Revision Booster WORKSHOP for NEET & JEE Main

Heat and Thermodynamics

Notes of Revision Booster Workshop for JEE Main & NEET

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Questions Based on

Stopping of a Moving Container

$m = n N_{Av} \cdot m'$

Suddenly stopped

$KE = \frac{1}{2} m v^2 = \frac{3}{2} k \Delta T$

$T_2 - T_1 = \Delta T = ----.$

$\frac{P_1}{T_1} = \frac{P_2}{T_2} \longrightarrow P_2 = \_\_\_$

Container at Constant speed:

$v \rightarrow$ Const.

$T \rightarrow$ Const.

QUESTIONS BASED ON

VALUE OF EQUIVALENT γ FOR A MIXTURE

$$U_{mix} = U_1 + U_2$$

$$U = \frac{f}{2} nRT \quad \& \quad f = \frac{2}{\gamma - 1}$$

$$\gamma_{eq} = \gamma_{mix} = \frac{C_P}{C_V} = \frac{n_1 C_{P_1} + n_2 C_{P_2} + \ldots}{n_1 C_{V_1} + n_2 C_{V_2} + \ldots}$$

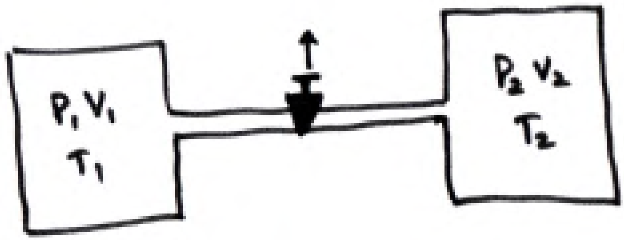
$$\frac{nRT}{\gamma_{eq} - 1} = \frac{n_1 RT}{\gamma_1 - 1} + \frac{n_2 RT}{\gamma_2 - 1}$$

$$\frac{n_1 + n_2}{\gamma_{eq} - 1} = \frac{n_1}{\gamma_1 - 1} + \frac{n_2}{\gamma_2 - 1} + \ldots$$

$$\gamma_{eq} = \text{—}$$

QUESTIONS BASED ON

MIXTING OF TWO GASES BY CONNECTING CHAMBERS



$$n_1 + n_2 = n_T$$

$$\frac{P_1 V_1}{T_1} + \frac{P_2 V_2}{T_2} = \frac{P_f (V_1 + V_2)}{T_f}$$

for Cons of IE $\longrightarrow$ $T_f = \dfrac{n_1 f_1 T_1 + n_2 f_2 T_2}{n_1 f_1 + n_2 f_2}$

for similar atomicity of gases $T_f = \dfrac{n_1 T_1 + n_2 T_2}{n_1 + n_2}$

QUESTIONS BASED ON

C_p AND C_v PER UNIT MASS

for per mole of an ideal gas

$$C_p - C_v = R$$

for 1 gm of gas $\quad C_p' = \frac{C_p}{M}$

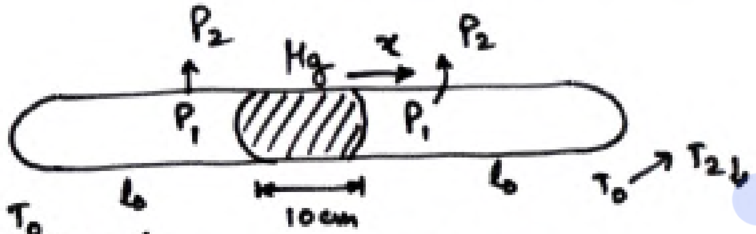
$M \longrightarrow$ molar mass in gm

$$C_p' = \frac{C_p}{M} \; ; \; C_v' = \frac{C_v}{M}$$

$$C_p' - C_v' = \frac{R}{M}$$

QUESTIONS BASED ON

Hg PALLET IN A HORIZONTAL TUBE



$T_1 > T_2$

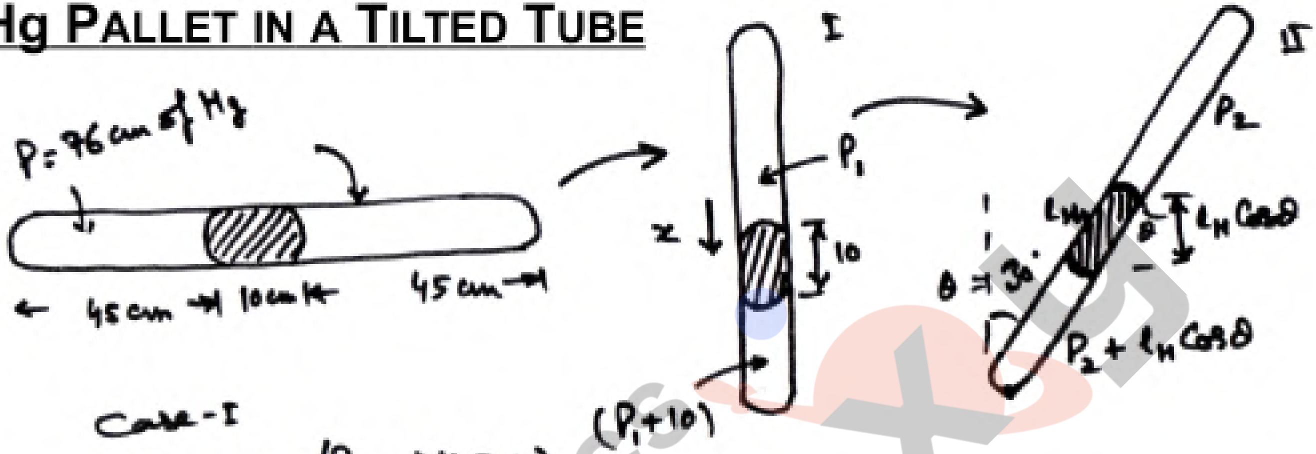
Q: displacement in pallet

$$\frac{P_1 l_0}{T_0} = \frac{P_2(l_0+x)}{T_1} = \frac{P_2(l_0-x)}{T_2}$$

$x =$ ———

Questions Based on

Hg Pallet in a Tilted Tube



Case-I

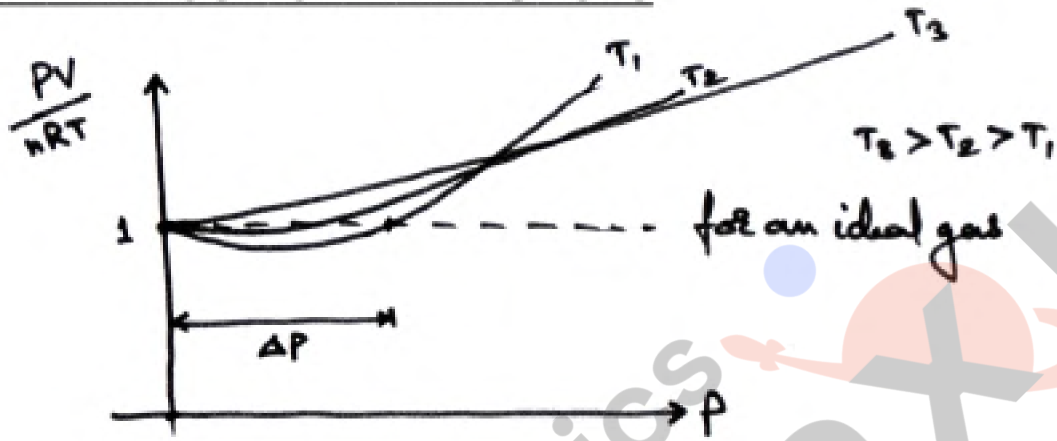
$$P_1(45+x) = (P_1+10)(45-x)$$

Case-II

$$P_2(45+x) = (P_2+10\cos 30^\circ)(45-x)$$

QUESTIONS BASED ON

BEHAVIOUR OF REAL GASES

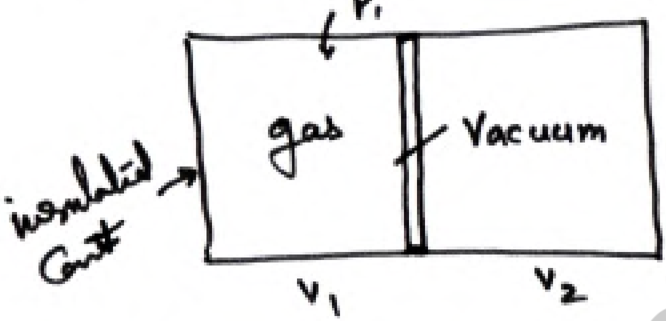


A real gas behaves like an ideal gas at v. low pressure & high temp

QUESTIONS BASED ON

FREE EXPANSION OF A GAS

in vacuum.



$P_1V_1 = P_2(V_1+V_2)$

$P_2 = \_\_\_$

There is no W/D against exp in vacuum

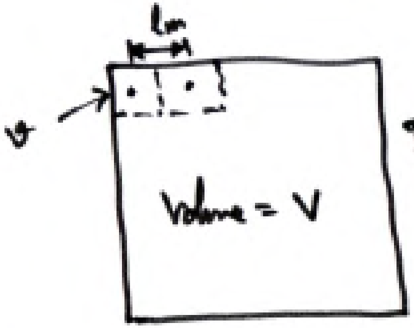
$\underline{W=0}$ & $\Delta Q = 0$

$\underline{\Delta U = 0}$

$\Rightarrow T \rightarrow$ Const.

Questions Based on

Mean Distance Between Gas Molecules



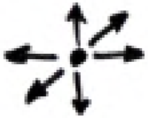
Total molecules = N

volume/molecule $v = \frac{V}{N}$

$$l_m = (v)^{1/3} = \left(\frac{V}{N}\right)^{1/3}$$

Questions Based on

Specific Heat of a Solid by KTG

for a Solid  3 dir of vib × 2 = 6 DoF

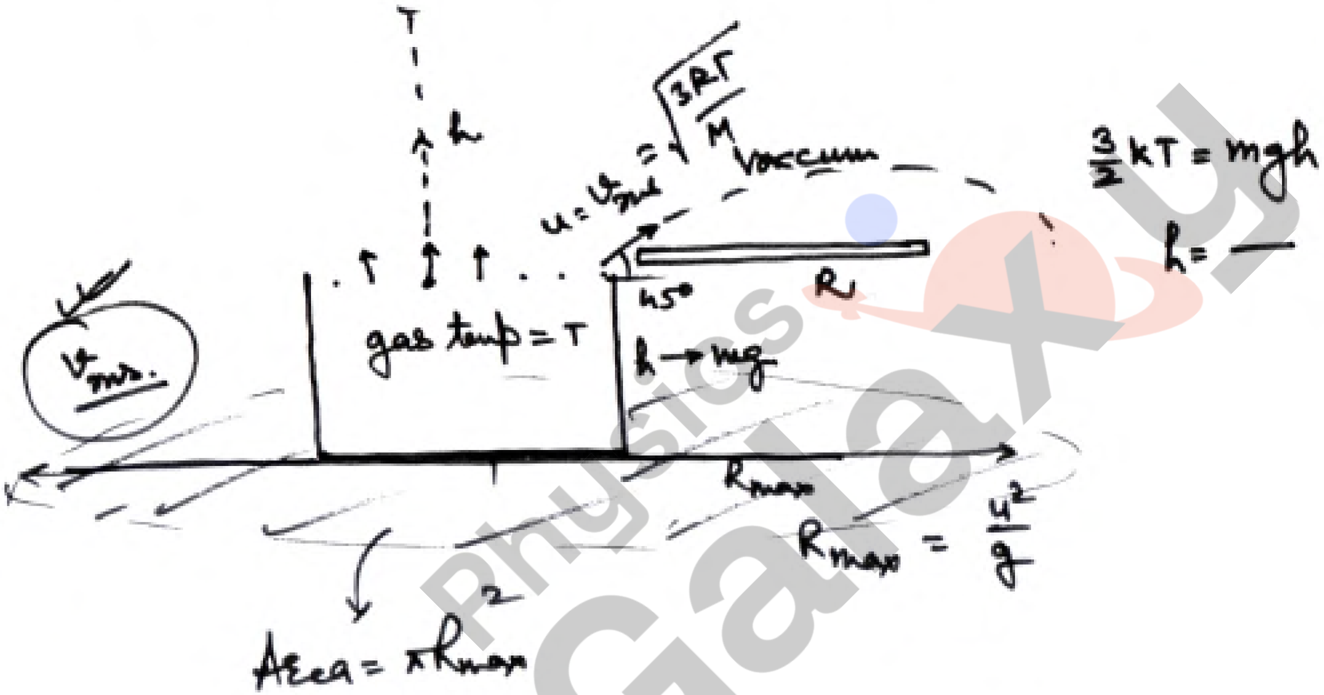
Energy of one molecule in a Solid $E = \frac{f}{2}kT = 3kT$

per mole sp. heat $C_V = \frac{f}{2}R = 3R$

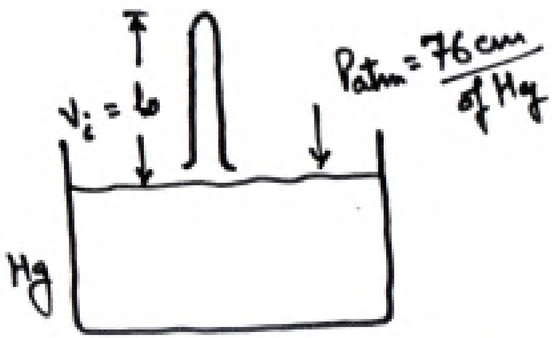
per ~~mole~~ gm sp. heat $s = \frac{C_V}{M} = \frac{3R}{M}$ (approx)

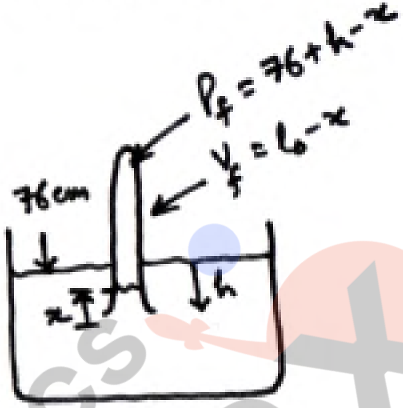
Questions Based on

Opening a Container in Vacuum



Questions Based on
Open Test Tube Immersion in Hg





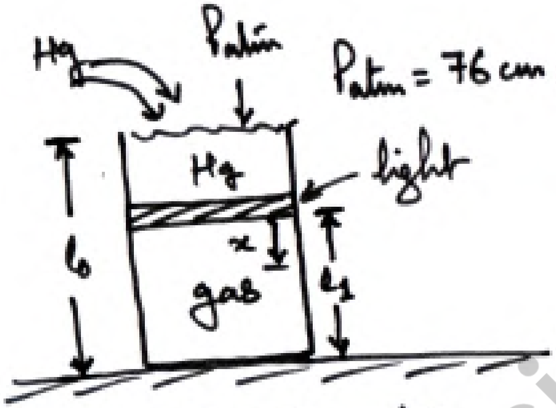
Considering $T \to$ Const

$$76 \times l_0 = (76 + h - x)(l_0 - x)$$

$x =$ ——— ✓

QUESTIONS BASED ON

POURING Hg ON A PISTON-CYLINDER SYSTEM



$P_{atm} = 76$ cm of Hg

$P_i = 76$ cm of Hg

Considering $T \rightarrow$ Const

$$76 \times l_1 = (76 + l_0 - l_1 + x)(l_1 - x)$$

$x = $ ___

QUESTIONS BASED ON

INTERNAL ENERGY IN TERMS OF P & V OF GAS

IE of gas $U = \frac{f}{2} nRT = \frac{f}{2} PV$

QUESTIONS BASED ON

ESCAPING A GAS FROM A PLANET

$$v_{esc} = \sqrt{2gR} = \sqrt{\frac{2GM}{R}}$$

for max no of molecules to escape from planet

$$v_{mp} = \sqrt{\frac{2RT}{M_g}} = \sqrt{\frac{2GM_p}{R}}$$

$$T = \_\_\_$$

Questions Based on

Mean Time Between Collisions

for ideal gas

mean sep between molecules $d_m = \left(\frac{V}{N}\right)^{1/3}$

mean time between collisions $t_m = \frac{d_m}{v_m} = \frac{(V/N)^{1/3}}{\sqrt{\frac{8RT}{M}}}$

$$t_m \propto \frac{V^{1/3}}{T^{1/2}} \propto \frac{T^{1/3}}{P^{1/3}T^{1/2}} \propto \frac{1}{P^{1/3}T^{1/6}}$$

$$\frac{t_{m_1}}{t_{m_2}} = \frac{P_2^{1/3}T_2^{1/6}}{P_1^{1/3}T_1^{1/6}}$$

QUESTIONS BASED ON

ENERGY CHANGES IN HEATING A LIQUID

$$\Delta Q = ms\Delta T \rightarrow \Delta U + \Delta W$$

volume exp → neglect $\Delta W = 0$

Considering volume exp

$\Delta V = \gamma V \Delta T$

$\Delta T \uparrow$

$W = P_{atm} \Delta V$

Questions Based on

Specific Heat Variation with Temperature

for solids & liq if $s = f(T)$

heat supp $Q = \int_{T_1}^{T_2} msdT =$ ___

[for gases $C = f(T)$

$Q = \int_{T_1}^{T_2} nCdT = \underline{\Delta U} + \underline{\Delta W}$

$\Delta U \rightarrow nC_v(T_2 - T_1)$

$\Delta W \rightarrow \int PdV$

$\Delta W = Q - \Delta U =$ ___

QUESTIONS BASED ON

$P = \alpha V^m$ BASED CASES

$PV^{-m} = \text{Const}$ [Polytropic processes]

$PV^n = \text{Const}$ [$n = -m$]

Specific heat of gas in given process $C = C_v + \dfrac{R}{1-n} = C_v + \dfrac{R}{1+m}$

$n \rightarrow$ polytropic Constant

heat supp

$Q = nC\Delta T = nC(T_2 - T_1)$

$\Delta U = nC_v\Delta T = nC_v(T_2 - T_1)$

$W = Q - \Delta U$

$n = \gamma$ (adiabatic)

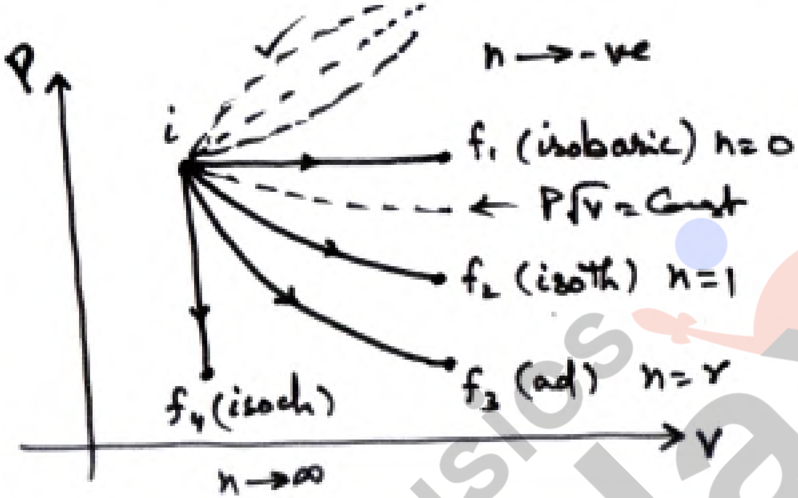
$n = 1$ (Isothermal)

$n = 0$ (Isobaric)

$n \rightarrow \infty$ (Isochoric)

QUESTIONS BASED ON

INDICATOR DIAGRAM OF POLYTROPIC PROCESSES



$PV^{1/2} = $ Const

$P\sqrt{V} = $ Const

$n = 1/2$

$P = a\sqrt{V}$

$PV^{-1/2} = $ Const

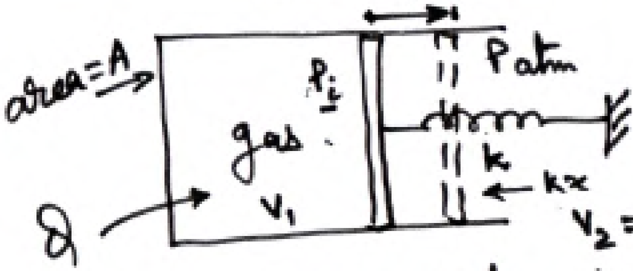
$n = -1/2$

Slope $\dfrac{dP}{dV} = \dfrac{a}{2\sqrt{V}}$ | as $V\uparrow \Rightarrow \dfrac{dP}{dV}\downarrow$

Questions Based on

Spring Based Piston Cylinder Cases Open to Atmosphere

Case - I



Case II

$V_2 = V_1 + Ax$

Initially spring is relaxed

$\Rightarrow P_i = P_{atm}$

final pressure

$P_f = \left(P_{atm} + \dfrac{kx}{A}\right)$

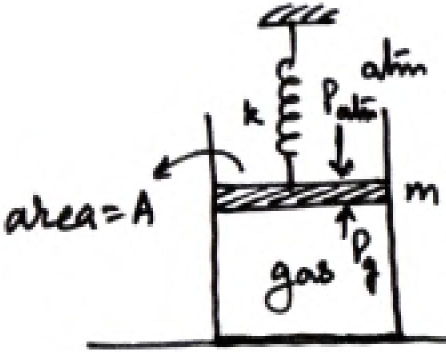
$$\left[\begin{aligned} &\text{W/D by gas} = P_{atm}(Ax) + \tfrac{1}{2}kx^2 \\ &\Delta U = nC_v(T_2 - T_1) \\ &Q = \Delta U + W \end{aligned}\right]$$

$$\left[\begin{aligned} &V_i = V_1 \qquad V_f = V_1 + Ax \\ &P_i = P_{atm} \qquad P_f = P_{atm} + \frac{kx}{A} \end{aligned}\right]$$

by Gas law $\quad \dfrac{P_{atm} V_1}{T_1} = \dfrac{\left(P_{atm} + \dfrac{kx}{A}\right)(V_1 + Ax)}{T_2}$ ✓

QUESTIONS BASED ON

PISTON CYLINDER SYSTEM WITH VERTICAL SPRING



if spring is relaxed

at eq^m

$$P_g = P_{atm} + \frac{mg}{A}$$

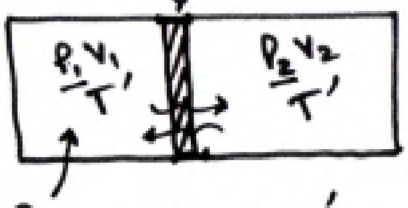
at spring compression x $\quad P_g = P_{atm} + \frac{kx}{A} + \frac{mg}{A}$

at spring elongation x $\quad P_g = P_{atm} - \frac{kx}{A} + \frac{mg}{A}$

Questions Based on

Closed Piston-Cylinder Systems

Dithermic Piston (Conducting)



$T \longrightarrow T'$

if fixed piston $\Rightarrow \Delta W = 0$

$$Q = \left(\frac{P_1V_1}{RT}\right) C_v (T' - T) + \left(\frac{P_2V_2}{RT}\right) C_v (T' - T)$$

$$T' = \_\_\_$$

$$\frac{P_1^f V_1}{T'} = \frac{P_1V_1}{T}$$

$$P_1^f = \_\_\_$$

$$\frac{P_{2f}}{T'} = \frac{P_2}{T}$$

$$P_{2f} = \_\_\_$$

Adiabatic Piston

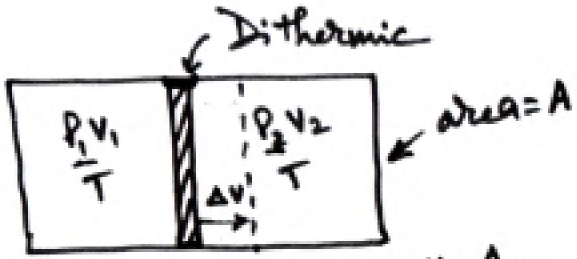
$$Q = \left(\frac{P_1V_1}{RT_1}\right) C_v (T_{1f} - T_1)$$

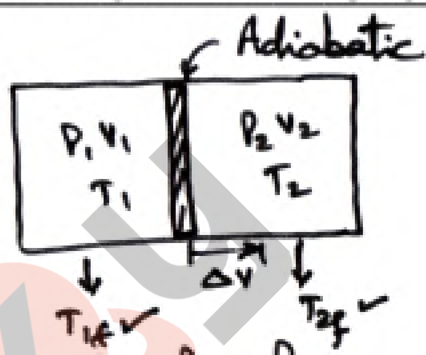
$$T_{1f}$$

$$\frac{P_{1f}}{T_{1f}} = \frac{P_1}{T_1} \Rightarrow P_{1f} = \_\_\_.$$

Questions Based on

Closed Piston-Cylinder Systems with Movable Piston





if piston is released

$\Delta V = Ax$

$T \to T_f$ ✓

$P_{1f} = P_{2f} = P_f$ ✓

$$\&\left[\begin{aligned} \frac{P_1V_1}{T} &= \frac{P_f(V_1+\Delta V)}{T_f} \\ \frac{P_2V_2}{T} &= \frac{P_f(V_2-\Delta V)}{T_f} \end{aligned}\right] ✓$$

$$|W_{gas1}| - |W_{on\,gas2}| = \underbrace{(n_1+n_2)C_V(T_f - T)}$$

$$|W_{gas1}| = -nC_V(T_{1f}-T)$$

$$|W_{on\,gas2}| \to nC_V(T_{2f}-T)$$

$P_{1f} = P_{2f} = P_f$

$$P_1V_1^{\gamma} = P_f(V_1+\Delta V)^{\gamma}$$

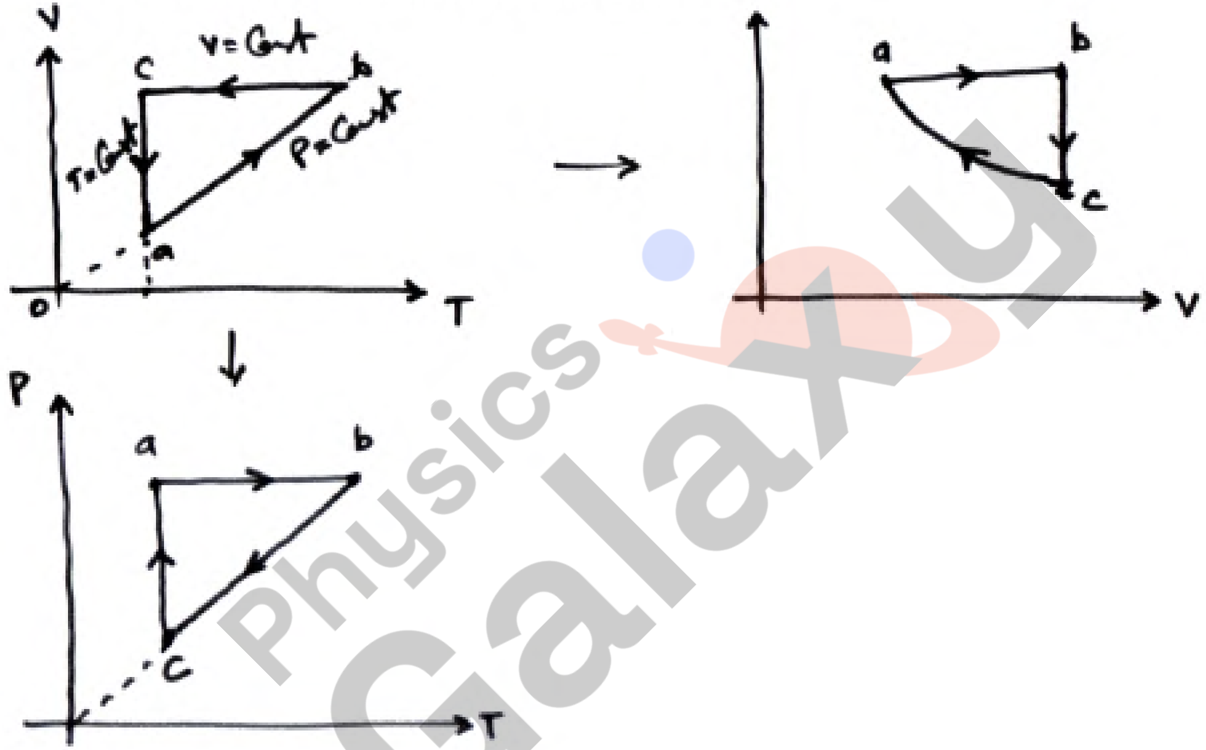
$$T_1V_1^{\gamma-1} = T_{1f}(V_1+\Delta V)^{\gamma-1}$$

$$\frac{P_1V_1}{T_1} = \frac{P_f(V_1+\Delta V)}{T_{1f}}$$

$$\& \quad \frac{P_2V_2}{T_2} = \frac{P_f(V_2-\Delta V)}{T_{2f}}$$

Questions Based on

Redrawing of Indicator Diagrams



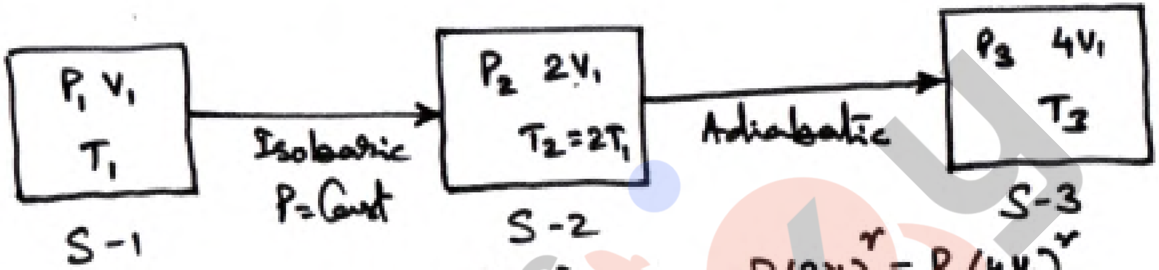
$\underline{P}V = nR\underline{T}$

$\downarrow$

Const

QUESTIONS BASED ON

CASCADING OF THERMODYNAMICS PROCESSES



$P_2 = P_1$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} = \frac{2V_1}{T_2}$

$\Rightarrow T_2 = 2T_1$

$W_1 = P\Delta V = \underline{P_1V_1}$

$\Delta U_1 = nC_vT_1$

$Q_1 = W_1 + \Delta U_1$

$P_1(2V_1)^{\gamma} = P_3(4V_1)^{\gamma}$

$\Rightarrow P_3 = \frac{P_1}{2^{\gamma}}$

$(2T_1)(2V_1)^{\gamma-1} = T_3(4V_1)^{\gamma-1}$

$T_3 = $ —

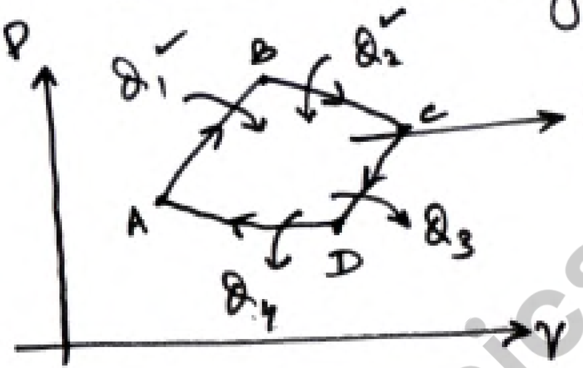
$W = \checkmark$

$\Delta U = \checkmark$

$Q = \checkmark$

Questions Based on

Heat Engine Based Questions



Cyclic Process clockwise

work done by gas in One complete Cycle

$$W = (Q_1+Q_2) - (Q_3+Q_4)$$

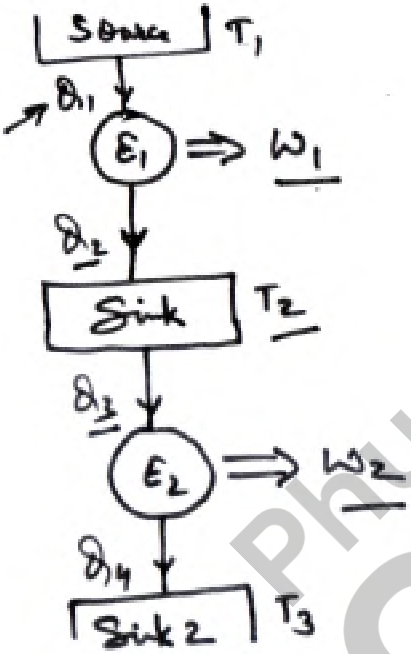
Cycle efficiency $\eta = \frac{W}{Q_1+Q_2} = 1 - \frac{Q_3+Q_4}{Q_1+Q_2} = 1 - \frac{Q_{out}}{Q_{in}}$

Carnot Cycle $\rightarrow$ 2 isoth + 2 ad.

$$\eta = 1 - \frac{T_2}{T_1}$$

Questions Based on

Cascading of Heat Engines



Efficiency of E_1 $\eta_1 = 1 - \frac{T_2}{T_1} \times 100\%$

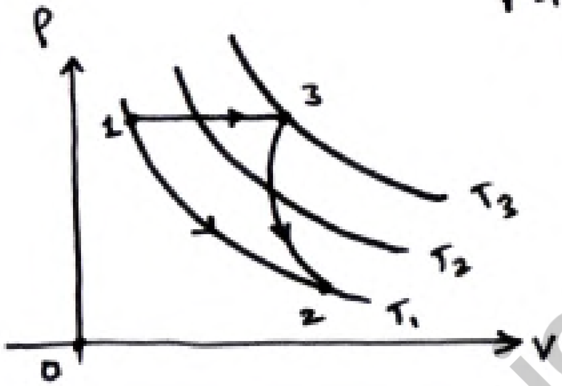
Efficiency of E_2 $\eta_2 = 1 - \frac{T_3}{T_2} \times 100\%$

Total efficiency $\eta_T = \frac{W_1 + W_2}{Q_1} = \text{——}$

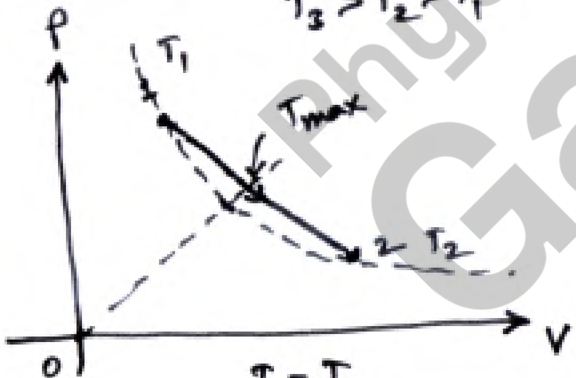
Questions Based on

Family of Isotherms

$P \propto \frac{1}{V} \rightarrow$ isothermal process



$T_3 > T_2 > T_1$



$T_1 = T_2$

QUESTIONS BASED ON

DENSITY VARIATION OF A GAS IN A PROCESS

$\downarrow$ $\rho = \frac{m}{V}$

$\rho \propto \frac{1}{V}$

$\rho' \longrightarrow 20\rho$

Compression

from $V \longrightarrow \frac{V}{20}$

for adiabatic process

$PV^{\gamma} = \text{Const}$

$\Rightarrow P\rho^{-\gamma} = \text{Const}$

or $\underline{P = k\rho^{\gamma}}$

for isothermal process

$PV = \text{Cst}$

$\Rightarrow \underline{P = k\rho}$

QUESTIONS BASED ON

SUDDEN PROCESSES → REVERSIBLE OR NOT

↓

No time available for heat exchange ⇒ adiabatic

↓

As process is v. quick ⇒ at intermediate states its (gas) state cannot be considered in eq^m

⇒ Not quasistatic

⇒ Not reversible.

QUESTIONS BASED ON

HEAT EXCHANGE WITH A GAS OF RIGID MOLECULES

$\Downarrow$

no vib mode is present

$\Rightarrow f_v = 0$

if x vib modes are present

$\Rightarrow f_v = 2x$

Sp heat

$\rightarrow C_V = \frac{f}{2}R$

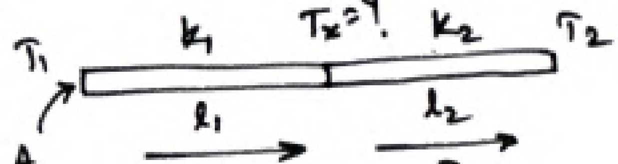
$\rightarrow C_P = \frac{f+2}{2}R$

$\rightarrow C =$ const for polytropic process

$\rightarrow C = f(P/V/T)$ for Non-polytropic process

QUESTIONS BASED ON

THERMAL RESISTANCE BASED QUESTIONS ON CONDUCTION



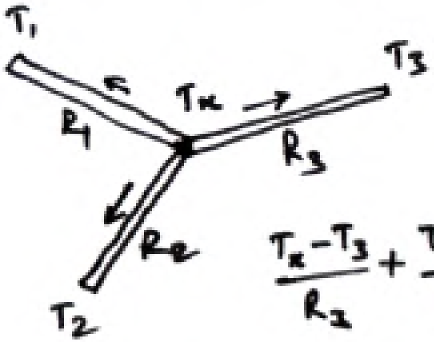
$$I_1 = I_2$$

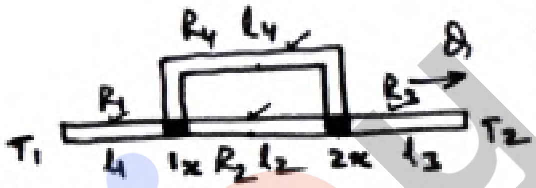
$$\left.\begin{aligned} R_1 &= \frac{1}{k_1}\cdot\frac{l_1}{A} \\ R_2 &= \frac{1}{k_2}\cdot\frac{l_2}{A} \end{aligned}\right] \quad \frac{T_1 - T_x}{R_1} = \frac{T_x - T_2}{R_2}$$

$$T_x = \underline{\qquad}$$

QUESTIONS BASED ON

HEAT CURRENT IN DIFFERENT CIRCUITS



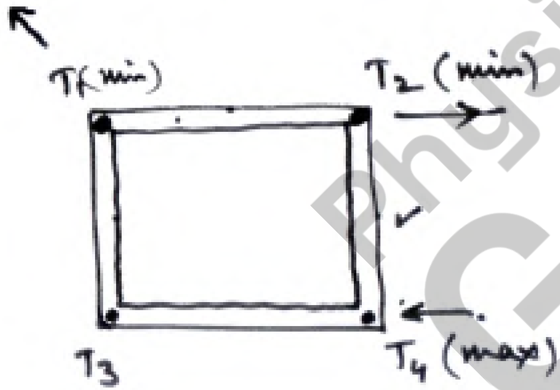


$$q = \frac{T_1 - T_2}{R_{eq}}$$

$$R_{eq} = R_1 + \frac{R_2 R_4}{R_2 + R_4} + R_3$$

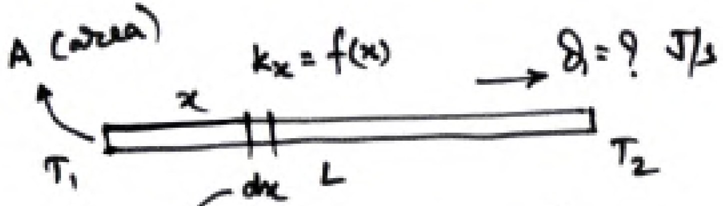
$$\frac{T_x - T_3}{R_3} + \frac{T_x - T_2}{R_2} + \frac{T_x - T_1}{R_1} = 0$$

$$T_x = \text{—}$$



Questions Based on

Variation in Thermal Conductivity

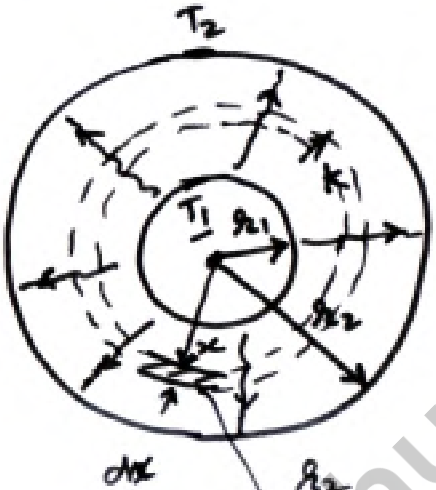


$$R_{th} = \int dR = \int \frac{1}{K} \cdot \frac{dx}{A} = \frac{1}{A} \int_0^L \frac{dx}{f(x)} = \_\_\_\_$$

$$\dot{Q} = \frac{T_1 - T_2}{R_{th}}$$

QUESTIONS BASED ON
HEAT CONDUCTION IN SPHERICAL SHELL

$T_1 > T_2$



$$\frac{dH}{dt} = Q_{th} = \frac{T_1 - T_2}{(r_2 - r_1)} \cdot 4\pi k r_1 r_2$$

$$R_{th} = \int dR = \int_{r_1}^{r_2} \frac{1}{k} \cdot \frac{dx}{4\pi x^2} = \frac{1}{4\pi k}\left[-\frac{1}{x}\right]_{r_1}^{r_2}$$

$(2\pi x l)$
if it is cylindrical shell

$$R_{th} = \frac{r_2 - r_1}{4\pi k r_1 r_2}$$

QUESTIONS BASED ON

RADIATION & ABSORPTION BY NON-BLACK BODIES

Surr temp = T_s

Total radiation power for BB

$$P_{th} = \sigma A T^4 - \sigma A T_s^4 = \sigma A (T^4 - T_s^4)$$

for Non-black bodies, we use

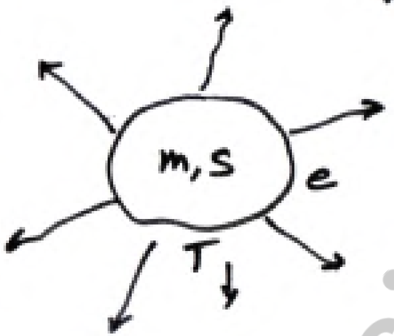
emissivity (e) & absorptivity (a)

$0 \le e \le 1$ $\quad$ $0 \le a \le 1$

$$P_{th} = e\sigma A T^4 - a\sigma A T_s^4$$

QUESTIONS BASED ON

COOLING OF A BODY BY RADIATION



vacuum 0K / T_s in space.

Radiation power $= \sigma T^4 \times e$ J/s-m²

heat current $= \underline{\sigma A T^4 e}$ watt

rate of cooling $\frac{dT}{dt}$ (°C/s) of body is related to heat current as-

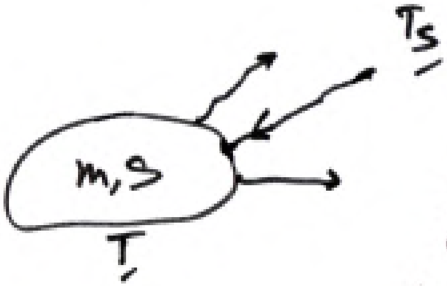
$\Delta Q = -ms\,\Delta T\downarrow$

$\frac{dQ}{dt} = -ms\frac{dT}{dt}$ → $eA\sigma T^4 = ms\frac{dT}{dt}$

$\frac{dT}{dt} = \frac{eA\sigma T^4}{ms}$ °C/s

QUESTIONS BASED ON

COLLING OF A BODY PLACED AT A SURROUNDING TEMPERATURE



for a black body

$$\frac{dH}{dt} = \underbrace{ms\frac{dT}{dt}}_{\text{heat current}} = (\sigma T^4 - \sigma T_s^4)A$$

$$\left|\frac{dT}{dt}\right| = \frac{\sigma A}{ms}(T^4 - T_s^4)$$

for a genr body

$$ms\frac{dT}{dt} = \sigma e A T^4 - \sigma a A T_s^4$$

$$\frac{dT}{dt} = \frac{\sigma A}{ms}\left[eT^4 - aT_s^4\right]$$

QUESTIONS BASED ON

COLLING OF A BODY WHEN $T \approx T_S$

Newton's law of Cooling ✓

T_s

v. imp

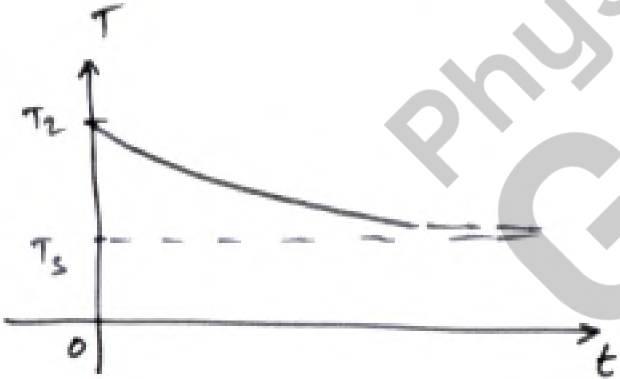
depends on T_s, A, e

$$\boxed{\checkmark \; \frac{dT}{dt} = -\frac{C}{ms}(T - T_s)}$$

$$\int_{T_2}^{T_t} \frac{dT}{T - T_s} = -\frac{C}{ms}\int_0^t dt$$

$$\ln\left(\frac{T - T_s}{T_2 - T_s}\right) = -\frac{Ct}{ms}$$

$$T = T_s + (T_2 - T_s)e^{-Ct/ms}$$



QUESTIONS BASED ON AVERAGE FORM OF NLC

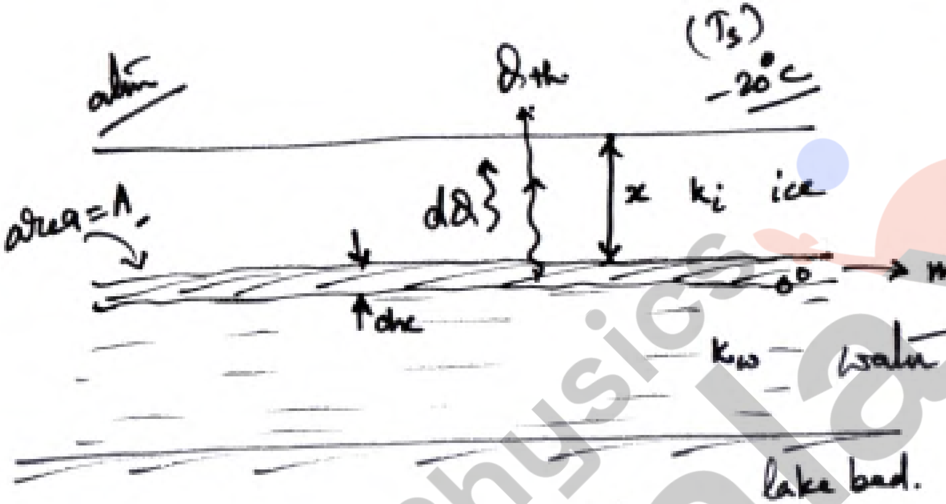
$$\frac{dT}{dt} = -\frac{C}{ms}(T - T_s)$$

if body cooling down from T_2 to T_1 in δt seconds

$$\boxed{\frac{T_2 - T_1}{\delta t} = -\frac{C}{ms}\left(\frac{T_1 + T_2}{2} - T_s\right)}$$

Questions Based on

Freezing of a Lake



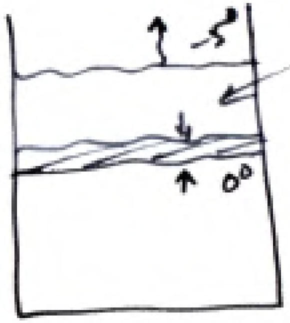
$$\mathcal{Q}_{th} = \frac{k_i A (T_s)}{x} \quad J/s$$

$$\frac{d\mathcal{Q}}{dt} = \left[\frac{k_i A T_s}{x}\right] = A\rho\, dx \cdot L_f$$

$$\rightarrow \text{mass} = A\,dx \cdot \rho$$

$$\int_0^t dt = \int_0^x \frac{A\rho L_f\, x\, dx}{k_i A T_s}$$

$$t = \frac{\rho L_f}{k_i T_s} \cdot x^2$$



Supercooled water at $T = -5°C$

$$t \propto x^2$$

QUESTIONS BASED ON

SOLAR CONSTANT

Intensity on earth's orbit

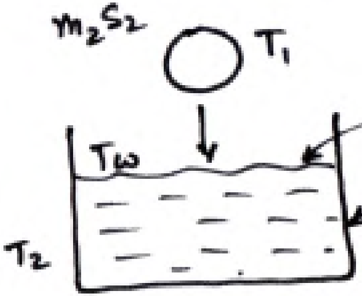
$$I = \frac{P_{th}}{4\pi r_e^2} \quad W/m^2$$

$$\Rightarrow S = \frac{\sigma T_s^4 (R_s^2)}{r_e^2}$$

(P_{th}) Rad power $= \sigma T_s^4 \cdot (4\pi R_s^2)$

Questions Based on

Placing a Hot Metal Shpere in a Liquid Both



water (m_1, s_1)

water eq^n $w_1 = \underline{m_3 s_3}$ in gms.

$$\text{Mixture} = \text{Everything at } 0^\circ C + \left\{ \frac{[m_2 S_2 T_1 + m_1 s_1 T_w + m_3 S_3 T_4]}{- Q} \right\}$$

$$= \text{Everything at } 100^\circ C + (\;\;)$$

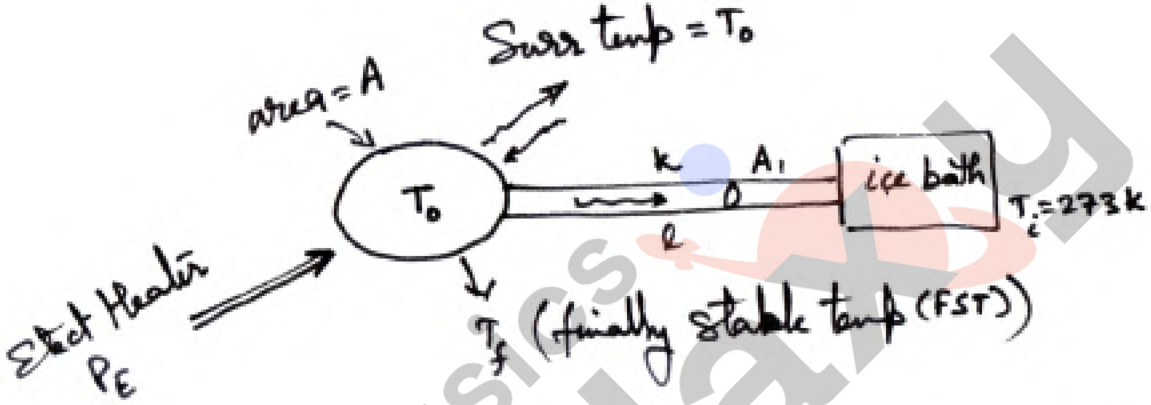
amount of vapour produced $= \dfrac{(\;\;)}{L_v}$

Heat reqd to raise the temp of mixture from 0 to 100 is

$$Q = [m_2 S_2 (100) + m_1 S_1 (100) + m_3 S_3 (100)]$$

QUESTIONS BASED ON

EQUILIBRIUM FOR RADIATION & HEATING TOGETHER



by Conservation of energy

if cond is present

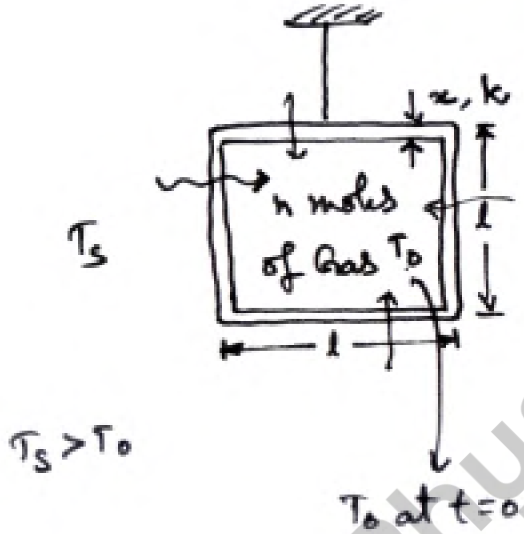
$$P_E + \sigma A a T_0^4 = \sigma A e T_f^4 \left(+ \frac{kA_1(T_f - 273)}{l} \right)$$

$T_f =$ ____ Ans

QUESTIONS BASED ON

HEATING OF A GAS BY CONDUCTION

Q: find gas temp as a f^n of time t



$$\frac{dH}{dt} = \frac{k(6l^2)(T_s - T)}{x}$$

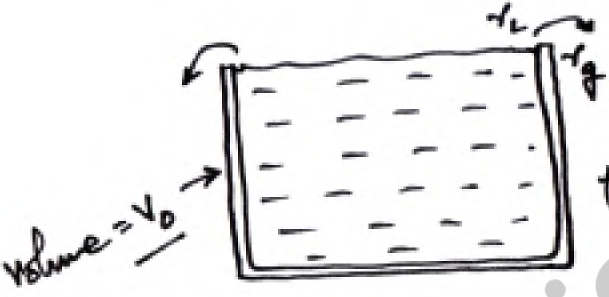
$$\int_{T_0}^{T_f} \frac{nC_v\,dT}{T_s - T} = \int_0^t \frac{6kl^2}{x}\,dt$$

$\Rightarrow$ --- $T_f =$ ——

Questions Based on

Apparent Expansion of a Liquid

As $\gamma_L > \gamma_g \Rightarrow$ liq will expand more



temp ↑ by ΔT

* overflow volume $\Delta V_{of} = V_0 \underbrace{(\gamma_L - \gamma_g)}_{\gamma_{ap}} \Delta T$

$\gamma_{ap} \rightarrow$ Coeff of app exp of liq w.r.to glass.

