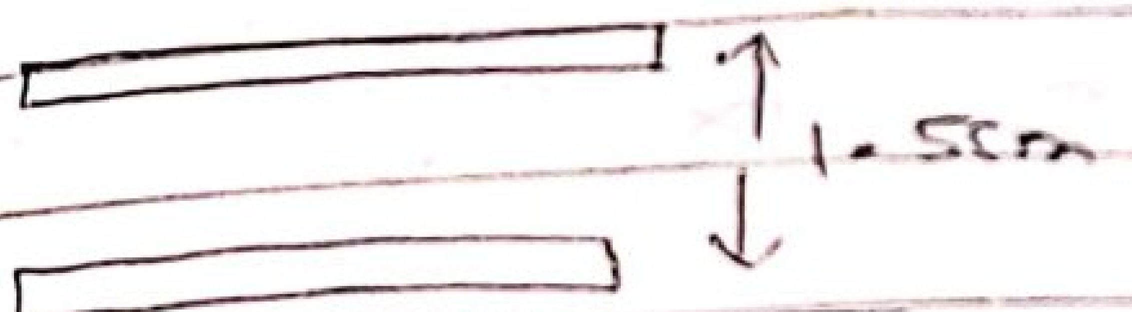
d)

⇒ A potentiometer at balance, does not draw any current from the cell; so the cell remains in open circuit. Hence potentiometer reads the actual value of emf.

11) a) ~~b~~

b) ⇒ In several experiments for oil drop of different radii, Millikan found that the charge on oil drop is always integral multiple of basic unit of charge i.e.
$q = \pm ne$ where $n = 0, 1, 2, \ldots$ and
$e = 1.6 \times 10^{-19} C$.

c)



$$r = \sqrt{\frac{9 \eta v}{2(\rho - \sigma) g}}$$

$$= \sqrt{\frac{9 \times 1.8 \times 10^{-5} \times 2.5 \times 10^{-4}}{2 \times 10 \times 900}}$$

$$= 1.5 \times 10^{-6} m$$

$$mg = qE$$

$$mg = q \frac{V}{d}$$

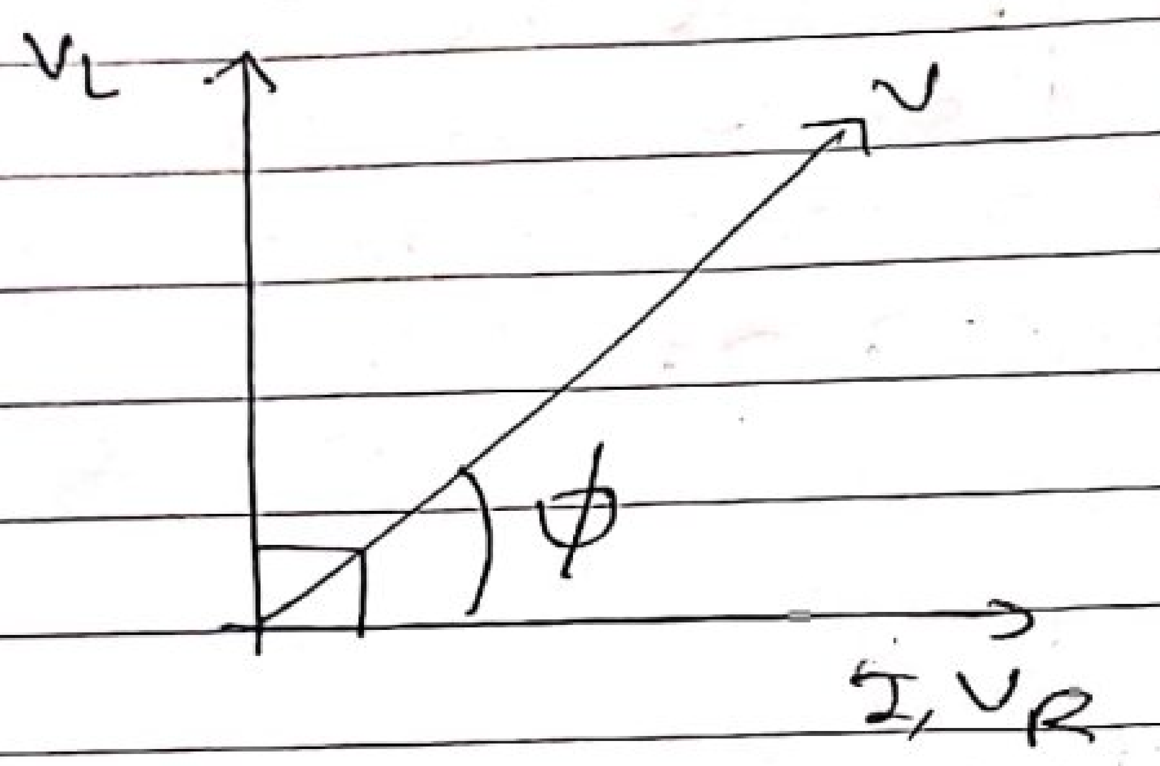
$$V \rho g = ne \frac{V}{d}$$

$$900 \times \frac{4}{3} \pi (1.5 \times 10^{-6})^3 \times 10 = n \times 1.6 \times 10^{-19} \times \frac{1500}{1.5 \times 10^{-2}}$$

$$\therefore n = 7.98 \simeq 8$$

6. a)

⇒ St. line that represents sinusoidally varying quantities & rotates anticlockwise with angular velocity equal to angular velocity of that quantity; called phasor diagram.