$A_T = A_i (1 + 2\alpha_g \Delta T)$

temp ↑ by ΔT

$$h = \frac{\Delta V_{of}}{A_{Tube}}$$

QUESTIONS BASED ON

PENDULUM CLOCK VS DIGITAL CLOCK

temp invariant

time lost/gained per sec compared to DC

In Summers → clock slows down

In Winters → clock speeds up

$$\frac{\delta t}{t} = \frac{1}{2}\alpha \Delta T$$

rise/fall of temp from graduation temp of Pendulum clock.

T_{PC}

QUESTIONS BASED ON

THERMOMETRY RELATION

$$\left[\frac{\text{Temp at X Scale} - LFP}{UFP - LFP}\right] = \text{Constant}$$

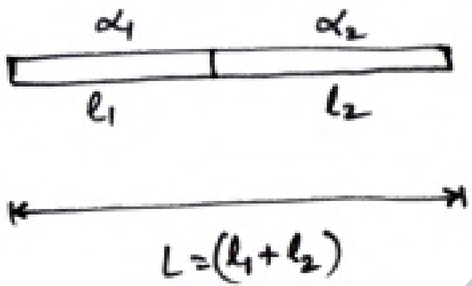
$°C \longrightarrow \overset{L}{0}$ to $\overset{U}{100°}$

$°F \longrightarrow 32$ to $212°$

$K \longrightarrow 273$ to $373K$

Questions Based on

Equivalent Coefficient of Expansion



temp ↑ by ΔT

$$l_f = L(1+\alpha_{eq}\Delta T)$$

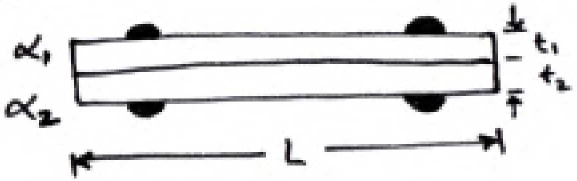
$$l_f = l_1(1+\alpha_1\Delta T) + l_2(1+\alpha_2\Delta T)$$

$$\alpha_{eq} = - - - -$$

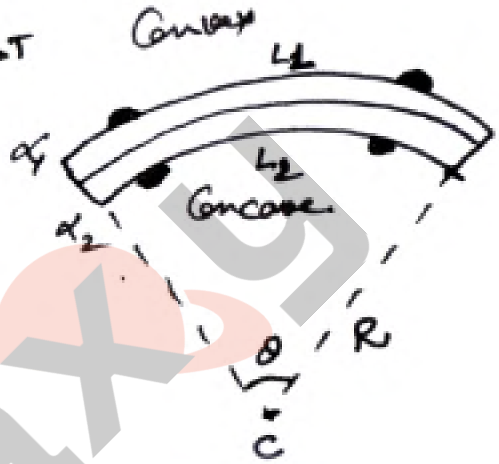
Questions Based on

Expansion of Riveted Rods

$\alpha_1 > \alpha_2$



temp ↑ by ΔT



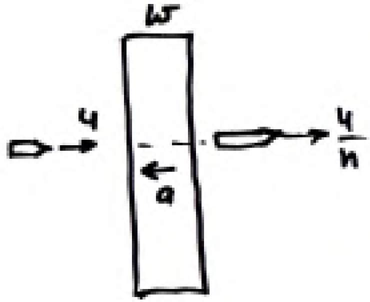
$$\left[\ \theta = \frac{L_2}{R} = \frac{L_1}{R + \frac{t_1}{2} + \frac{t_2}{2}}\ \right]$$

Revision Booster
WORKSHOP
for
NEET & JEE Main

MECHANICS
Kinematics & Laws of Motion

Questions Based on

Bullet Penetrating A Plank



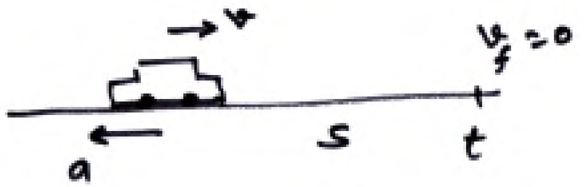
$$\left(\frac{u}{n}\right)^2 = u^2 - 2aw \longrightarrow a = \text{—}$$

$$0 = u^2 - 2a(nw) \longrightarrow n = ---$$

$$\left(\frac{u}{m}\right)^2 = u^2 - 2aw' \longrightarrow w' = ---$$

Questions Based on

Breaking of a Car



$$a = \frac{v^2}{2s} = \frac{v}{t}$$

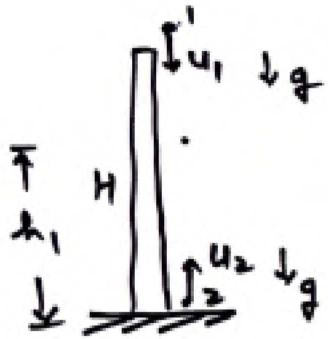
$\rightarrow v'$

$$s' = ? \quad \left[t' = ? = \frac{v'}{v} \cdot t\right]$$

$$\left[s' = \frac{v'^2}{2a} = \frac{v'^2}{v^2} \cdot s\right]$$

Questions Based on

Projection From Tower



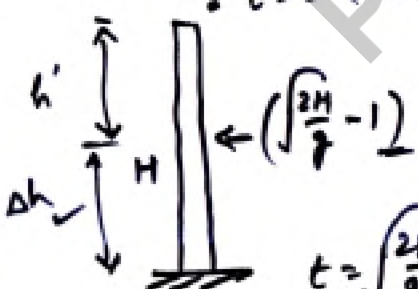
$a_{rel} = 0$

time to collide

$$t = \frac{H}{u_1 + u_2}$$

$$h_1 = u_2 t - \frac{1}{2} g t^2$$

$t = 0$ (drop $u = 0$)



$$t = \sqrt{\frac{2H}{g}}$$

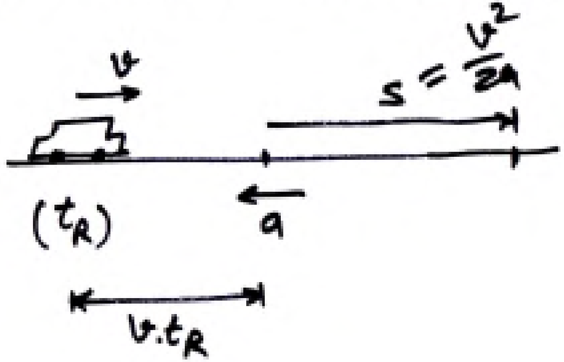
find dist trav in last sec of motion

$$h' = \frac{1}{2} g \left(\sqrt{\frac{2H}{g}} - 1\right)^2$$

$$\Delta h = H - h' = \text{—}$$

Questions Based on

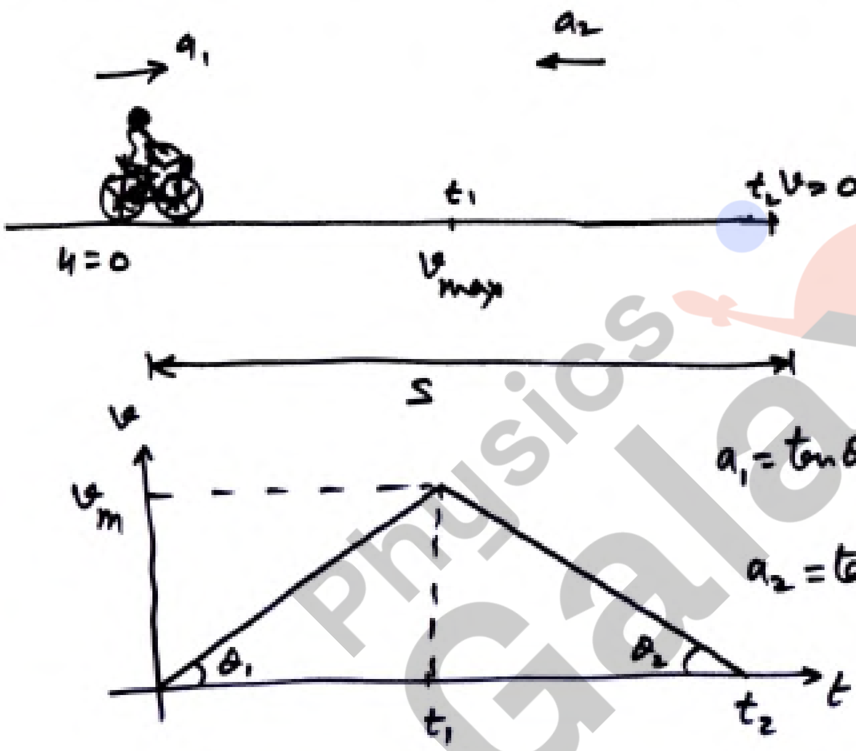
Cases of Reaction Time



Total breaking distance $= v.t_R + \frac{v^2}{2a}$

QUESTIONS BASED ON

DISTANCE COVERED IN ACCELERATION & RETARDATION CASES



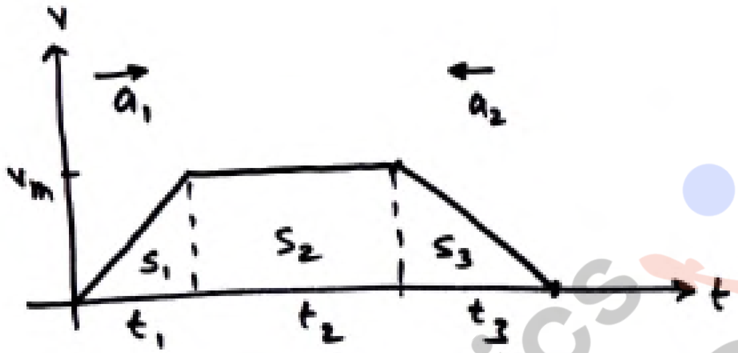
$a_1 = \tan\theta_1 = \frac{v_m}{t_1}$ ✓

$a_2 = \tan\theta_2 = \frac{v_m}{t_2 - t_1}$ ✓

$S = \frac{1}{2} v_m t_2$ ✓

Questions Based on

Journey With Acceleration, Uniform Motion & Retardation



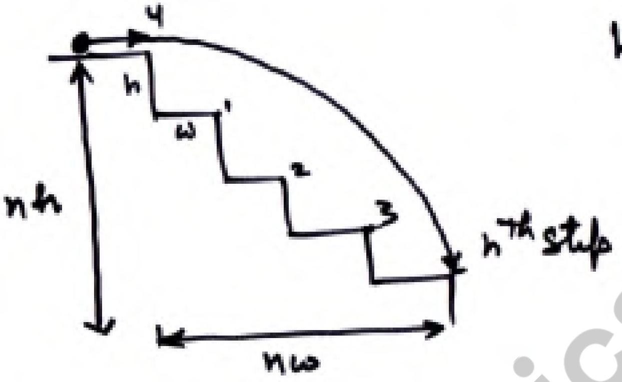
$$s_2 = v_m t_2$$

$$s_1 = \frac{1}{2} v_m t_1 = \frac{v_m^2}{2a_1} \qquad s_3 = \frac{1}{2} v_m t_3 = \frac{v_m^2}{2a_2}$$

$$a_1 = \frac{v_m}{t_1} \quad ; \quad a_2 = \frac{v_m}{t_3}$$

QUESTIONS BASED ON

BALL ROLLING OVER STEPS



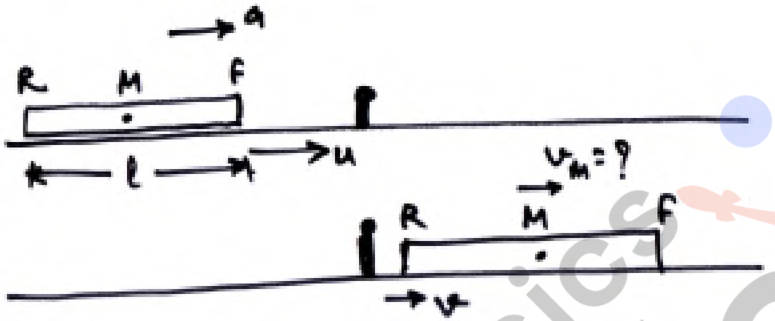
horiz proj → eq^n

$$y = -\frac{gx^2}{2u^2}$$

$$-nh = -\frac{g(nw)^2}{2u^2}$$

Questions Based on

Train Passing a Pole



$$v^2 = u^2 + 2al$$

$$v_M^2 = u^2 + 2a(l/2)$$

$$v_M = \sqrt{\frac{v^2 + u^2}{2}} \quad \text{Ans}$$

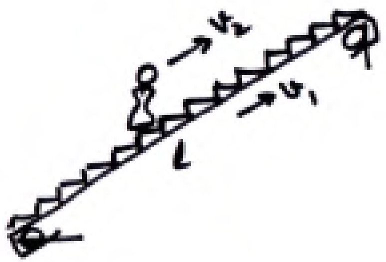
$$v = u + at$$

$$v_M = u + at'$$

$$t' = \ldots$$

QUESTIONS BASED ON

PERSON WALKING ON ESCALATOR



if only man is walking $t_2 = \dfrac{l}{v_2}$

if only esc is moving $t_1 = \dfrac{l}{v_1}$

if man is walking on moving esc $t_f = \dfrac{l}{v_1 + v_2} = \dfrac{t_1 t_2}{t_1 + t_2}$

Questions Based on

Variable Motion Cases

$a = b\sqrt{x}$

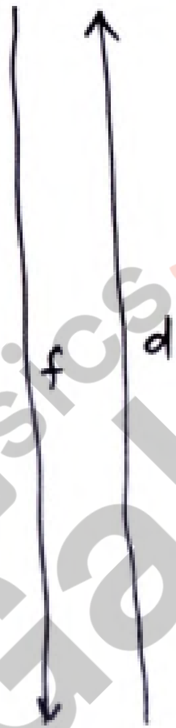
$\frac{v\,dv}{dx} = b\sqrt{x}$

$\int_u^v v\,dv = \int_0^x b\sqrt{x}\,dx$

$\frac{dx}{dt} = v = \frac{f(x)}{}$

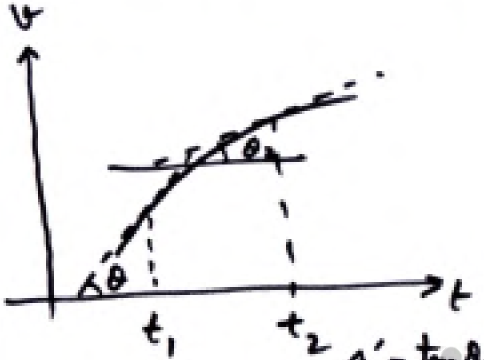
$\int_0^x \frac{dx}{f(x)} = \int_0^t dt$

$x = f_1(t)$



QUESTIONS BASED ON

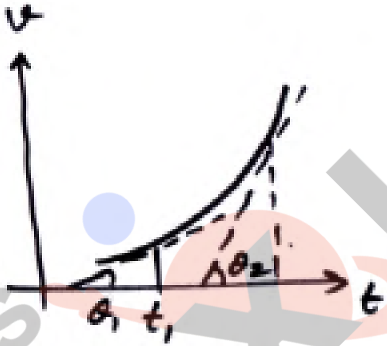
SLOPE ANALYSIS OF CURVES



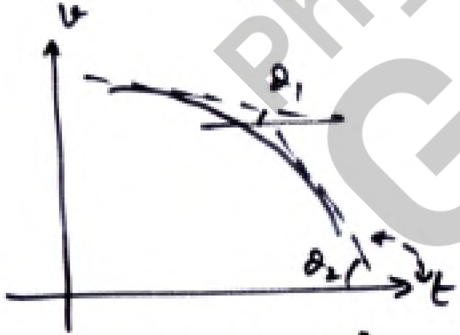
$a' = \tan\theta_2 \rightarrow +ve$

$a = \tan\theta \rightarrow +ve$

$a' < a$



$a \uparrow +ve$



$a \rightarrow \underline{-ve} \uparrow$

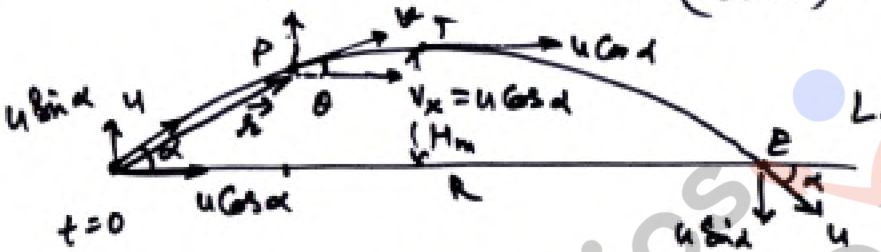
$a \rightarrow -ve \downarrow$

Questions Based on

Angle of Motion in Projectile

$v_y = u\sin\alpha - gt$

$\vec{r} = (u\cos\alpha\, t)\hat{i} + (u\sin\alpha\, t - \tfrac{1}{2}gt^2)\hat{j}$



$L_T = m(u\cos\alpha)H_m$

$L_E = mu\sin\alpha \cdot \underline{R}$

$\theta = \tan^{-1}\frac{v_y}{v_x} = \tan^{-1}\left(\frac{u\sin\alpha - gt}{u\cos\alpha}\right)$

Angular momentum in Projectile motion:

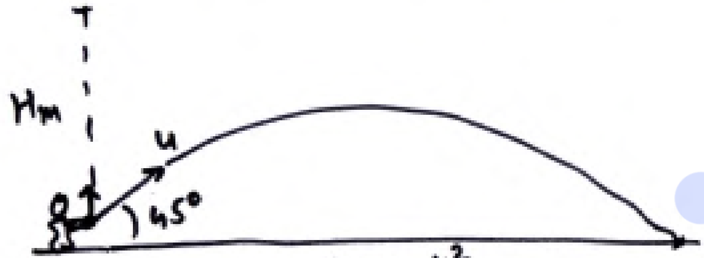
$\vec{L} = m(\vec{r}\times\vec{v})$

$\vec{L} = m[\ \longrightarrow\ ]\times[u\cos\alpha\,\hat{i} + (u\sin\alpha - gt)\hat{j}]$

$= \underline{\qquad}$

Questions Based on

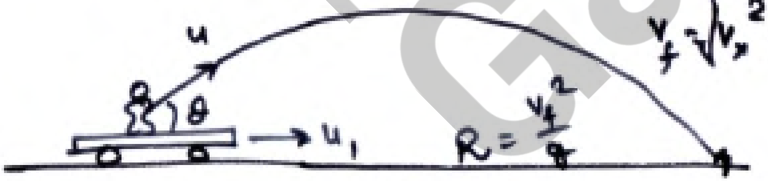
Maximum Projection Capacity



$$R_H = \frac{u^2}{g} = 2H_m$$

$$H_m = \frac{u^2}{2g}$$

$u = \sqrt{2gH_m}$ (max speed)



$$v_f = \sqrt{v_x^2 + v_y^2}$$

$$R = \frac{v_f^2}{g}$$

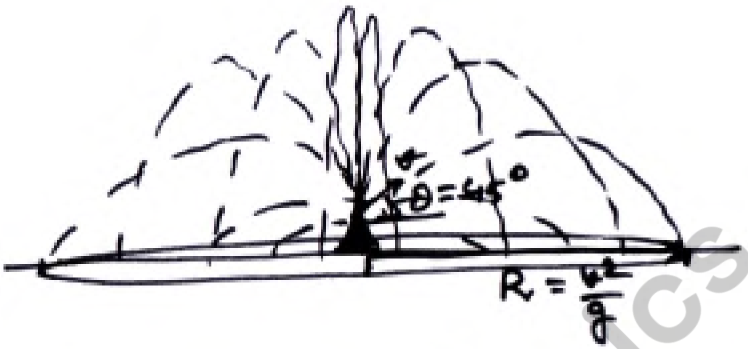
$$\left.\begin{aligned} v_x &= u_1 + u\cos\theta \\ v_y &= u\sin\theta \end{aligned}\right] \text{ for } \theta_g = 45^\circ$$

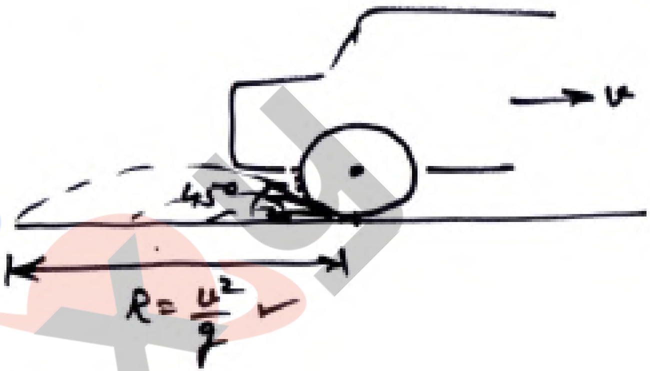
$$u_1 + u\cos\theta = u\sin\theta$$

$\theta =$

QUESTIONS BASED ON

WATER FOUNTAIN WETTING THE GROUND



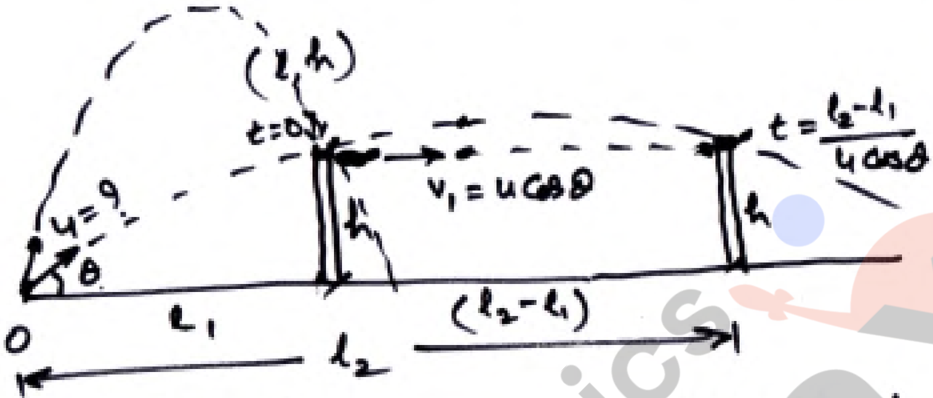


max area wetting is

$$A = \pi R^2 = \frac{\pi v^4}{g^2}.$$

QUESTIONS BASED ON

PROJECTILE CLEARING A WALL : BIRD FLIGHT CASE



eqⁿ of traj

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

$$h = l\tan\theta - \frac{gl^2}{2u^2\cos^2\theta}$$

if θ is reqd

$$h = l\tan\theta - \frac{gl^2}{2u^2}(1+\tan^2\theta)$$

$\theta = \text{—}, \text{—}$

$u = \text{—}$

QUESTIONS BASED ON

ANGLE BETWEEN $\vec{v}$ & $\vec{a}$ IN GENERAL 2D MOTION

$t = (x/\alpha)^{1/3}$

$a_x = 6\alpha t \xleftarrow{d} \left[v_x = 3\alpha t^2 \xleftarrow{d} \left[x = \alpha t^3 \right. \right.$

$a_y = 12\beta t^2 + 2\gamma \qquad v_y = 4\beta t^3 + 2\gamma t \qquad y = \beta t^4 + \gamma t^2$

$y = f(x)$

$\frac{dy}{dx} = \_\_\_ = \tan\theta$

$\vec{v} = v_x\hat{i} + v_y\hat{j}$

$\vec{a} = a_x\hat{i} + a_y\hat{j}$

$\rightarrow \tan\theta = \frac{v_y}{v_x}$

at $t = t_1$

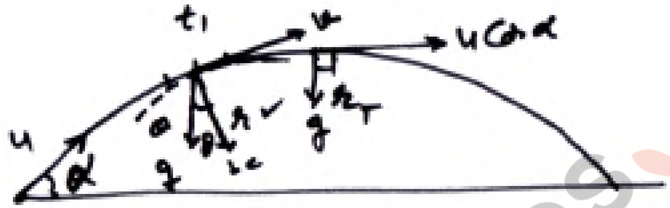
$\theta = \cos^{-1}(\hat{a}\cdot\hat{v})$

✓ $= \_\_\_\_$

eliminate t betwn x and y to get eqn of traj

Questions Based on

Radius of Curvature in a Trajectory



$$\checkmark \; r = \frac{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\left|\frac{d^2y}{dx^2}\right|} = \_\_\_\_$$

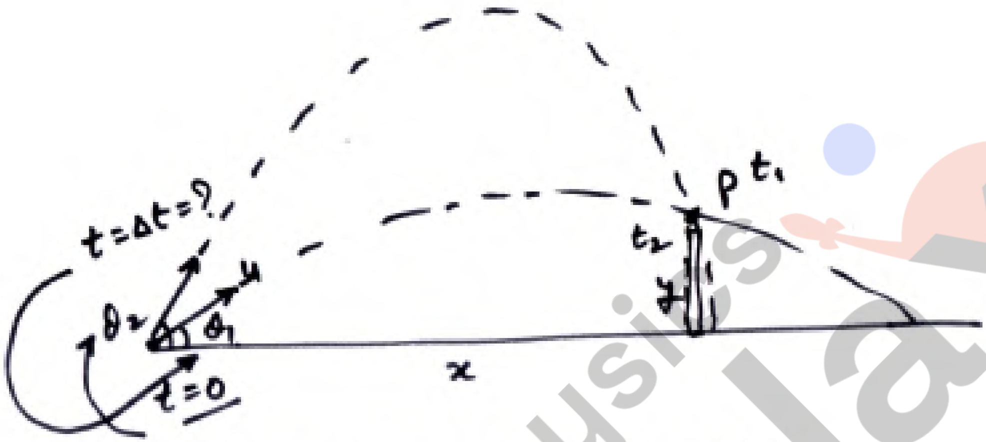
radial accⁿ $\quad a_r = g\cos\theta = \frac{v^2}{r}$

$$\Rightarrow r = \frac{v^2}{g\cos\theta}$$

at topmost pt $\quad g = \frac{v^2}{r_T} = \frac{u^2\cos^2\theta}{r_T} \Rightarrow r_T = \frac{u^2\cos^2\theta}{g}$

Questions Based on

Collison of Two Projectiles



$$\left[\begin{aligned} x &= u\cos\theta_2\, t_2 = u\cos\theta_1 \cdot t_1 \\ y &= u\sin\theta_2 \cdot t_2 - \tfrac{1}{2} g t_2^2 = u\sin\theta_1\, t_1 - \tfrac{1}{2} g t_1^2 \end{aligned}\right]$$

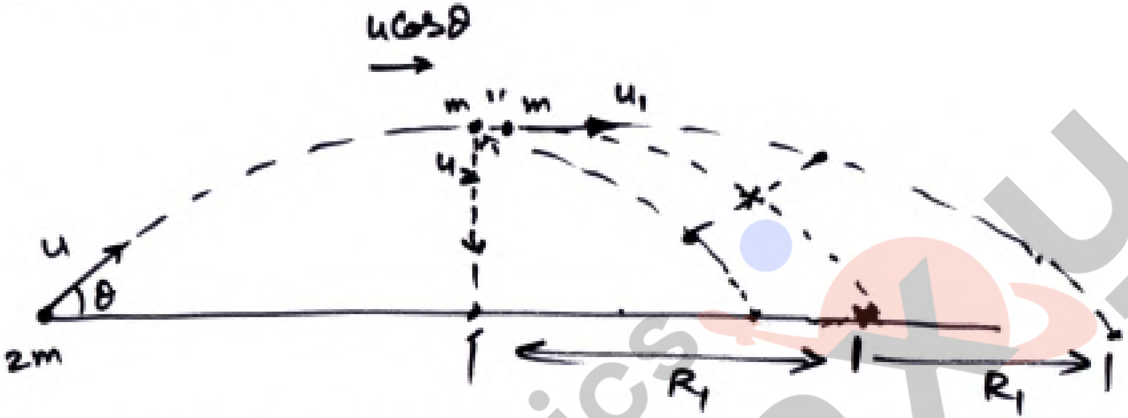
$t_1 =$ ———

$t_2 =$ ———

$\Delta t = t_2 - t_1$

Questions Based on

Explosion in a Projectile



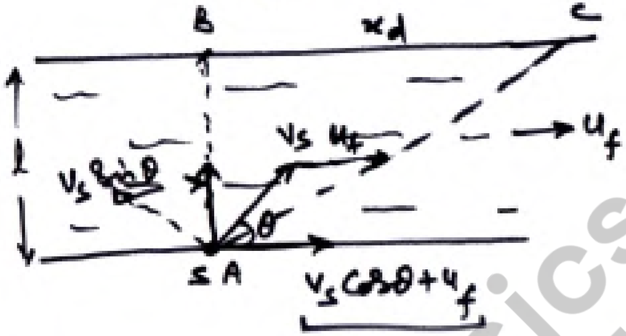
$$2m(u\cos\theta) = mu_1 + mu_2$$

If $\underline{u_2 = 0}$

Questions Based on

River-Swimmer Cases

$t = \frac{l}{v_s \sin\theta}$

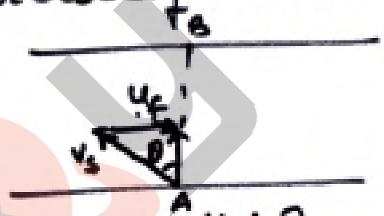


$$\left[x_d = (v_s \cos\theta + u_f) \cdot \frac{l}{v_s \sin\theta} \right]$$

for x_d to be min $\left[\frac{dx_d}{d\theta} = 0 \quad \theta = \text{—} \right]$

for min time to cross $\theta = 90^\circ$

for crossing at shortest path.

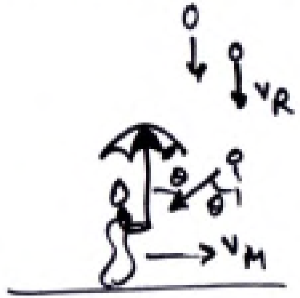


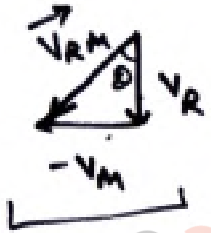
$$\left[\theta = \sin^{-1}\left(\frac{u_f}{v_s}\right) \right]$$

if $v_s < u_f$ then this is NOT possible.

Questions Based on

Rain Man Problems

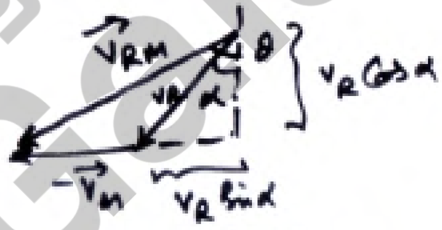




$$\theta = \tan^{-1}\left|\frac{v_M}{v_R}\right|$$

Vel of rain drops w.r.t man

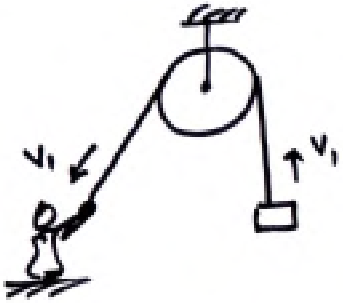
$$\left[\vec{v}_{RM} = \vec{v}_R - \vec{v}_M\right]$$

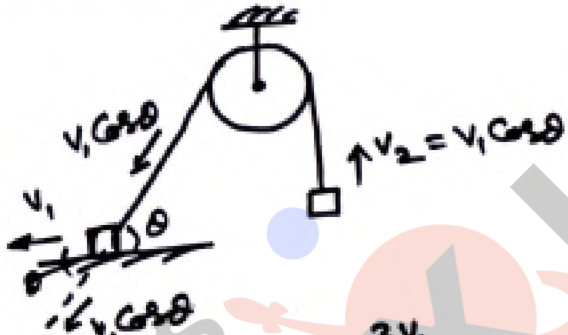


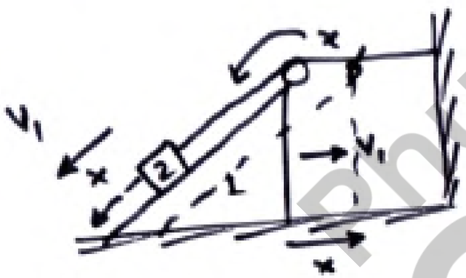
$$\theta = \tan^{-1}\left(\frac{v_M + v_R \sin\alpha}{v_R \cos\alpha}\right) \text{ Ans.}$$

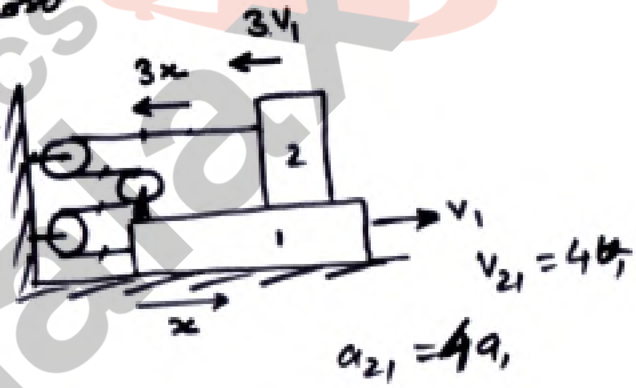
Questions Based on

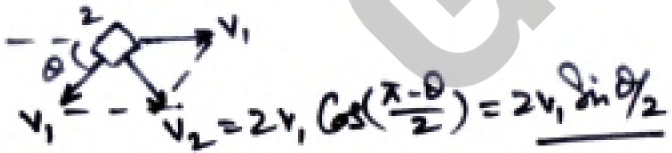
String Constrained Relations









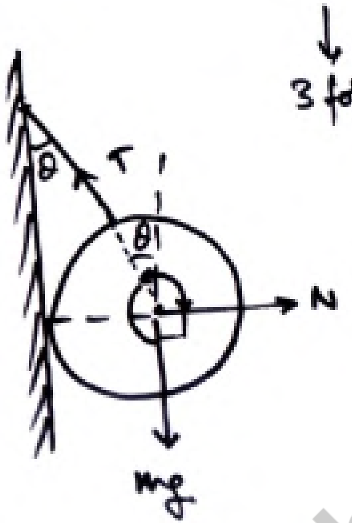


Questions Based on

Applications of Lami's Theorem

Ex

3 forces are in eq^n

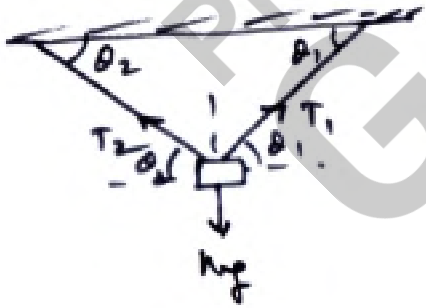


$$\frac{T}{\sin 90^\circ} = \frac{N}{\sin(\pi-\theta)} = \frac{mg}{\sin(\pi/2+\theta)}$$

$T = \_\_\_$

$N = \_\_\_$

Ex.



$$\frac{T_1}{\sin(90+\theta_2)} = \frac{T_2}{\sin(90+\theta_1)} = \frac{mg}{\sin(180-\theta_1-\theta_2)}$$

$T_1 = \_\_\_$

$T_2 = \_\_\_$

Questions Based on

Thrust on a Rocket

$F_{th} \leftarrow$ due to ejection of gases

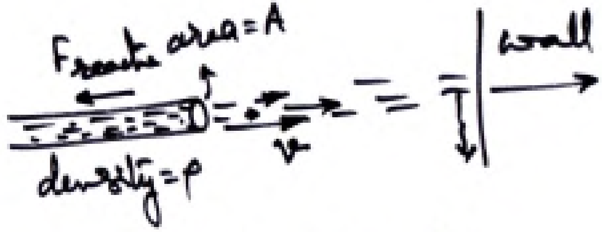
$$\boxed{F_{th} = \lambda u}$$

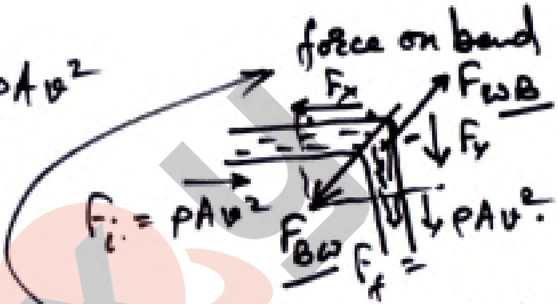
at $t=0$

after time $t \longrightarrow m = M - \lambda t$

Questions Based on

Force Due to Ejection of Water From Pipe





volume flow rate = Av m^3/s

mass/sec = $\rho A v$ kg/s

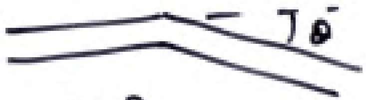
momentum/sec = $\rho A v \times v = \rho A v^2$ newton = F_{react}

(force)

Power → KE/sec = $\frac{1}{2}\rho A v \cdot v^2 = \frac{1}{2}\rho A v^3$

$\vec{\Delta P} = \sqrt{2}\rho A v^2$ ans

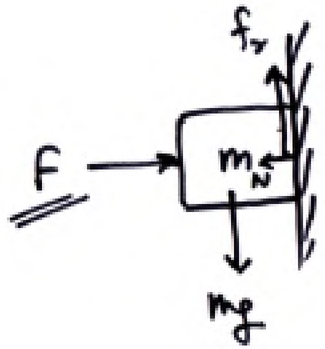
$|F_{BW}| = |F_{wB}|$



$F = ?$

Questions Based on

Friction on a Block Supported on Wall



$N = F$

$\underline{f_r = mg.}$ as block is at rest

$f_{rL} = \mu F$

for block not to fall $mg \le \mu F$

$F \ge \frac{mg}{\mu}$ ✓

if a horiz force parallel to wall F_w is applied on block then we use

$\sqrt{F_w^2 + (mg)^2} \le \mu F$

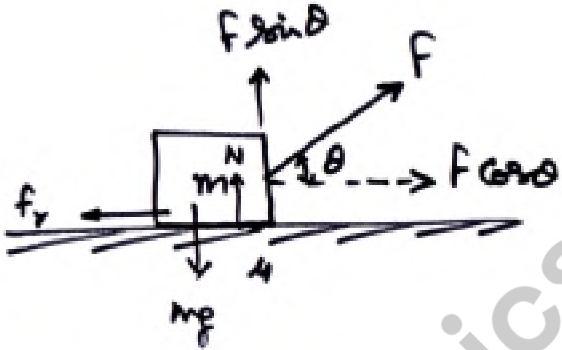
$F \ge \frac{\sqrt{F_w^2 + (mg)^2}}{\mu}$

$f_w =$ ______

$m =$ ______

Questions Based on

Minimum Force Required to Slide a Block



$N = mg - F\sin\theta$

to slide the block

$F\cos\theta \geq \mu(mg - F\sin\theta)$

$F \geq \dfrac{\mu mg}{\cos\theta + \mu\sin\theta}$

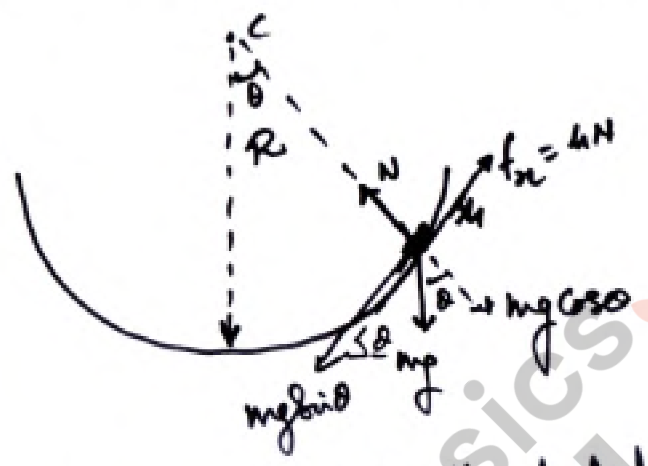
F is min when $\dfrac{dF}{d\theta} = 0$

$\theta = \tan^{-1}(\mu)$ ✓

$F = \dfrac{\mu mg}{\sqrt{1+\mu^2}}$ ✓

QUESTIONS BASED ON

SLIDING CONDITION ON A CIRCULAR TRACK



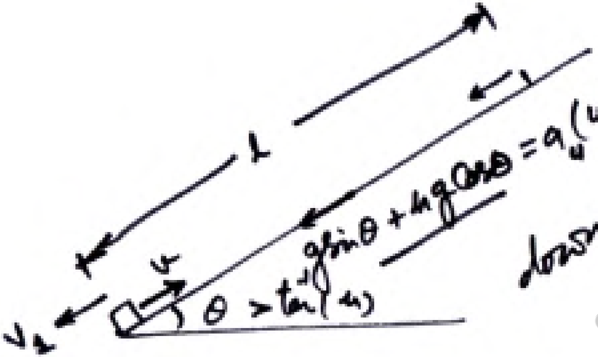
insect will reach a pt without sliding

$$mg\sin\theta = \mu mg\cos\theta$$

$$\theta = \tan^{-1}(\mu)$$

QUESTIONS BASED ON

SLIDING UP & DOWN AN INCLINE



$g\sin\theta + \mu g\cos\theta = a_u$ (upward motion)

downward motion

$a_d = g\sin\theta - \mu g\cos\theta$

$v_1 = \sqrt{2a_d \cdot l}$

$l = \frac{u^2}{2a_u}$

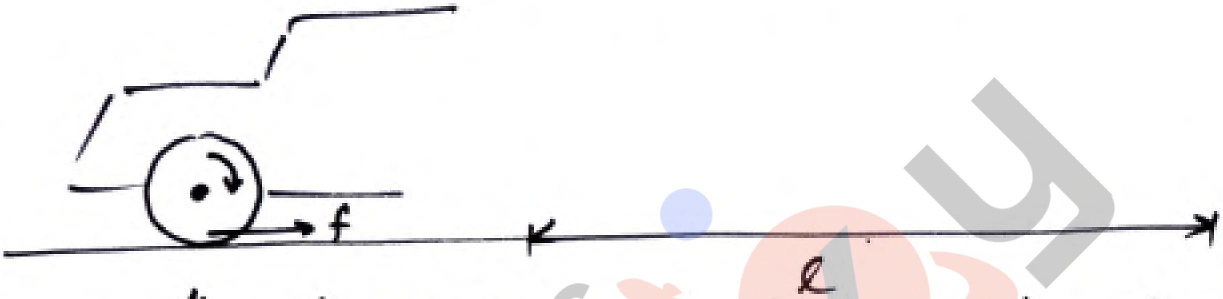
$t_u = \sqrt{\frac{2l}{a_u}} = \frac{u}{a_u}$

$t_{down} = \sqrt{\frac{2l}{a_d}}$

$$\frac{t_{up}}{t_{down}} = \sqrt{\frac{a_d}{a_u}} = \sqrt{\frac{\cancel{g}(\sin\theta - \mu\cos\theta)}{\cancel{g}(\sin\theta + \mu\cos\theta)}}$$

QUESTIONS BASED ON

MAXIMUM ACCELERATION OF A CAR ON ROAD



μ

(max) $\rightarrow f_{sL} = \mu mg$

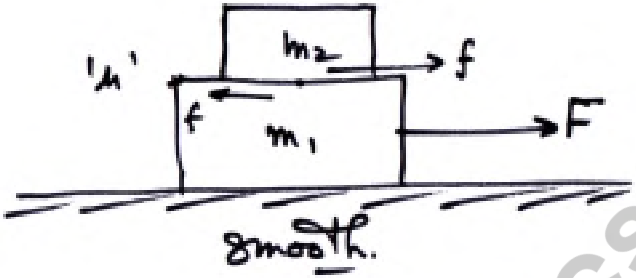
min time $= t_{min} = \sqrt{\frac{2l}{\mu g}}$

max accⁿ $a_{max} = \frac{f_{sL}}{m} = \underline{\mu g}$

max accⁿ of a runner on a racing track!

Questions Based on

Block Over Block Basic Cases



Common accⁿ $a_c = \frac{F}{m_1+m_2}$

motion of m_2

$f = m_2 a_c = \mu m_2 g$

m_2 will slide when $F =$ ____ Ans

$a_c = \frac{F - \mu_1(m_1+m_2)g}{m_1+m_2}$

$f = m_2 a_c = \mu_2 m_2 g$

$F =$ ____ Ans

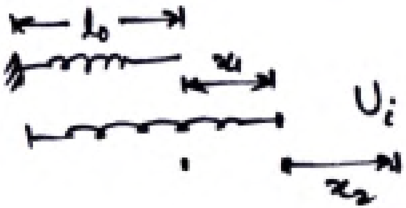
Revision Booster
WORKSHOP
for
NEET & JEE Main

MECHANICS

Work, Energy, Power, SOP & RBD

QUESTIONS BASED ON

WORK DONE IN EXTENDING STRETCH IN A SPRING



$U_i = \frac{1}{2} k x_1^2$

$U_f = \frac{1}{2} k (x_1 + x_2)^2$

W/D in ext $\quad W = U_f - U_i =$

QUESTIONS BASED ON

A BODY MOVING AT CONSTANT POWER

$F \longrightarrow \boxed{m} \xrightarrow{v}$

$\longrightarrow a = F/m$

$\underline{P = F.v} \rightarrow$ Const

$\underline{a.v = C}$

$v\dfrac{dv}{dx} = \dfrac{dv}{dt} = a = \dfrac{c}{v} \longrightarrow \int v^2 dv = \int c\,dx$

$\dfrac{v^3}{3} = Cx$

$\underline{v = (3c)^{1/3} x^{1/3}}$

$\int_0^v v\,dv = \int_0^t c\,dt$

$\dfrac{v^2}{2} = ct$

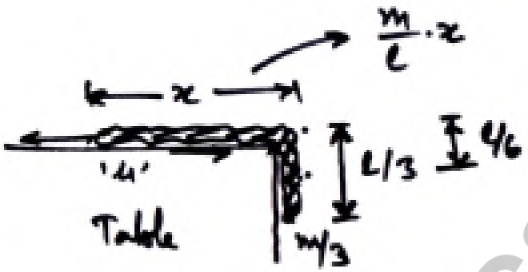
$\dfrac{dx}{dt} = v = k\sqrt{t}$

$\int dx = \sqrt{c}.\int t^{1/2} dt$

$x = \sqrt{c}\,\dfrac{2}{3} t^{3/2} \longrightarrow \underline{x \propto t^{3/2}}$

QUESTIONS BASED ON

CHAIN SLIDING ON A TABLE



if Table is Smooth $\underline{W} = \left(\frac{m}{3}\right) g \cdot \left(\frac{l}{6}\right) = \frac{1}{18} mgl$

" " is rough. $W = \int_{2l/3}^{l} \mu \left(\frac{m}{l} x\right) g \cdot dx + \frac{1}{18} mgl$

QUESTIONS BASED ON

A PARTICLE IN A POTENTIAL FIELD

$U_{(x)} = \left(\frac{x^4}{4} - \frac{x^2}{2}\right) J \longrightarrow$ Conservative field

force $F_{(x)} = -\frac{dU_{(x)}}{dx} = x^3 - x = 0$

$(x^2 - 1) \cdot x = 0$

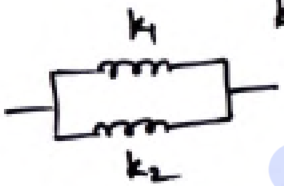
$\left.\begin{array}{l} x = 0 \\ \text{or} \quad x = \pm 1 \end{array}\right]$ Type of eq^n

E_x at a partical value of x $\left.\begin{array}{l} K_x = 5J \\ U_x = C_{(x)} \end{array}\right]$ $TE = 5 + C_{(x)} = $ Constant

QUESTIONS BASED ON

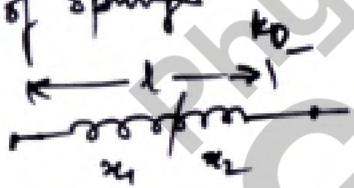
CASES OF SPRING COMBINATION

$$k_{eq} = \frac{k_1 k_2}{k_1 + k_2}$$



$$k_{eq} = k_1 + k_2$$

Cutting of Springs



n equal parts

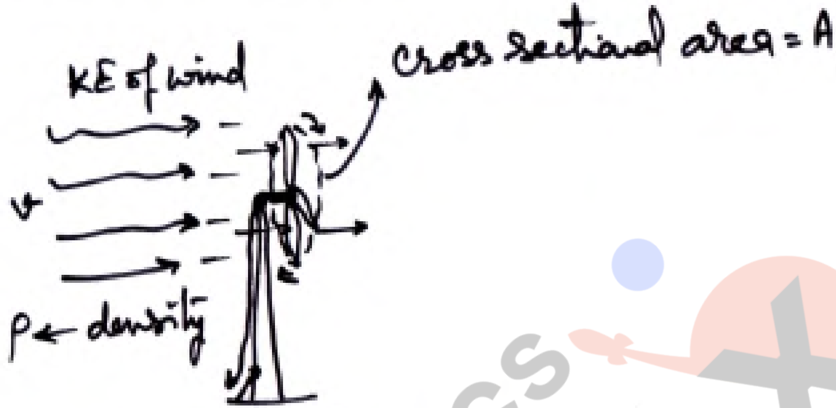
$k_{each} = nk_0$

k_1 k_2

$$k_1 = \frac{k_0 l}{x_1} \qquad k_2 = \frac{k_0 l}{x_2}$$

QUESTIONS BASED ON

POWER GENERATED BY A WIND MILL



volume flow rate of wind = Av

mass/sec $= \rho A v$

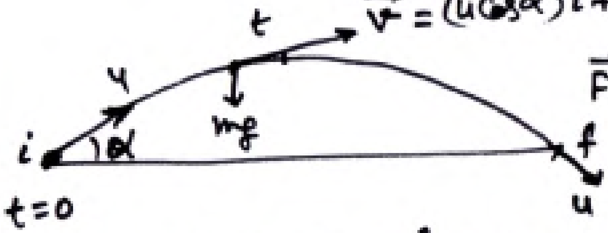
KE/sec $= \frac{1}{2}(\rho A v)v^2$

$= \underline{\frac{1}{2}\rho A v^3}$

$\underline{\underline{P_w \propto v^3}}$.

QUESTIONS BASED ON

AVERAGE POWER CALCULATION



$\vec{v} = (u\cos\alpha)\hat{i} + (u\sin\alpha - gt)\hat{j}$

$\vec{F} = -mg\hat{j}$

Power due to grav forces is $P_t = \vec{F}\cdot\vec{v}$

$P_t = -mg(u\sin\alpha - gt)$ ans

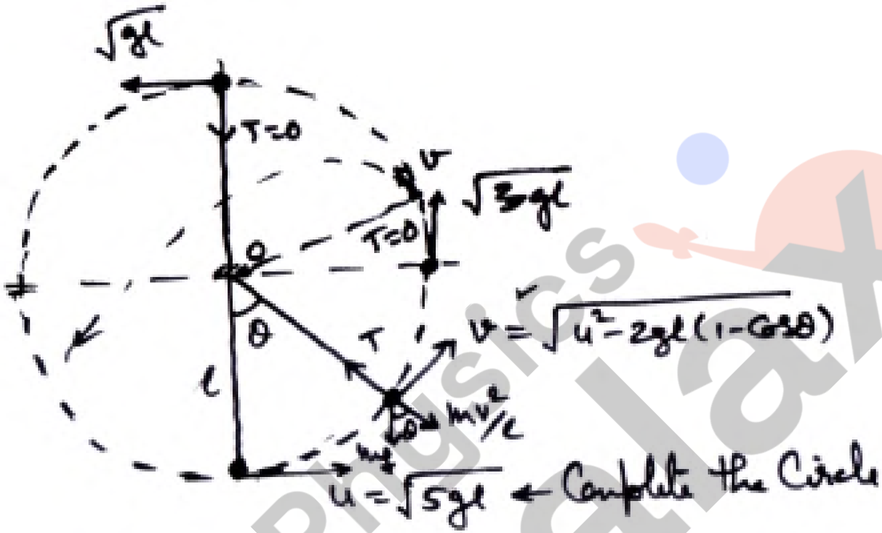
$$\langle P_{avg} \rangle = \frac{\Delta K}{\Delta t} = \frac{\Delta W}{\Delta t}$$

$$\underset{\text{whole ToF}}{P_{avg}} = \frac{0}{T_f} = 0$$

$$\underset{\text{start to Top}}{\langle P_{avg} \rangle} = \frac{-\left(\frac{1}{2}mu^2 - \frac{1}{2}mu^2\cos^2\alpha\right)}{(u\sin\alpha/g)}$$

Questions Based on

Cases Of Vertical Circular Motion



$$T = mg\cos\theta + \frac{mv^2}{l}$$

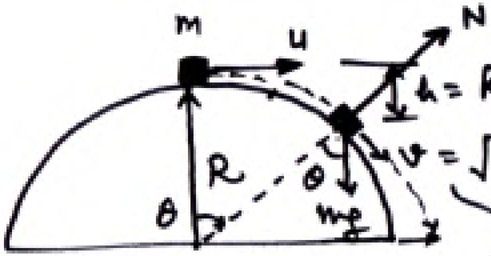
if $u \le \sqrt{2gl}$ ← Oscillate in lower half

$u \ge \sqrt{2gl}$ ← in upper half it may start projectile motion

QUESTIONS BASED ON

VERTICAL CIRCULAR MOTION OUTSIDE A CIRCULAR TRACK

$h = R[\cos\theta_1 - \cos\theta_2]$



$h = R(1-\cos\theta)$

$v = \sqrt{u^2 + 2gR(1-\cos\theta)}$ ✓

$v = \sqrt{2gh}$

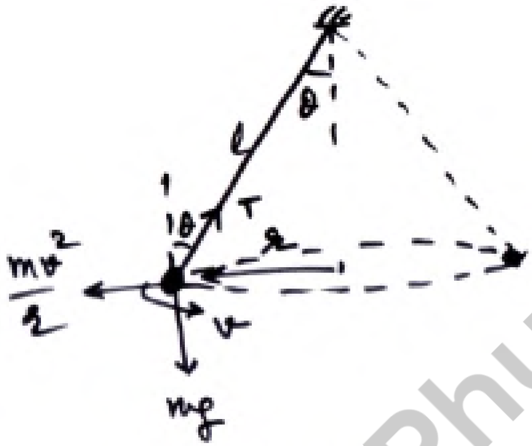
At angle θ $\quad N = mg\cos\theta - \frac{mv^2}{R}$

$\theta_2 = $ — Ans

Body will loose contact from surface
where $N = 0$

QUESTIONS BASED ON

ANALYSIS OF CONICAL PENDULUM



$r = l\sin\theta$

for stable UCM

$T\sin\theta = \frac{mv^2}{r}$

$T\cos\theta = mg$

$\left[\tan\theta = \frac{v^2}{rg}\right]$

$T = m\sqrt{g^2 + \frac{v^4}{r^2}}$

QUESTIONS BASED ON

POWER IN CIRCULAR MOTION

UCM

$a_t = 0$

$a_N = \frac{v^2}{r}$

$P = \vec{F}\cdot\vec{v} = (m\vec{a}_N)\cdot\vec{v} = 0$

NUCM

$P = \vec{F}\cdot\vec{v} = m(\vec{a}_t + \vec{a}_N)\cdot\vec{v}$

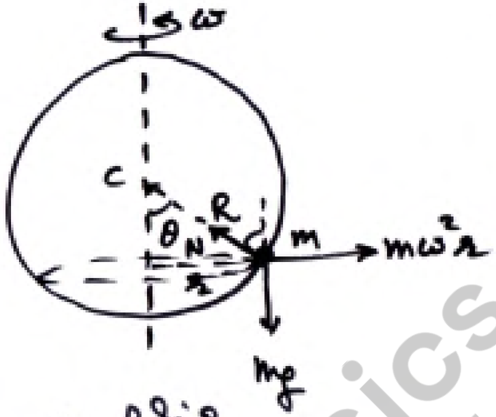
$P_t = m a_t v$ → +ve if accelerating, −ve if retarding

if $a_t = f(t)$

$v = \int_0^v dv = \int_0^t f(t)\,dt$

Questions Based on

Motion of a Bead on a Rotating Circular Wire



$r = R\sin\theta$

for eq^m of bead

$N\cos\theta = mg$

$N\cancel{\sin\theta} = m\omega^2 R\cancel{\sin\theta}$

QUESTIONS BASED ON

EXPLOSION OF A MOVING BODY

$\Downarrow$

$K_f > K_i$

only by internal

no external is present $\Rightarrow P_i = P_f$

by Cons. of linear momentum

$$\left[\begin{array}{l} 2mv_0 = mv_1\cos\theta_1 + mv_2\cos\theta_2 \\ mv_1\sin\theta_1 = mv_2\sin\theta_2 \end{array}\right]$$

QUESTIONS BASED ON

ELASTIC/PARTICAL ELASTIC HEAD ON COLLISION OF BODIES

$e = 1 \leftarrow$ elastic

$0 < e < 1$

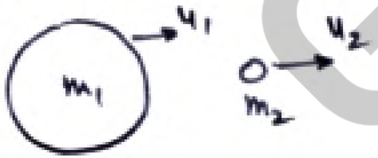
partial elastic

$u_1 > u_2$

$$\vec{v}_1 = \frac{m_1 - e m_2}{m_1 + m_2}\vec{u}_1 + \frac{m_2}{m_1 + m_2}(1+e)\vec{u}_2$$

$$\vec{v}_2 = \frac{m_2 - e m_1}{m_1 + m_2}\vec{u}_2 + \frac{m_1}{m_1 + m_2}(1+e)\vec{u}_1$$

for $e = 1$ & $m_1 >> m_2$

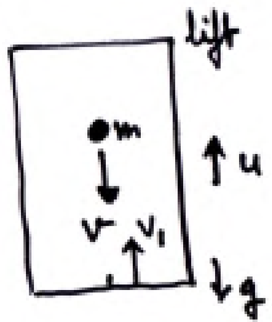


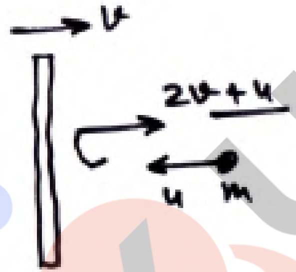
$\rightarrow \boxed{v_1 = u_1}$ $\quad \boxed{\vec{v}_2 = 2u_1 - u_2}$

Questions Based on

Collision of a Falling Particle in a Lift

$M_{lift} >> m$





$$\vec{v}_1 = 2\vec{u} - \vec{v}$$

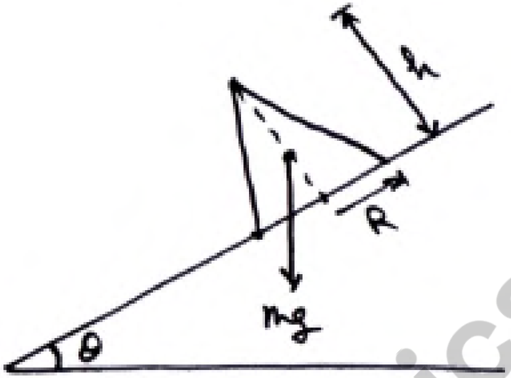
$$v_1 = 2u + v$$

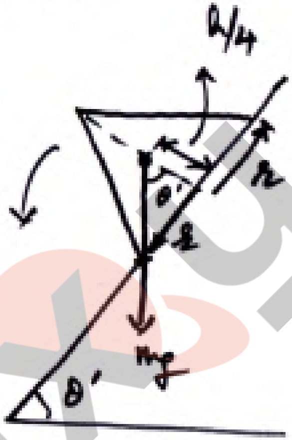
after rebound, max height attained

$$H_{max} = \frac{v_1^2}{2g} = \frac{(2u+v)^2}{2g} = \text{—— Ans}$$

QUESTIONS BASED ON

CASES OF TOPPLING ON INCLINED PLANE





$$\tan\theta' = \frac{4R}{h}$$

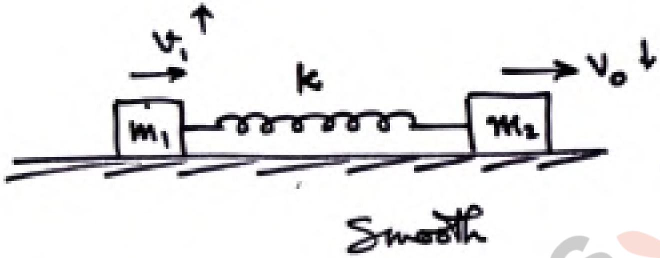
$$\theta' = \tan^{-1}\left(\frac{4R}{h}\right)$$

if $\theta' < \theta_R$ then body will topple before sliding

QUESTIONS BASED ON

SPRING BLOCK SYSTEMS

spring elongation will be max when $v_1 = v_2 = \frac{m_2 v_0}{m_1 + m_2}$



$m_2 v_0 = (m_1 + m_2) v_f$

if initial vel are v_1 and v_2

$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_2$

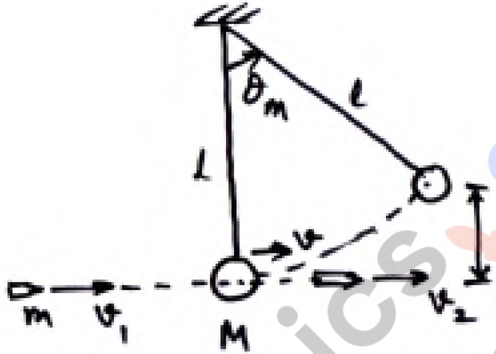
By Cons. of energy

$\frac{1}{2} m_2 v_0^2 = \frac{1}{2} k x_m^2 + \frac{1}{2}(m_1 + m_2)\left(\frac{m_2 v_0}{m_1 + m_2}\right)^2$

$x_m = \text{———}$

QUESTIONS BASED ON

CASES A BULLET HITTING A PENDULUM BOB



$h = \frac{v^2}{2g} = l(1-\cos\theta_m)$

By Cons of momentum

$mv_1 = Mv + mv_2$ — (1)

QUESTIONS BASED ON

SAND FALLING ON A CONVEYOR BELT

per unit time momentum gained by sand $F = \lambda v$

force required by rollers to keep belt moving at uniform speed

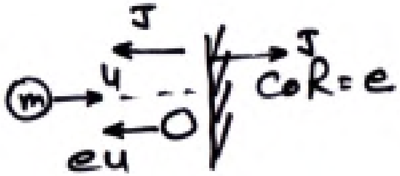
Power reqd = energy/sec gained by sand $= \frac{1}{2}\lambda v^2$

[+ energy loss due to inelastic collision] → $\frac{1}{2}\lambda v^2$

$\Big\} = \lambda v^2$

QUESTIONS BASED ON

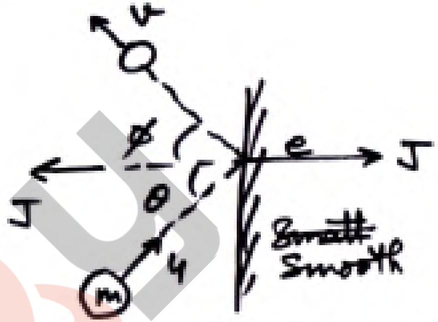
IMPULSE IN A COLLISION



Impulse eqn for ball

$$mu - J = -m(eu)$$

$$mu(1+e) = J$$



$$u\sin\theta = v\sin\phi$$

$$v\cos\phi = eu\cos\theta$$

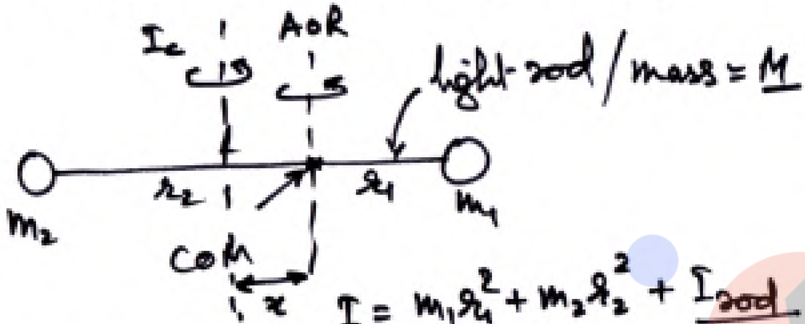
Impulse-momentum eqn

$$mu\cos\theta - J = -mv\cos\phi$$

$$J = m[u\cos\theta + v\cos\phi]$$

Questions Based on

Moment of Inertia Calculation



$$I_c = \frac{Ml^2}{12}$$

$$I = m_1 r_1^2 + m_2 r_2^2 + I_{rod}$$

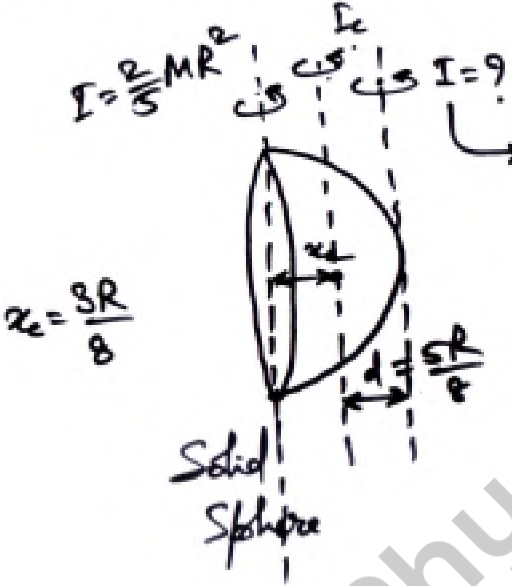
$$I_{rod} = I_c + M\left(\frac{l}{2} - r_1\right)^2$$

$$r_1 = \frac{m_2 l}{m_1 + m_2}$$

$$r_2 = \frac{m_1 l}{m_1 + m_2}$$

Questions Based on

Reverse Parallel Axes Theorem



$$I = I_c + M\left(\frac{5R}{8}\right)^2$$

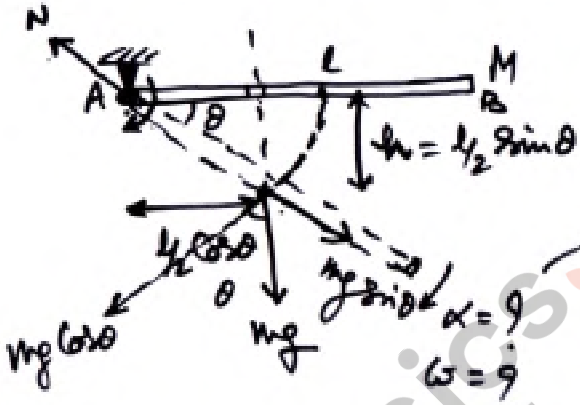
$$= \_\_\_\_ \checkmark$$

$$\frac{2}{5}MR^2 = I_c + M\left(\frac{3R}{8}\right)^2$$

$$I_c = \_\_\_\_$$

Questions Based on

Falling Rod Pivoted at a Point



$\alpha = ?$

$\omega = ?$

$K = \frac{1}{2} I\omega^2$

$\tau = I\alpha$

$mg \cdot \frac{l}{2}\cos\theta = \frac{Ml^2}{3} \cdot \alpha$

$\alpha = \frac{3g}{2l}\cos\theta$ ✓

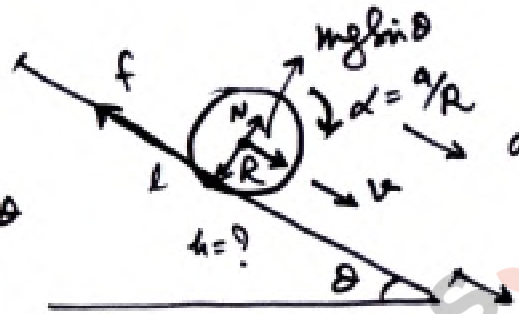
By WE theorem.

$mg\left(\frac{l}{2}\sin\theta\right) = \frac{1}{2}\left(\frac{Ml^2}{3}\right)\omega^2$

$\omega = \_\_\_$ ✓

QUESTIONS BASED ON

ACCELERATION OF ROLLING BODIES ON INCLINED PLANE



$N = mg\cos\theta$

$$a = \frac{g\sin\theta}{1 + \frac{k^2}{R^2}}$$

$$v = \sqrt{2al}$$

$$t = \sqrt{\frac{2l}{a}}$$

Ring $k = R$

Disc $k = \frac{R}{\sqrt{2}}$

Cyl $k = R/\sqrt{2}$

H. Sph. $k = \sqrt{\frac{2}{3}}R$

S. Sph $k = \sqrt{2/5}R$

Calculation of Static friction on Rolling body on incline

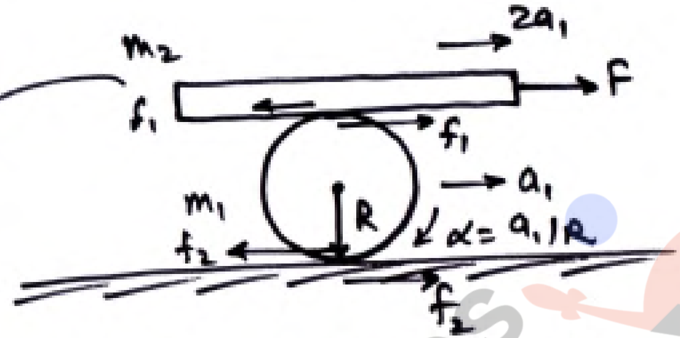
eqⁿ of motion $mg\sin\theta - f = ma$

$f = \text{——} \le \mu mg\cos\theta$ for pure rolling to continue

or $f.R = I.(a/R)$

Questions Based on

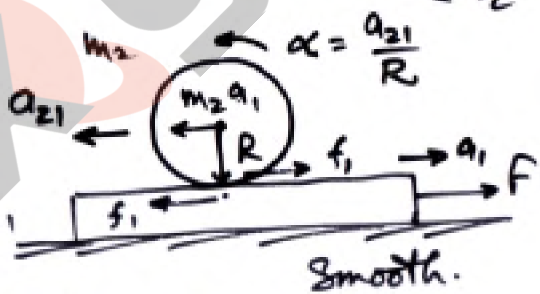
Motion of a Plank Over a Roller



in pure rolling

$f_1, f_2 \rightarrow$ Static friction $\leq f_L$

$$\left[\begin{aligned} F - f_1 &= m_2(2a_1) \\ f_1 - f_2 &= m_1 a_1 \\ f_1 R + f_2 R &= \tfrac{1}{2} m_1 R^2 \left(\tfrac{a_1}{R}\right) \end{aligned}\right]$$

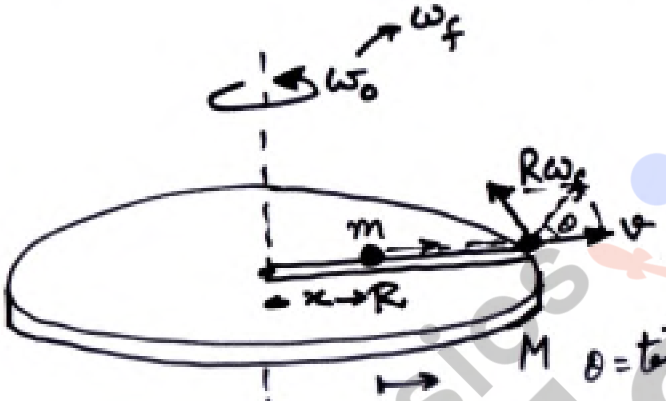


$$\left[\begin{aligned} F - f_1 &= m_1 a_1 \\ m_2 a_1 - f_1 &= m_2 a_{21} \\ f_1 R &= \tfrac{1}{2} m_2 R^2 \left(\tfrac{a_{21}}{R}\right) \end{aligned}\right] \rightarrow \begin{aligned} a_1 &= \text{—} \\ a_{21} &= \text{—} \\ f_1 &= \text{—} \leq \mu m_2 g \end{aligned}$$

$$a_{2\,ground} = a_{21} - a_1 = \text{—} \text{ (leftward)}$$

Questions Based on

Ball Sliding in a Groove on Disc



by conservation of angular momentum

$$I_1\omega_0 = I_2\omega_f$$

$$\left(\frac{1}{2}MR^2\right)\omega_0 = \left(\frac{1}{2}MR^2 + mR^2\right)\omega_f$$

$$\omega_f = \text{—}$$

$$\theta = \tan^{-1}\frac{R\omega_f}{R\omega}$$

$$\theta = \tan^{-1}\left(\frac{\omega_f}{R}\right)$$

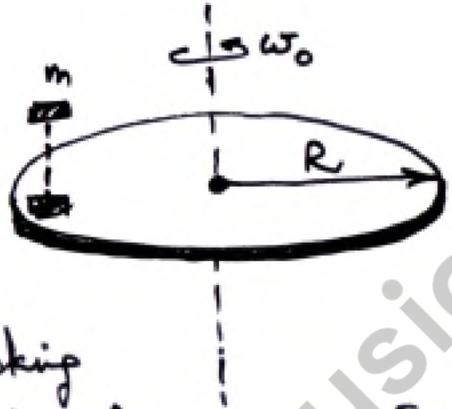
$$v\frac{dv}{dx} = a = \omega^2 x$$

$$\int_0^v v\,dv = \int_0^R \omega^2 x\,dx$$

$$\frac{v^2}{2} = \frac{\omega^2R^2}{2} \Rightarrow v = \omega R$$

QUESTIONS BASED ON

ADDING A BODY ON ANOTHER ROTATING BODY



By ang momentum conservation

$$\left(\frac{1}{2}MR^2\right)\omega_0 = \left[\frac{1}{2}MR^2 + mR^2\right]\omega_f$$

$$\omega_f = \_\_\_\_$$

Sticking

$\Rightarrow$ loss of energy

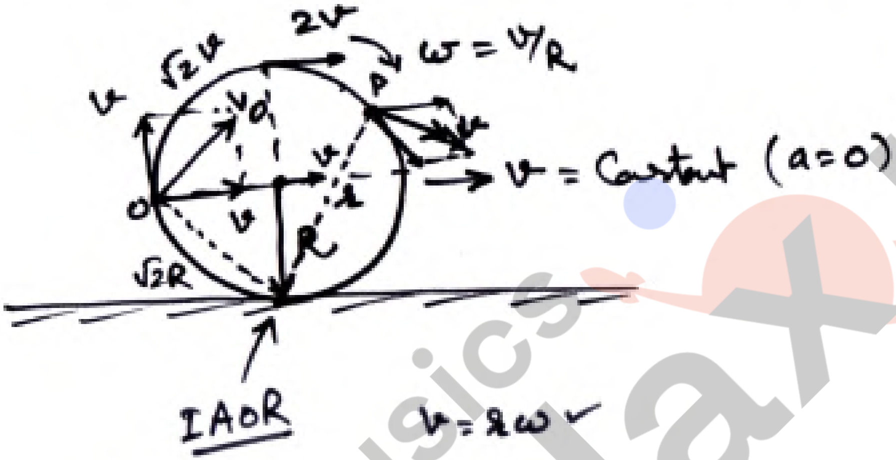
$$\Delta E = E_i - E_f$$

$$E_i = \frac{1}{2}I\omega_0^2 \qquad E_f = \frac{1}{2}I'\omega_f^2$$

$$= \_\_\_\_\_\_\_\_$$

Questions Based on

Velocities and Accelerations of Particles in a Rolling Body

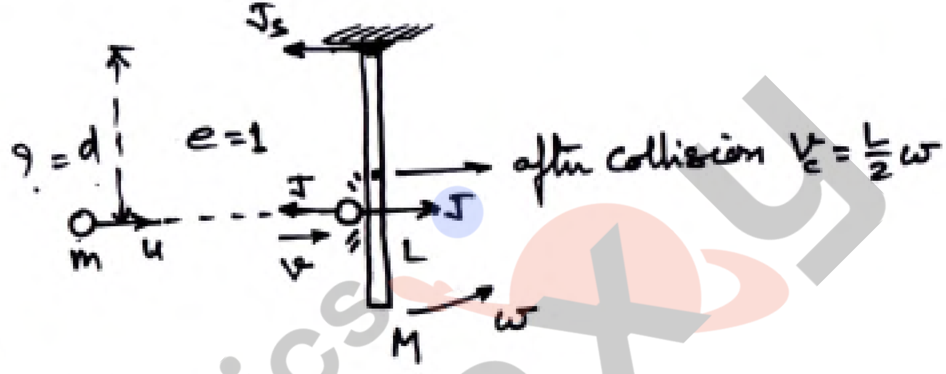


$v = R\omega$ ✓

$V_0 = \sqrt{2}R.\omega = \sqrt{2}v$

QUESTIONS BASED ON

A BALL HITTING A VERTICAL HANGING ROD



Impulse eq^n

$$\left.\begin{array}{l} mu - J = mv \\ Jd = \frac{ML^2}{3}\cdot\omega \end{array}\right] — (1)$$

as $e=1$ ⇒

$$eu = (d\omega - v) — (2)$$

$v = —$

$\omega = —$

for rod we use

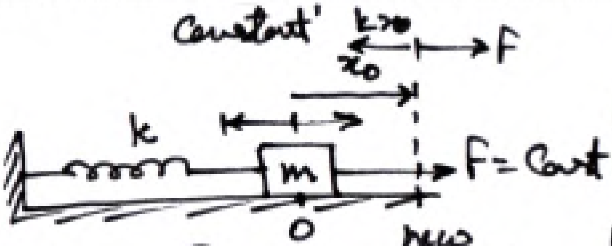
$$J - J_s = M\cdot\frac{L}{2}\omega \longrightarrow J_s = J - \frac{ML\omega}{2} = —$$

Revision Booster
WORKSHOP
for
NEET & JEE Main

Simple Harmonic Motion

QUESTIONS BASED ON

EFFECT OF EXTERNAL FORCE IN SHM



new mean pos. $[F = kx_0]$

(1) changes mean pos of SHM

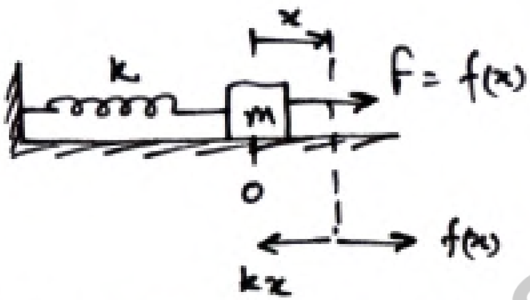
(2) does not change ω of SHM

$$\omega = \sqrt{\frac{k}{m}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$$

QUESTIONS BASED ON

EFFECT OF VARIABLE EXTERNAL FORCE IN SHM



Restoring force $kx - f(x) = ma$

$$a = -\frac{kx - f(x)}{m} = -cx$$

Comp with $a = -\omega^2 x$

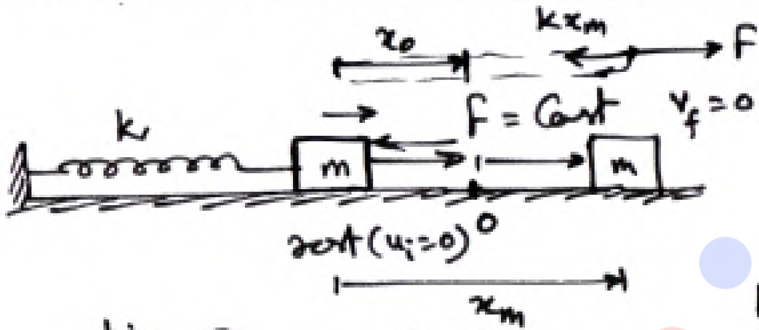
$$\omega = \sqrt{c}$$

By Taylor's th.

$$\omega = \sqrt{\frac{f'(0)}{m}}$$

QUESTIONS BASED ON

SHM AMPLITUDE DUE TO EXTERNAL FORCE



$$kx_0 = F$$

$$x_0 = F/k$$

$$\overset{k_i}{0} + F x_m - \frac{1}{2} k x_m^2 = \overset{k_f}{0}$$

$$x_m = \frac{2F}{k}$$

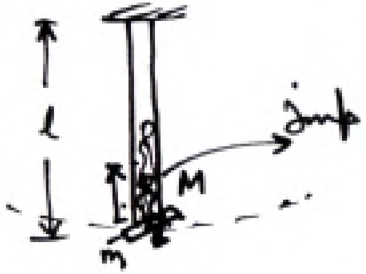
Amp of osc $A = x_m - x_0 = F/k$

if $F = f(x)$

$$W = \int_0^{x_m} f(x)\, dx = \_\_\_\_$$

QUESTIONS BASED ON

A BOY SWINGING ON A SWING



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

$l\downarrow \Rightarrow T\downarrow$ osc. will become faster

if boy jumps $\Rightarrow$ l_{eff} $\rightarrow$ remains same

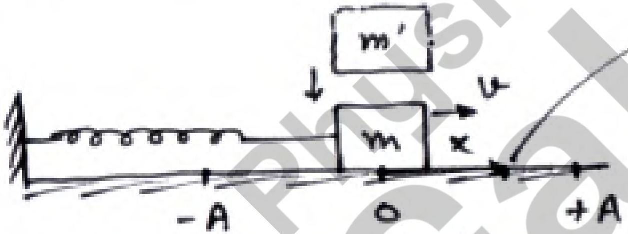
$\Rightarrow T \longrightarrow$ same.

Questions Based on

Adding or Removing Mass From a Spring-Block System

$$\frac{1}{2}kA^2 = \frac{1}{2}(m+m')v'^2_{max}$$

$$\omega = \sqrt{\frac{k}{m}} \longrightarrow \omega' = \sqrt{\frac{k}{m+m'}}$$



$$v_x = \omega\sqrt{A^2 - x^2} = \omega'\sqrt{A'^2 - x^2}$$

$$\omega_{new} = \sqrt{\frac{k}{m+m'}}$$

$A' = \text{——}$ ✓

$$v_{max} = A\omega$$

$$mv_{max} = (m+m')v'_{max} \checkmark$$

$$v'_{max} = \frac{mv}{(m+m')}$$

$$\frac{1}{2}(m+m')v'^2_{max} = \frac{1}{2}kA'^2$$

$A' = \text{——}$ new amp of SHM.

QUESTIONS BASED ON

AMPLITUDE OF A GIVEN SHM EQUATION

$$y = A \sin(\omega t + \alpha)$$
A → amp

if at $t=0$ particle is moving away from mean pos $\Rightarrow \alpha < 90$ or $180^\circ < \alpha < 270^\circ$

" " " " towards " " $\Rightarrow 90^\circ < \alpha < 180^\circ$ or $270^\circ < \alpha < 360^\circ$

or $y = A_1 \sin\omega t + A_2 \cos\omega t$

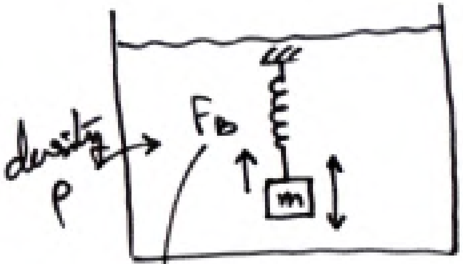
$A_1 \to R\cos\theta$, $A_2 \to R\sin\theta$

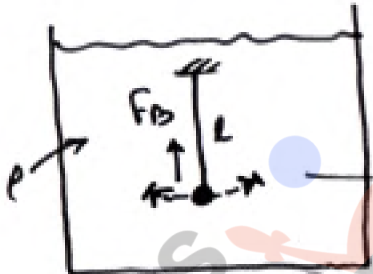
$$\left.\begin{aligned} R\sin\theta &= A_2 \\ R\cos\theta &= A_1 \end{aligned}\right\} \Rightarrow \begin{aligned} R &= \sqrt{A_1^2 + A_2^2} \\ \theta &= \tan^{-1}(A_2/A_1) \end{aligned}$$

$$\Rightarrow y = R \sin(\omega t + \theta)$$
R → amp of Osc^n.

Questions Based on

SHM Submerging in a Liquid





$\rightarrow g_{eff} = g\left(1 - \frac{\rho}{\rho_s}\right)$

Const $F_B = mg\left(\frac{\rho}{\rho_s}\right) \rightarrow$ Constant

$\Rightarrow \quad \omega_f = \omega_i = \sqrt{\frac{k}{m}}$

$\omega_i = \sqrt{\frac{g}{l}}$ $\longrightarrow$ $T = 2\pi\sqrt{\frac{l}{g_{eff}}}$

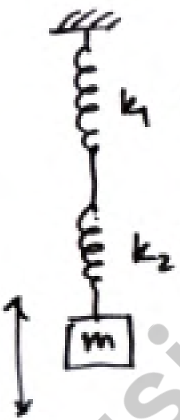
$\omega_f = \sqrt{\frac{g_{eff}}{l}}$

$\Rightarrow$ Osc. will slow down!

Questions Based on

SHM With Cascading of Springs

$$T = 2\pi\sqrt{\frac{m}{k}}$$



$$\longrightarrow k_{eq} = \frac{k_1 k_2}{k_1 + k_2}$$

$$k_{eq} = \underline{k_1 + k_2}$$

$$T' = 2\pi\sqrt{\frac{m}{k_{eq}}}.$$

$$T_{new} = 2\pi\sqrt{\frac{m}{k_{eq}}}$$

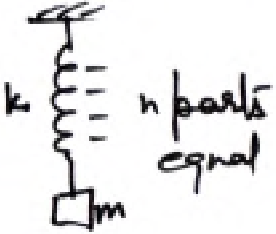
if only k_1 $\quad T = T_1 = 2\pi\sqrt{\frac{m}{k_1}} \nearrow k_1 = \frac{4\pi^2 m}{T_1^2}$

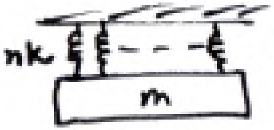
if only k_2 $\quad T = T_2 = 2\pi\sqrt{\frac{m}{k_2}} \nearrow k_2 = \frac{4\pi^2 m}{T_2^2}$

k_1, k_2 Series $\quad T = \underline{\qquad\qquad}$

Questions Based on

SHM With a Part of Spring

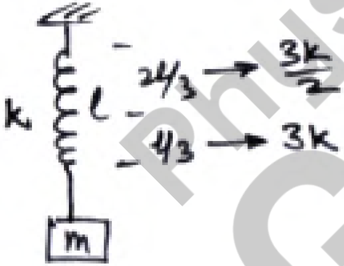


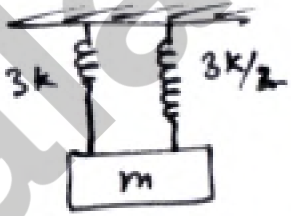


$$k_{eq} = n(nk) = n^2k$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T_{new} = 2\pi\sqrt{\frac{m}{n^2k}} = \frac{T}{n}$$



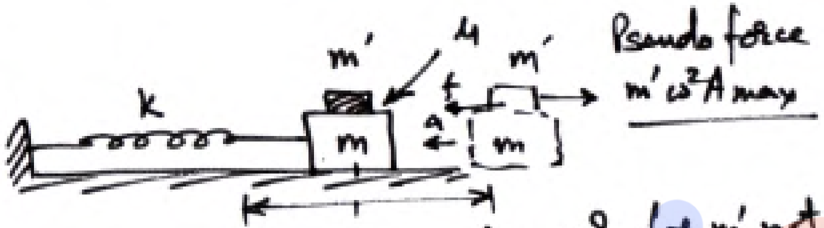


$$k_{eq} = 3k + \frac{3k}{2} = \frac{9k}{2}$$

$$T = 2\pi\sqrt{\frac{2m}{9k}}$$ ✓

Questions Based on

Sliding of a Body in SHM



$A_{max} = ?$ for m' not to slide

$a_{max} = \omega^2 A_{max}$

for m' not to slide

$\Rightarrow \quad m'\omega^2 A_{max} < \mu m' g$

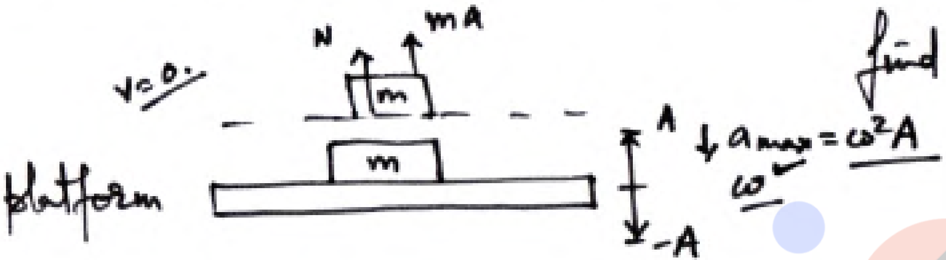
$A_{max} < \frac{\mu g}{\omega^2}$ ✓

$\omega = \sqrt{\frac{k}{m+m'}}$

Questions Based on

Breaking off From Platform in SHM

find A_{max} for m not to break off



if $ma \geq mg \Rightarrow N = 0$

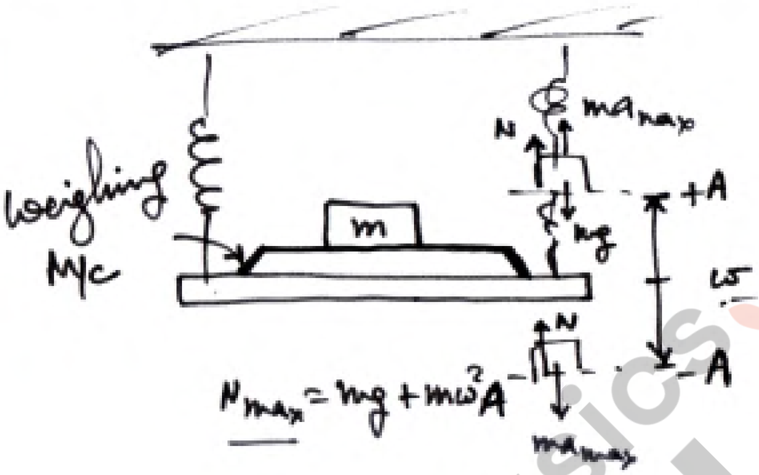
$a \geq g \Rightarrow$ breaking off

$\omega^2 A \geq g$

max $A \geq g/\omega^2$

Questions Based on

Maximum and Minimum Weight in Weighing Machine



$$\omega = \sqrt{\frac{k}{m+M_{p+WM}}}$$

$$\underline{N_{min}} = mg - m\omega^2 A = 0$$

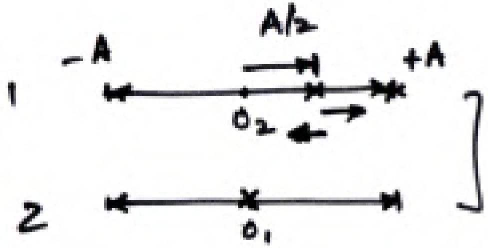
$$W_{meas\ min} = \frac{N_{min}}{g}\ kgf$$

$$\underline{N_{max}} = mg + m\omega^2 A$$

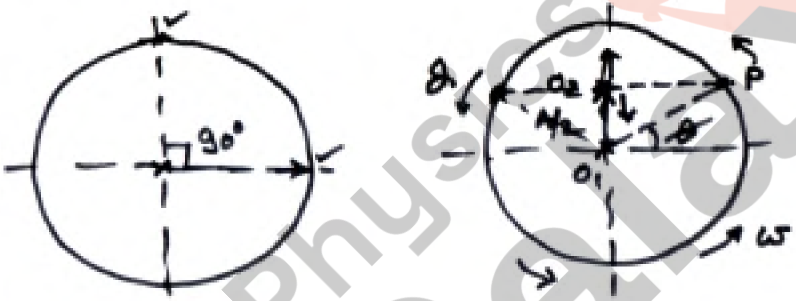
$$W_{meas\ max} = \frac{N}{g}\ kgf$$

Questions Based on

Phase Difference Between Two SHMs



$\omega \rightarrow$ Same $\Rightarrow$ Phase diff $\rightarrow$ Const



$\phi_P = \sin^{-1}(1/2) = \pi/6$ ✓

$\phi_Q = \pi - \pi/6 = \dfrac{5\pi}{6}$ ✓

Questions Based on

Kinetic & Potential Energy Variation in SHM

if $x = A\sin(\omega t+\phi)$

$$K_x = \frac{1}{2}m\omega^2(A^2-x^2) = \frac{1}{2}m\omega^2A^2\cos^2(\omega t+\phi) \longrightarrow K_{avg} = \frac{1}{4}m\omega^2A^2 = P_{avg}$$

$$P_x = \frac{1}{2}m\omega^2x^2 = \frac{1}{2}m\omega^2A^2\sin^2(\omega t+\phi)$$

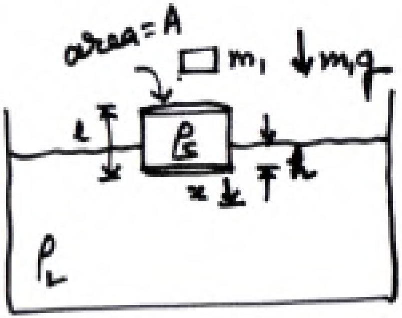
$$E = \frac{1}{2}m\omega^2A^2 = C$$

$$\cos 2(\omega t+\phi) = 2\cos^2(\omega t+\phi) - 1$$

$$K_t = \frac{1}{2}m\omega^2A^2\left(\frac{1+\cos 2(\omega t+\phi)}{2}\right) \longrightarrow$$ variation freq of K & P $\rightarrow$ 2× freq of SHM.

Questions Based on

Wooden Block Floating in a Liquid Executing SHM



at eq^m

$$lA\rho_s g = hA\rho_L g \quad \text{—} (1)$$

Restoring force

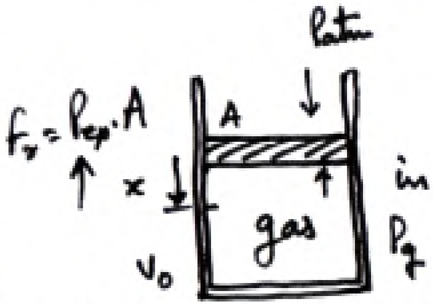
$$-\rho_L x A g = ma$$

$$\Rightarrow a = -\underbrace{\left(\frac{\rho_L A g}{m}\right)}_{\omega^2} x$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{(m + m_1)}{A\rho_L g}}$$

QUESTIONS BASED ON

SHM OF A PISTON ABOVE A TRAPPED GAS



in eq^m $\Rightarrow P_g = P_{atm}$

Say isothermal compression is taken

✓ $P_{atm} \cdot V_0 = P_f (V_0 - Ax)$

$$\Rightarrow \quad P_f = \frac{P_{atm} \cancel{V_0}}{\cancel{V_0}\left(1 - \frac{Ax}{V_0}\right)} = P_{atm}\left(1 + \frac{Ax}{V_0}\right)$$

$P_f - P_{atm}$

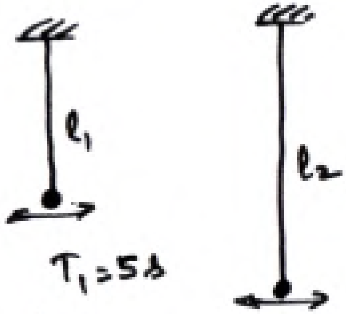
Restoring force on piston upward $\quad F_R = \underbrace{- \frac{P_{atm} A}{V_0}}\cdot x$

$$a = -\left(\frac{P_{atm} A}{m V_0}\right) x \longrightarrow \omega^2$$

QUESTIONS BASED ON

SAME PHASE PERIOD OF TWO PENDULUMS

$T = 2\pi\sqrt{l/g}$



$T_1 = 5s$ $\quad$ $t=0$

$T_2 = 6s$ $\quad$ $t=0$

$(n+1)$ osc $\quad$ n osc

$[n(6) = (n+1)5]$

$n = 5$ osc

$\Delta t = 5\times 6 = 30s.$

after every 30 s both pendulums will be in same phase!