For inductor resistor (RL) series.

b) $L = 2\times10^{-4} H$

$R = 10\Omega$

$V = 0.1 V$

$f = 10^6 Hz$

i) $X_C = X_L$

$= 2\pi f L$

$= 400\pi$

$X_C = \frac{1}{2\pi f}$

$\Rightarrow C = 1.26\times10^{-10} F$

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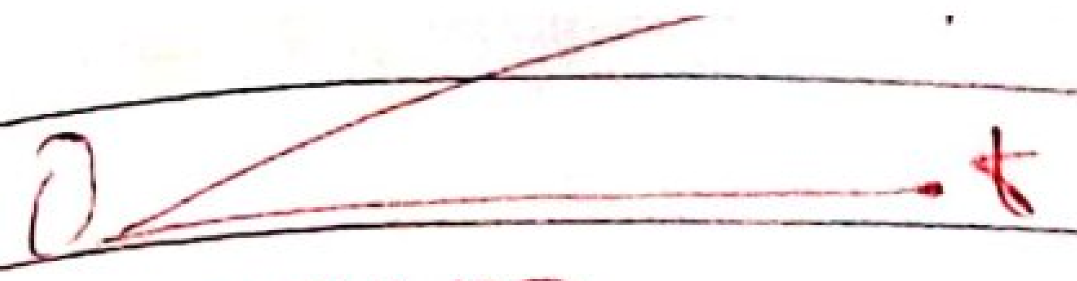
ii) Quality factor $= \frac{1}{R}\sqrt{\frac{L}{C}}$

$$= \frac{1}{10}\sqrt{\frac{2\times10^{-4}}{1.26\times10^{-10}}}$$

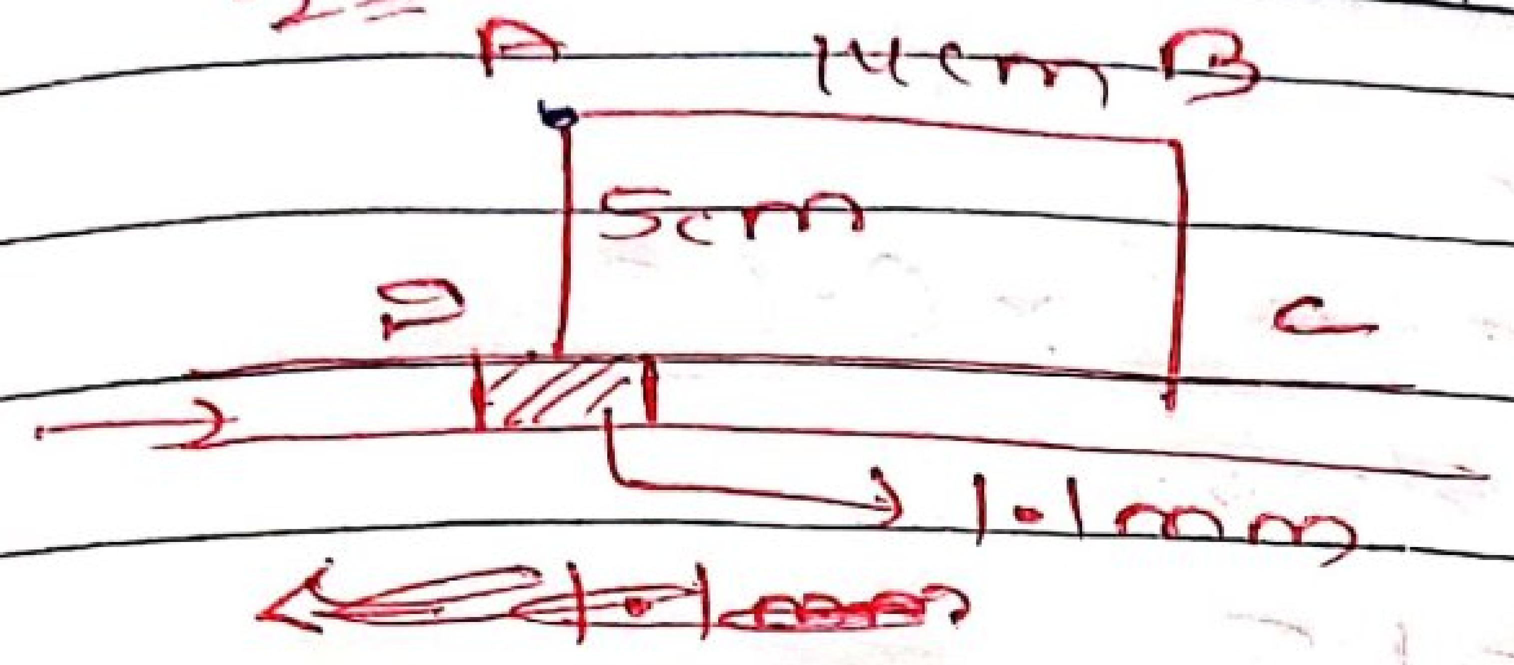
$= 126$



30cm

set-2 Group-C

(a)



$$dB = \frac{\mu_0}{4\pi}\frac{i\,dl\sin\theta}{r^2}$$

$$= \cancel{10^{-7}\times 10\times 1.1\times 10^{-3}}$$

$$\cancel{B = \frac{\mu_0}{4\pi}\frac{i}{a}} \qquad dB = \frac{\mu_0}{4\pi}\frac{i\,dl\sin\theta}{r^2}$$

$$= \frac{10^{-7}\times 10\times 1.1\times 10^{-3}}{(5\times 10^{-2})^2}$$

$$dB = 4.4\times 10^{-7}\,T$$

(iii)