QUESTIONS BASED ON

AMPLITUDE DECAY IN DAMPED OSCILLATIONS

$$\boxed{A = A_0 e^{-bt/2m}}$$

at $t = 10\,s \longrightarrow A = 0.8 A_0$

at $t = 20\,s \longrightarrow A = ?$

$$0.8 = e^{-10b/2m}$$

$$A = A_0 e^{-20b/2m}$$

$$\Rightarrow A = A_0 (0.64) = 0.64 A_0 \text{ Ans}$$

QUESTIONS BASED ON

DIFFERENTIAL EQUATION OF FORCED OSCILLATIONS

damping force $f_v = -bv$

diff eq^n

$$m\frac{d^2x}{dt^2} = -bv - m\omega^2 x$$

$$\Rightarrow \frac{d^2x}{dt^2} + \frac{b}{m}v + \omega^2 x = 0$$

Sol^n $\longrightarrow$ $x = \underline{A_0 e^{-bt/2m}} \sin(\omega t + \phi)$

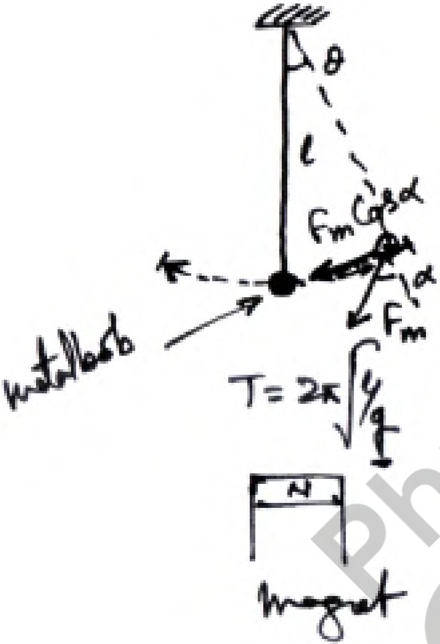
Average lifetime of damping

at $\underline{t = \tau} \longrightarrow A = A_0/e$ $\Rightarrow \frac{A_0}{e} = A_0 e^{-b\tau/2m}$

$\frac{b\tau}{2m} = 1 \Rightarrow \boxed{\tau = \frac{2m}{b}}$

Questions Based on

Damping of Simple Pendulum by External Forces



In such cases

effective value of $g \uparrow \Rightarrow T \downarrow$

$\Rightarrow$ pendulum osc will be faster

Here F_m also act as a damping force.

Questions Based on

Overdamped or Critically Damped Oscillations

Differential eq^n of damped SHM -

$$m\frac{d^2x}{dt^2} + bv + kx = 0$$

here natural freq of SHM

$$\omega_0 = \sqrt{\frac{k}{m}}$$

Sol^n to this eq^n is

$$x = \underbrace{A_0 e^{-bt/2m}} \sin(\omega t + \phi)$$

here $\omega = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

if $b = \sqrt{2mk} \rightarrow \omega = 0$ [~~Overda~~ Critically damped]

$b > \sqrt{2mk} \rightarrow \omega \rightarrow$ imag [Overdamped Osc

almost no oscillations

QUESTIONS BASED ON

ENERGY IN DAMPED OSCILLATIONS

$$A = A_0 e^{-bt/2m}$$

$$\Rightarrow \underline{E_t = E_0 e^{-bt/m}}$$

at $t = 0$: $E = E_0$

at $t = 10s$: $E = \frac{E_0}{100} \Rightarrow \frac{\cancel{E_0}}{100} = \cancel{E_0} e^{-10b/m}$

$$\frac{10b}{m} = \ln(100)$$

$$b = \frac{m}{10} \ln(100)$$

QUESTIONS BASED ON

DAMPING OF SHM IN A LIQUID

here viscous force acts as damping force.

if Stoke's law is valid:

$\rightarrow F_r = -6\pi\eta r v$

$F_r = -bv$

$b = 6\pi\eta r$

$b \propto \eta$

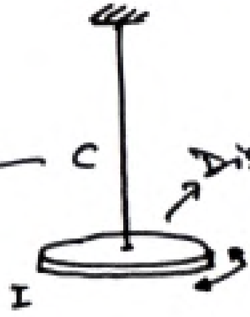
or $\frac{b_1}{b_2} = \frac{\eta_1}{\eta_2}$

Questions Based on

Angular SHM of Torsional Pendulum

$I\alpha = \tau_R = C\theta$

$\alpha = \left(\frac{C\theta}{I}\right)$



Disc ← rod.

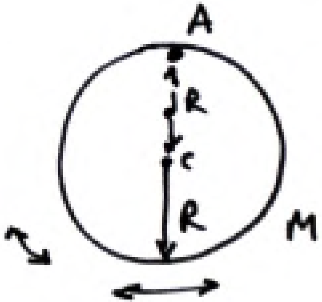
$\omega = \sqrt{\frac{C}{I}} \rightarrow \frac{1}{2}MR^2 \rightarrow \frac{ML^2}{12}$

$\theta_t = \theta_0 \sin(\omega t+\alpha)$

$\sin\alpha = \frac{\theta}{\theta_0}$

Questions Based on

Angular SHM of a Hanging Ring



$$T_1 = 2\pi\sqrt{\frac{I}{mgl}} = 2\pi\sqrt{\frac{2MR^2}{MgR}} = 2\pi\sqrt{\frac{2R}{g}}$$

$$T_2 = 2\pi\sqrt{\frac{3/2\,MR^2}{MgR}} = 2\pi\sqrt{\frac{3R}{2g}}$$

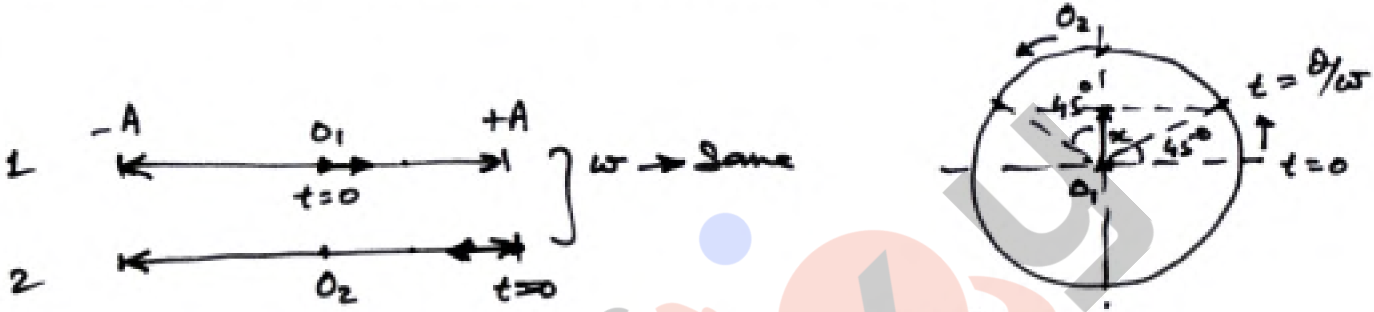
$$\left(l_{eq} = l + \frac{k^2}{l}\right)$$

in Compd pendulum T is min when $l = k$

Ring $k = R$; Disc $k = R/\sqrt{2}$ ----

QUESTIONS BASED ON

TIME OF CROSSING PARTICLES IN TWO SHMS



$x = A/\sqrt{2}$

$t = \frac{\pi/4}{\omega} = \frac{\pi}{4\omega}$ Ans.

if phase diff = ϕ in 1 & 2 if 1 is starting from mean pos.

time to cross → $t = \frac{\pi/2 - \phi/2}{\omega}$

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Waves &
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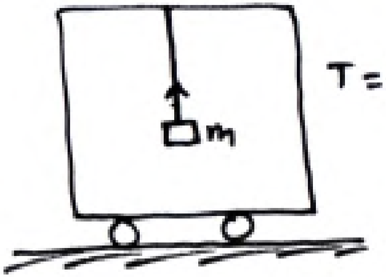
Questions Based on

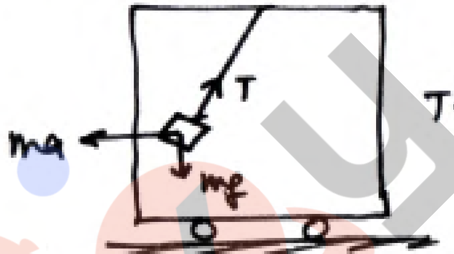
Wave Speed in an Accelerating Car



$T = mg$

rest

$\longrightarrow a$ (accⁿ)

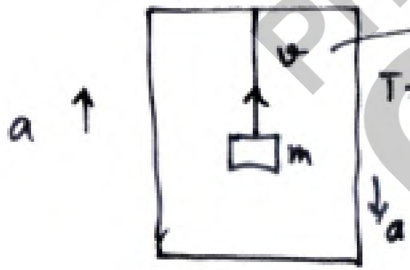


$T' = m\sqrt{a^2+g^2}$

Wave speed

$v' = \sqrt{\frac{T'}{\mu}}$

Wave speed in string $v = \sqrt{\frac{T}{\mu}}$



$v \longrightarrow \sqrt{\frac{T}{\mu}}$

$T = mg \pm ma$

QUESTIONS BASED ON

PARTICLE SPEED RELATED TO WAVE SPEED

SHW wave eq $y = A\sin(\omega t - kx) = A\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right)$

+x dir

wave speed $\left[v_w = f\lambda = \frac{1}{T}\cdot\frac{2\pi}{k} = \frac{\omega}{k}\right]$

particle speed $v_p = \frac{\partial y}{\partial t} = A\omega\cos(\omega t - kx)$

Q → find x where $\left[\begin{array}{l} v_p = 2v_w \\ v_w = 2v_p \end{array}\right]$

Questions Based on

Slope of Displacement Curve & Particle Speed

$$y = A\sin(\omega t - kx) \longrightarrow \tan\theta = \frac{\partial y}{\partial x} = -Ak\cos(\omega t - kx)$$

$$\frac{\partial y}{\partial t} = A\omega\cos(\omega t - kx)$$

$$\frac{\partial y}{\partial x} = -\frac{1}{v}\frac{\partial y}{\partial t}$$

Displacement curve

Slope $= -\frac{1}{v} \times$ (Particle speed)

→ Strain in case of longitudinal wave

QUESTIONS BASED ON

DIFFERENTIAL EQUATION OF A SHW

$$\underline{y = A\sin(\omega t - kx)}$$

SHW eqn

$$\frac{\partial y}{\partial x} = -Ak\cos(\omega t - kx) \rightarrow \frac{\partial^2 y}{\partial x^2} = -Ak^2\sin(\omega t - kx)$$

$$\frac{\partial y}{\partial t} = A\omega\cos(\omega t - kx) \rightarrow \frac{\partial^2 y}{\partial t^2} = -A\omega^2\sin(\omega t - kx)$$

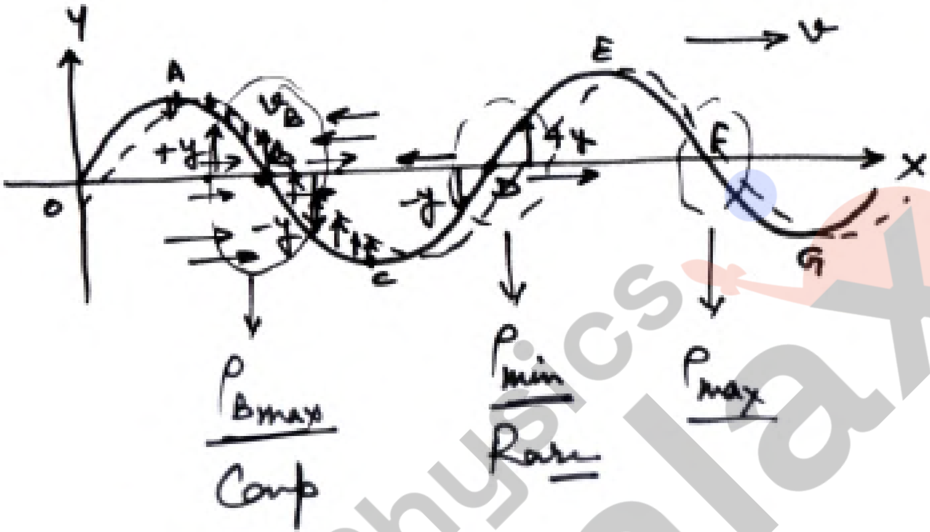
$$\frac{\partial y}{\partial x} = -\frac{1}{v}\frac{\partial y}{\partial t}$$

$$\boxed{\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}}$$

$$\left[\begin{matrix}\text{Curvature} \\ \text{of disp} \\ \text{curve}\end{matrix}\right] = \frac{1}{v^2}\left[\text{particle acc}^n\right]$$

QUESTIONS BASED ON

COMPRESSIONS & RAREFACTIONS IN DISPLACEMENT CURVE



Questions Based on

Wave Equation of a Non-Sinusoidal Wave

$$y = f(a_1 x + a_2 t)$$

$v = \left(\frac{a_2}{a_1}\right)$ wave speed in $-x$ dir

$y = f(x - vt)$

Shift of f^n $y = f(x)$

$$y = e^{-(C_1 x + C_2 t)}$$

wave speed / pulse speed $v = \frac{C_2}{C_1}$

$$v = \frac{\text{Coeff of } t}{\text{Coeff of } x}$$

QUESTIONS BASED ON

PRESSURE VARIATION IN SOUND WAVES

Pressure waves

Pressure variation

$eq^n \longrightarrow$ disp max $\longrightarrow \Delta P$ min

disp 0 $\longrightarrow \Delta P$ max

Pressure Amp

Wave Intensity $I = \frac{(\Delta P_0)^2}{2\rho v}$

$\Delta P_0 = \frac{2\pi}{\lambda} AB$

Phase diff between ΔP_x and y_x is $90°$

$\Rightarrow$ if $y_x = A \sin(\omega t - kx)$

$\Rightarrow \Delta P_x = \Delta P_0 \cos(\omega t - kx)$

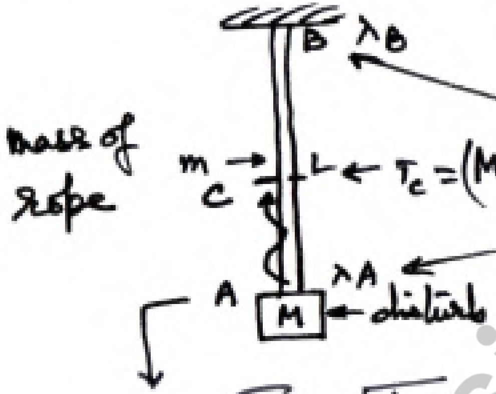
at pos $y = 0$ at these pos of x P_{max} or P_{min}

$P_{atm} + \Delta P_0$ $\quad P_{atm} - \Delta P_0$.

QUESTIONS BASED ON

WAVE PROPAGATING IN A HANGING ROPE

$$\frac{\lambda_A}{\lambda_B} = ?$$



$$T_B = (M+m)g$$

$$T_C = \left(M + \frac{m}{2}\right)g$$

$$T_A = Mg$$

$$v_A = \sqrt{\frac{T_A}{\mu}} = \sqrt{\frac{MgL}{m}} \; ; \quad v_B = \sqrt{\frac{T_B}{\mu}} = \sqrt{\frac{(M+m)gL}{m}}$$

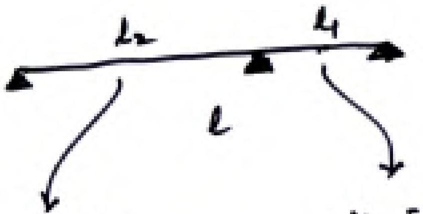
$$v = f\lambda$$

$$\mu = \frac{m}{L}$$

$$\Rightarrow \frac{v_A}{v_B} = \frac{\lambda_A}{\lambda_B} = \sqrt{\frac{M}{M+m}}$$

QUESTIONS BASED ON

RESONANCE IN DIFFERENT PARTS OF A STRING



$$n_f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

$$n_{2f} = \frac{v}{2l_2} \qquad n_{1f} = \frac{v}{2l_1}$$

$$p\,n_{2f} = q\,n_{1f}$$

$$\frac{p}{q} = \frac{n_{1f}}{n_{2f}} = \frac{3}{7}$$ ⇒ both parts resonate at $p = 3$ & $q = 7$

$$\Rightarrow n_{fR} = 3n_{2f} = 7n_{1f} = \_\_\_$$

Questions Based on

Beats in Tuning Fork and a Clamped String

When tuning fork arms are filed.

$\Rightarrow n_f \uparrow$ or $n_0 \uparrow$

$n_1 = \frac{v}{2l}$, $= \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

on loading arms of fork

$\Rightarrow n_f \downarrow$ or $n_0 \downarrow$

(f_B) Beats $= |\underbrace{n_1^{\uparrow} - n_0}| $ Beats/s.

$\rightarrow (n_0 - \underbrace{n_1})$

Case-I if $n_1 > n_0$

$\Rightarrow$ on $T \uparrow \Rightarrow$ f_B will increase

Case-II: if $n_1 < n_0$

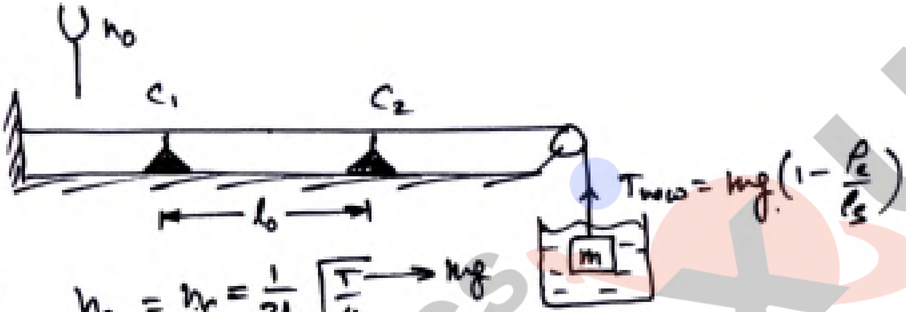
on $T \uparrow \Rightarrow$ first as T increases f_B decrease

but on further inc in T

f_B may increase!

Questions Based on

Submerging Load of Sonometer in a Liquid



Initially

$$\frac{n_0}{3} \quad\text{if string oscillates in III Harmonic}$$

$$n_0 = n_f = \frac{1}{2l_0}\sqrt{\frac{T}{\mu}} \quad T \rightarrow mg$$

$$n_f' = \frac{1}{2l_0}\sqrt{\frac{T_{new}}{\mu}} < n_f$$

as $n_f' < n_f \Rightarrow l_0$ is to be decreased to l_f

Such that

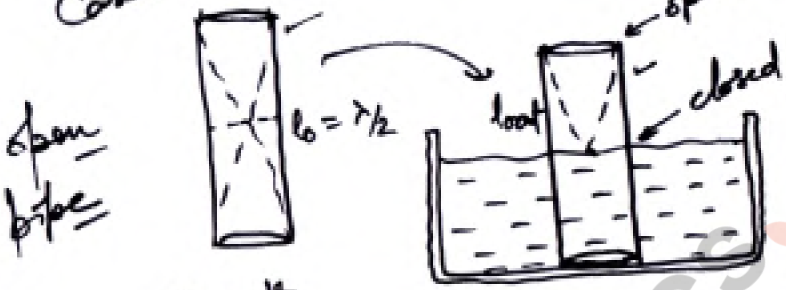
$$\frac{1}{2l_f}\sqrt{\frac{T_{new}}{\mu}} = n_f = n_0.$$

$$l_f = \text{\_\_\_\_\_\_}$$

Questions Based on

Dipping of an Organ Pipe in Water

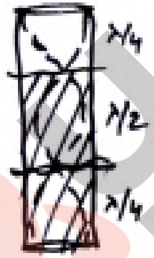
Case-I



$n_f = \frac{v}{2l_0}$

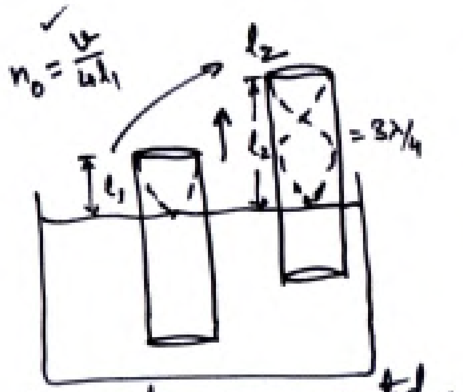
$n = \frac{v}{4l_{out}} = \frac{v}{2l_0} = n_f.$

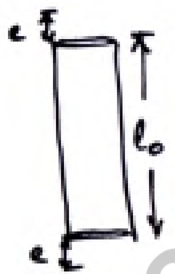
Case-II II Harmonic



Questions Based on

Pulling Out a Pipe From Water





$$n_{fo} = \frac{v}{2(l_0+2e)}$$

if end correction is accounted

$$n_0 = \frac{v}{4(l_1+e)} = \frac{3v}{4(l_2+e)}$$

$$e = \underline{\quad}$$

Case-I: if $l_2 = 3l_1 \Rightarrow$ ignore 'e'

if $l_2 \neq 3l_1 \Rightarrow$ Consider 'e'

QUESTIONS BASED ON

OSCILLATIONS OF COMPOSIT STRINGS

$$\frac{p v_1}{2l_1} = \frac{q v_2}{2l_2}$$

$$\frac{p}{q} = \frac{v_2 l_1}{v_1 l_2} = \frac{4}{11}$$

→ for min freq of resonance, we use

$p = 4$ & $q = 11$

$$\nu_{min} = \frac{4v_1}{2l_1} = \frac{11 v_2}{2l_2} = \ldots$$

QUESTIONS BASED ON

SUCCESSIVE RESONANT FREQUENCIES OF AN OSCILLATING DEVICE

for a clamped string n_1 and n_2 are two successive Res. freq.

$n_1 \downarrow$ 75 Hz, 5th Harmonic

$n_2 \downarrow$ 90 Hz, 6th Harmonic

$\Delta n = 90 - 75 = 15 Hz$ fund freq of clamped string

for closed pipe only odd harmonic freq are available for resonance.

n_1 and n_2 are two succ freq of resonance.

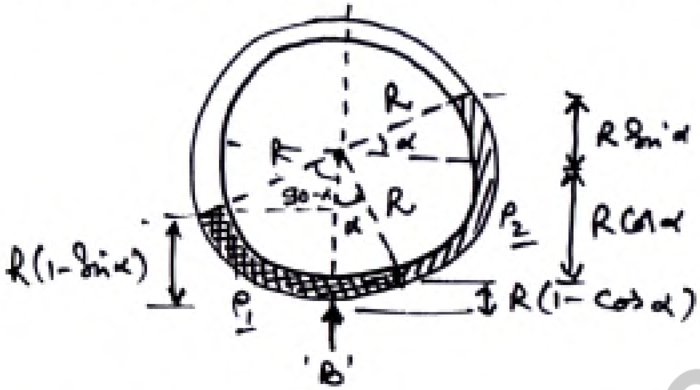
n_1: 3rd, n_2: 5th.

$n_2 - n_1 = 2n_0$

$n_0 \longrightarrow$ fundamental freq.

Questions Based on

Equilibrium in a Circular Tube



$\rho_1 > \rho_2$

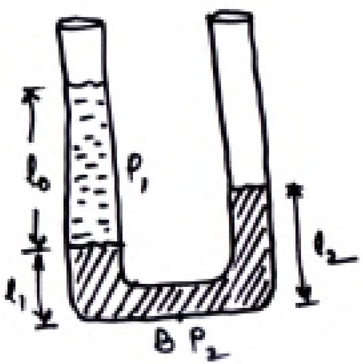
at pt B, we use

$\rho_1 g R(1-\sin\alpha) = \rho_1 g R(1-\cos\alpha) +$
$\rho_2 g R(\sin\alpha + \cos\alpha)$

$\alpha =$ —

QUESTIONS BASED ON

EQUILIBRIUM IN U-TUBE



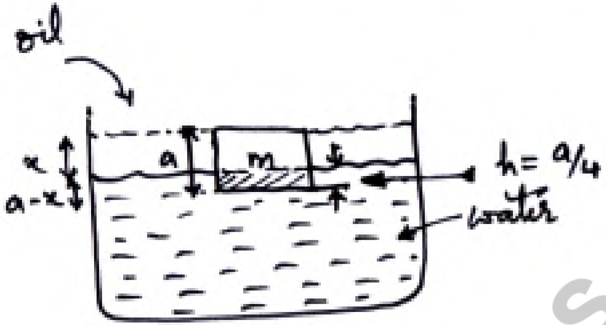
$\rho_2 > \rho_1$

at pt B.

$$l_0 \rho_1 g + l_1 \rho_2 g = l_2 \rho_2 g$$

Questions Based on

Submerging a Floating Body



Initially

$$mg = \rho_\omega A(a/4)g \quad \text{— ①}$$

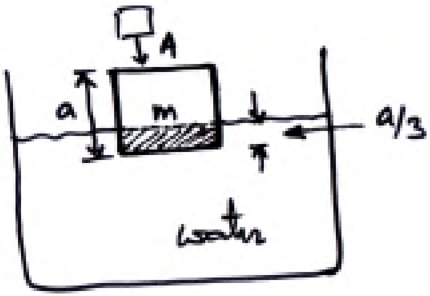
after pouring of oil for eqm of block, we use

$$mg = \rho_\omega A(a-x)g + \rho_{oil} A x g \quad \text{— ②}$$

$x =$ ______

QUESTIONS BASED ON

WEIGHT REQUIREMENT FOR COMPLETE SUBMERGING



Initially at eqm

$$mg = \rho_\omega A(a/3)\,g$$

if m_1 is placed over m for complete submerging the block

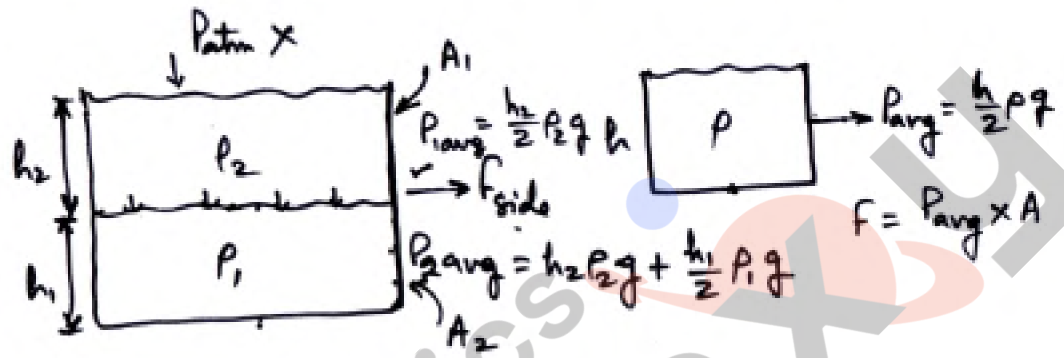
we use

$$(m_1+m)g = \underline{\rho_\omega A a g}$$

$$m_1 = \_\_\_$$

Questions Based on

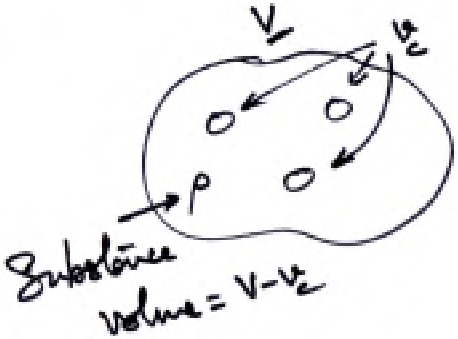
Force on Side Walls of a Container



$$\underline{f_{side}} = \left(\frac{h_2}{2}\rho_2 g\right)A_1 + \left(h_2\rho_2 g + \frac{h_1}{2}\rho_1 g\right)A_2$$

QUESTIONS BASED ON

ANALYSING CAVITY VOLUME IN A SOLID



weight in air = $\underline{m}$ kgf $= (V - v_c)\rho$

weight in water = $\underline{m'}$ kgf

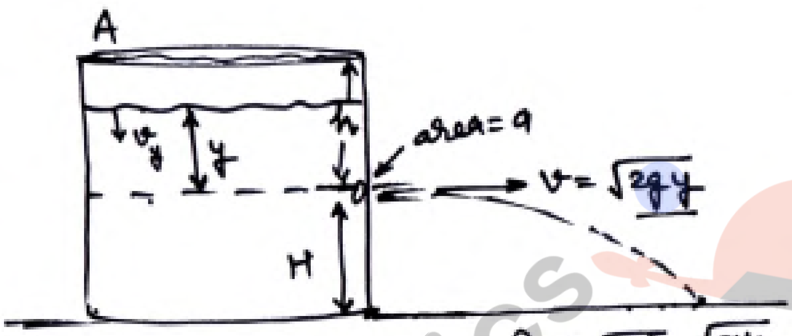
$v_c = $ —

$$m'\cancel{g} = m\cancel{g} - V\rho_w \cancel{g}$$

$$m' = m - V\rho_w \longrightarrow V = \text{—}$$

QUESTIONS BASED ON

CHANGING WATER LEVEL IN A CONTAINER



$R = \sqrt{2gy} \cdot \sqrt{2H/g}$

$a \cdot \sqrt{2gy} = A \cdot v_y$

$-\frac{dy}{dt} = v_y = \frac{a}{A}\sqrt{2gy}$

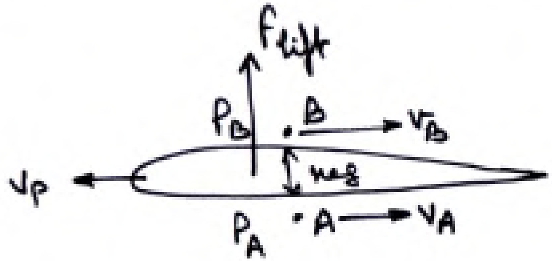
$-\int_h^y \frac{dy}{\sqrt{y}} = \frac{a}{A}\sqrt{2g}\int_0^t dt$

$-2(\sqrt{y} - \sqrt{h}) = \frac{a}{A}\sqrt{2g}\, t$

$h \propto t^2$ & $t \propto \sqrt{h}$

QUESTIONS BASED ON

PRESSURE DIFFERENCE ON SIDES OF AN AEROPLANE WING



using Bernoulli's theorem

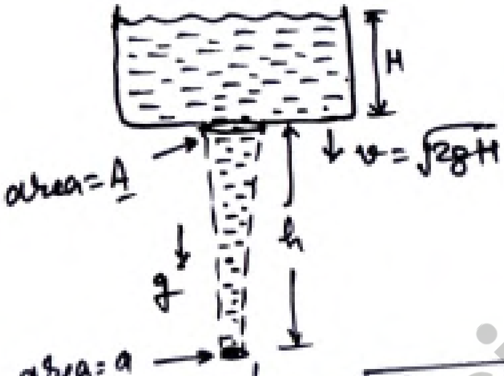
$$P_A + \frac{1}{2}\rho v_A^2 = P_B + \frac{1}{2}\rho v_B^2$$

$$\underline{P_A - P_B} = \frac{1}{2}\rho\left(v_B^2 - v_A^2\right)$$

$$F_{lift} = (P_A - P_B) \times \text{area of wing} = Mg.$$

Questions Based on

Cross-Section of a Vertical Water Stream

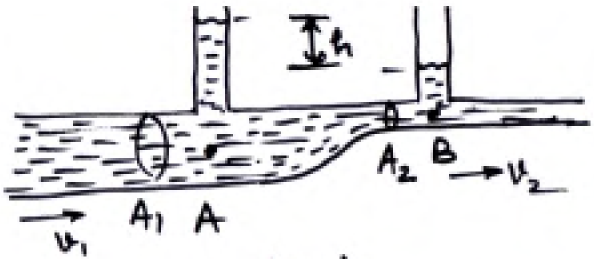


$$v_f = \sqrt{v^2 + 2gh} \quad \text{—} (2)$$

by eqⁿ of Cont

$$vA = v_f \cdot a \quad \text{—} (1)$$

QUESTIONS BASED ON VENTURI TUBE



$A_1 > A_2$

$A_1 v_1 = A_2 v_2 \longrightarrow v_2 = \frac{A_1 v_1}{A_2}$

Using Bernoulli's eqn at A and B.

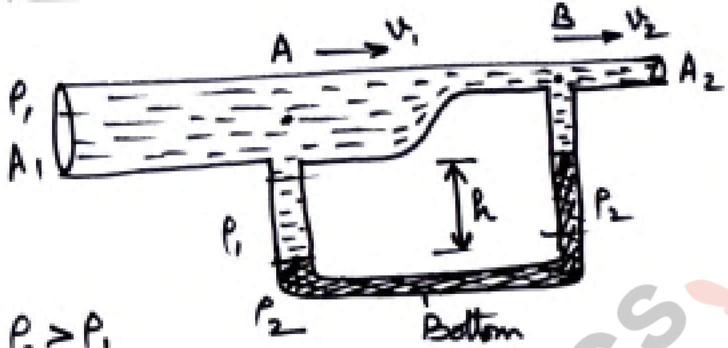
$P_A + \frac{1}{2}\rho v_1^2 = P_B + \frac{1}{2}\rho v_2^2$

$P_A - P_B = h\rho g = \frac{1}{2}\rho(v_2^2 - v_1^2)$

$v_1 = \_\_\_\_$

QUESTIONS BASED ON

QUESTIONS BASED ON PITOT TUBE



$\rho_2 > \rho_1$

$A_1 v_1 = A_2 v_2$ — (1)

using B.T. at A & B, we get

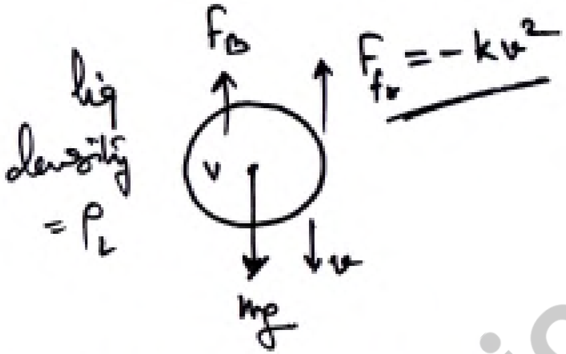
$$P_A + \frac{1}{2}\rho v_1^2 = P_B + \frac{1}{2}\rho v_2^2$$

$$P_A - P_B = h(\rho_2 - \rho_1)g = \frac{1}{2}\rho(v_2^2 - v_1^2) \quad \text{— (2)}$$

$h = $ ____

QUESTIONS BASED ON

TERMINAL SPEED OF A FALLING BALL IN VISCOUS LIQUID



terminal speed is attained when

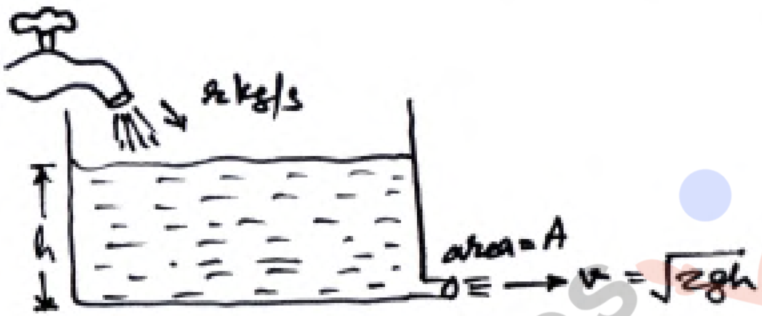
$$mg = F_B + F_{fr}$$

$$V\rho_S g = V\rho_L g + kv_T^2$$

$$v_T = \_\_\_\_\_\_$$

QUESTIONS BASED ON

EQUILIBRIUM LEVEL OF A LIQUID IN A CONTAINER



At eqⁿ height, we use

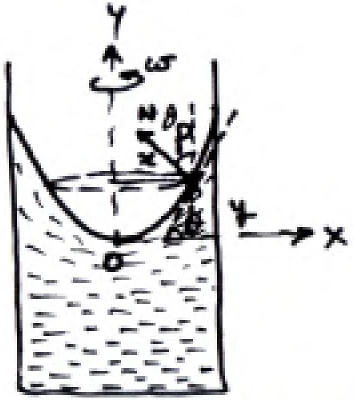
$$\lambda = \rho A v$$

$$\lambda = \rho A \sqrt{2gh}$$

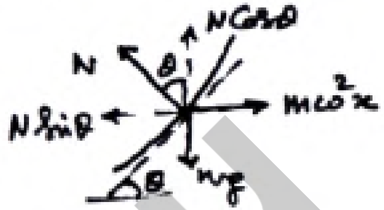
$$\Rightarrow \quad h = \frac{\lambda^2}{2g\rho^2 A^2}$$

QUESTIONS BASED ON

SURFACE PROFILE OF A ROTATING FLUID



$\tan\theta = \frac{dy}{dx}$



for rotation of particle at P

$$\begin{cases} N\cos\theta = mg \\ N\sin\theta = m\omega^2 x \end{cases}$$

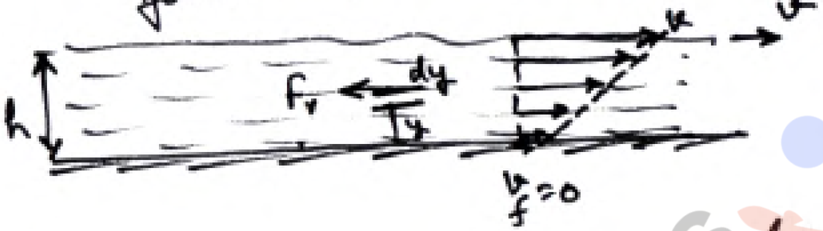
$\tan\theta = \frac{dy}{dx} = \frac{\omega^2 x}{g}$

$\Rightarrow \boxed{y = \frac{\omega^2 x^2}{2g}}$

Questions Based on

Shear Stress in Layers of Flowing Fluid

for small h, we consider linear velocity profile



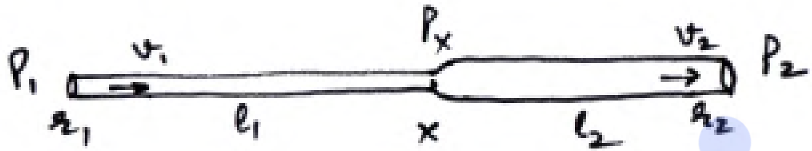
$$\frac{\partial v}{\partial y} = \frac{v}{h}$$

force of viscosity $F_v = \eta A \frac{dv}{dy} = \eta \frac{A v}{h}$

Shear stress $= \left(\frac{F_{tang}}{A}\right) = \frac{\eta v}{h}$ ✓

Questions Based on

Fluid Flowing Through Capillaries in Series



$$A_1 v_1 = A_2 v_2$$

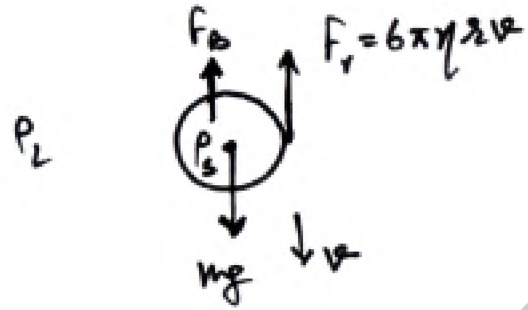
$$\pi r_1^2 \qquad \pi r_2^2$$

volume flow rate of fluid is given as

$$\frac{dQ}{dt} = \frac{\pi r_1^4}{8\eta l_1}(P_1 - P_x) = \frac{\pi r_2^4}{8\eta l_2}(P_x - P_2)$$

QUESTIONS BASED ON

TERMINAL SPEED OF A BALL BY STOKE'S RULE



At terminal speed, $a = 0$

$$\Rightarrow \quad mg = F_B + F_r$$

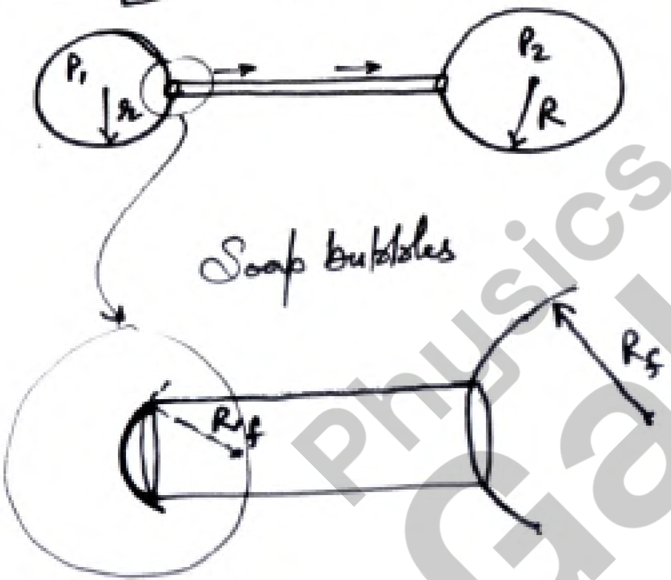
$$\frac{4}{3}\pi r^3 \rho_s g = \frac{4}{3}\pi r^3 \rho_L g + 6\pi\eta r v$$

$$v_T = \underline{\qquad\qquad}.$$

QUESTIONS BASED ON

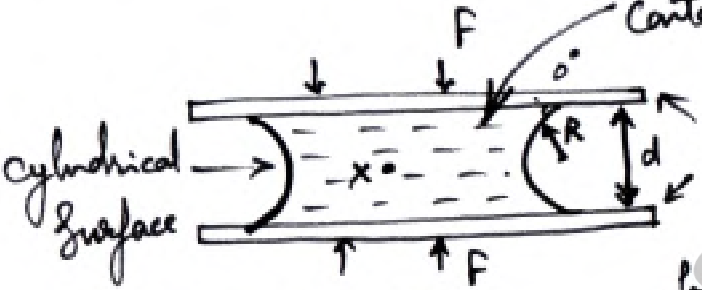
AIR FLOW IN CONNECTED BUBBLES

$P_1 = P_{atm} + \frac{4T}{r}$ $\quad (P_1 > P_2) \quad$ $P_2 = P_{atm} + \frac{4T}{R}$



Questions Based on

Force Between Two Glass Plates



for glass water $\theta_c \sim 0°$

$\Rightarrow R = d/2$

$$P_x = P_{atm} - \frac{T}{R}$$

$$P_x = P_{atm} - \left(\frac{2T}{d}\right)$$

excess pressure in atm

excess force by atm to hold plates together is

$$F = \Delta P . A = \frac{2TA}{d}$$

Questions Based on

Energy Changes in Merging Liquid Drops

n drops, rad = r ⇒ 

$$n\cdot\frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$$

$$R = n^{1/3}\cdot r$$

Surface energy initial

$$E_i = n\cdot 4\pi r^2 \times T$$

final

$$E_f = 4\pi R^2 \times T$$

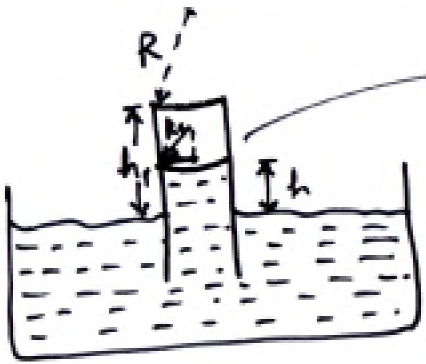
loss in S.E

$$4\pi T\left[n r^2 - n^{2/3} r^2\right] = ms\Delta T$$

$$\Delta T = - - -$$

QUESTIONS BASED ON

WATER RISE IN LOW HEIGHT CAPILLARY



$h_c = \frac{2T\cos\theta}{r\rho g}$ ✓

$r_c = R_c \cos\theta$

if $h_1 < h_c \Rightarrow$ liq will rise to the top and its rad of curvature increases to R such that

$\theta \simeq 0°$

$h_c R_c = hR \leftarrow h_c r_c = hR$

$R =$

$\left(\frac{r_c}{\cos\theta}\right)$

Questions Based on

Common Curvature of Two Soap Bubbles

$$P_1 - P_2 = \frac{4T}{r_c} \longrightarrow \frac{1}{r_1} - \frac{1}{r_2} = \frac{1}{r_c}$$

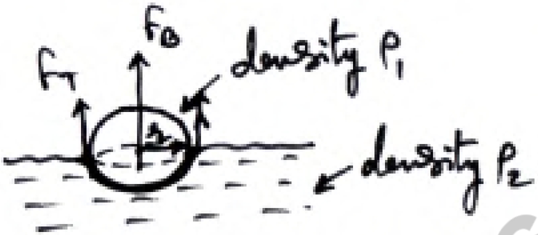
$$r_c = \text{———}$$

$$P_1 = P_{atm} + \frac{4T}{r_1}$$

$$P_2 = P_{atm} + \frac{4T}{r_2}$$

QUESTIONS BASED ON

FLOATING DROP IN ANOTHER LIQUID



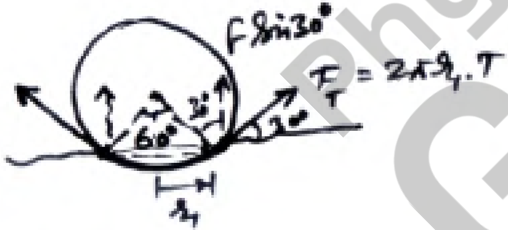
Floating conditions $F_T + F_B = mg$

$F_T = T \cdot 2\pi r$

$F_B = \frac{2}{3}\pi r^3 \cdot \rho_2$

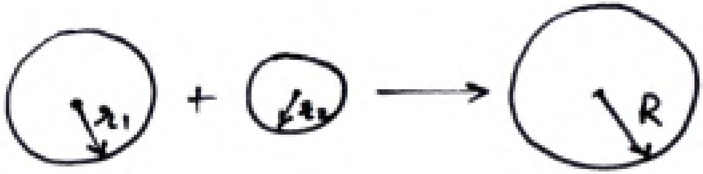
$\rho_2 > \rho_1$

$$\left[T(2\pi r) + \frac{2}{3}\pi r^3 \cdot \rho_2 = \frac{4}{3}\pi r^3 \cdot \rho_1 \right]$$



Questions Based on

Coalescing of Two Soap Bubbles



If $T = \text{Const}$

$$P_1V_1 + P_2V_2 = P_fV_f$$

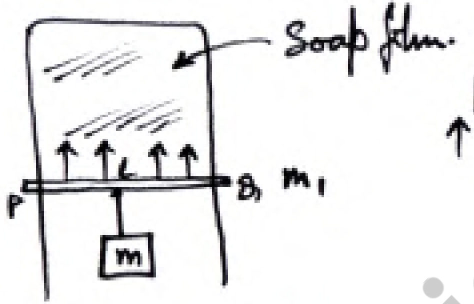
$$\left[\left(P_{atm}+\frac{4T}{r_1}\right)\frac{4}{3}\pi r_1^3 + \left(P_{atm}+\frac{4T}{r_2}\right)\frac{4}{3}\pi r_2^3 = \left(P_{atm}+\frac{4T}{R}\right)\frac{4}{3}\pi R^3\right]$$

change in SE $\Delta E = T\left[4\pi r_1^2 + 4\pi r_2^2\right] - T\left[4\pi R^2\right].$

Questions Based on

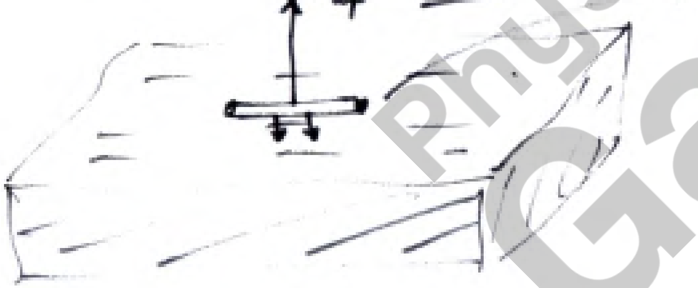
Liquid Film Supporting a Weight

Eq^m



$$\uparrow F_{up} = Tl \times 2 = (m + m_1)g.$$

$$\uparrow F_{up} = 2Tl.$$



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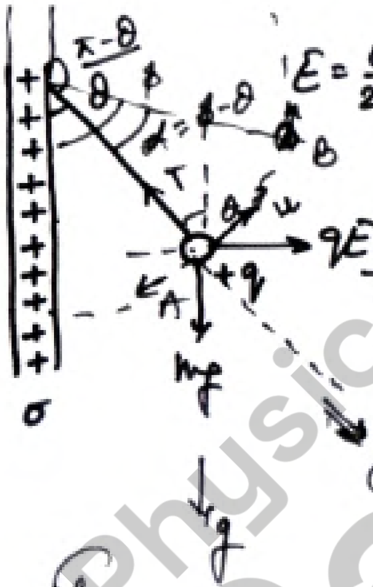
QUESTIONS BASED ON

EQUILIBRIUM OF A BOB HANGING FROM A CHARGED SHEET



$E=\frac{\sigma}{2\epsilon_0}\ /\ \frac{\sigma}{\epsilon_0}$

$T\sin\theta = qE$

$T\cos\theta = mg$

$\rightarrow a = qE/m$

$\rightarrow \theta = \tan^{-1}\frac{qE}{mg}$

$\rightarrow T = \sqrt{(qE)^2+(mg)^2}$

$g_{eff}=\sqrt{g^2+a^2}$

Osc period

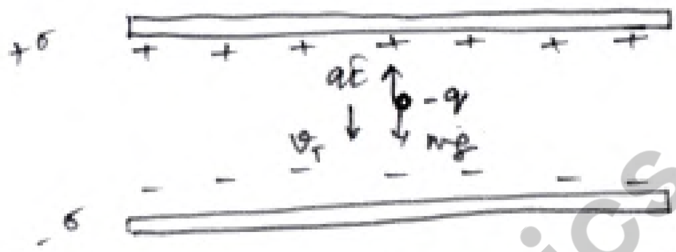
$T = 2\pi\sqrt{\frac{l}{g_{eff}}}$

W/E theorem from A to B

QUESTIONS BASED ON

OIL DROP IN MILLIKAN EXPERIMENT

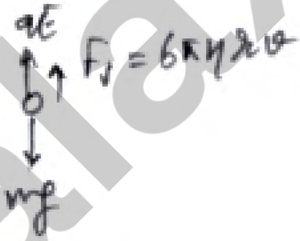
for eq^n of drop



$q\frac{\sigma}{\epsilon_0} = mg$

$q = ne$

if drop is moving at T. speed



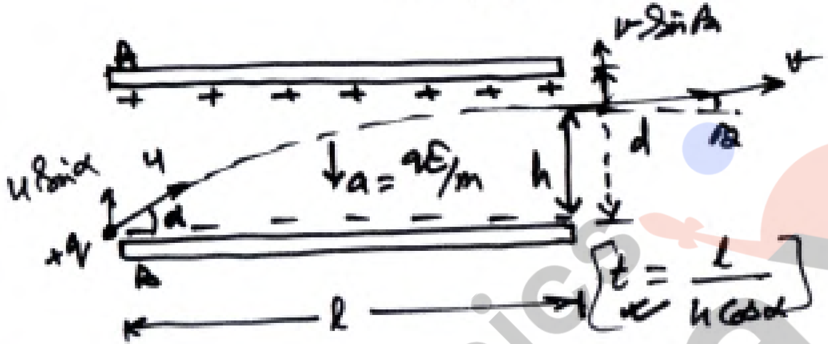
at T. speed

$[qE + 6\pi\eta r v = \frac{4}{3}\pi r^3 \rho . g]$

QUESTIONS BASED ON

PROJECTILE INSIDE A CAPACITOR

$E = \sigma/\epsilon_0$



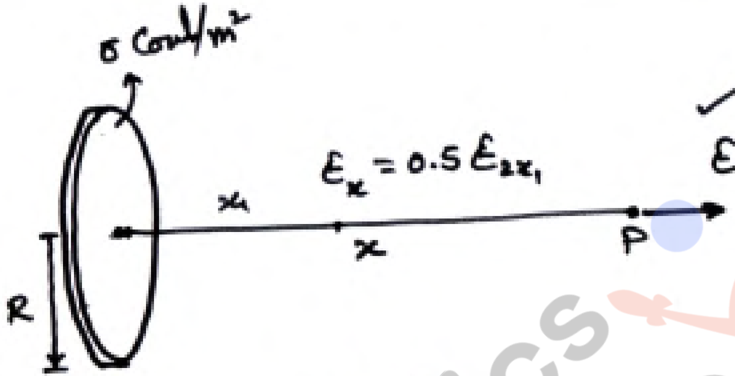
$$\left[\begin{aligned} u\cos\alpha &= v\cos\beta \\ v\sin\beta &= u\sin\alpha - gt \end{aligned}\right]$$

$g \rightarrow a = \dfrac{q\sigma}{m\epsilon_0}$

$$h = u\sin\alpha\, t - \frac{1}{2}at^2$$

QUESTIONS BASED ON

ELECTRIC FIELD VARIATION ALONG AXIS OF A DISC



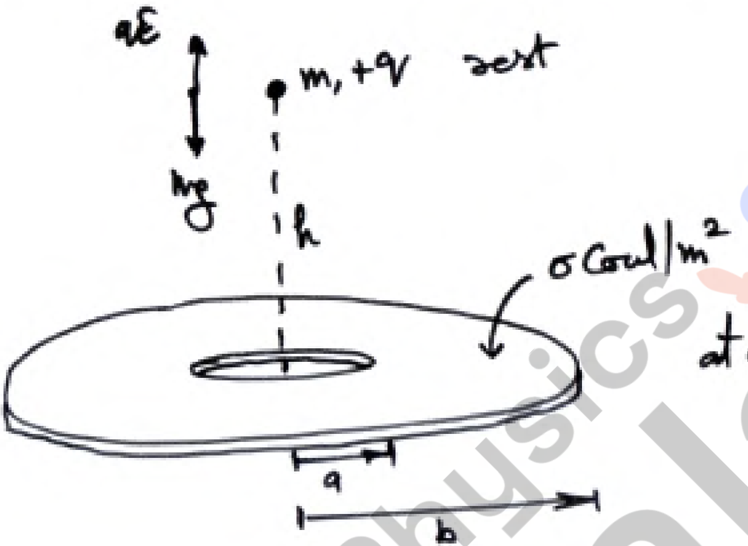
$E_x = 0.5\, E_{2x_1}$

$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{x}{\sqrt{x^2+R^2}}\right)$$

at $x \to 0 \longrightarrow E = \frac{\sigma}{2\epsilon_0}$

Questions Based on

Particle in Equilibrium Over an Annular Disc



$$E = E_b - E_a$$

$$E = \frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{h}{\sqrt{h^2+b^2}}\right)-\left(1-\frac{h}{\sqrt{h^2+a^2}}\right)\right]$$

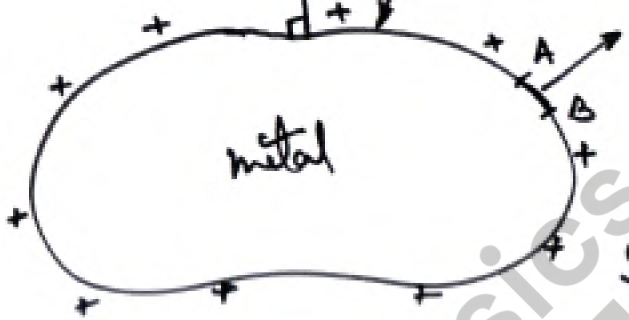
at eq^m $mg = qE$

QUESTIONS BASED ON

ELECTRIC FIELD JUST OUTSIDE A CHARGED CONDUCTOR

$E = \sigma/\epsilon_0$ (v. close to surface)

$\sigma \propto \frac{1}{r}$



$P_e \rightarrow$ electric pressure

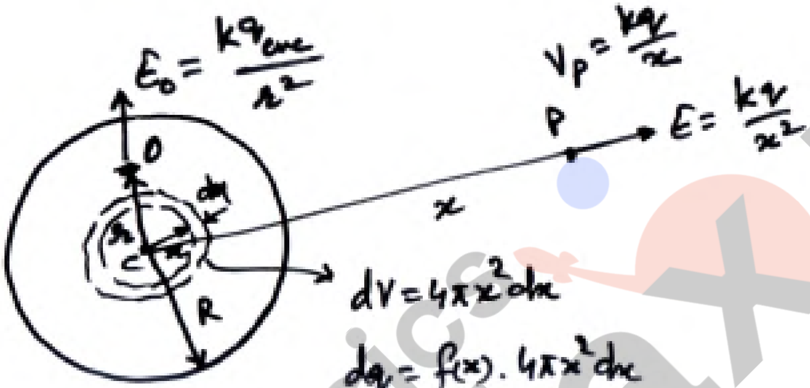
$$P_e = \frac{\sigma^2}{2\epsilon_0}$$

Just outside AB, field energy density (J/m^3)

$$u_e = \frac{\sigma^2}{2\epsilon_0} = \frac{1}{2}\epsilon_0 E^2$$

Questions Based on

Electric Field & Potential Due to Spherical Charge Distribution



$dV = 4\pi x^2 dx$

$dq = f(x) \cdot 4\pi x^2 dx$

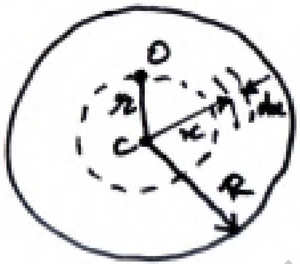
$\rho_{(x)} = f(x)$

$q = \int_0^R$

$q_{encl} = \int_0^x \quad = \text{—}$

QUESTIONS BASED ON

ELECTRIC POTENTIAL INSIDE A SPHERICAL CHARGE DISTRIBUTIONS



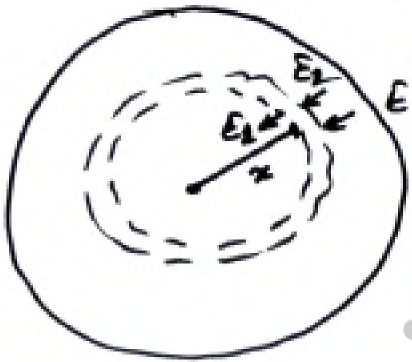
$$V_0 = \left|\int_{\infty}^{R} (E_{out} \cdot dx)\right| + \left|\int_{R}^{r} |E_{in} \cdot dx|\right|$$

OR

$$V_0 = \left[\frac{K q_{encl}}{r} + \int_{r}^{R} \frac{(f(x) \cdot 4\pi x^2 dx) K}{x}\right]$$

QUESTIONS BASED ON

CALCULATION OF CHARGE DISTRIBUTION



$V = f(x) = ax^2 + b$ find $\rho(x) = ?$

$$E = -\frac{dV}{dx} = -2ax$$

$$E_2 = -2ax$$

$$E_1 = -2a(x+dx)$$

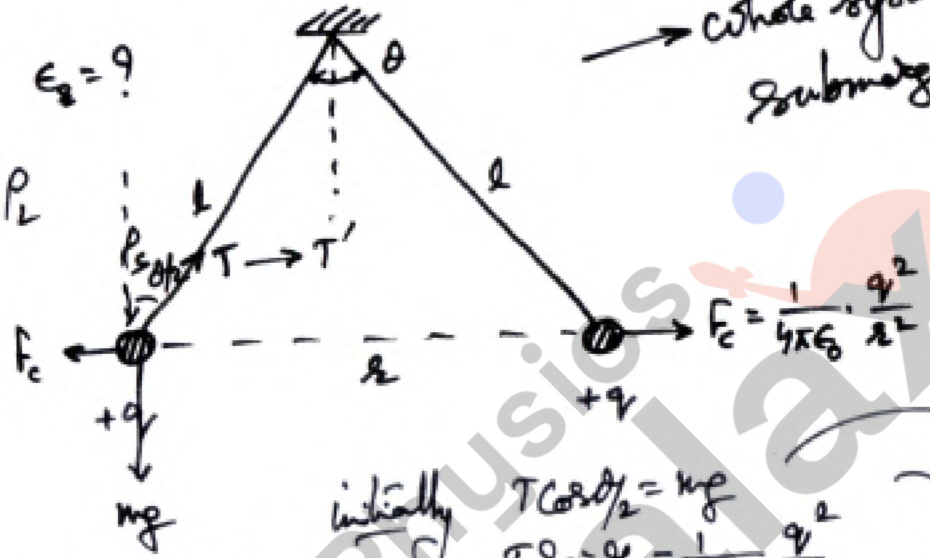
Gauss's law on elemental shell, we get

$$E_2\left(4\pi(x+dx)^2\right) - E_1\left(4\pi x^2\right) = \frac{dq}{\epsilon_0} = \rho(x)\cdot\frac{4\pi x^2}{dx}$$

$\rho(x) =$ ______

QUESTIONS BASED ON

PENDULUMS SUBMERGING IN A LIQUID



→ whole system is submerged in a liquid

for eq^n of balls

initially
$$T\cos\theta/2 = mg$$
$$T\sin\theta/2 = \frac{1}{4\pi\epsilon_0}\frac{q^2}{r^2}$$

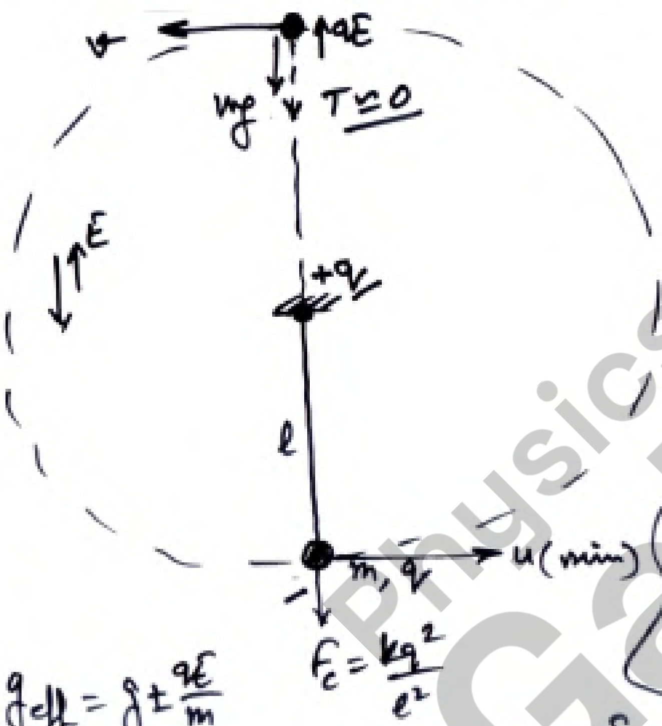
finally
$$T'\cos\theta/2 = mg\left(1 - \frac{\rho_L}{\rho_s}\right)$$
$$T'\sin\theta/2 = \frac{1}{4\pi\epsilon_0\epsilon_r}\cdot\frac{q^2}{r^2}$$

$$\tan\theta/2 = \tan\theta/2$$

→ - - - - -

Questions Based on

Vertical Circular Motion With Charges in EF



$g_{eff} = g \pm \frac{qE}{m}$

In presence of EF $u_{min} = \sqrt{5 g_{eff} l}$.

In presence of +q at suspension pt

at topmost point speed of bob

$v = \sqrt{u^2 - 4gl}$.

At topmost pt, we use

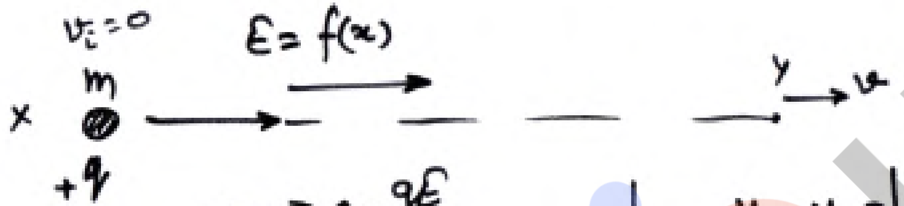
for u_{min} —

$mg - qE = \frac{mv^2}{l}$

$u_{min} =$ —— Ans

Questions Based on

A Charge Moving in Non-Uniform EF



$\rightarrow a = \frac{qE}{m}$

$v\frac{dv}{dx} = \frac{qE_x}{m}$

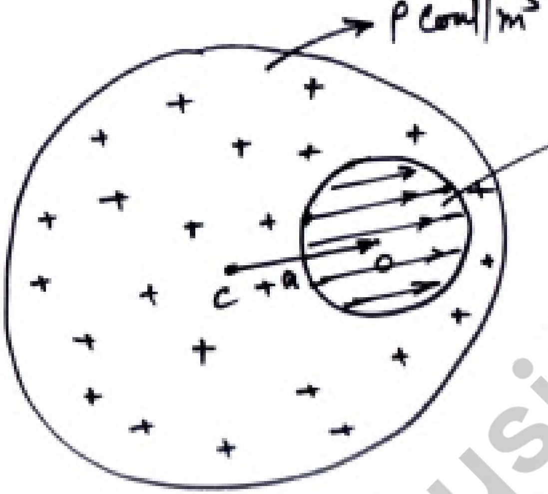
$\int_0^v v\,dv = \int_0^x \frac{qE_x}{m}\,dx$

$V_x - V_y = \left|\int_0^x E_x\,dx\right|$

W/E theorem $\Rightarrow q(V_x - V_y) = \frac{1}{2}mv^2$

QUESTIONS BASED ON

MOTION OF A CHARGE INSIDE CAVITY



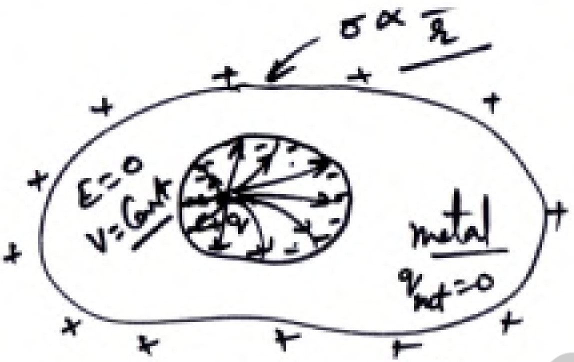
$E_{in\,C} = \dfrac{\rho a}{3\epsilon_0}$

$a_{charge\ in\ cav} = \left(\dfrac{qE}{m}\right)$

$E_{in} = \dfrac{\rho a}{2\epsilon_0}$

Questions Based on

Induced Charges Inside Metal Cavities



flux from a pt charge

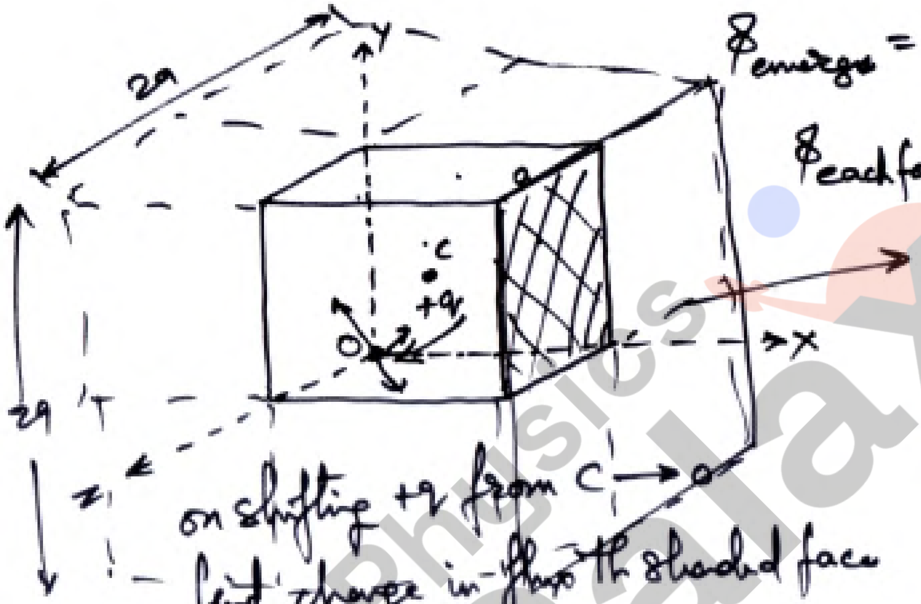
$$\phi = \frac{q}{\epsilon_0}$$

amt of induced surface charges on cavity inner surfaces $q_{in} = -q$

Surface of cavity close to pt charge has higher value of σ_i (-ve)

QUESTIONS BASED ON

ELECTRIC FLUX FROM A CUBICAL SURFACE



$\phi_{emerge} = \frac{q}{\epsilon_0}$

$\phi_{each face} = \frac{q}{6\epsilon_0}$

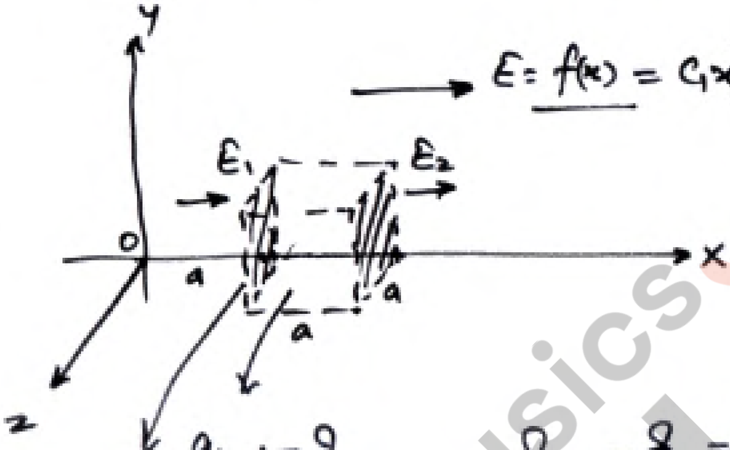
$\phi_{shaded} = \frac{q}{24\epsilon_0}$

$\phi_{cube} = \frac{q}{8\epsilon_0}$

on shifting +q from C → O
find change in flux th shaded face

QUESTIONS BASED ON

CHARGE ENCLOSED IN A CUBE IN VARYING ELECTRIC FIELD



$$\longrightarrow E = \underline{f(x)} = C_1 x^2 + C_2$$

area $= a^2$

$q_{encl} = ?$

$$\phi_{in} = (C_1 a^2 + C_2) \cdot a^2$$

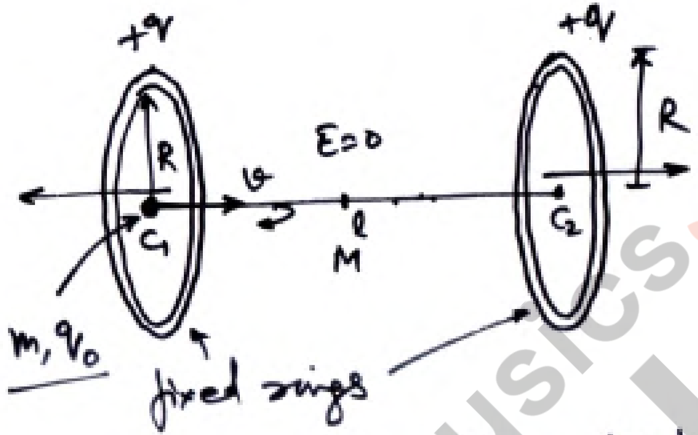
$$\phi_{out} = (C_1(4a^2) + C_2)\, a^2$$

$$\phi_{out} - \phi_{in} = \frac{q_{encl}}{\epsilon_0}$$

$$q_{encl} = \_\_\_\_ \checkmark$$

QUESTIONS BASED ON

THROWING OF A PARTICALE BETWEEN RING CENTERS



if KE reqd to cross null pt is $K = \frac{1}{2} m v_{min}^2$

$$\Rightarrow \quad K \geq q(V_M - V_{C_1})$$

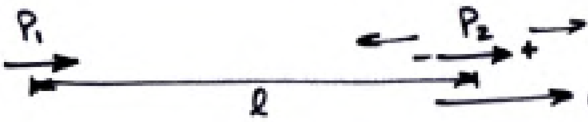
$$\frac{1}{2} m v_{min}^2 = q\left[2\frac{kq}{\sqrt{R^2+(l/2)^2}} - \left(\frac{kq}{R} + \frac{kq}{\sqrt{l^2+R^2}}\right)\right]$$

$$v_{min} = \_\_\_\_ \quad \text{Ans}$$

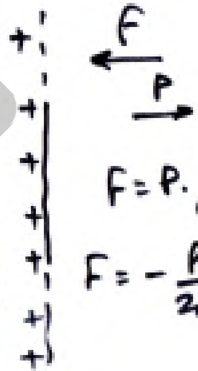
Questions Based on

Force Between Two Dipoles

force on a dipole $F = +\vec{P}\frac{d\vec{E}}{dx}$



$E_l = \frac{2kP_1}{l^3}$



$F = P\cdot\frac{d}{dx}\left(\frac{\lambda}{2\pi\epsilon_0 x}\right)$

$F = -\frac{P\lambda}{2\pi\epsilon_0 x^2}$

force on P_2 is given as

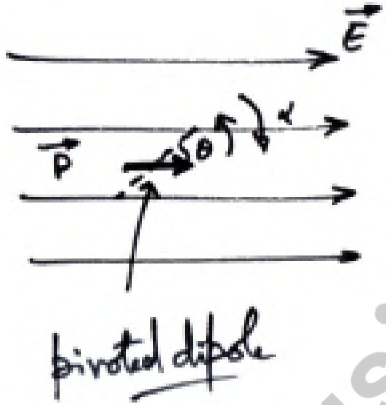
$F = P_2\frac{2kP_1}{l^4}\times 3 = -\frac{6kP_1P_2}{l^4}$ (attractive)

$\vec{F} = -\frac{dU}{dx}\hat{i}$ and $U = -\vec{P}\cdot\vec{E}$

$\vec{F} = \left(\vec{P}\cdot\frac{d\vec{E}}{dx}\right)\hat{i}$

Questions Based on

Oscillation of a Dipole in External EF



if dipole is slightly rotated, restoring torque on dipole

$$\vec{\tau} = \vec{P} \times \vec{E}$$

$$\tau_R = PE\sin\theta$$

for small θ $\quad \tau_R = PE\theta$

$$I\alpha = PE\theta$$

$$\alpha = -\frac{PE}{I}\theta$$

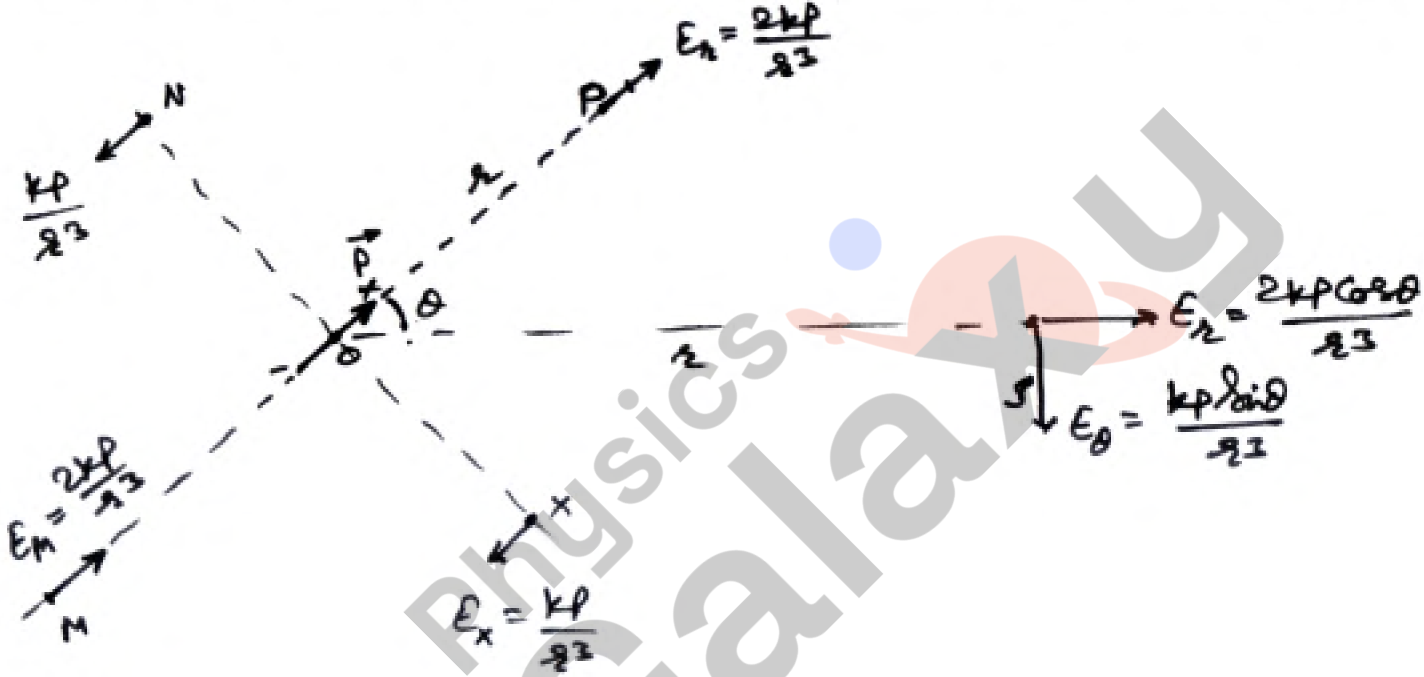
Comp with $\alpha = -\omega^2\theta$

$$\omega = \sqrt{\frac{PE}{I}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{I}{PE}}$$

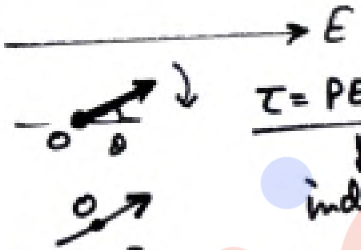
QUESTIONS BASED ON

DIRECTIONS OF RADIAL & TRANSVERSE FIELD DUE TO A DIPOLE



Questions Based on

Oscillation of Bodies in Electric Field With a Dipole

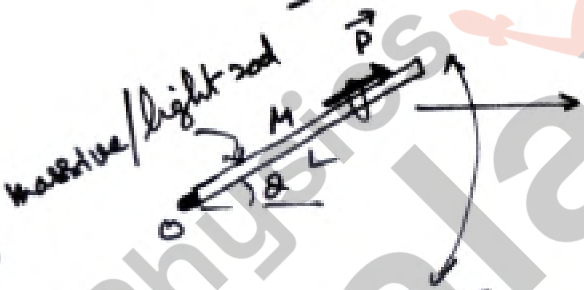


$T = 2\pi\sqrt{\frac{I}{PE}}$ ✓

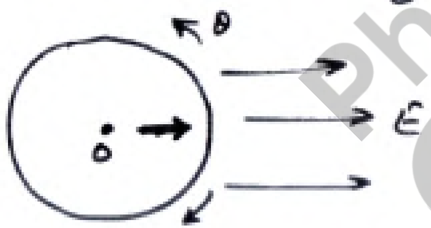
$\tau = PE\sin\theta$ ✓

independent of AoR

Disc



$T = 2\pi\sqrt{\frac{ML^2/3}{PE}}$ ✓



$T = 2\pi\sqrt{\frac{\frac{1}{2}MR^2}{PE}}$

QUESTIONS BASED ON

POTENTIAL ENERGY OF A POINT CHARGE & DIPOLE

due to the Interaction bet^n q & P

$\vec{p}$ - - - - r - - - - $+q$

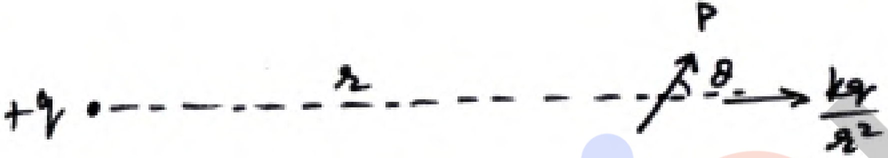
$E = \dfrac{kp}{r^2}$

$\text{In } E_q \rightarrow U = qV = q\left(\dfrac{kp}{r^2}\right) = \dfrac{kqp}{r^2}$ ✓

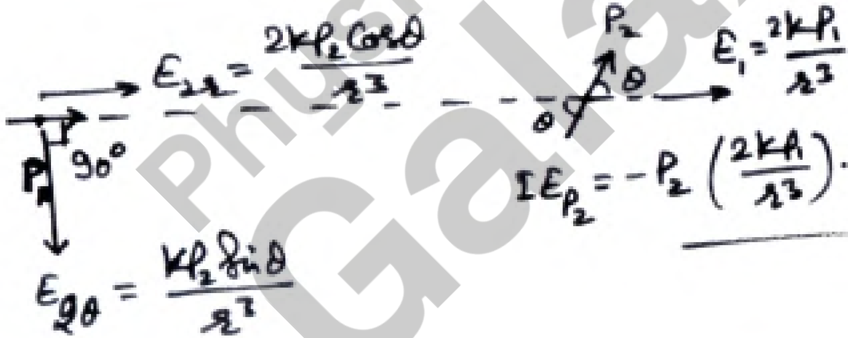
$\text{In } E_p \longrightarrow U = -pE\cos\theta = -p\left(\dfrac{kq}{r^2}\right)\cos 180^\circ = \dfrac{kqp}{r^2}$ ✓

Questions Based on

Potential Energy of Two Dipoles



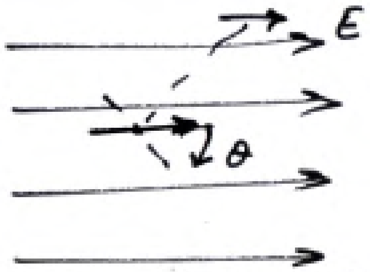
$$IE_p = -PE\cos\theta = -P\left(\frac{kq}{r^2}\right)\cos\theta$$



$$IE_{p_2} = -P_2\left(\frac{2kP_1}{r^3}\right)\cdot\cos\theta$$

Questions Based on

Work Done in Moving a Dipole



initial PE $\rightarrow U_i$

final PE $\rightarrow U_f$

$W_{ext} = U_f - U_i$

$W_{sys} = U_i - U_f$

$\left.\begin{array}{l} U_i = -PE \\ U_f = -PE\cos\theta \end{array}\right]$

$W_{ext} = PE(1-\cos\theta)$

$W_{field} = PE(\cos\theta - 1)$

if I is MI of dipole, we can use

$W_{ext} = \frac{1}{2} I\omega^2 \longrightarrow \omega = \_\_\_\_$ ✓

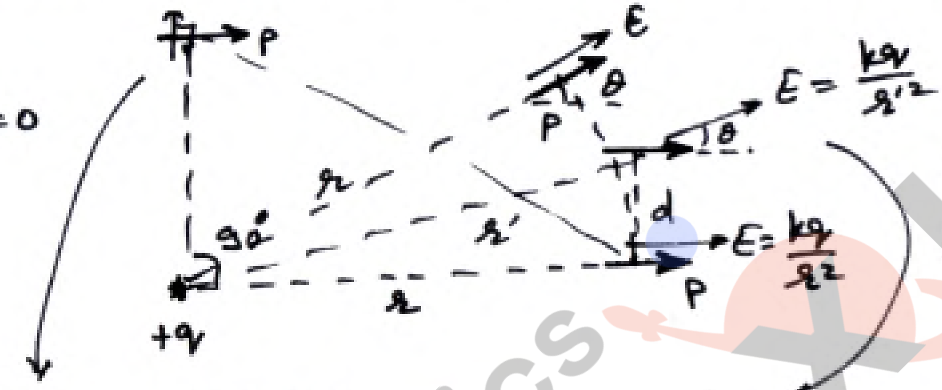
<u>NOTE:</u> if dipole orientation is not changing in motion

<u>$W = 0$</u>.

Questions Based on

Work in displacing a Dipole in Surrounding of a Charge

$U_f' = 0$



$U = -PE\cos\theta$

$U_i = -P\left(\frac{kq}{r^2}\right) = U_f$

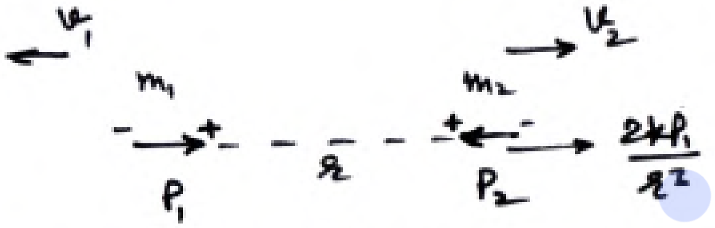
$W_{ext} = 0$

$W = 0 - \left(-\frac{kPq}{r^2}\right) = \_\_\_$

$U_f = -P\left(\frac{kq}{r'^2}\right)\cos\theta \Rightarrow W_{ext} = U_f - U_i = \_\_\_$

QUESTIONS BASED ON

KINETIC ENERGY IN REPELLING DIPOLES



find KE of P_1 and P_2 when sep increases to $2r$

$$U_i = \frac{2kP_1P_2}{r^3}$$

$$U_f = \frac{2kP_1P_2}{8r^3} = \frac{kP_1P_2}{4r^3}$$

finally

$$U_i - U_f = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

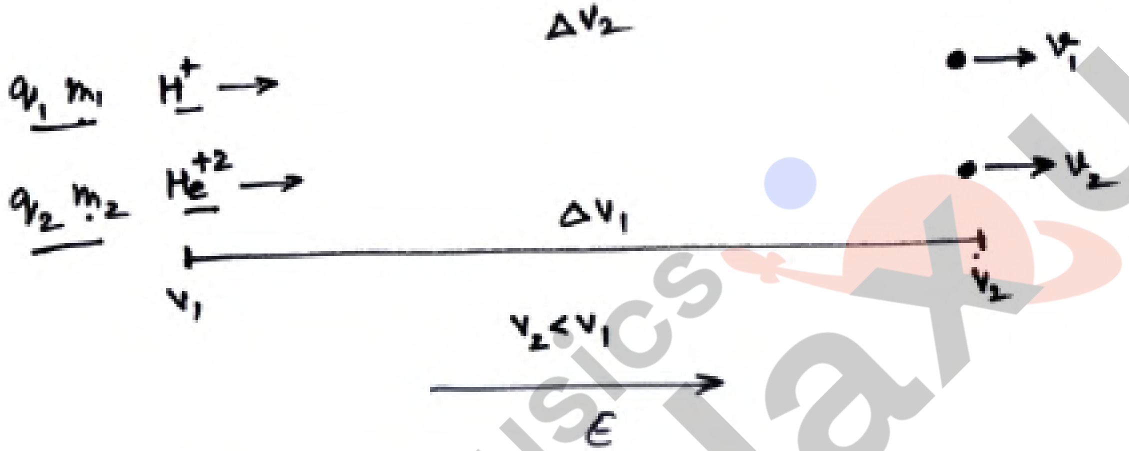
$$m_1v_1 = m_2v_2$$

$v_1 = \_\_\_\_$

$v_2 = \_\_\_\_$

Questions Based on

Two Ions Accelerated By Same Potential Difference



W

$$q_1(V_1 - V_2) = \frac{1}{2} m v_1^2$$

$$q_2(V_1 - V_2) = \frac{1}{2} m v_2^2$$

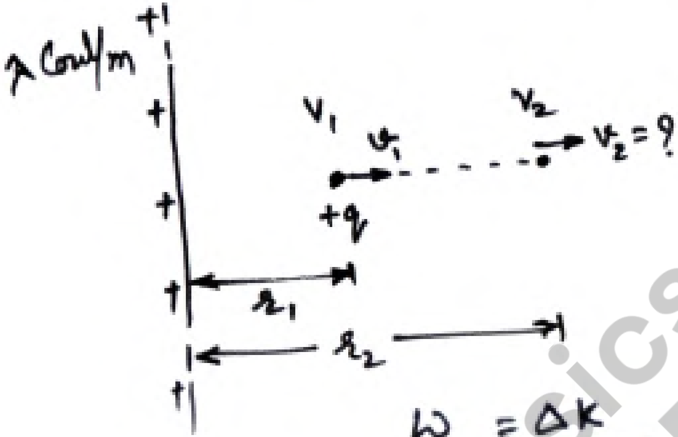
$$W = q\Delta V.$$

if final KE are same then we use

$$q_1 \Delta V_1 = q_2 \Delta V_2 \longrightarrow \left[\frac{q_1}{q_2} = \frac{\Delta V_2}{\Delta V_1}\right]$$

Questions Based on

Work Done by a Line Charge on Point Charge



$$V_1 - V_2 = \int_{r_1}^{r_2} E \cdot dx = \int_{r_1}^{r_2} \frac{\lambda}{2\pi\epsilon_0 x} \cdot dx$$

$$V_1 - V_2 = \frac{\lambda}{2\pi\epsilon_0} \ln(r_2/r_1)$$

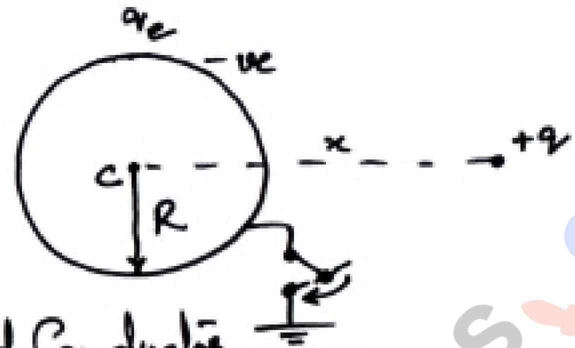
$$W = \Delta K$$

$$q(V_1 - V_2) = \frac{1}{2}m(v_2^2 - v_1^2)$$

$$\frac{q\lambda}{2\pi\epsilon_0} \ln\frac{r_2}{r_1} = \frac{1}{2}m(v_2^2 - v_1^2)$$

QUESTIONS BASED ON

EARTHING OF SPHERICAL SHELLS



Earthed Conductor

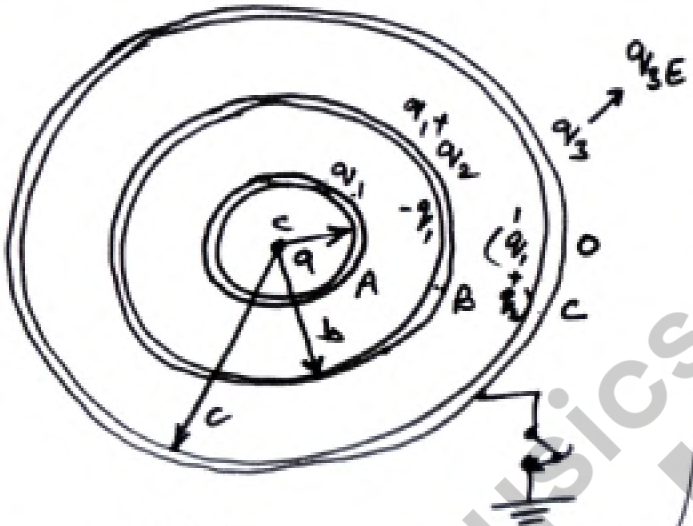
$V_f = 0$

$$\frac{kq}{x} + \frac{kq_e}{R} = 0$$

$$q_e = -\frac{qR}{x}$$

QUESTIONS BASED ON

EARTHING OF CONCENTRIC SHELLS



$$V_A = \frac{kq_1}{a} + \frac{kq_2}{b} + \frac{kq_3}{c}$$

$$V_B = \frac{kq_1}{b} + \frac{kq_2}{b} + \frac{kq_3}{c}$$

$$V_C = \frac{k(q_1+q_2+q_3)}{c}$$

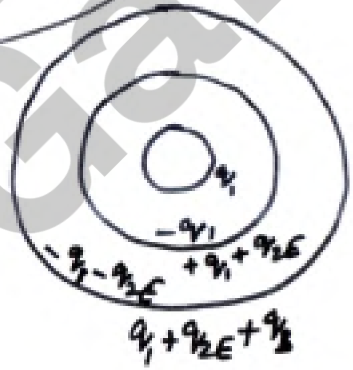
$$V_{C\,new} = \frac{k(q_1+q_2+q_{3E})}{c} = 0$$

$$q_{3E} = -(q_1+q_2)$$

If B is earthed

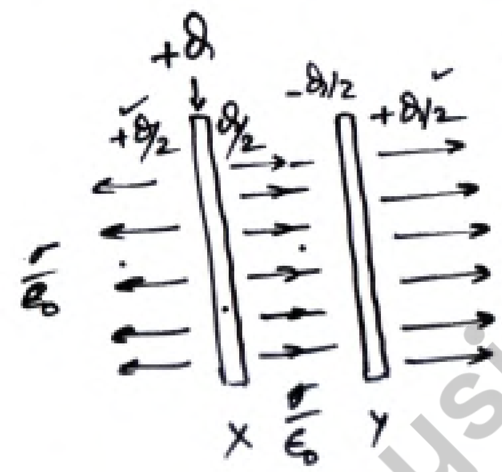
$$\frac{q_1+q_{2E}}{b} + \frac{q_3}{c} = 0$$

$$q_{2E} = -b\left[\frac{q_3}{c} + \frac{q_1}{b}\right]$$



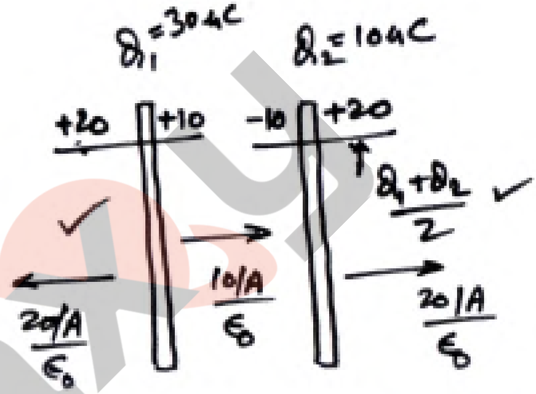
Questions Based on

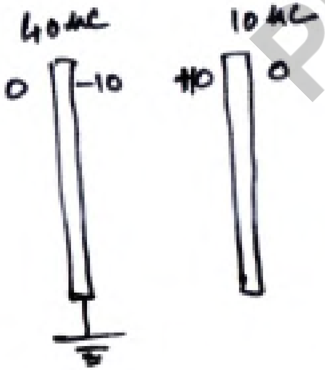
Charge Distribution & Field Configuration in Parallel Plates



$$\sigma = \frac{Q/2}{A}$$

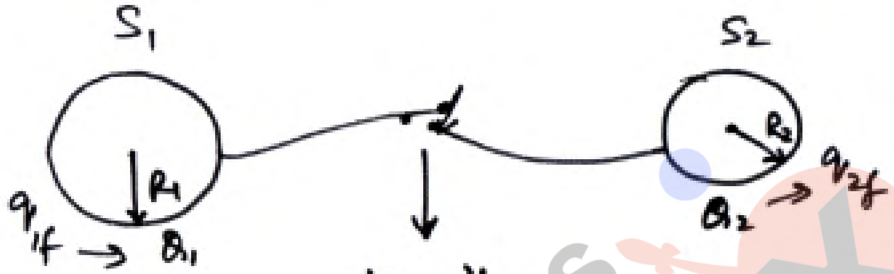
$$E = \sigma/\epsilon_0$$





Questions Based on

Connecting Two Conducting Spheres



$$V_{1f} = V_{2f}$$

$$Q_1 + Q_2 = q_{1f} + q_{2f}$$

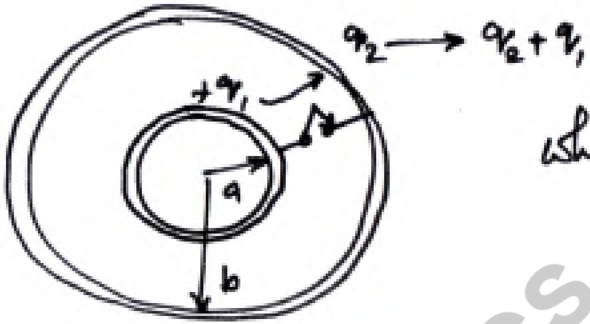
$$\frac{kq_{1f}}{R_1} = \frac{kq_{2f}}{R_2}$$

$$q_{1f} = \_\_\_\_$$

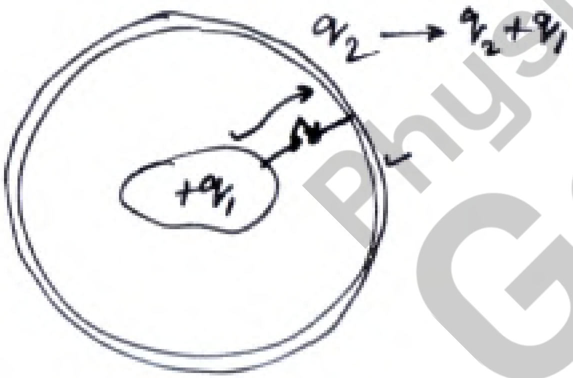
$$q_{2f} = \_\_\_\_$$

Questions Based on

Connecting Concentric Shells

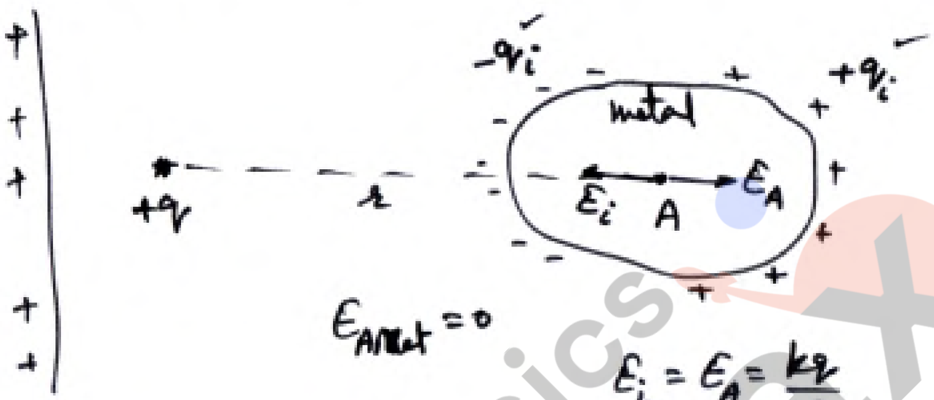


whole charge flows to outer shell



QUESTIONS BASED ON

ELECTRIC FIELD DUE TO INDUCED CHARGES ON METAL BODY



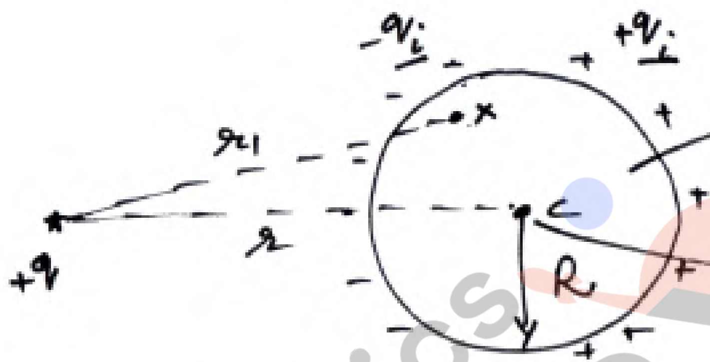
$E_{A\,net} = 0$

$E_i = E_A = \frac{kq}{r^2}$

$\vec{E}_i = -\vec{E}_{ext}$

QUESTIONS BASED ON

POTENTIAL DUE TO INDUCED CHARGES ON A METAL BODY



$$V_{in} = \text{Constant}$$

$$V_{cq} = \frac{kq}{r} = V_{cnet}$$

$$V_{ci} = 0$$

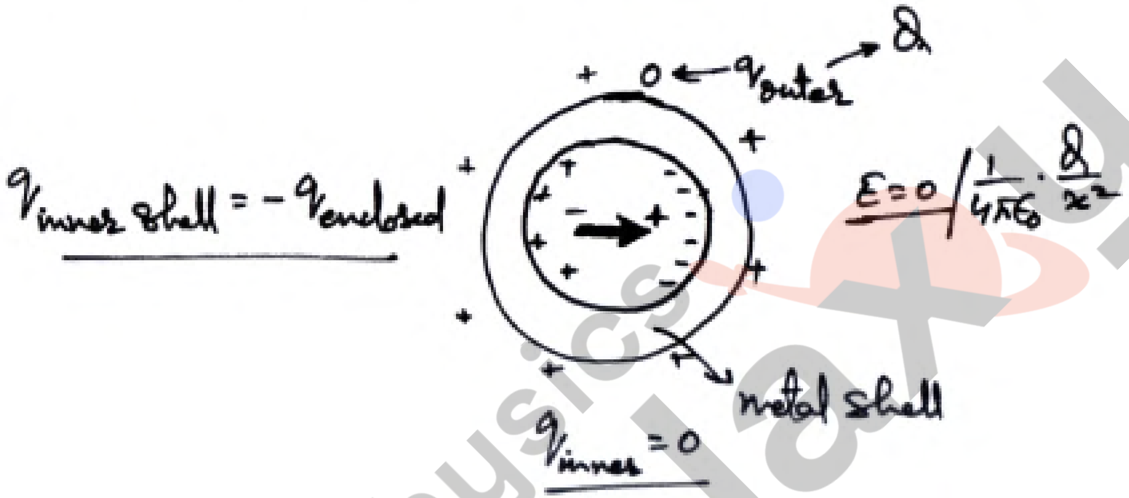
$$V_{xq} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r_1}$$

$$V_x = V_{cnet} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r_1} + V_i$$

$$\Rightarrow \quad V_i = kq\left[\frac{1}{r} - \frac{1}{r_1}\right]$$

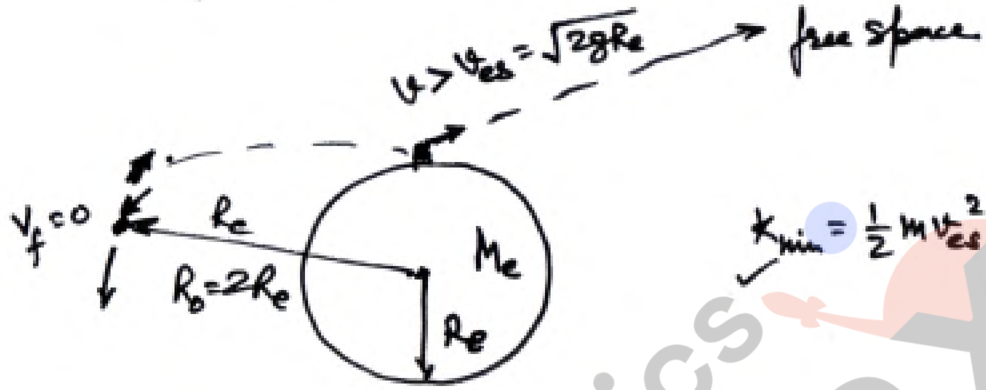
QUESTIONS BASED ON

INDUCED CHARGES IN A SHELL DUE TO A DIPOLE



QUESTIONS BASED ON

ENERGY REQUIRED TO LAUNCH A SPACESHIP



$K_{min} = \frac{1}{2}mv_{es}^2 = \frac{1}{2}m(2gR_e) = \underline{mgR_e}$

Energy reqd to raise the spaceship to $\underline{R_0}$.

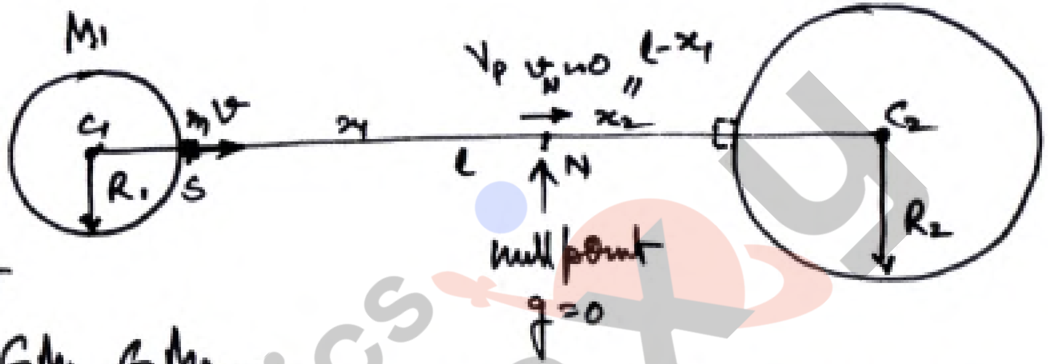
$$K_i + P_i = P_f$$

$$\frac{1}{2}mv^2 - \frac{GM_e m}{R_e} = -\frac{GM_e m}{R_0}$$

$$v = \_\_\_\_$$

Questions Based on

Transferring a Body From One Planet to Another



Pot^n of null pt

$$V_P = -\frac{GM_1}{x_1} - \frac{GM_2}{x_2}$$

$$\frac{GM_1}{x_1^2} = \frac{GM_2}{(l-x_1)^2} \Rightarrow x_1 = \_\_\_$$

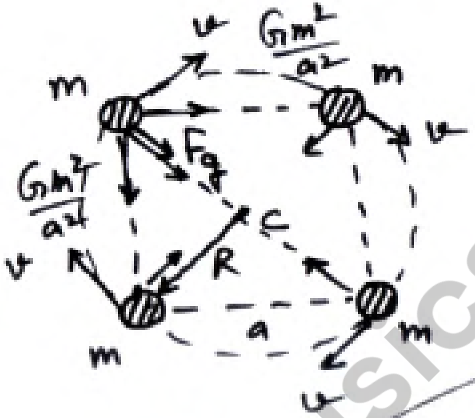
using energy cons from S to N

$$\frac{1}{2}mv^2 - \left(\frac{GM_1}{R_1} - \frac{GM_2}{l-R_1}\right)m = -mV_P$$

$$v = \_\_\_\_$$

QUESTIONS BASED ON

REVOLUTION OF FOUR PARTICLES UNDER GRAVITATIONAL FORCE



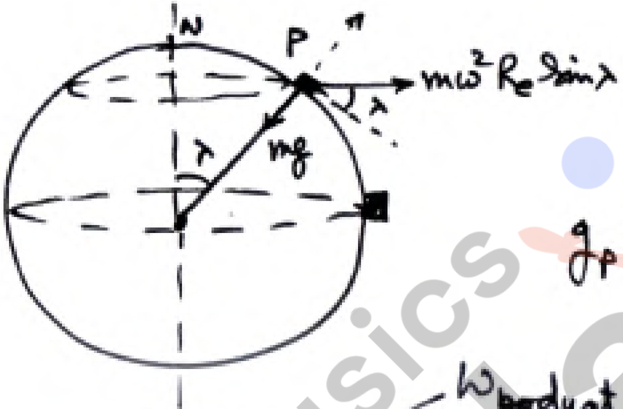
$$F_g = \frac{\sqrt{2}Gm^2}{a^2} + \frac{Gm^2}{2a^2} = \frac{mv^2}{(a/\sqrt{2})}$$

$$R = \frac{a}{\sqrt{2}}$$

$v =$ ——

Questions Based on

Effect of Rotation of Earth on Weight of Bodies



$$g_P = g_s - \omega^2 R_e \sin^2\lambda$$

if $\omega_e \longrightarrow \underline{\underline{3\omega_e}}$

$W_{\text{body at N}} \longrightarrow$ remain

$W_{\text{equator}} \longrightarrow g_i = g_s - \omega^2 R_e$

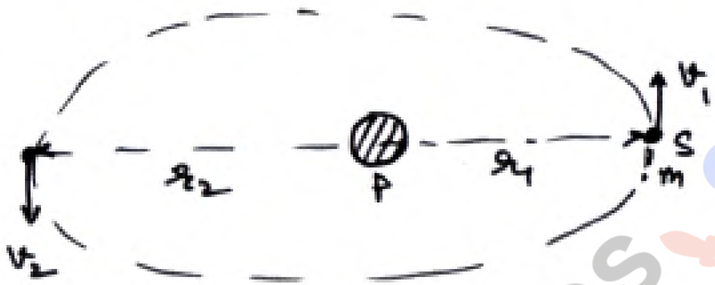
$$\underline{g_f} = g_s - \underline{9\omega^2 R_e}$$

at a particular λ, we use

$$g_P = \frac{g_{Pi}}{5} = g - 9\omega^2 R_e \sin^2\lambda$$

QUESTIONS BASED ON

PERIGEE & APOGEE RELATION IN ELLIPTICAL PATH



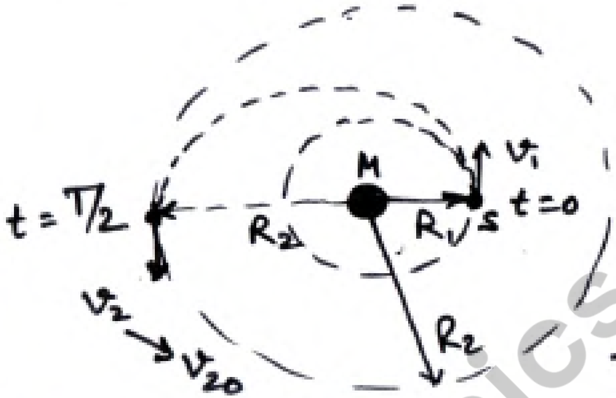
$$m v_1 r_1 = m v_2 r_2$$

$$\frac{1}{2} m_1 v_1^2 - \frac{GMm}{r_1} = \frac{1}{2} m v_2^2 - \frac{GMm}{r_2}$$

$$T^2 = \frac{4\pi^2}{Gm}\left(\frac{r_1 + r_2}{2}\right)^3$$

QUESTIONS BASED ON

CHANGING ORBIT OF A SETELLITE IN ELLIPTICAL PATH



$v_1 \leftarrow v_{10} = \sqrt{\frac{GM}{R_1}}$

$v_2 \rightarrow v_{20} = \sqrt{\frac{GM}{R_2}}$

$$a = \frac{R_1+R_2}{2}$$

time of elliptical orbit $T^2 = \frac{4\pi^2}{GM} a^3$

time of orbit transfer

$t = T/2$

for elliptical path

$$\frac{1}{2}mv_1^2 - \frac{GMm}{R_1} = \frac{1}{2}mv_2^2 - \frac{GMm}{R_2}$$

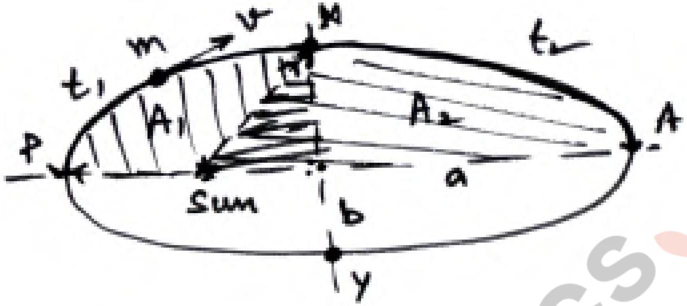
$$v_1 R_1 = v_2 R_2$$

$v_1 =$ ___

$v_2 =$ ___

QUESTIONS BASED ON

TIME TO COVER AN ELLIPTICAL ARC BY A SATELLITE OR A PLANET



Areal vel → Const

area of ellipse $= \pi ab$

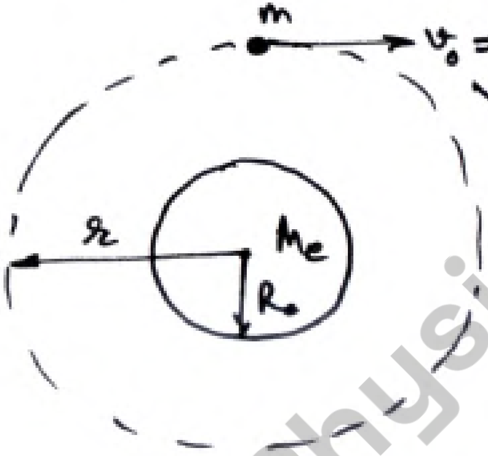
$$\frac{t_1}{t_2} = \frac{A_1}{A_2} =$$

$$A_1 = \frac{\pi ab}{4} - A_T$$

$$A_2 = \frac{\pi ab}{4} + A_T$$

Questions Based on

Escaping of a Satellite



$$v_0 = \sqrt{\frac{GM}{r}}$$

$$v_{es} = \sqrt{2}\, v_0$$

To free from gravity

$$E_{ts} = 0$$

$$\frac{1}{2} m v_{es}^2 - \frac{GMm}{r} = 0$$

$$v_{es} = \sqrt{\frac{2GM}{r}}$$

$$\left(\frac{v_{es}}{v_0} = \sqrt{2} \right) \longrightarrow 1.414\, v_0$$

41.4% inc.

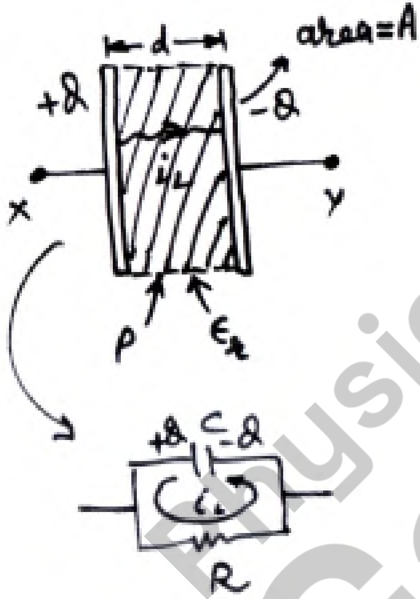
Revision Booster WORKSHOP for NEET & JEE Main

Current & Capacitance

Notes of Revision Booster Workshop for JEE Main & NEET

QUESTIONS BASED ON

DISCHARGE IN A LEAKY CAPACITOR



$$R_{xy} = \frac{\rho d}{A}$$

$$C_{xy} = \frac{\epsilon_0 \epsilon_r A}{d}$$

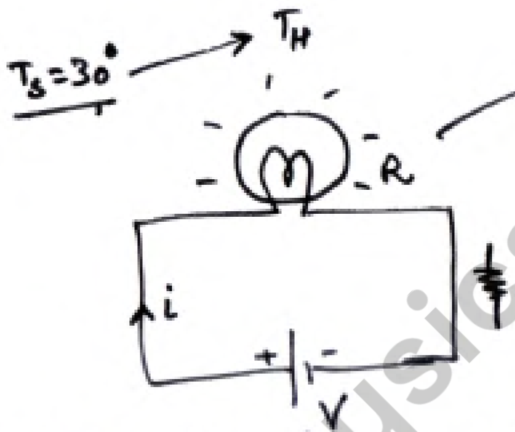
Parallel

$$i_L = \frac{Q}{RC} e^{-t/RC}$$

time constant $\tau = RC = \underline{\rho \epsilon_0 \epsilon_r}$

QUESTIONS BASED ON

VARYING RESISTANCE OF A BULT



$R_H = R(1+\alpha\Delta T)$

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

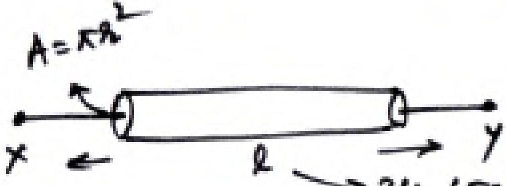
$\frac{5R}{4} = R(1+\alpha\Delta T)$

$\Delta T = $ ——

find temp of bulb when $i \rightarrow \frac{4i}{5} \Rightarrow R \rightarrow \frac{5R}{4}$

Questions Based on

Variation in Resistance by Deformation



$l \to 3l/2$ (50% increase)

$V \to$ Const

$V = lA$

$l \to 3l/2$, $A \to \dfrac{2A}{3}$

$$R_{xy} = \frac{\rho l}{A}$$

new resistance $R_{new} = \dfrac{\rho(3l/2)}{2A/3} = \dfrac{9}{4} \cdot R_{xy} = 2.25\, R_{xy}$

125% increase in resistance.

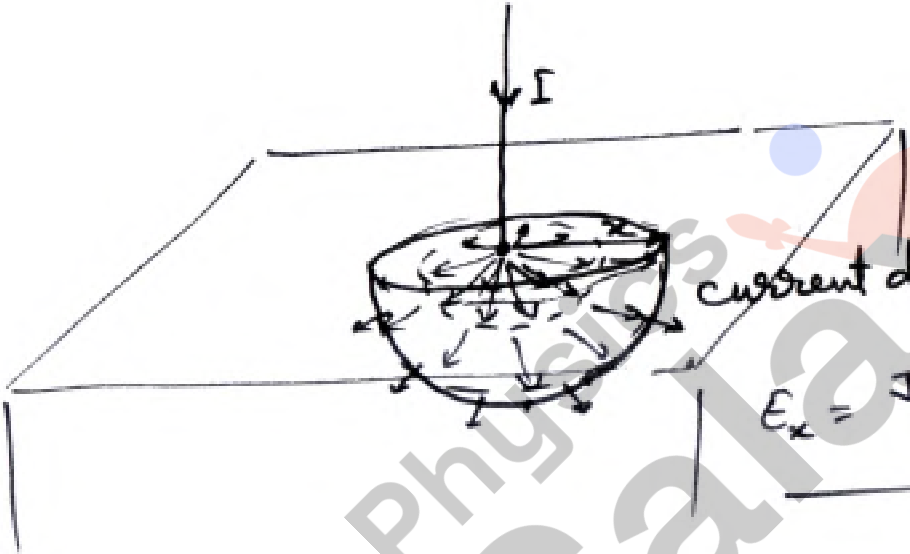
If temp is inc by ΔT

if $\rho \to$ constant

$$R_{new} = \frac{\rho l(1+\alpha\Delta T)}{A(1+2\alpha\Delta T)} = \underline{R(1-\alpha\Delta T)}$$

QUESTIONS BASED ON

ELECTRIC CURRENT SPREADING IN VOLUME



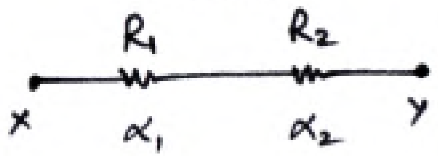
current density $J = \frac{I}{2\pi x^2}$

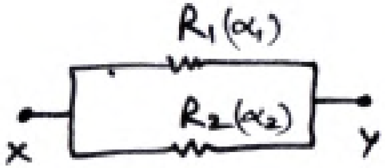
$E_x = J.\rho = \frac{\rho I}{2\pi x^2}$

Questions Based on

Equivalent Temperature Coefficient of Resistance

Series





$\Delta T \uparrow$

$R_1 + R_2$

(α_s)

$\frac{R_1 R_2}{R_1 + R_2}\,(\alpha_p)$

$$\frac{1}{R_{eq}} = \frac{1}{R_1(1+\alpha_1\Delta T)} + \frac{1}{R_2(1+\alpha_2\Delta T)}$$

$$(R_1+R_2)_f = R_1(1+\alpha_1\Delta T) + R_2(1+\alpha_2\Delta T)$$

$$(R_1+R_2)(1+\alpha_s\Delta T) = R_1 + R_2 + R_1\alpha_1\Delta T + R_2\alpha_2\Delta T$$

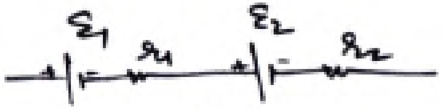
$$\alpha_s = \_\_\_\_\_\_$$

$$\left(\frac{R_1R_2}{R_1+R_2}\right)(1+\alpha_p\Delta T) = \_\_\_\_\_\_$$

$$\alpha_p = \_\_\_\_\_\_$$

QUESTIONS BASED ON

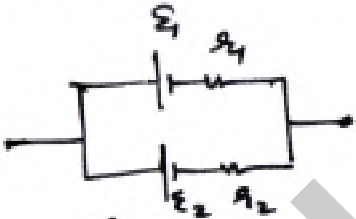
CIRCUIT SOLVING USING CALL COMBINATIONS



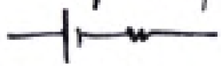
$\equiv$

$r_1 + r_2 = r_{eq}$

$\mathcal{E}_{eq} = \mathcal{E}_1 + \mathcal{E}_2$



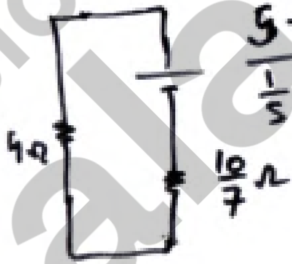
$=$



$r_{eq} = r_1 r_2 / r_1 + r_2$

$$\mathcal{E}_{eq} = \left(\frac{\mathcal{E}_1/r_1 + \mathcal{E}_2/r_2}{1/r_1 + 1/r_2}\right)$$

$\underline{Ex:}$ $\mathcal{E}_{4\Omega} = ?$



$$\frac{5-4}{\frac{1}{5}+\frac{1}{2}} = \mathcal{E}_{eq} = \frac{10}{7}\,V$$

$$I = \frac{10/7}{4 + 10/7}\ A \quad Ans$$

Questions Based on

Fusing of a Bulb in Circuit

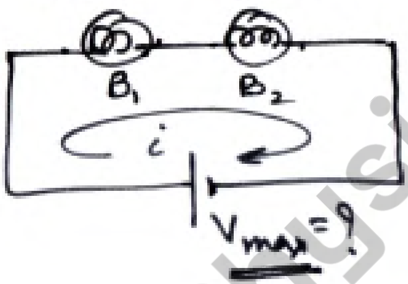
↓

200V, 100W

V_B P_B $\longrightarrow R_B = \dfrac{V^2}{P}$

Ex:

200V, 100W 100V, 20W



$R_1 = \dfrac{(200)^2}{100} = 400\ \Omega$

$R_2 = \dfrac{(100)^2}{20} = 500\ \Omega$

$i = \dfrac{V_m}{900}$

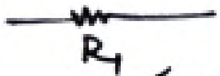
$V_1 = \dfrac{V_m}{900} \times 400 \le 200 \longrightarrow V_m = \text{—}$

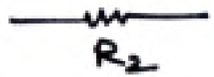
$V_2 = \dfrac{V_m}{900} \times 500 \le 100 \longrightarrow V_m = \text{—}$

Questions Based on

Heating Coils Combination

$t_1 \rightarrow$ water Boil $\leftarrow t_2$



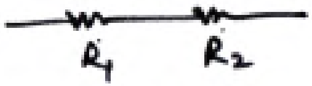


$i^2 R_1 t_1 = H = i^2 R_2 t_2$ — ①

Case I $\rightarrow$ i Const

Case II $\rightarrow$ V Const

$$\frac{V^2}{R_1} t_1 = \frac{V^2}{R_2} t_2 = H$$



$$\left(\frac{V^2}{R_1+R_2}\right) t = H$$

$$i^2 (R_1+R_2) t = H$$

$$\frac{\cancel{H}}{t_1} + \frac{\cancel{H}}{t_2} = \frac{\cancel{H}}{t}$$

$$t_s = \frac{t_1 t_2}{t_1+t_2}$$

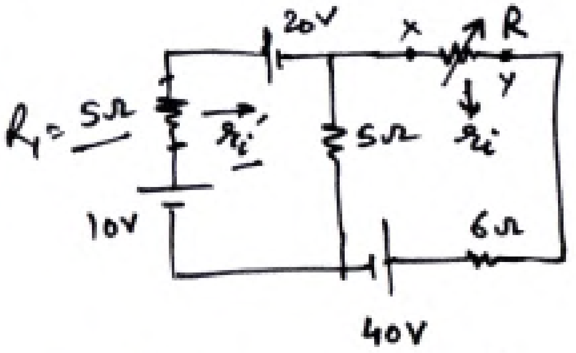
$$\left(\frac{V^2}{\frac{V^2 t_1}{H} + \frac{V^2 t_2}{H}}\right) = \frac{H}{t}$$

$$\frac{H}{t_1+t_2} = \frac{H}{t}$$

$$t = t_1 + t_2$$

QUESTIONS BASED ON

MAXIMUM POWER IN A CIRCUIT



for max power in a "variable resistance"

$$R_v = r_i$$

$$R_v = 6 + 2.5 = 8.5\,\Omega.$$

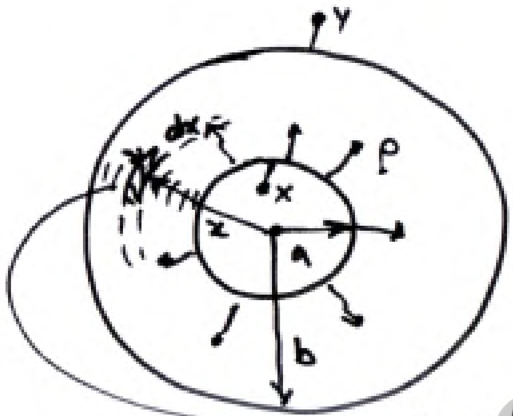
if Power in R_1 is to be maximised.
then r_i' is to be minimised.

$$r_i = \frac{5(6+R)}{5+(6+R)}$$

$$\left(\frac{1}{r_i}\right) = \frac{1}{5} + \frac{1}{6+R} \rightarrow \boxed{0.} \text{ Ans}$$

Questions Based on

Current Density in Spherical or Cylindrical Conductors



$dR = \frac{\rho\, dx}{4\pi x^2}$

$V_x > V_y$

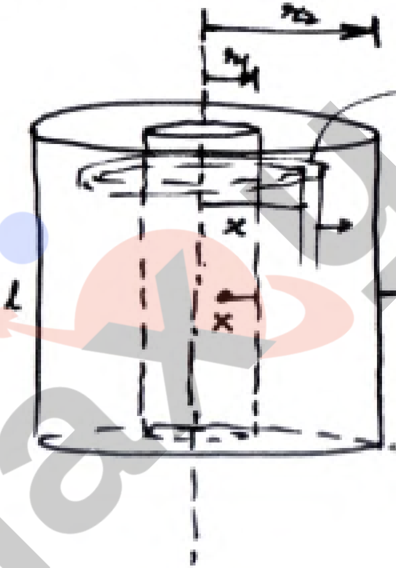
$R = \int dR = \frac{\rho}{4\pi}\int_a^b \frac{dx}{x^2}$

$R = \frac{\rho}{4\pi}\left[\frac{1}{a} - \frac{1}{b}\right]$

$I = \frac{V_x - V_y}{R}$

$J_x = \frac{I}{4\pi x^2}$ A/m²

$E_x = \rho J_x.$



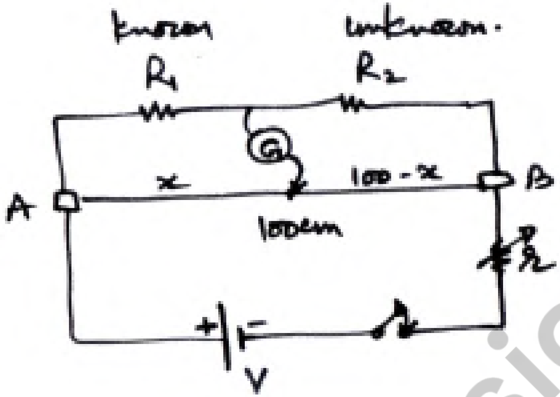
$dR = \frac{\rho . dx}{2\pi x l}$ ✓

$J_x = \frac{I}{2\pi x l}$

$I = \frac{V_x - V_y}{R}$ ✓

QUESTIONS BASED ON

METER BRIDGE FOR UNKNOWN RESISTANCES



for null pt $\frac{R_1}{x} = \frac{R_2}{100-x}$

$x = \_\_\_\_$

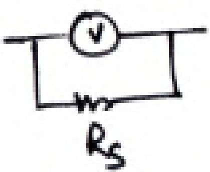
$\frac{R_1}{R_2} = \_\_\_\_$

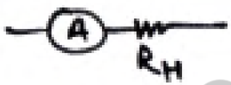
Questions Based on

Ammeter Replacing a Voltmeter

$R \rightarrow$ low

$R \rightarrow$ High



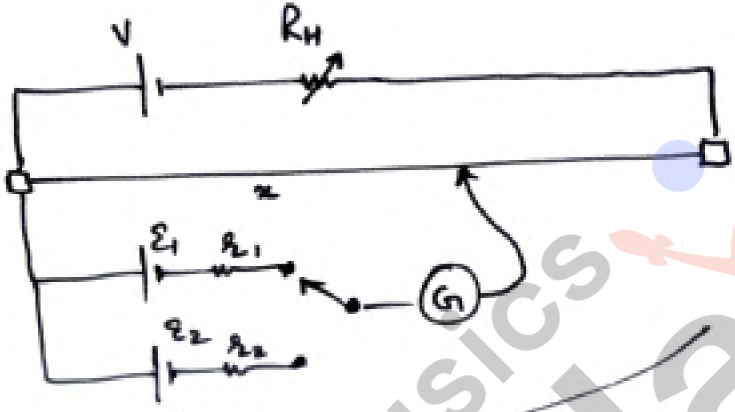


$$R_V = R_A + R_H$$

$$R_A = \frac{R_S R_V}{R_S + R_V}$$

QUESTIONS BASED ON

CELL COMPARISON IN A POTENTIOMETER



potential gradient = λ

$x = l_1$ for $\mathcal{E}_1$

$\Rightarrow \mathcal{E}_1 = \lambda l_1$ — ①

$x = l_2$ for $\mathcal{E}_2$

$\mathcal{E}_2 = \lambda l_2$ — ②

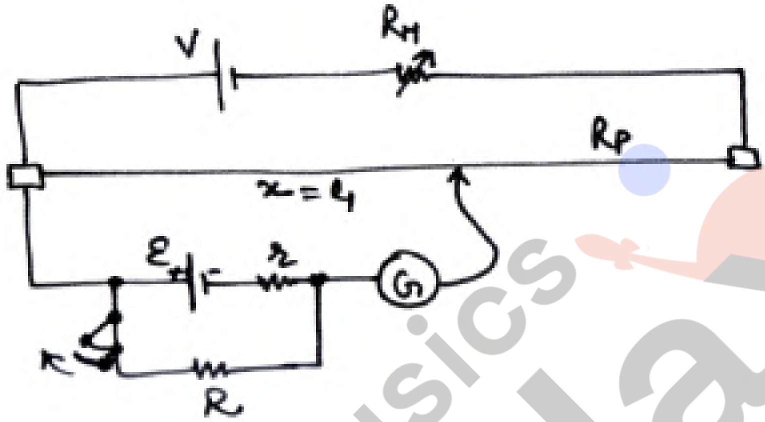
K ✓

$$\left[\frac{\mathcal{E}_1}{\mathcal{E}_2} = \frac{l_1}{l_2}\right]$$

UK

QUESTIONS BASED ON

INTERNAL RESISTANCE BY A POTENTIOMETER



p.g. = λ V/cm

$$\lambda = \frac{V}{R_H + R_P} \cdot \frac{R_P}{L}$$

at $x = l_1$ $\quad \varepsilon = \lambda l_1$ — (1)

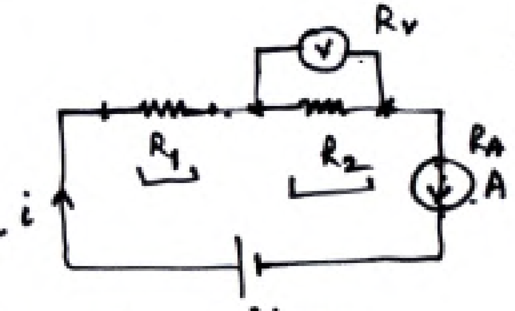
after R is connected

at $x = l_2$ $\quad \varepsilon - iR = \lambda l_2$

$$\frac{\varepsilon R}{r + R} = \lambda l_2 \quad \text{— (2)}$$

QUESTIONS BASED ON

ERROR IN VOLTMETER OR AMMETER



Error in Reading of V = ?

$$i = \frac{V}{R_1+R_2+R_A}$$

$$V_{Reading} = i\left(\frac{R_V R_2}{R_V+R_2}\right)$$

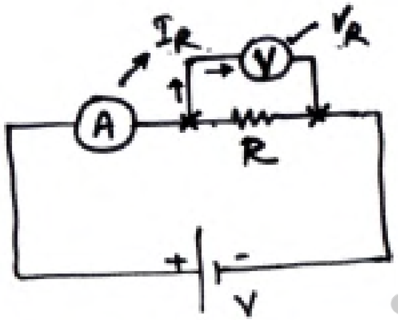
$$= \left(\frac{V}{R_1+\frac{R_V R_2}{R_V+R_2}}\right)\left(\frac{R_V R_2}{R_V+R_2}\right)$$

In absence of voltmeter ⟵ $V_{actual} = \frac{V}{R_1+R_2} \cdot R_2$

$$\% \text{ error} = \frac{|V_a - V_R|}{V_a} \times 100\%$$

Questions Based on

Effect on Measured Value of R due to V and A



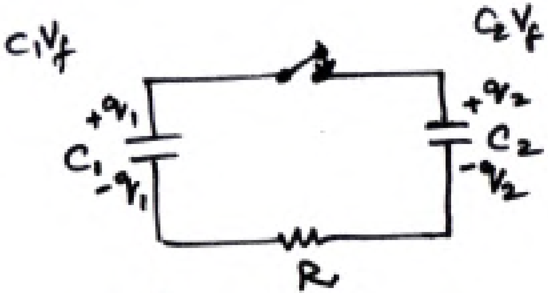
meas value of Resistance

$$\rightarrow R_m = \frac{V_R}{I_R}$$

here $I_R >$ Iactual R $\Rightarrow$ $R_{meas} < R_{actual}$

Questions Based on

Heat Produced in Closing the Switch



$$\boxed{V_f = \frac{q_1+q_2}{C_1+C_2}}$$

$$U_i = \frac{q_1^2}{2C_1} + \frac{q_2^2}{2C_2}$$

$$U_f = \frac{1}{2}(C_1+C_2)V_f^2$$

$$H = U_i - U_f$$

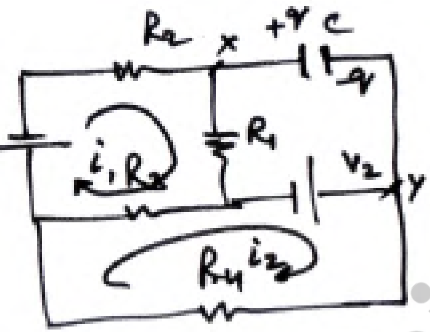
alternative

$$H = \frac{\Delta q_1^2}{2C_1} + \frac{\Delta q_2^2}{2C_2}$$

Questions Based on

Steady State of Capacitor in Electric Circuit

$\underline{\underline{i_c = 0}}$

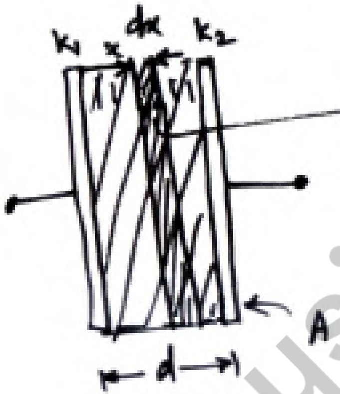


$q = C(V_x - V_y)$

in SS $C \longrightarrow$ 

QUESTIONS BASED ON

DIELECTRIC VARIATION IN CAPACITORS



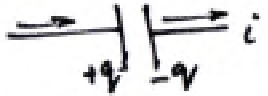
$$k = k_1 + \frac{k_2 - k_1}{d}\cdot x$$

$$dC = \frac{k\epsilon_0 A}{dx}$$

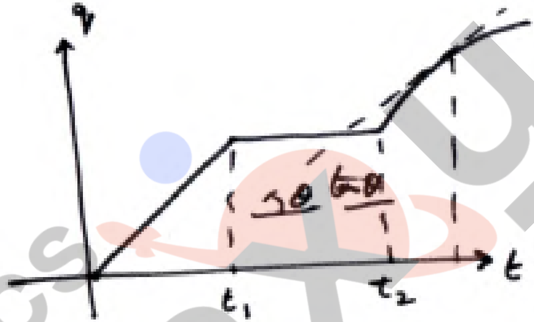
$$\frac{1}{C} = \int \frac{1}{dC} = \int_0^d \frac{dx}{k\epsilon_0 A} = \text{——}$$

QUESTIONS BASED ON

CHARGE VARIATION ON PLATES OF A CAPACITOR



$q = f(t)$



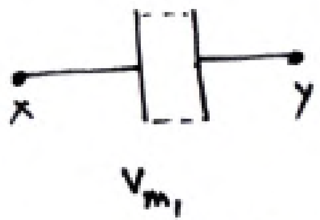
ckt current $i = \frac{dq}{dt}$

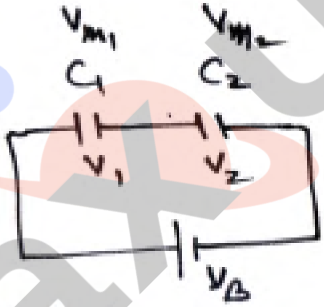
$i \leftarrow$ slope of q vs t curve

QUESTIONS BASED ON

VOLTAGE RATING OF A CAPACITOR

$V_{max} \leftarrow$ causes dielectric breakdown.





Q: find V_B max for which both the capacitors will withstand

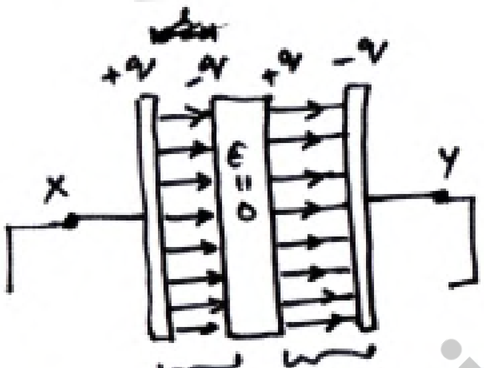
$$\underline{V_{m_1}} = V_1 = \frac{C_2 V_B}{C_1 + C_2} \quad ; \quad V_2 = \frac{C_1 V_B}{C_1 + C_2} = \underline{V_{m_2}}$$

$$\underbrace{V_B = \_\_\_\_} \qquad \underbrace{V_B = \_\_\_\_}$$

whichever is less is the max permissible value of $\underline{\underline{V_B}}$.

QUESTIONS BASED ON

METAL PLATE INSERTED IN A CAPACITOR



Series.

$C_1 = \frac{\epsilon_0 A}{l_1}$

$C_2 = \frac{\epsilon_0 A}{l_2}$

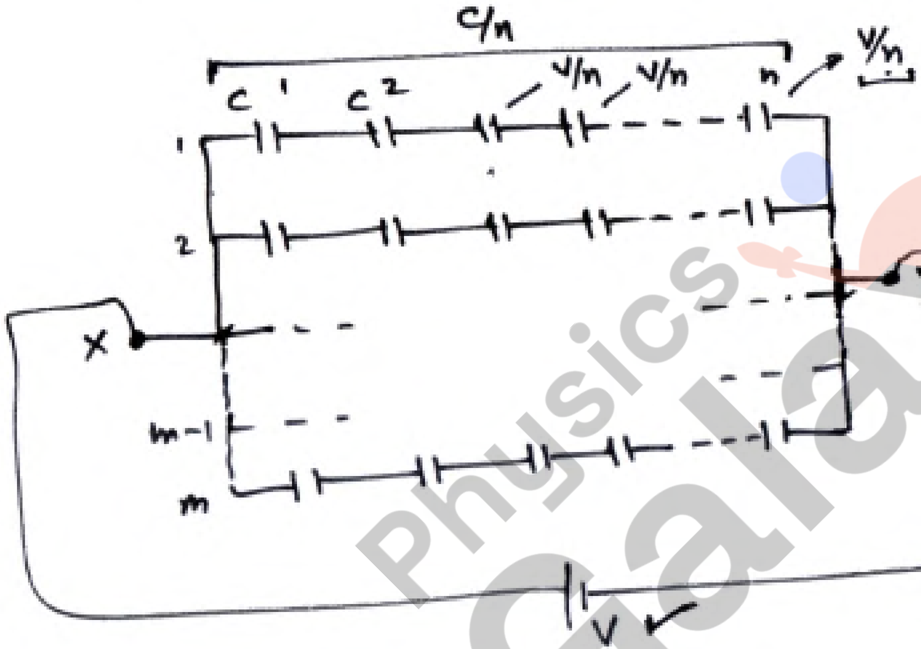
l_1, l_2, d

$C_{xy} = \frac{C_1 C_2}{C_1 + C_2}$

Original cap $C_i = \frac{\epsilon_0 A}{d}$

QUESTIONS BASED ON

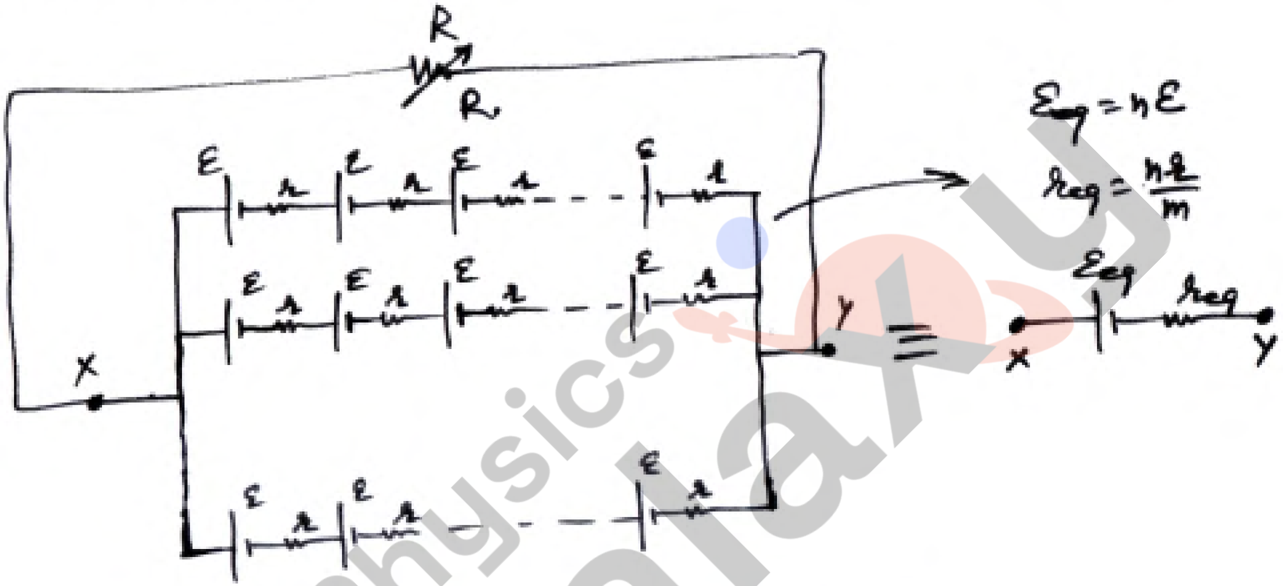
CAPACITANCE GRID



$$C_{xy} = \frac{mC}{n}$$

Questions Based on

Battery Grid

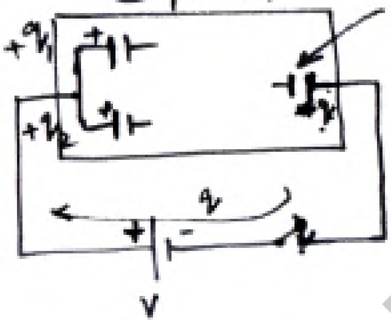


for max power in R, we use $R = \frac{nr}{m}$.

QUESTIONS BASED ON

WORK DONE BY BATTERY IN CHARGING A CAPACITIVE CIRCUIT

Cap. ckt



$q = q_1 + q_2$

$|q_1|$ $|q_1 + q_2|$

W/D by battery $W = \underline{\underline{\Delta q_f}} \cdot V = $ ____

Revision Booster WORKSHOP for NEET & JEE Main

Magnetism, EMI & AC

Notes of Revision Booster Workshop for JEE Main & NEET

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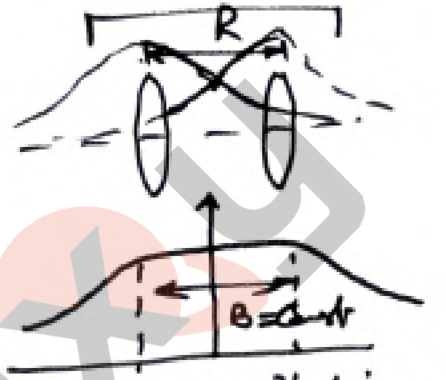
QUESTIONS BASED ON

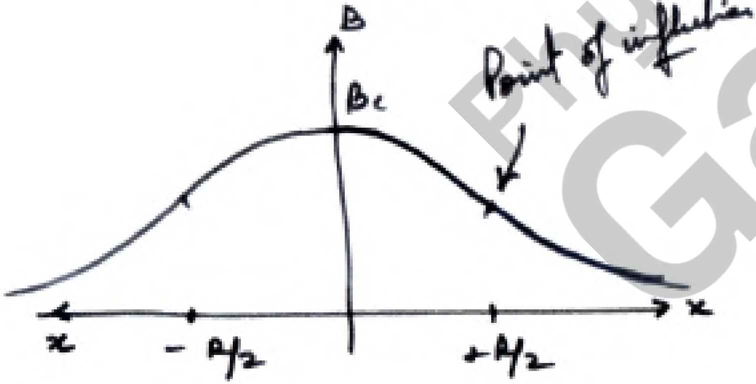
HELMHOLTZ COILS

$$B = \frac{\mu_0 i R^2 N}{2(x^2+R^2)^{3/2}}$$

$$B_c = \frac{\mu_0 i}{2R} \times N$$



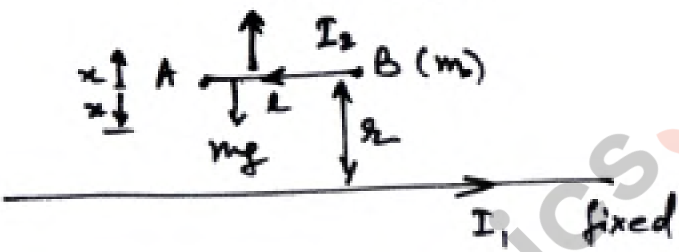
$$B_H = \left(\frac{4}{5}\right)^{3/2} \cdot \frac{\mu_0 i}{R} N$$



Questions Based on

Equilibrium of a Wire Above Another Wire

$$f_m = \frac{\mu_0 I_1 I_2 l}{2\pi r}$$



for eq^m of AB $\quad \frac{\mu_0 I_1 I_2 l}{2\pi r} = mg$

after disp by x, we use

$$ma = F_R = -\left(\frac{\mu_0 I_1 I_2 l}{2\pi(r-x)} - mg\right)$$

(x)

$$a = -\omega^2 x$$

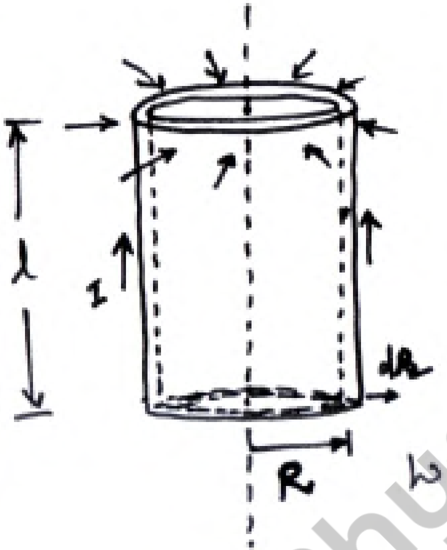
for eq^m x → r

$$\omega = \sqrt{\frac{f'(r)}{m}} =$$

$$f'(x) = -\frac{\mu_0 I_1 I_2 l}{2\pi x^2} = \left(\frac{\mu_0 I_1 I_2 l}{2\pi r^2}\right)$$

QUESTIONS BASED ON

MAGNETIC PRESSURE IN A METAL PIPE



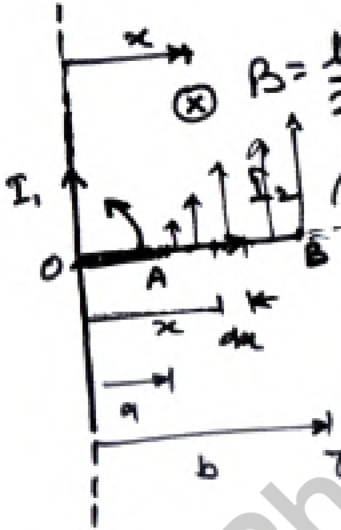
magnetic pressure $P_m = \frac{B^2}{2\mu_0} = u_m$

W/D in expanding the rod from R to R'

$W = \int P_m \, dV = \int_R^{R'} P_m \cdot (2\pi r l \cdot dr) = - - - -$

Questions Based on

Magnetic Torque Between Two Wires



$B = \frac{\mu_0 I_1}{2\pi x}$

mag force on dx

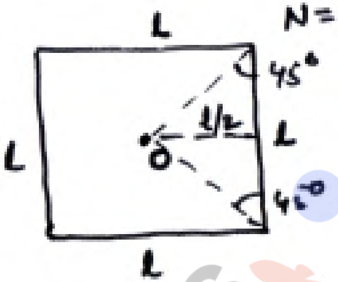
$F = \int dF = \int B I_2 dx = \int_a^b \frac{\mu_0 I_1}{2\pi x} \cdot I_2 dx = \frac{\mu_0 I_1 I_2}{2\pi} \ln(b/a)$

$\tau = \int d\tau = \int dF \cdot dx = \text{-----}$

QUESTIONS BASED ON

MAGNETIC FIELD BY CHANGING SHAPE OF A COIL

$$B_0 = \frac{\mu_0 I}{2R}$$



$N = N_0/2$

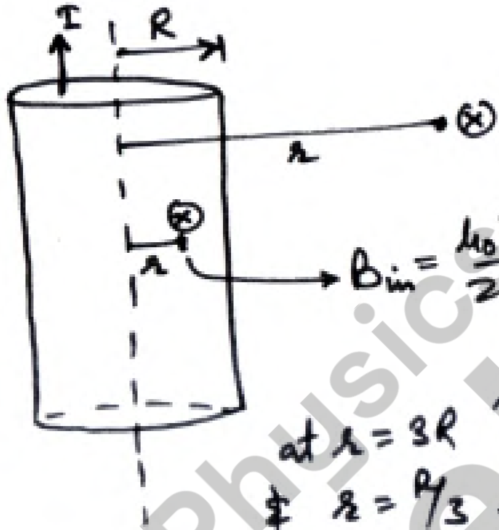
$$N_0 \cdot 2\pi R = \frac{N_0}{2}(4L)$$

$$L = \pi R.$$

$$B_0' = \frac{\mu_0 I}{4\pi(L/2)}\left(\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right) \times 4 \times N_0/2 = \text{---}$$

Questions Based on

Ratio of Magnetic Field Inside and Outside a Wire



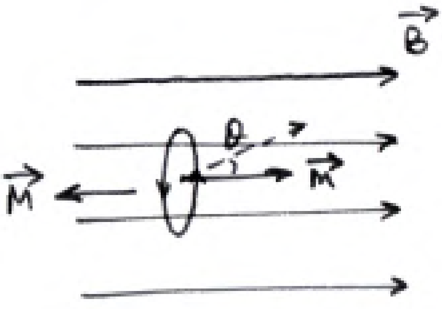
$$B_{out} = \frac{\mu_0 I}{2\pi r}$$

$$B_{in} = \frac{\mu_0 I r}{2\pi R^2}$$

$$\left.\begin{array}{l} \text{at } r = 3R \\ \& \;\; r = R/3 \end{array}\right\} \frac{B_1}{B_2} = ? = \_\_\_$$

Questions Based on

Torque on Loop in Unform Magnetic Field



$\vec{\tau} = \vec{M} \times \vec{B} = 0$

$\underbrace{\vec{M} \times \vec{B}}_{\rightarrow MB\sin\theta}$

if $\vec{M}$ is $||^{l}$ to $\vec{B}$ $\Rightarrow U = -MB$ (min) $\Rightarrow$ stable eq^m

if $\vec{M}$ is $\downarrow\uparrow^{l}$ to $\vec{B}$ $\Rightarrow U = MB$ (max) $\Rightarrow$ unstable eq^m

Restoring torque $\tau_R = -MB\theta$

$\alpha = -\frac{MB}{I}\theta = -\omega^2\theta$

angular SHM $\rightarrow$

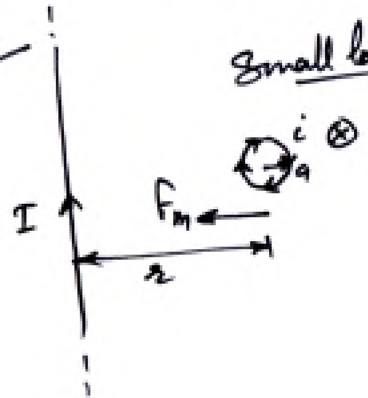
$\omega = \sqrt{\frac{MB}{I}} \Rightarrow T = 2\pi\sqrt{\frac{I}{MB}}$ ✓

$\boxed{\vec{F}_{net} = 0}$

Questions Based on

Torque on a Loop Due to a Wire

force



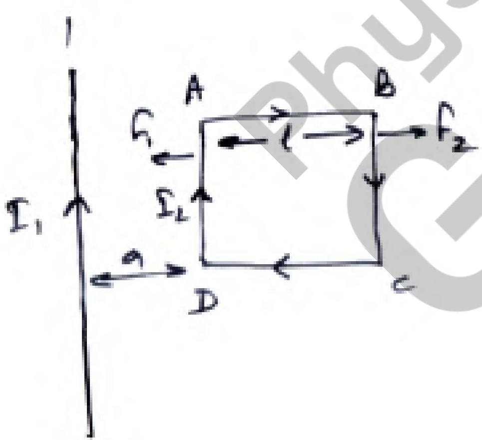
Small loop → magnetic dipole

$\mu = i\pi a^2$

$\vec{\mu}$ is $||^l$ to $\vec{B}$

$\vec{\tau}_{net} = 0$

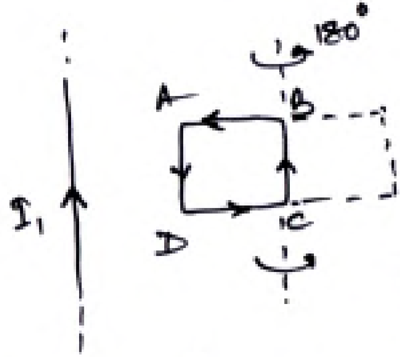
force on dipole $\vec{F} = \vec{\mu}\cdot\frac{d\vec{B}}{dx}\hat{i} = \_\_\_$



$$F_{ABCD} = \frac{\mu_0 I_1 I_2}{2\pi a}\cdot l - \frac{\mu_0 I_1 I_2}{2\pi(a+l)}\cdot l = \checkmark$$

Questions Based on

Work Done in Moving/Changing Orientation of a Coil



Work done on a coil in MF

$-\underline{NIA}B\cos\theta$ $\boxed{W = -I\Delta\phi} \boxed{= I(\phi_i - \phi_f)}$

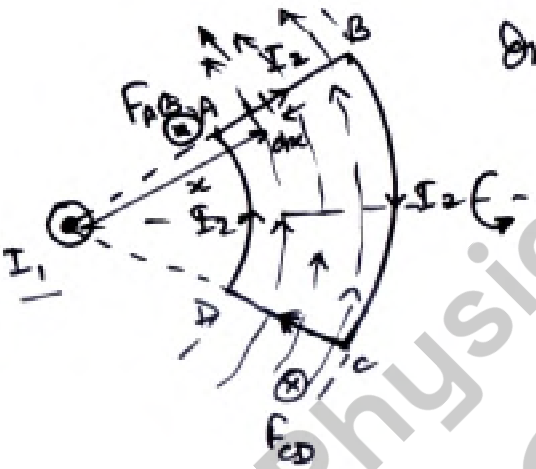
$U = -MB\cos\theta$

magnetic PE of a coil in MF $U = -I\phi$

$$\boxed{W = U_f - U_i = I(\phi_i - \phi_f)}$$

Questions Based on

Magnetic Torque on a Coil in Cross-sectional Plane of a Wire



On wires AD and BC $F_{net} = 0$

anticlockwise rotational torque on loop ABCD.

Questions Based on

Different Charges Entering in Magnetic Field At Same Momentum

$$R = \frac{mv}{qB}$$

$$\Rightarrow R \propto \frac{1}{q}$$

Same KE particles enter in MF

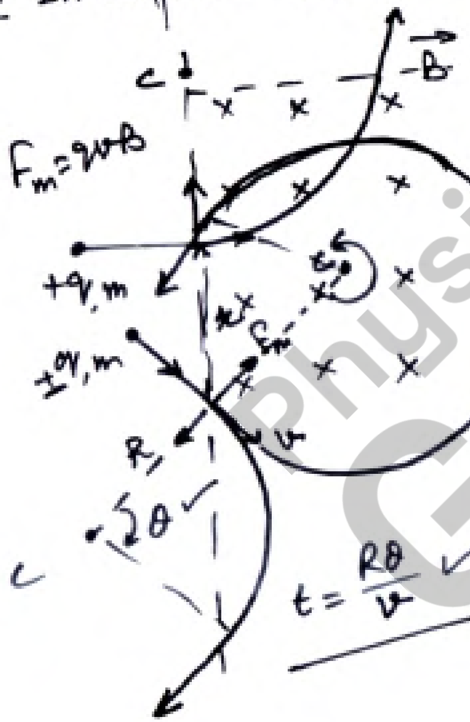
$$R = \frac{\sqrt{2mk}}{qB}$$

$$\left(R \propto \sqrt{m}\right) \; \& \; \left(R \propto \frac{1}{q}\right)$$

QUESTIONS BASED ON

CIRCULAR PATH IN UNIFORM MAGNETIC FIELD

✓ **NOTE:** In uniform MF, particle from outside can never complete the circle.

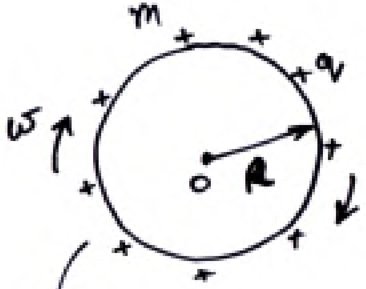


$$R = \frac{mv}{qB}$$

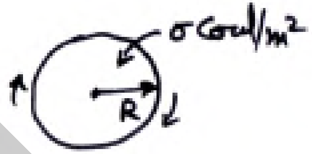
$$t = \frac{R\theta}{v}$$

QUESTIONS BASED ON

MAGNETIC FIELD DUE TO ROTATION OF CHARGE



Convection current $I = \frac{q\omega}{2\pi}$



$B_0 = \frac{\mu_0 I}{2R}$

$q = \sigma \cdot \pi R^2$

magnetic moment of disc

$\mu = \frac{q}{2m} \cdot \left(\frac{1}{2} mR^2 \cdot \omega\right)$

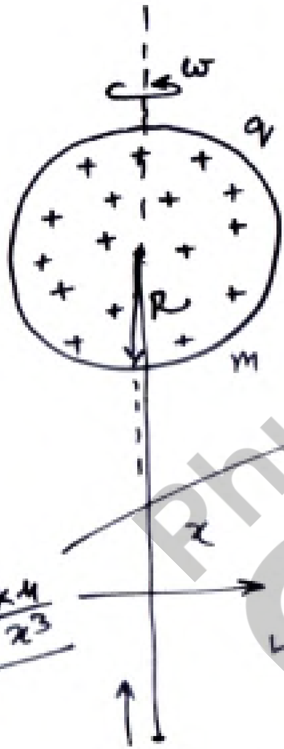
magnetic moment $\mu = I \cdot \pi R^2$

$\mu = \frac{q}{2m} \cdot L$

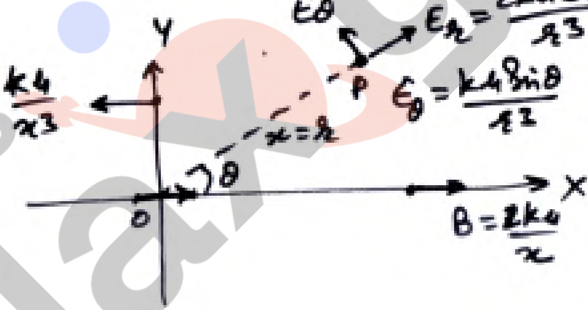
for a rotating charged body we use $\boxed{\frac{\mu}{L} = \frac{q}{2m}}$

QUESTIONS BASED ON

MAGNETIC DIPOLE MOMENTUM OF A ROTATING SPHERE



magnet moment $\mu = \frac{q}{2m}\left(\frac{2}{5}mR^2\omega\right)$ ✓



$$E_r = \frac{2k\mu\cos\theta}{r^3}, \quad E_\theta = \frac{k\mu\sin\theta}{r^3} \qquad k = \frac{\mu_0}{4\pi}$$

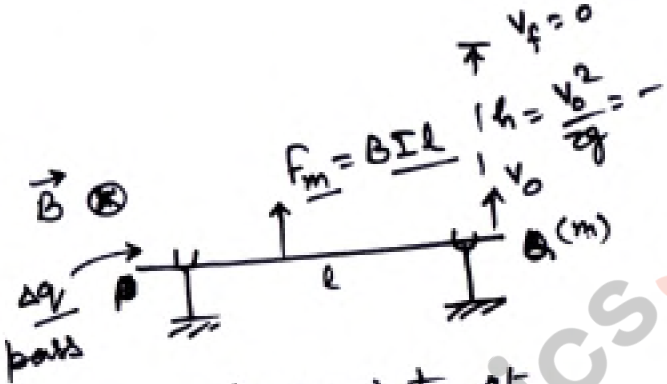
$$E_p = \frac{k\mu}{r^3}\sqrt{1+3\cos^2\theta}$$

$$B = \frac{2k\mu}{x^3} \rightarrow \frac{2}{x^3}\left(\frac{\mu_0}{4\pi}\right)\left(\frac{2}{5}qR^2\omega\right) \text{ Tesla.}$$

for $x \gg R$.

Questions Based on

Magnetic Impulse on a Wire



By impulse eq^n

$$J_m = F\Delta t = m v_0$$

$$J_m = B\Delta q l = m v_0$$

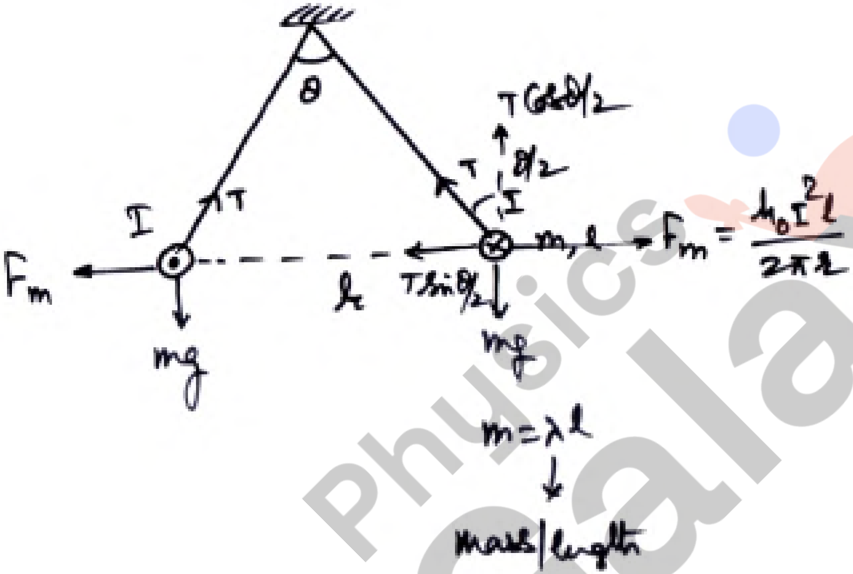
$$v_0 = \frac{B\Delta q l}{m}$$

Say charge Δq passes in time Δt

$$\Rightarrow \quad I_{avg} = \frac{\Delta q}{\Delta t}$$

QUESTIONS BASED ON

EQUILIBRIUM OF TWO SUSPENDED WIRES



for wires to be in eq^m

$$T \sin\theta/2 = \frac{\mu_0 I^2 l}{2\pi r} \quad — (1)$$

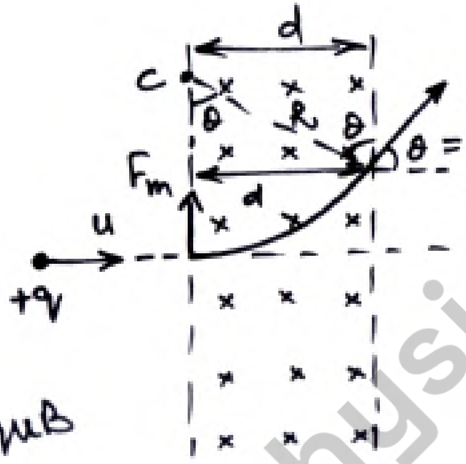
$$T \cos\theta/2 = mg \quad — (2)$$

$$\tan\theta/2 = - - -$$

$$T = \sqrt{(\ )^2 + (\ )^2}$$

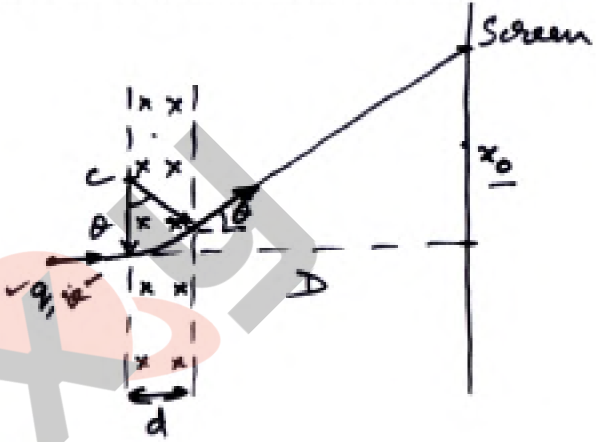
QUESTIONS BASED ON

DEFLECTION OF A CHARGE BY SECTOR OF MAGNETIC FIELD



$$\theta = \sin^{-1}\frac{qdB}{mu}$$

if $d < R$



if $d \ll D$

$\Rightarrow x_0 = D\tan\theta$

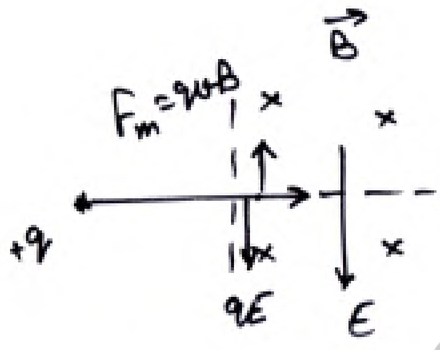
$F_m = quB$

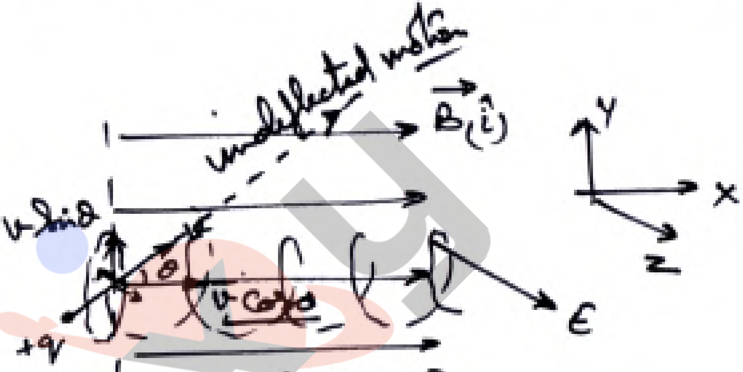
$R = \frac{mu}{qB}$

if $d > R \Rightarrow \theta = 180^\circ$

QUESTIONS BASED ON

MOTION OF A CHARGE IN BOTH ELECTRIC AND MAGNETIC FIELD





$F_m = qvB\sin\theta = qE$

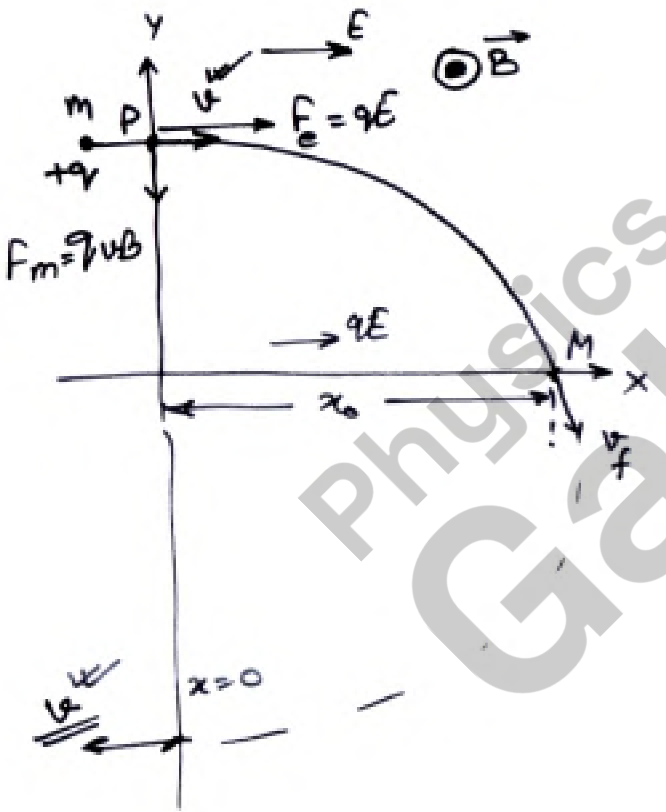
$\hookrightarrow v = \left(\frac{E}{B\sin\theta}\right)$

if $qE = qvB \Rightarrow$ it causes undeflected motion of charge

$v = \frac{E}{B}$

Questions Based on

Deflective Motion of a Charge in Both Electric & Magnetic Field



NOTE: WD by F_m is always zero.

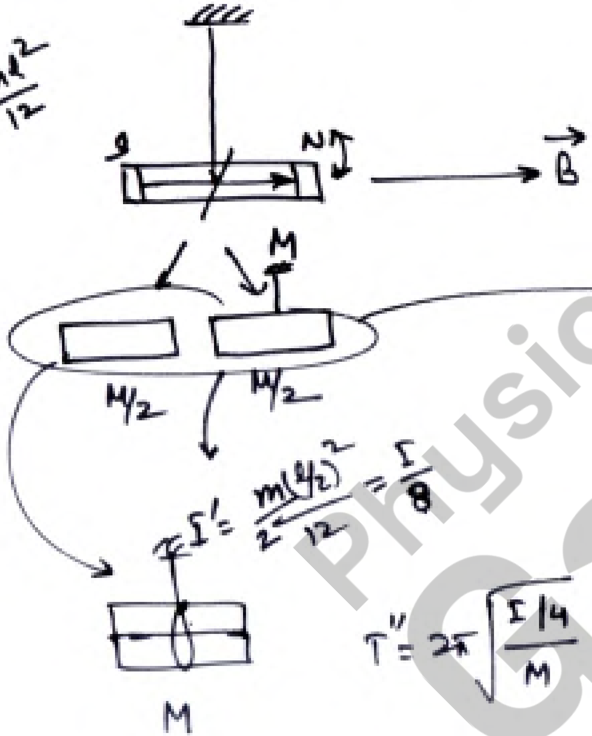
from P to M, WD by Electric force

$$W = qEx_0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv^2$$

Questions Based on

Breaking an Oscillating Magnet

$I = \frac{ml^2}{12}$



$T = 2\pi\sqrt{\frac{I}{M}}$

$T' = 2\pi\sqrt{\frac{I'}{M'}}$

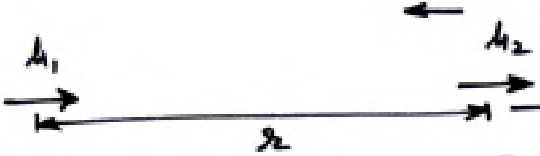
$I' = \frac{\frac{m}{2}\left(\frac{l}{2}\right)^2}{12} = \frac{I}{8}$

$T' = 2\pi\sqrt{\frac{I\,2}{8M}} = \frac{T}{2}$

$T'' = 2\pi\sqrt{\frac{I/4}{M}} = \frac{T}{2}$ ✓

Questions Based on

Force Between Magnetic Dipoles



$\rightarrow B_1 = \frac{2k\mu_1}{r^3} = \frac{\mu_0 \mu_1}{2\pi r^3}$ magnetic moment

force on μ_2 due to μ_1 is given as

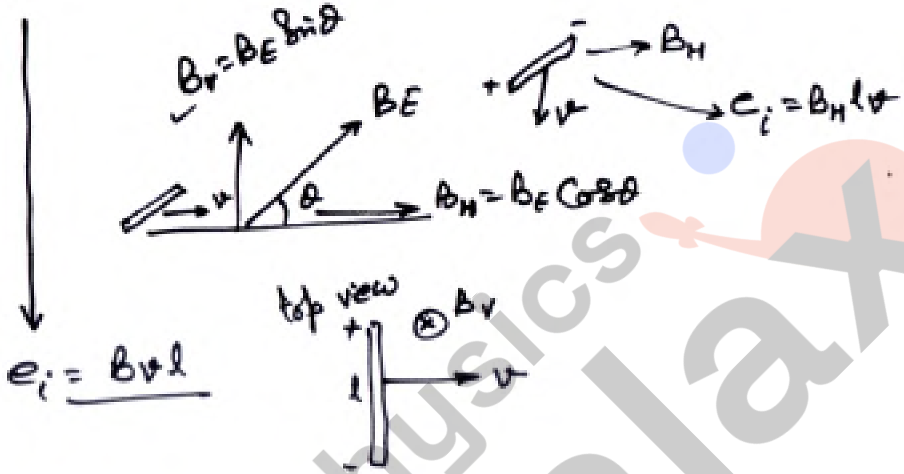
$$F = \underline{\mu_2 \frac{dB_1}{dr}} = \mu_2 \left(-\frac{3\mu_0\mu_1}{2\pi r^4}\right) = -\frac{3\mu_0 \mu_1 \mu_2}{2\pi r^4}$$

$$F \propto \frac{1}{r^4}$$

$$F \propto r^n \rightarrow \underline{n = -4.}$$

QUESTIONS BASED ON

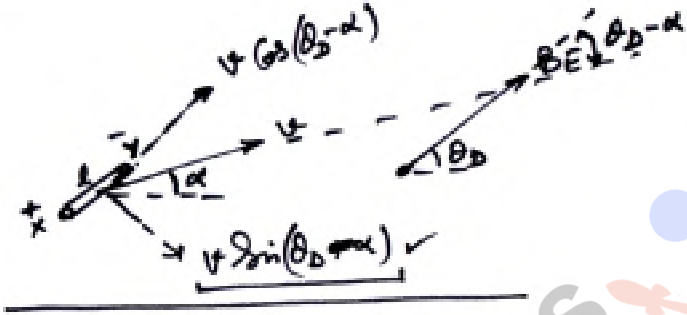
EMF INDUCED IN EARTH'S MAGNETIC FIELD



$e = B_V l v$

QUESTIONS BASED ON

EMF INDUCED IN A CONDUCTOR IN INCLEINED MOTION

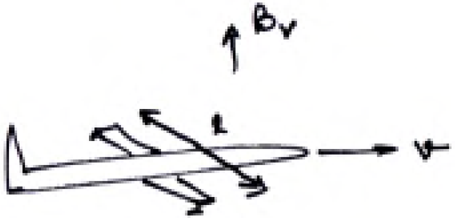


Motional emf in cond XY is

$$e_{xy} = B_E l v \sin(\theta_D - \alpha)$$

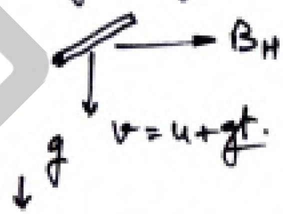
Questions Based on

EMF Induced Across Wings of a Plane



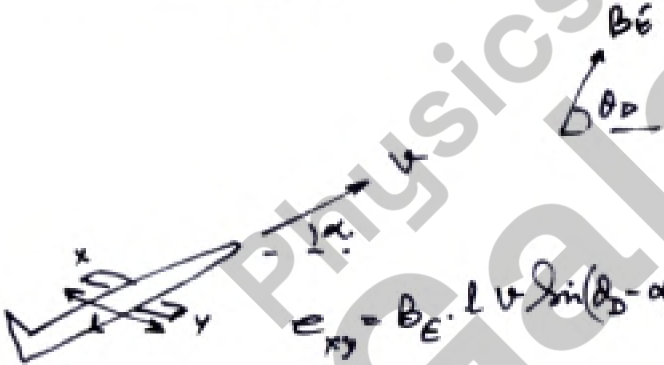
$e = B_V \cdot l \cdot v$

vertically falling Conductor



$v = u + gt.$

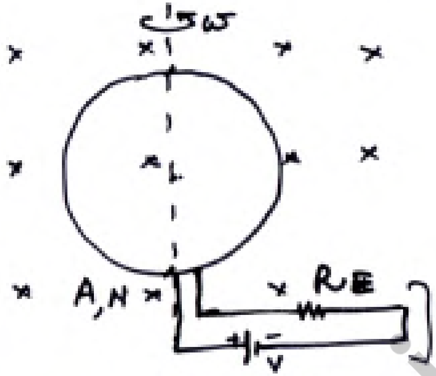
$e = B_H \cdot v \cdot l$



$e_{xy} = B_E \cdot l\, v \sin(\theta_D - \alpha)$

Questions Based on

EMF Induced in a Rotating Coil



$$i = \frac{V - NBA\omega \sin(\omega t+\theta)}{R}$$

in absence of R_E

$$e = NBA\omega \sin(\omega t+\theta)$$

$$i = \frac{e}{R}$$

$$P_{TH} = i^2R = \frac{N^2B^2A^2\omega^2}{R} \cdot \sin^2(\omega t+\theta)$$

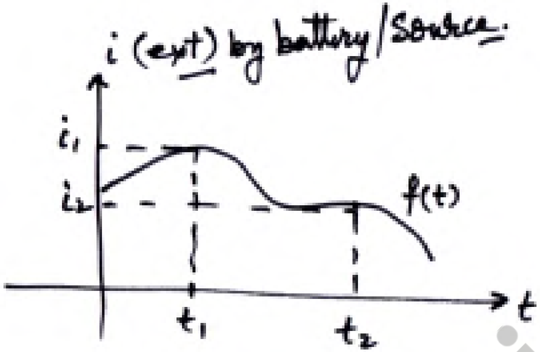
$$P_{avg} = \frac{N^2B^2A^2\omega^2}{2R}$$

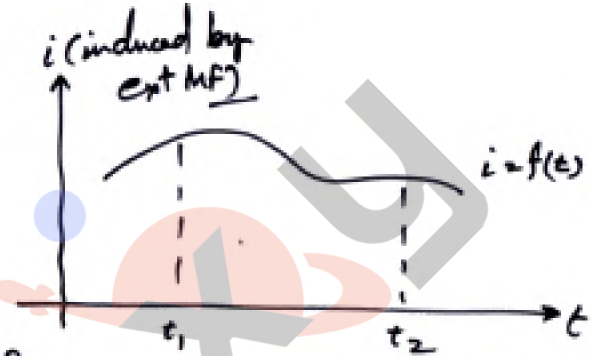
charge flown in a coil due to change in flux

$$\Delta q = \frac{\Delta\phi}{R} = \frac{L\Delta i}{R}$$

Questions Based on

Flux Calculation by Varying Current





$\longmapsto \Delta\phi = ?$

R

$\Delta q_f = \int_{t_1}^{t_2} i\,dt$ = area under i-t curve

$\phi = Li$

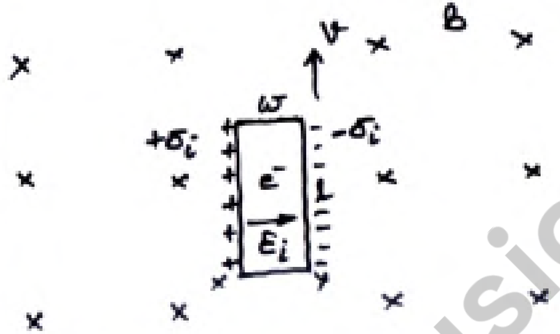
$\Delta q_f = \dfrac{\Delta\phi}{R}$

$\Delta\phi = L\Delta i = L(i_2 - i_1)$ ✓

$\Rightarrow \Delta\phi = \Delta q_f \times R$ ✓

QUESTIONS BASED ON

INDUCED SURFACE CHARGES CAUSING MOTIONAL EMF



Induced Surface charge are such that

$$E_i = \frac{\sigma_i}{\epsilon_0}$$

$$\Rightarrow \underline{\sigma_i = \epsilon_0 v B.}$$

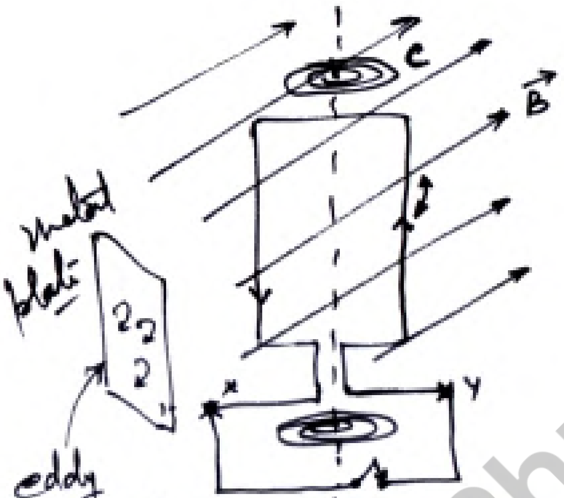
$$e_{xy} = Bvw$$

$eE_i \longleftarrow \bullet \longrightarrow evB$

inside conductor on e^- $\quad \underline{E_i = vB}$

QUESTIONS BASED ON

DAMPING OF AN OSCILLATING COIL



Restoring torque $\tau_R = C\theta$

$\alpha = -\left(\frac{C}{I}\right)\theta$

In moving coil Galvanometer

$BINA = C\theta$

$\theta = \left(\frac{BNA}{C}\right)I$

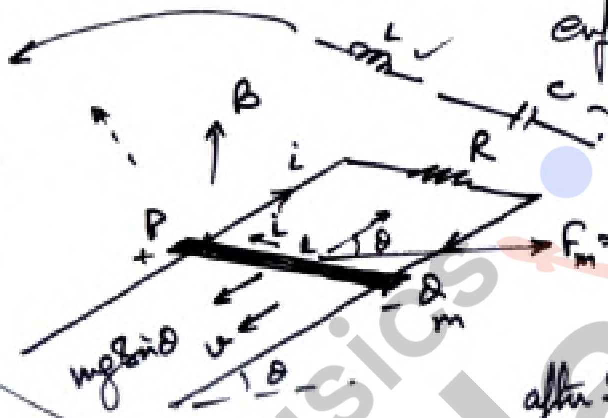
On short ckting x and y, an induced current flows in coil which quickly damps the oscillations.

Questions Based on

Terminal Speed on Inclined Rails

$e_{PQ} = L\frac{di}{dt}$

$i = $ ——



emf in PQ $\quad e_{PQ} = Blv\cos\theta$

$i = \frac{Blv\cos\theta}{R} = i_T$

$F_m = BiL$

$q = Ce_{PQ}$

$i = \frac{dq}{dt} = - - -$

after some time $a = 0$

$v_T = \frac{mgR\sin\theta}{B^2l^2\cos^2\theta} \rightarrow$ Terminal speed.

eqn of motion

$$mg\sin\theta - \frac{B^2l^2v}{R}\cos\theta = ma$$

(exp fn in t)

$a = \frac{dv}{dt} = $ ——

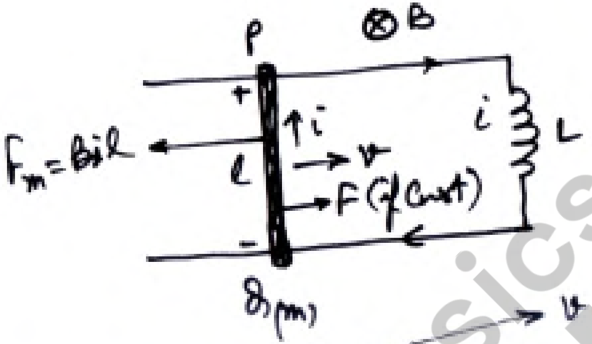
$= \frac{v\,dv}{dx} = $ ——

$\left[\underline{mgv_T} = \underline{i_T^2R}\right]$

Power supp by grav. forces.

QUESTIONS BASED ON

AN INDUCTOR ACROSS MOTIONAL EMF



$\Rightarrow$ Rod PQ executes SHM.

If ext force F is present

$F - Bil = ma$

$a = \ldots$

$e_{PQ} = Bvl = L\frac{di}{dt}$ — (1)

$v = \frac{L}{Bl}\frac{di}{dt}$

$\frac{dv}{dt} = a = -\frac{Bil}{m}$

$\frac{L}{Bl}\cdot\frac{d^2i}{dt^2} = -\frac{Bil}{m}$

$\Rightarrow \frac{d^2i}{dt^2} + \left(\frac{B^2l^2}{mL}\right)i = 0$

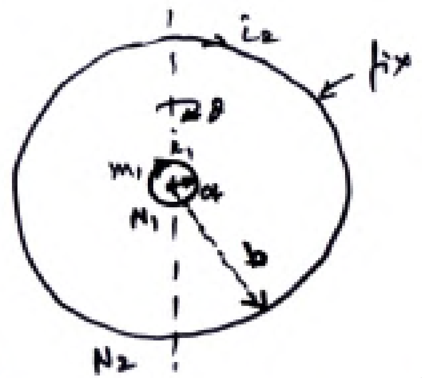
diff eqn of SHM in i

$i = i_0 \sin(\omega t + \alpha)$

$\omega = \frac{Bl}{\sqrt{mL}}$

Questions Based on

Interaction Between Two Concentric Coils



$a << b$

Stable eqm → when coils in same plane

On slight disp by θ, Restoring ~~force~~ torque on smaller coil

$$\tau_R = -\underbrace{i_1 \pi a^2 N_1 \left(\frac{\mu_0 i_2}{2b} \cdot N_2\right)}\theta$$

$$\alpha = -\left[\frac{[\quad]}{\left(\frac{1}{2}m_1 a^2\right)}\right]\theta \leftarrow \omega^2$$

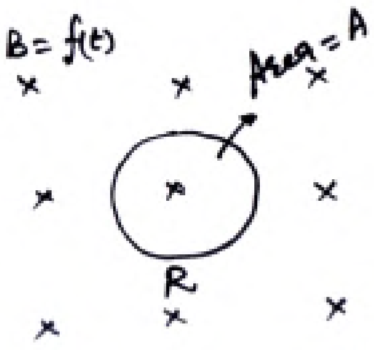
$$T = \frac{2\pi}{\omega} = \text{—}$$

Interaction energy betwn coils

$$U = -M \cdot B = -\left(i_1 \pi a^2 N_1\right)\left(\frac{\mu_0 i_2}{2b} N_2\right)\cos\theta$$

$$W_{ept} = U_f - U_i \;;\; W_{sys} = U_i - U_f$$

QUESTIONS BASED ON
THERMAL POWER DUE TO TVMF



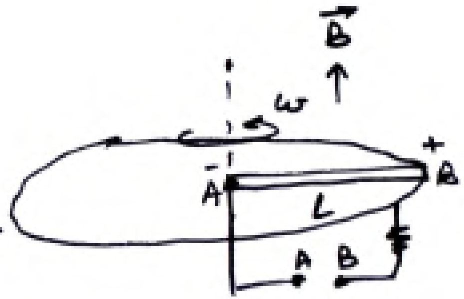
$$e_{coil} = A\frac{dB}{dt}\cdot N$$

$$i_{coil} = \frac{e_{coil}}{R}$$

$$P_{th} = i_c^2 R = \frac{e_{coil}^2}{R^2}\cdot R = \frac{e_{coil}^2}{R} = \frac{1}{R}\left(\frac{dB_i}{dt}\right)^2$$

Questions Based on

Motional EMF in a Rotating Rod



$e_{AB} = \frac{1}{2} B\omega l^2$

$\theta = \omega t$

⊥ plane

$\omega \to$ Const

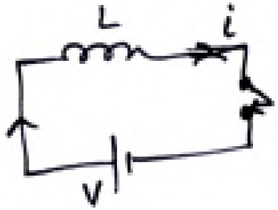
$\Rightarrow \alpha = 0$

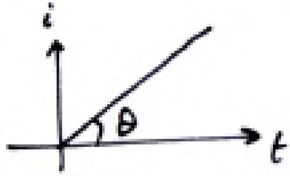
$\tau_{net} = 0$

$$e_{AB} = \int de = \int_a^{a+l} B(x\omega)\,dx = \text{—}$$

Questions Based on

Inductors in Circuits





$\tan\theta = \frac{V}{L}$

$i = \frac{V}{L} t$

When inductor is reconnected in any ckt

$i = f(t)$

flux const

$\Rightarrow i_i = i$

$i_t = f(t_1)\, e^{-R_1 t/L}$

At any instant flux linked with inductor $\phi = Li$

QUESTIONS BASED ON

TRANSFORMER APPLICATIONS & LOSSES

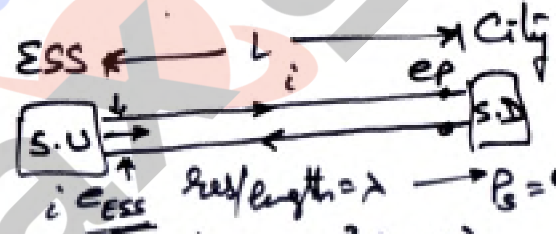
losses < iron → cannot be calculated directly $P_{Li} = P_{TL} - P_{CL}$

losses < copper → $\underline{i_p^2 R_p} + \underline{i_s^2 R_s}$

for transfer eq^n ⇒ $\dfrac{e_s}{e_p} = \dfrac{N_s}{N_p}$

$$e_s i_s = e_p i_p - P_{Li} - P_{Lc}$$

for ideal T_x $e_s i_s = e_p i_p$

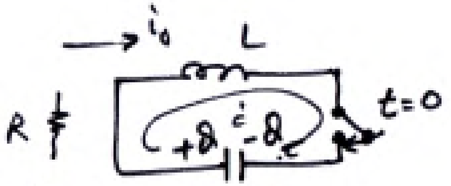


res/length = λ → $P_s = e_p i$

Comm line loss = $\underline{i}^2(\lambda(2L))$

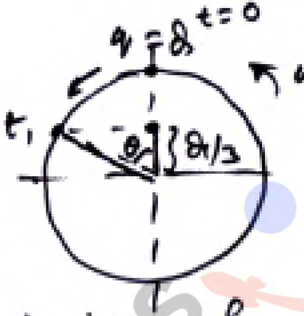
Questions Based on

Phase Charges in LC Oscillations



$Q=0$

$\alpha_i = 90^\circ$



$\omega = \frac{1}{\sqrt{LC}}$

find time when charge on cap reduces to $Q/3$.

$$\theta = \cos^{-1}\frac{Q/3}{Q}$$

$$t_1 = \frac{\theta}{\omega} = \sqrt{LC}\cos^{-1}(1/3)$$

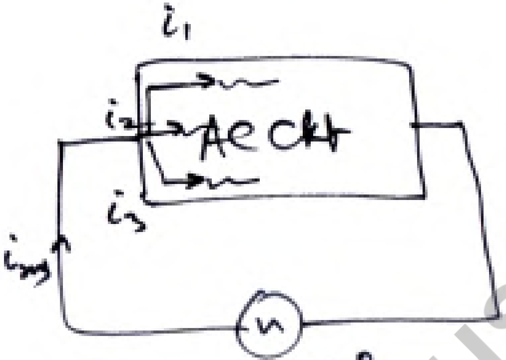
$$q = Q\sin(\omega t + \alpha_i)$$

$$i = Q\omega\cos(\omega t + \alpha_i)$$

$$Q = Q_0 e^{-\beta t}$$

QUESTIONS BASED ON

PHASE ANALYSIS IN AC CIRCUITS

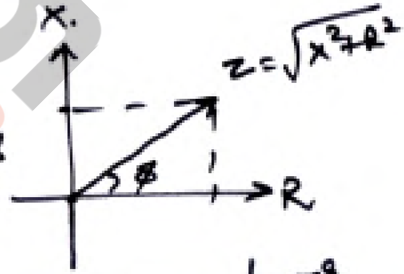


$e = e_0\angle 0^\circ$

$\bar{i} = \bar{i}_1 + \bar{i}_2 + \bar{i}_3$

$\bar{i} = \dfrac{\bar{e}}{\bar{z}} = \dfrac{e_0\angle 0^\circ}{z_0\angle \phi} = \dfrac{e_0}{z_0}\angle -\phi$

$i = \left(\dfrac{e_0}{z_0}\right)\sin(\omega t - \phi)$



Power factor of ckt $= \cos\phi$

$P_{avg} = i_{rms}\, e_{rms} \cos\phi$

at $\cos\phi = 1 \longrightarrow$ ckt is in resonance.

Resonant ckts — Q-factor, Selectivity, Bandwidth] P/Q.

H.W to analyse instantaneous power

Power → avg = 0

Current → wattless current.

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Notes of Revision Booster Workshop for JEE Main & NEET

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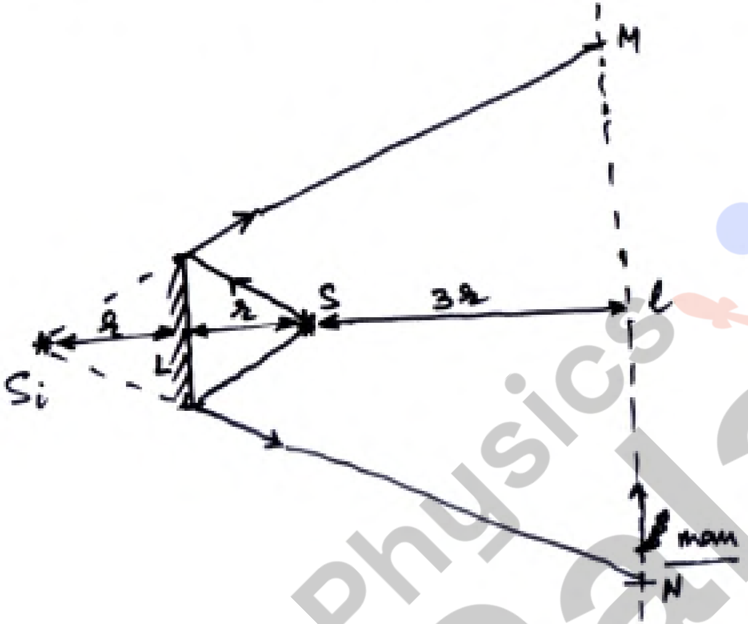
QUESTIONS BASED ON

A MAN WALKING IN FRONT OF A PLANE MIRROR

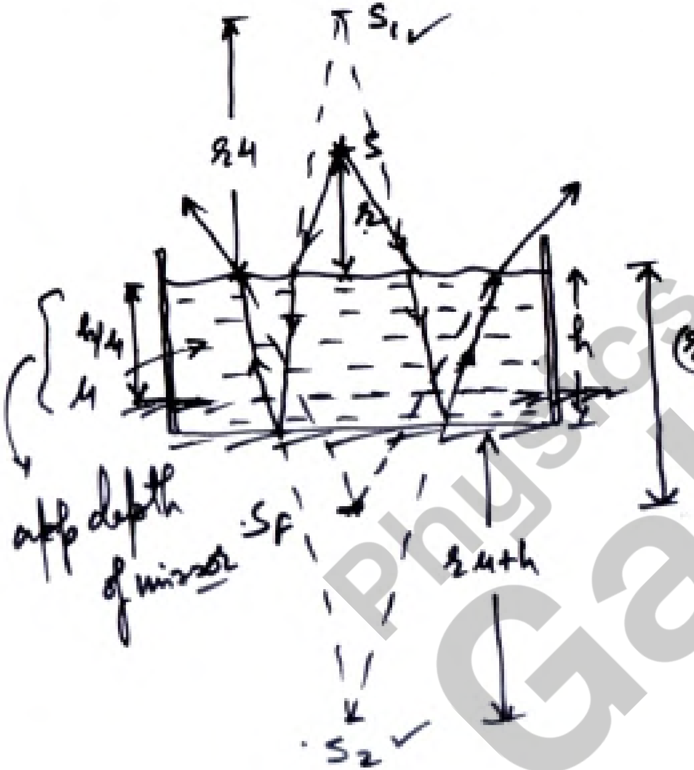


$$\frac{l}{L} = \frac{5x}{x}$$

$$\Rightarrow \underline{l = 5L}$$

Questions Based on

Mirror Placed Inside a Liquid



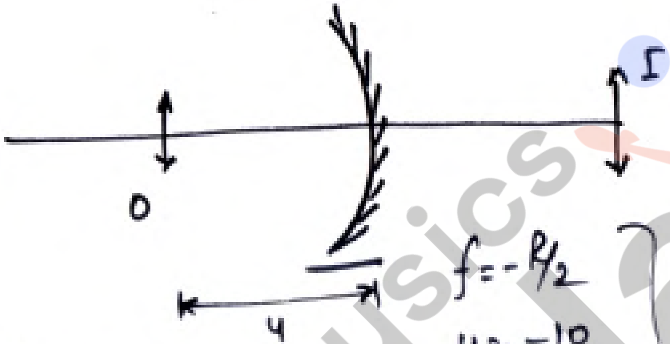
distance between S & $S_F' = \left(x + \frac{h}{\mu}\right)2$

$$\frac{(x\mu + h) + h}{\mu} = \left(x + \frac{2h}{\mu}\right)$$

$+x$

Questions Based on

Man's Face in Shaving Mirror



$f = -R/2$

$u = -10$

$v = +25$

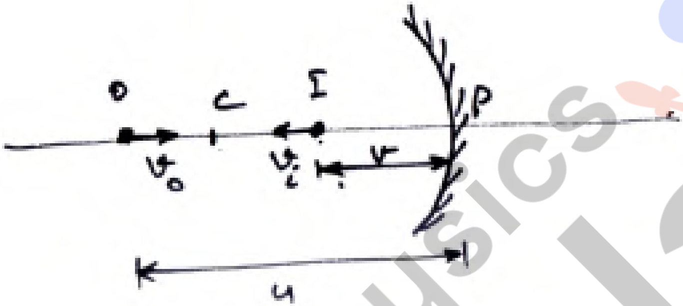
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$R = $ ——

find image at say 25cm.
face is at 10cm from mirror
find R = ?

Questions Based on

Relative Speed of Image by Spherical Mirror

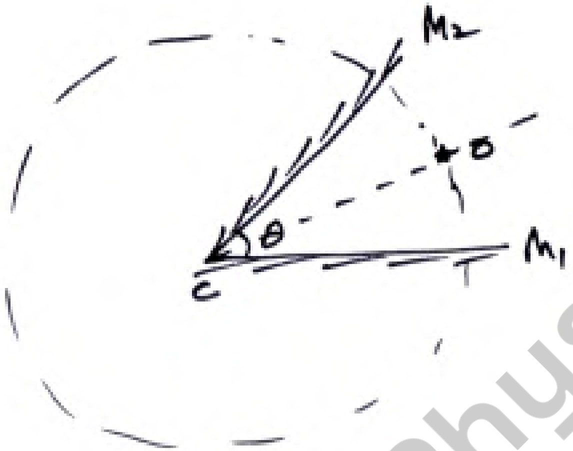


$$\boxed{v_i = \left(\frac{v^2}{u^2}\right) \cdot v_o}$$

$$v_{app} = |v_o| + |v_i|$$

Questions Based on

Image Formation by Inclined Mirrors



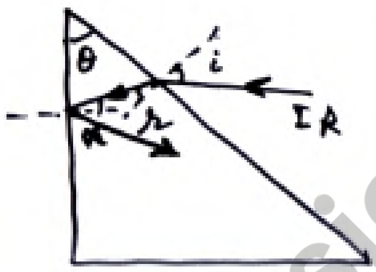
✓ $\frac{180}{\theta} \in I \Rightarrow \left[N = \frac{360}{\theta} - 1\right]$

→ $\frac{180}{\theta} \notin I \longrightarrow N \rightarrow$ Refer Concept video

of PG Book vol V

QUESTIONS BASED ON

INTERNAL REFLECTION BY A PRISM



$\sin i_0 = 4 \sin r$

$\alpha > \sin^{-1}\left(\frac{1}{4}\right)$

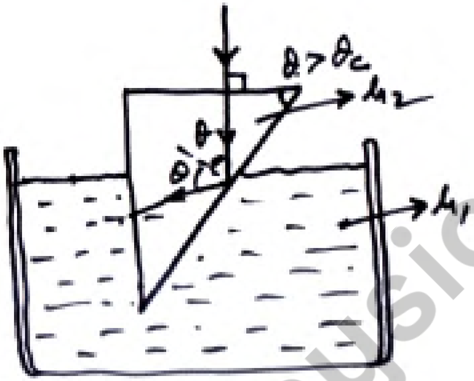
$\theta = r + \alpha$

$r = \theta - \sin^{-1}(1/4)$

for all $i < i_0$ light ray will be internally reflected from vertical face

Questions Based on

Internal Reflection From a Prism Partially Inversed in Water

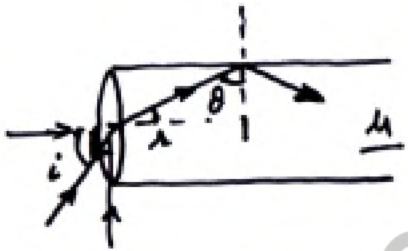


$$\mu_2 \sin\theta_c = \mu_1$$

$$\theta_c = \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$$

Questions Based on

Condition of RI for an Optical Fiber or a Rod



θ is min when r is max → $\underline{i = 90^\circ}$

↓

$r_{max} = \theta_c$

$\theta = 90 - \theta_c > \theta_c$ for optical fibers

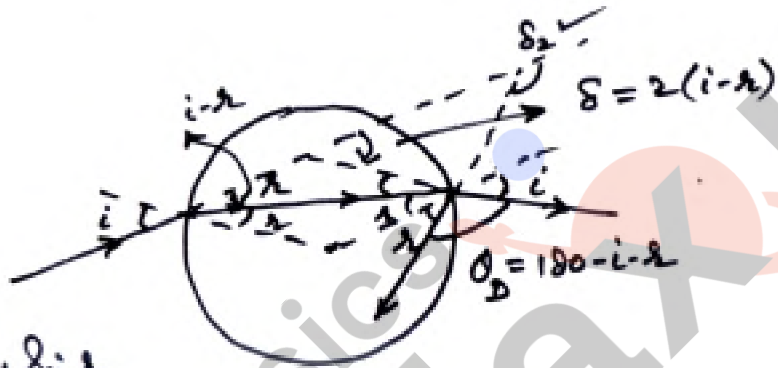
$\Rightarrow \quad \underline{\theta_c = 45^\circ}$

$\Rightarrow \quad \mu \sin\theta_c = 1 \Rightarrow \mu = \sqrt{2}$

for optical fibers $\underline{\mu \geq \sqrt{2}}$

QUESTIONS BASED ON

REFRACTION FROM A SPHERE



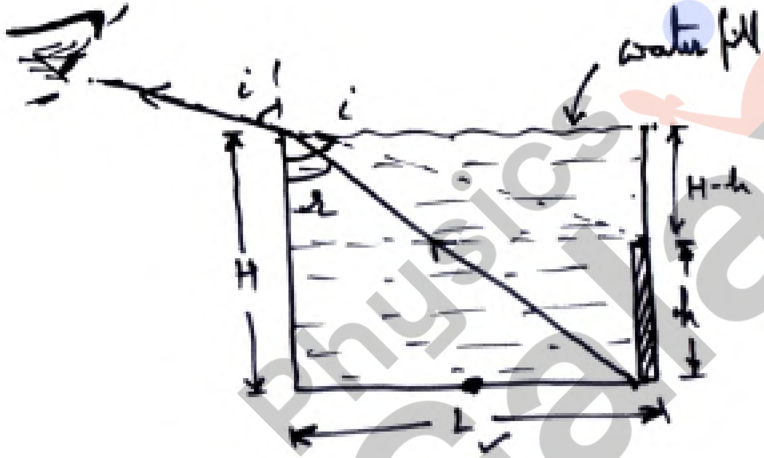
$\sin i = \mu \sin r$

Total deviation of internally reflected ray

$$\delta_2 = (i-r) + (\pi - 2r) = \underline{\pi - i - 3r}$$

Questions Based on

Water Filling in a Container



$$\frac{L}{\sqrt{L^2+(H-h)^2}} = \mu_\omega \frac{L}{\sqrt{L^2+H^2}}$$

$$\sin i = \mu_\omega \sin r$$

$$\tan i = \frac{L}{H-h}$$

$$\tan r = \frac{L}{H}$$

QUESTIONS BASED ON

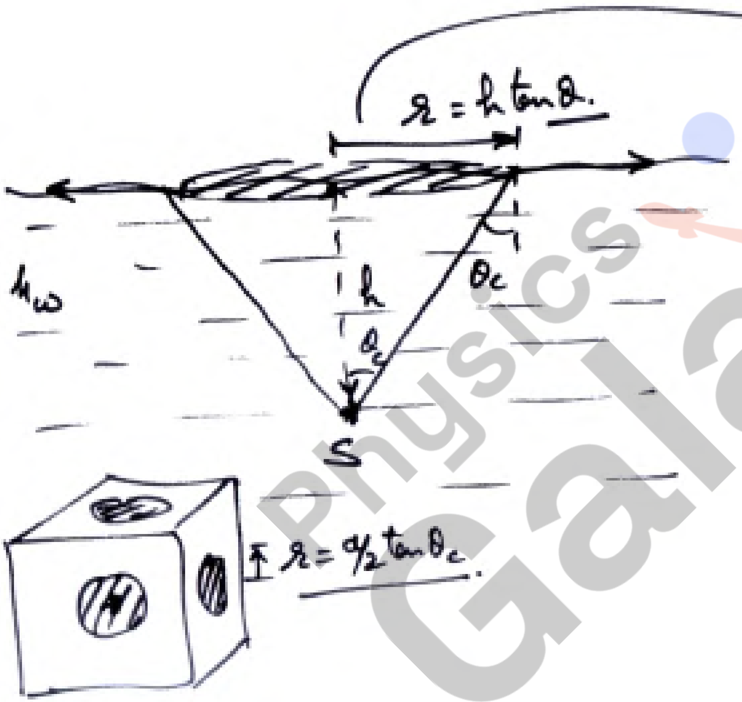
CRITICAL ANGLE IN TERMS OF $\in_r$ AND μ_r

R.I. of a medium $\mu = \sqrt{\epsilon_r \mu_r}$

$$\theta_c = \sin^{-1}\frac{1}{\sqrt{\epsilon_r \mu_r}}$$

QUESTIONS BASED ON

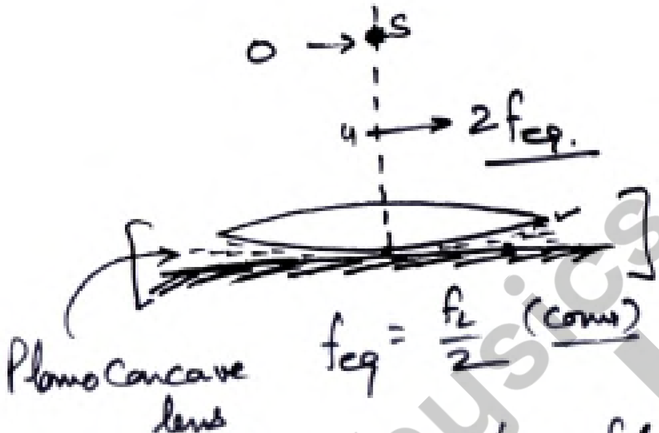
LIGHT SOURCE INSIDE WATER



on hiding this circular area no light from S will escape from water

QUESTIONS BASED ON

LENS PLACED ON A MIRROR



$$\frac{1}{f_{eq}} = \frac{2}{f_L} + \frac{1}{f_M} + \frac{2}{f_L'} = \frac{(f_L + f_L')2}{f_L f_L'}$$

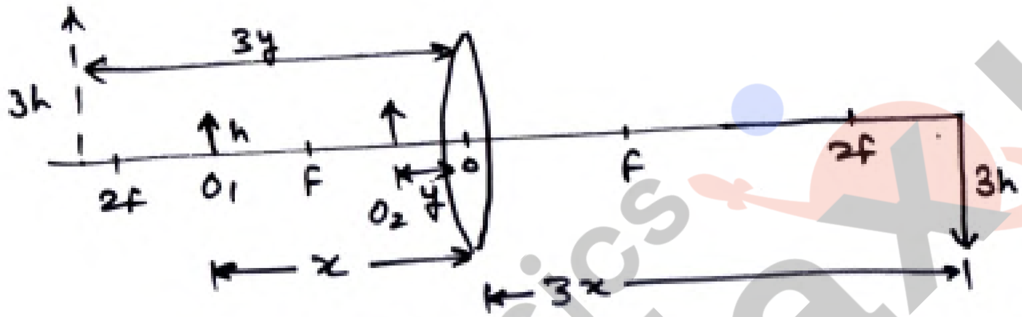
$$f_{eq} = \frac{f_L}{2} \text{ (conv)}$$

$$f_L' = \frac{R}{\mu_L - 1}$$

$$f_{eq}' = \frac{f_L f_L'}{2(f_L + f_L')}$$

QUESTIONS BASED ON

SAME MAGNIFICATION FOR TWO POSITIONS OF OBJECT



$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\left[\begin{array}{l} \dfrac{1}{3x} + \dfrac{1}{x} = \dfrac{1}{f_L} \\ \\ -\dfrac{1}{3y} + \dfrac{1}{y} = \dfrac{1}{f_L} \end{array}\right]$$

Say $\underline{m = 3.}$

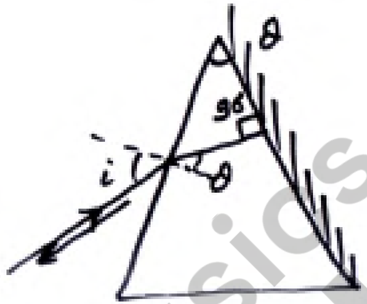
$x - y =$ ______

QUESTIONS BASED ON

RETRACING OF A LIGHT RAY BY A PRISM

Condition:

when light ray normally incident on Mirror

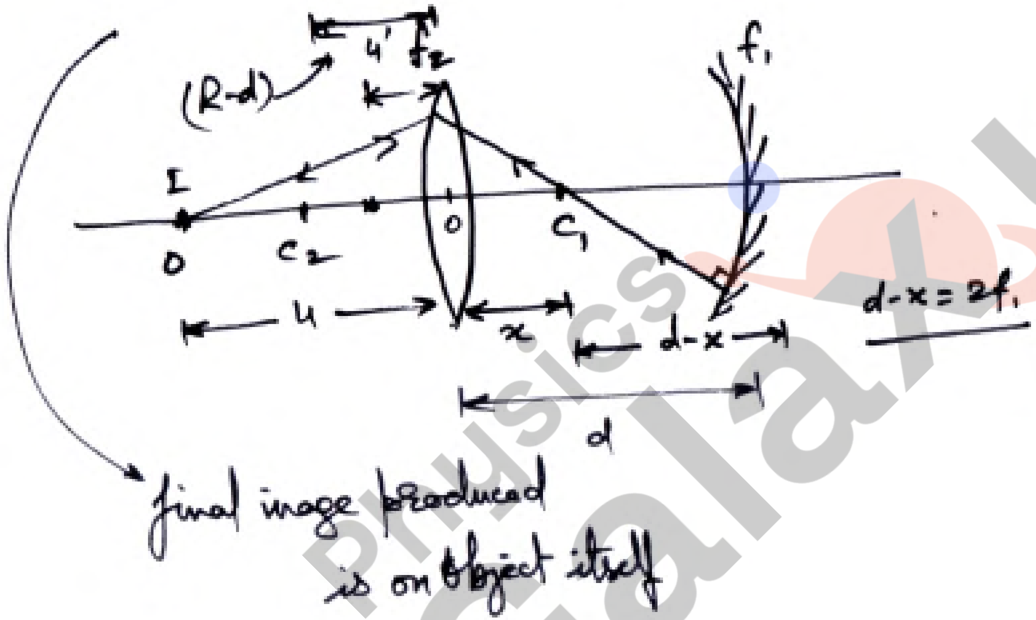


$\sin i = \mu \sin\theta$

$i = \_\_\_\_$

Questions Based on

Retracing For a Spherical Mirror



$$-\frac{1}{x} + \frac{1}{u} = \frac{1}{f_2}$$

$u = $ ——

$d - x = 2f_1$

Questions Based on

Retracing For Refraction

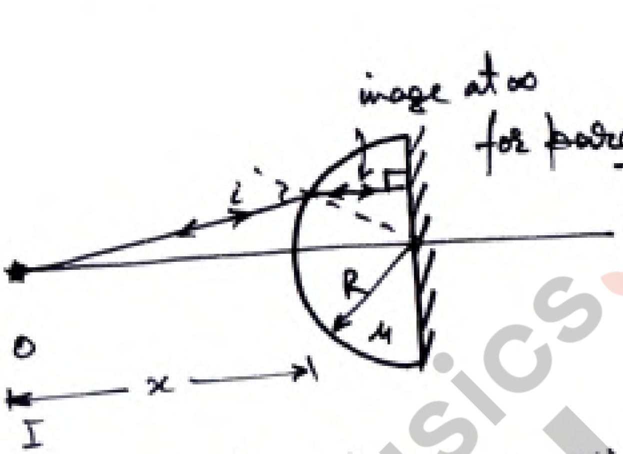


image at ∞

for paraxial rays

$i \simeq$ v. small

$\sin i = \mu \sin r$

$\sin i = \mu \dfrac{h}{\sqrt{R^2 - h^2}}$

$i = \_\_\_\_$

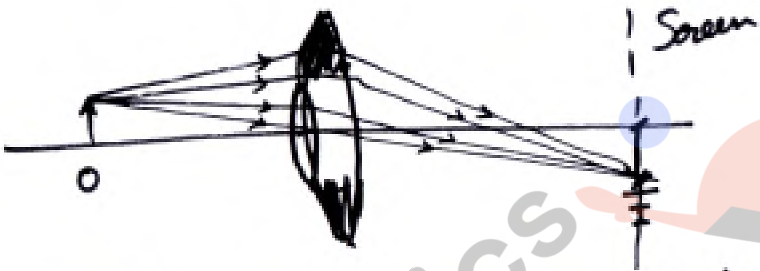
by refraction formula (i is small)

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \Rightarrow 0 + \frac{1}{x} = \frac{\mu - 1}{R}$$

$$\Rightarrow x = \frac{R}{\mu - 1} \checkmark$$

QUESTIONS BASED ON

ERRECT ON IMAGE BY COVERING A LENS



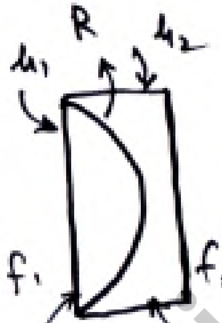
due to lens covering → less no of light rays will produce image

⇒ image intensity will be decreased!

long f' image location & size will remain same!

Questions Based on

Focal Length of Plano Convex & Plano Concave Lens Combined



$$f_1 = \frac{R}{\mu_1 - 1}$$

$$f_2 = \frac{R}{\mu_2 - 1}$$

Plano concave lens.

Plano convex lens

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$$

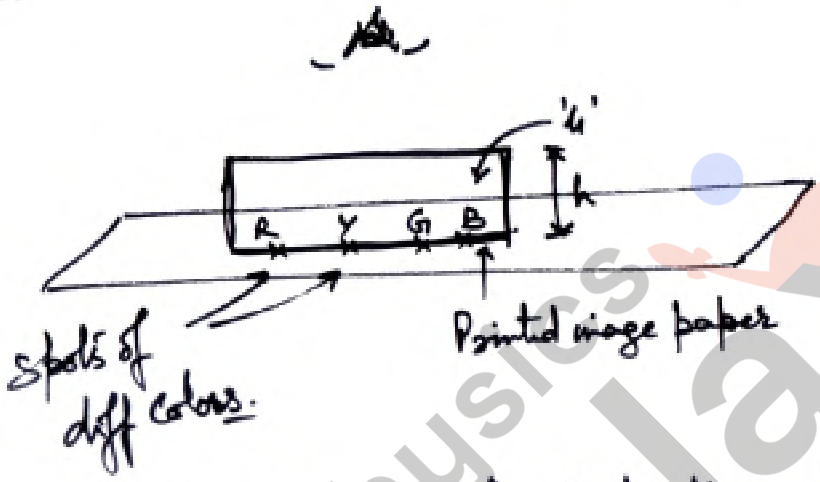
$$= \frac{\mu_1 - 1}{R} - \frac{\mu_2 - 1}{R}$$

$$= \frac{\mu_1 - \mu_2}{R}$$

$$f_{eq} = \frac{f_1 f_2}{f_1 + f_2} = \frac{R}{\mu_1 - \mu_2}$$ ✓

QUESTIONS BASED ON

APPARENT DEPTH OF COLOURED OBJECTS



apparent depth

$h_{ap} = \frac{h}{\mu}$

$\mu = a + \frac{b}{\lambda^2}$

for Red colour $\mu \leftarrow$ least. $\rightarrow$ elevated least

for blue colour $\mu \leftarrow$ max $\rightarrow$ elevated most

QUESTIONS BASED ON

CHANGE IN FOCAL LENGTH OF LENS BY LIGHT COLOUR

$$f_L = \frac{R_1 R_2}{(R_1+R_2)(\mu-1)}$$

$$\mu = a + \frac{b}{\lambda^2}$$

Red $\longrightarrow$ Violet

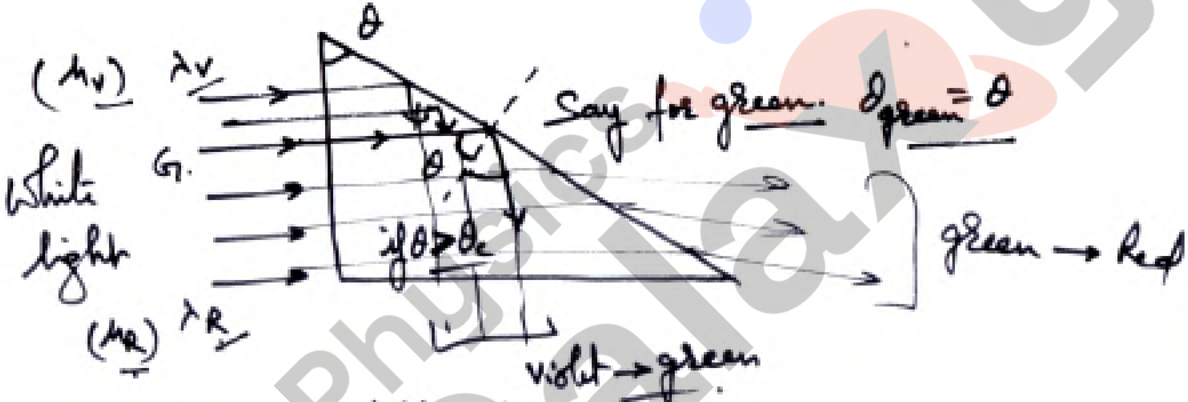
λ_R max λ_v min

μ min μ max

$$f_R > f_v$$

Questions Based on

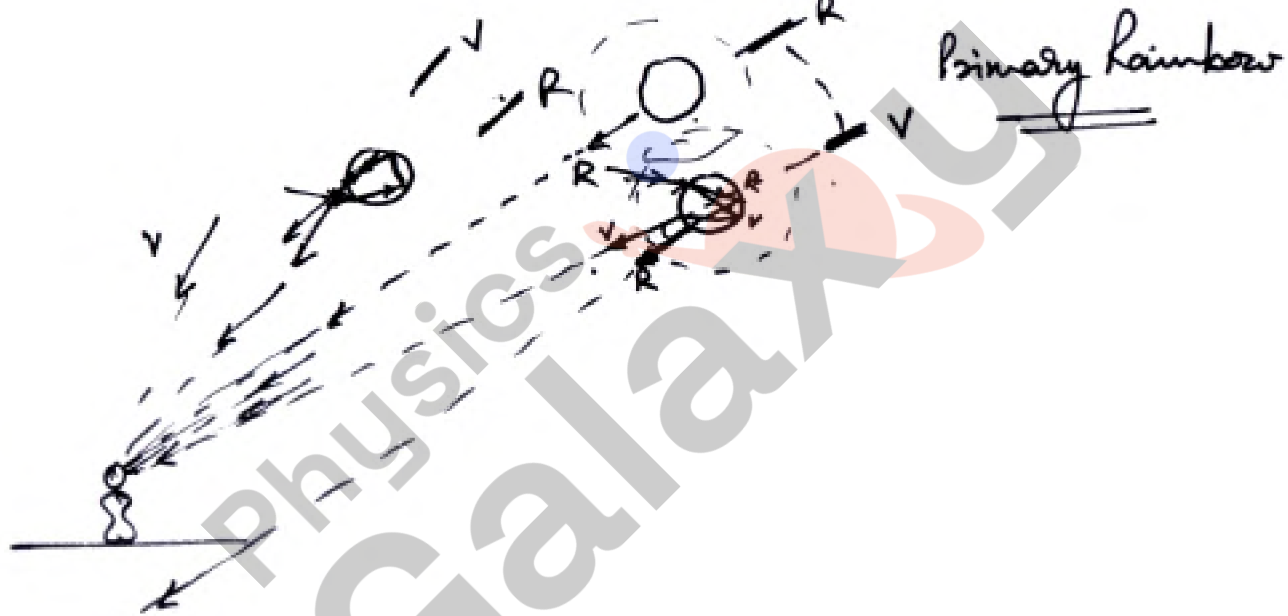
Separation of Light Colours by a Prism



$$\theta_c = \theta_{colour} = \sin^{-1}\left(\frac{1}{\mu_{colour}}\right)$$

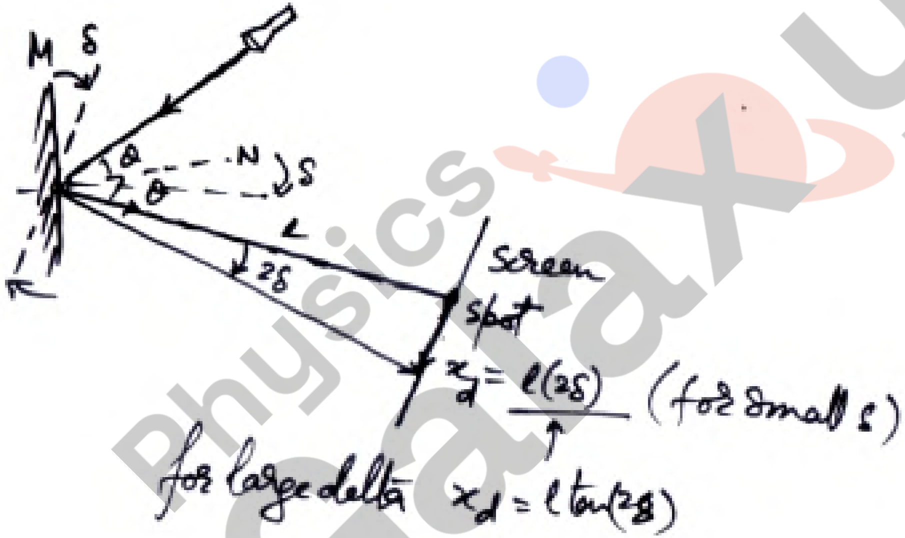
QUESTIONS BASED ON

FORMATION OF RAINBOW



Questions Based on

Displacing a Reflected Spot by a Plane Mirror



QUESTIONS BASED ON

ANGULAR WIDTH OF RESOLUTION

$$\theta = \frac{d}{x} = \frac{1.22\lambda}{D}$$

$d =$ ______

QUESTIONS BASED ON

COMPARISON OR RESOLVING POWERS

$$\downarrow$$

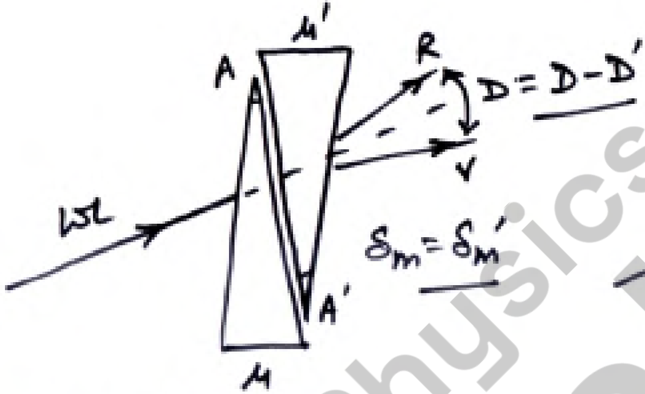
$$R \simeq \frac{1}{\theta} = \frac{D}{1.22\lambda}$$

or $R \propto \frac{1}{\lambda}$.

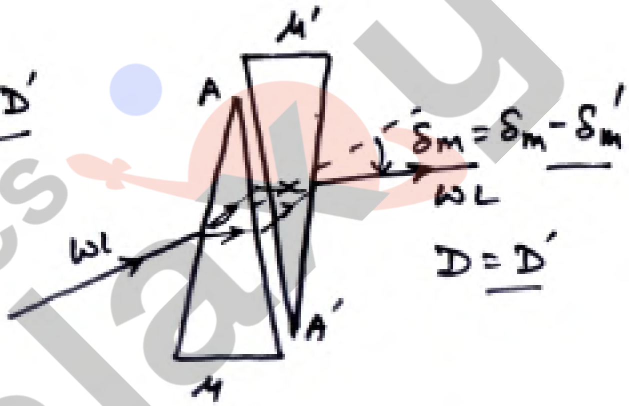
for same dia of lens for two (mic/teles) $\longrightarrow \frac{R_1}{R_2} = \frac{\lambda_2}{\lambda_1}$

Questions Based on

Achromatic Combination of Thin Prisms



Dispersion without deviation

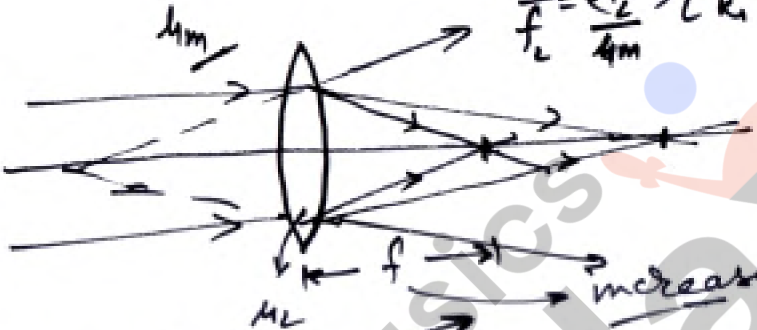


Deviation without dispersion

QUESTIONS BASED ON

SUBMERGING A LENS IN A MEDIUM

$$\frac{1}{f_L} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$



increase

$\mu_m < \mu_L$

if $\mu_m = \mu_L \Rightarrow f \to \infty$

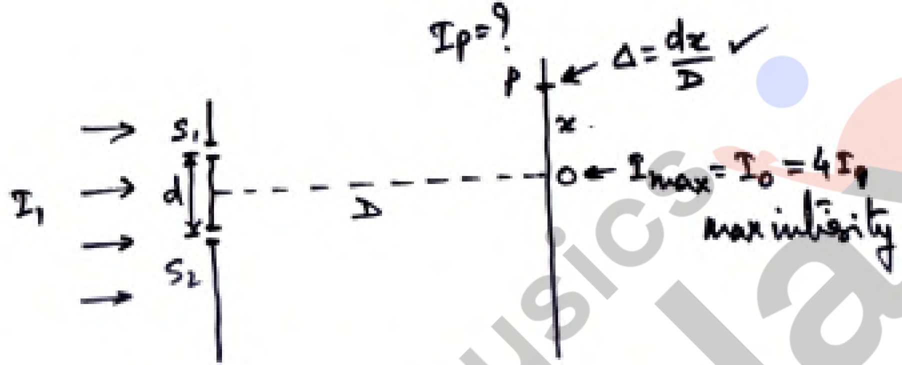
if $\mu_m > \mu_L \Rightarrow f = -ve$ Convex lens start behaving as div lens.

Revision Booster WORKSHOP for NEET & JEE Main

Wave Optics

Questions Based on

Intensity on YDSE Screen at Specific Path Difference



$$I_p = 4I_1\cos^2\phi/2 = I_0\cos^2\left(\frac{\pi}{\lambda}\Delta\right)$$

QUESTIONS BASED ON

OVERLAPPING INTERFERENCE PATTERNS IN YDSE

$$\Delta = \frac{dx}{D} = 3\lambda_1 = 4\lambda_2$$

$$x_{B3_1} = x_{B4_2}$$

$$\frac{3\lambda_1 \cancel{D}}{\cancel{d}} = \frac{4\lambda_2 \cancel{D}}{\cancel{d}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{4}{3}$$

QUESTIONS BASED ON

YDSE WITH NON-COHERENT SOURCES

$$I_R = I_1 + I_2$$

for coherent sources $I_R = (\sqrt{I_1} + \sqrt{I_2})^2$ max

$-$ min

$= I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

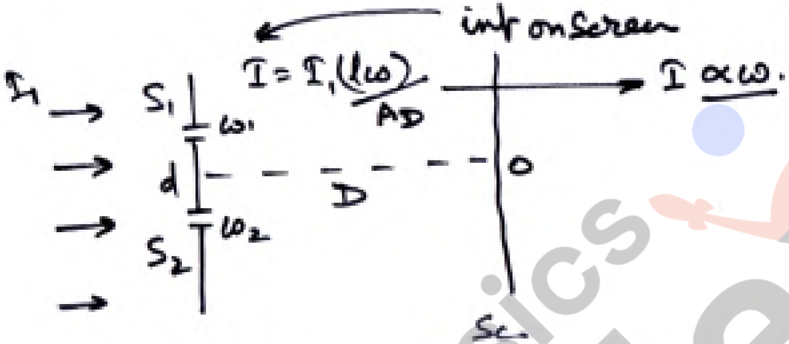
if each slit produces int I_0

$\Rightarrow I_{max} = 2I_0$

for coherent s $I'_{max} = 4I_0$

QUESTIONS BASED ON

CONTRAST RATIO ON YDSE SCREEN



Be careful abt lang of ques if given $A \propto \omega$:

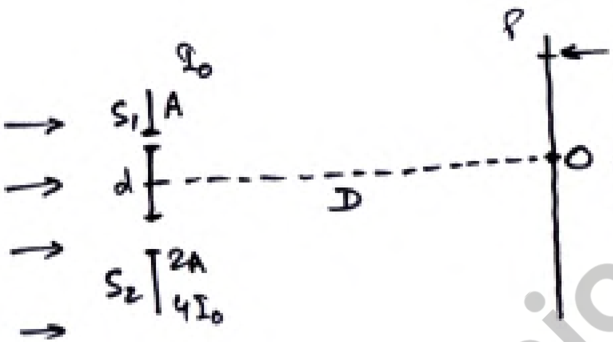
$$\mathcal{R} = \frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2 = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2 = \left(\frac{\sqrt{\omega_1} + \sqrt{\omega_2}}{\sqrt{\omega_1} - \sqrt{\omega_2}}\right)^2$$

if S_1 and S_2 produce same Int on screen $= I_0$

$$\left.\begin{aligned} I_{max} &= 4I_0 \\ I_{min} &= 0 \end{aligned}\right\} \quad \mathcal{R} \longrightarrow \infty .$$

Questions Based on

YDSE With Different Slit Widths



ϕ (phase diff)

$I_p = I_0 + 4I_0 + 4I_0\cos\phi$

$= (5 + 4\cos\phi)\, I_0$

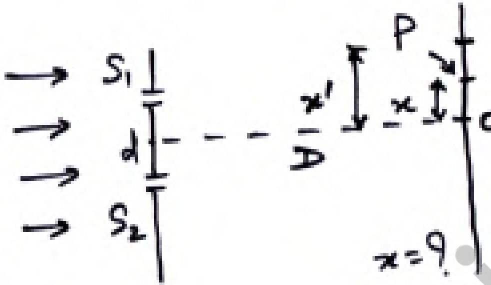
$I_m = I_0(1+2)^2 = 9I_0$

$= \frac{I_m}{9}(5 + 4\cos\phi)$

$I \propto A^2$

QUESTIONS BASED ON

SEPARATION BETWEEN DIFFERENT INTENSITY POINTS



$2I_0 \longrightarrow \Delta = \frac{dx'}{D} \Rightarrow \phi' = \frac{2\pi}{\lambda}\cdot\frac{dx'}{D}$

$I = 3I_0 \longrightarrow \Delta_x = \frac{dx}{D} \longrightarrow \phi = \frac{2\pi}{\lambda}\times\frac{dx}{D}$

$I_m = 4I_0$

$S = x' - x = \_\_\_\_$

at pt P

$3I_0 = 4I_0 \cos^2 \phi/2 \longrightarrow 2I_0 = 4I_0 \cos^2 \phi/2.$

$\downarrow$

$x' = \_\_\_\_$

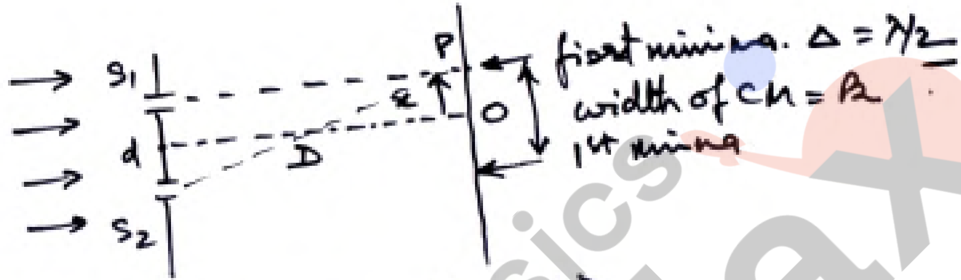
$\cos \phi/2 = \frac{\sqrt{3}}{2}$

$\phi/2 = \pi/6 \Rightarrow \phi = \pi/3 = \frac{2\pi}{\lambda}\cdot\frac{dx}{D}$

$\Rightarrow x = \frac{\lambda D}{6d}$ dy

Questions Based on

First Minima Facing The Slit (if d << D)



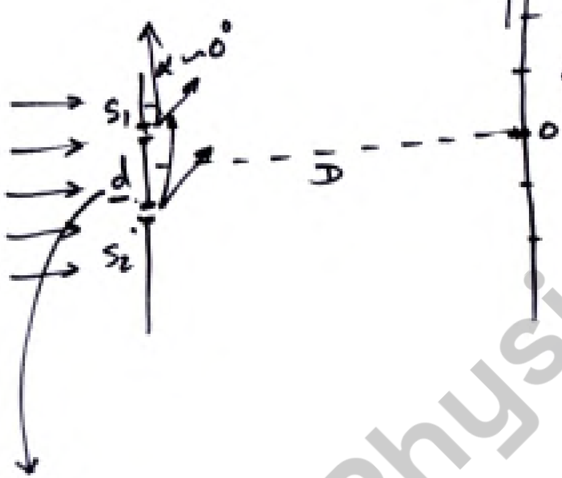
$$x = d/2 = \beta/2 = \frac{\lambda D}{2d}$$

$$\lambda = \frac{d^2}{D} \quad (\text{if } d << D)$$

if $d \not< D$ path diff at P $\Delta_P = \left[\sqrt{D^2 + d^2} - D = \lambda/2\right]$

QUESTIONS BASED ON

MAXIMUM NO. OF BRIGHT FRINGES IN YDSE



at ∞ $\Delta = d = 4.5\lambda$

$2\lambda \rightarrow B$

$\Delta = \lambda \rightarrow B$

0 $\Delta = 0 \rightarrow$ Bright ✓

} 4B, 4D (above)

} 4B, 4D (below)

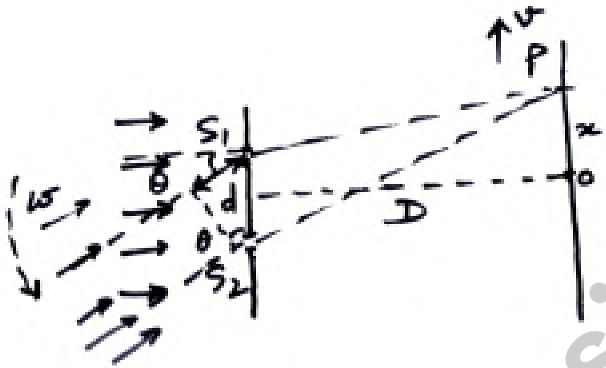
Total bright $= \underline{9}$

Total Dark $= \underline{8}$

$d = \underline{4.5\lambda}$

QUESTIONS BASED ON

SHIFT OF INTERFERENCE PATTERN



$\Delta'_p = d\sin\theta - \frac{dx}{D} = 0$ (new pos of CM)

Bright (CM) $\Delta = 0$

$\Delta_{new} = d\sin\theta \longrightarrow \phi_{new} = \frac{2\pi}{\lambda} . d\sin\theta$

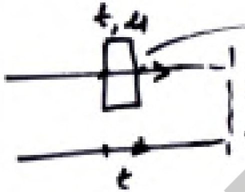
$\underbrace{I_{new\,O}}_{} = \underbrace{4I_0}_{I_i}\cos^2\phi/2$

$x = D\sin\theta$

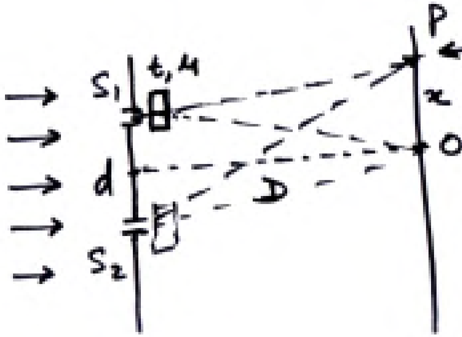
$v = \frac{dx}{dt} = D\cos\theta . \omega$

QUESTIONS BASED ON

INSERTION OF A THIN SHEET AT A SLIT



$\boxed{\Delta = t(\mu-1)}$ eq path $= \mu t$



← $\Delta_{new} = 0$

O (CM) $I_m = 4I_0$

$\Delta_{new} = t(\mu-1) \Rightarrow \phi_n = \frac{2\pi}{\lambda} \times t(\mu-1)$

$I_{new} = I_m \cos^2 \phi_n/2 = $ —

at pt P $\quad \Delta_{new} = t(\mu-1) - \frac{dx}{D} = 0$

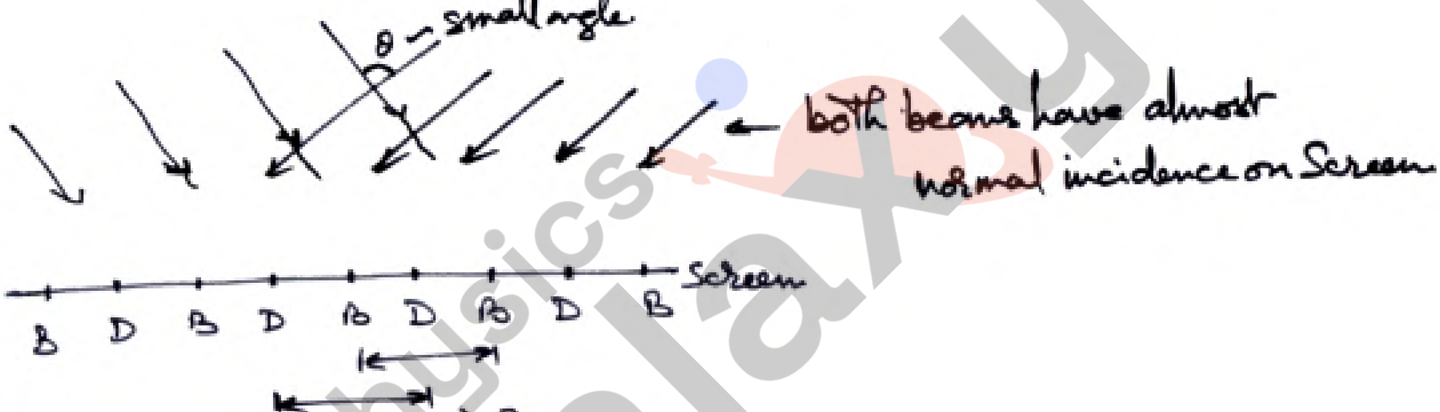
$\Rightarrow x = \frac{t(\mu-1)D}{d}$ → shift of int pattern

if t_1 & t_2 thickness two sheets are used for S_1 and S_2

$\Rightarrow \Delta_{new} = \mu_1 t_1 - \mu_2 t_2 - \frac{dx}{D} = 0$

QUESTIONS BASED ON

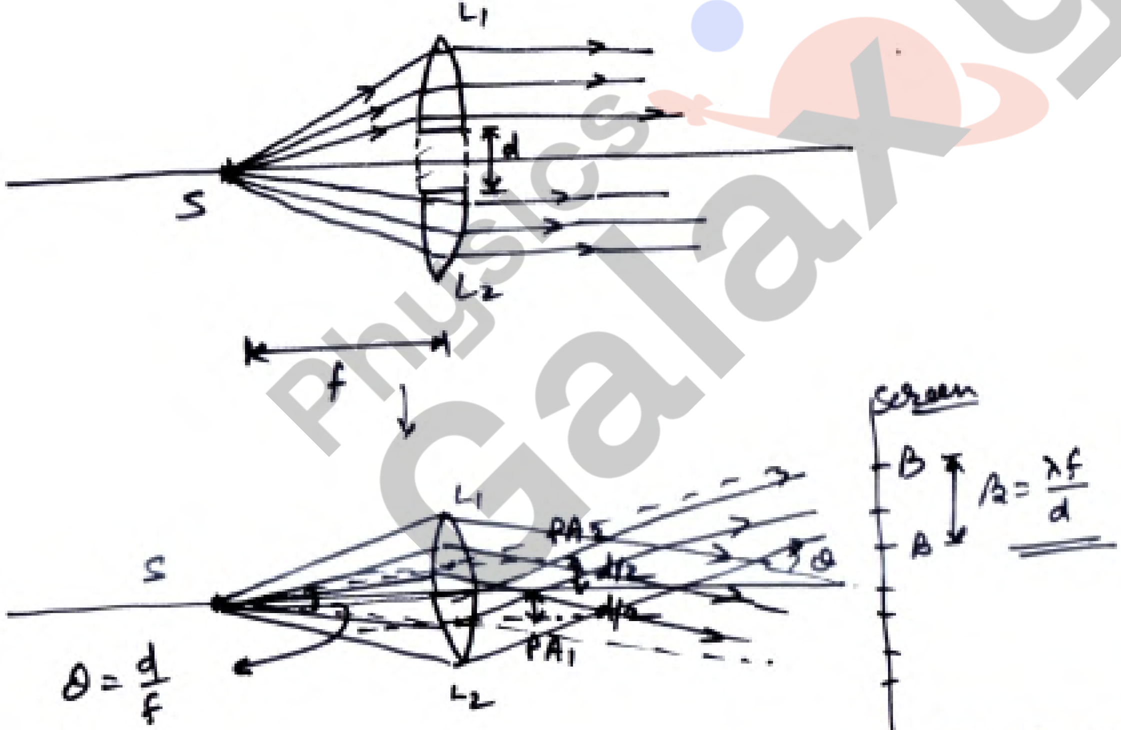
FRINGE PATTERN DUE TO PARALLEL (ALMOST) & CONVERGING BEAMS



$$\left[\beta = \frac{\lambda}{\theta}\right]$$

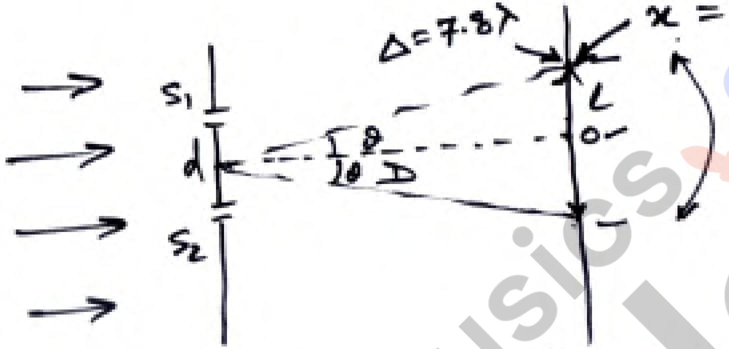
Questions Based on

Converging Parallel Beams by a Split Lens



Questions Based on

Number of Fringes in a Given Angular Range



fringe pattern

$d << D$

$x = D\theta$ or $D\tan\theta$ $= l/2 \rightarrow \Delta = \frac{dx}{D} \rightarrow \phi = \frac{2\pi}{\lambda}\Delta$

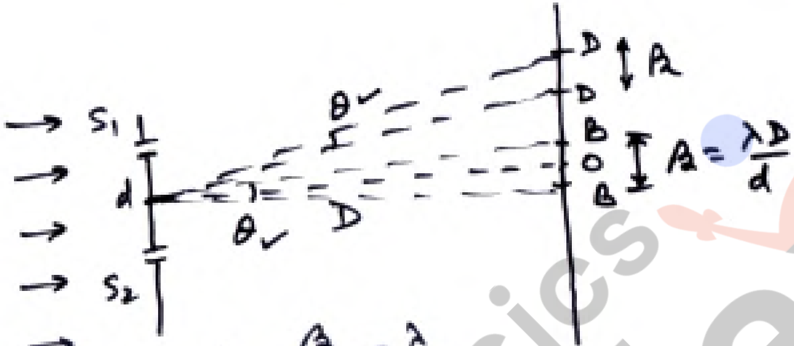
$\underline{Z_P} = \frac{\Delta}{\lambda} = \underline{7.8}$

angular range from $-\theta$ to $+\theta$

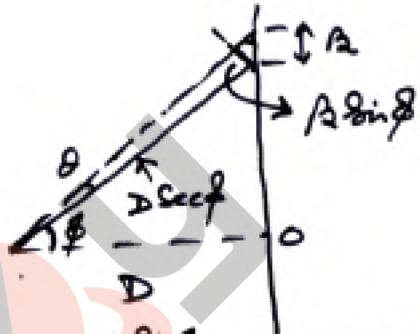
no of fringes $N = \frac{l}{\beta}$ (Not an exact value)

QUESTIONS BASED ON

ANGULAR WIDTH OF FRINGES IN YDSE



$$\theta = \frac{\beta}{D} = \frac{\lambda}{d}$$



$$\theta = \frac{\beta \sin\phi}{D\sec\phi} = \frac{\lambda}{d} \cdot \sin\phi\cos\phi$$

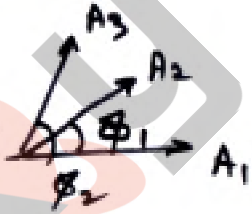
Questions Based on

Interference of Multiple Coherent Waves

$y_1 = A_1 \sin \omega t$

$y_2 = A_2 \sin(\omega t + \phi_1)$

$y_3 = A_3 \sin(\omega t + \phi_2)$



↑ Coherent

Resulting amp for multiple wave interference can be given as

$R_x = A_1 + A_2 \cos\phi_1 + A_3 \cos\phi_2$

$R_y = \underline{A_1 \sin 0^\circ} + A_2 \sin\phi_1 + A_3 \sin\phi_3$

$\underline{R} = \sqrt{R_x^2 + R_y^2}$

if waves are non coherent $\longrightarrow$ $I_R = I_1 + \underline{I_2 + I_3} + \cdots$

QUESTIONS BASED ON

RESULTING INTENSITY OF COHERENT & NON-COHERENT WAVES

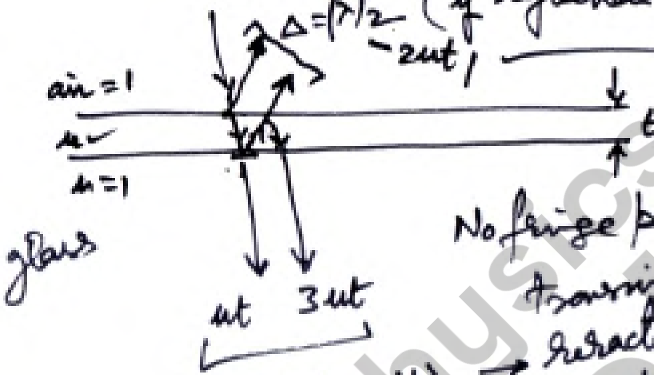
n waves superposition → for coherent $I_R = n^2 I_0$

→ for non-coherent $I_R' = n I_0$

each wave int $= I_0$

Questions Based on

Interference due to Films & Wedges



$\Delta = \lambda/2$ (if reflection is from a denser med)

$2\mu t$

→ int of reflected light will be max

when $|2\mu t - \lambda/2| = N\lambda$

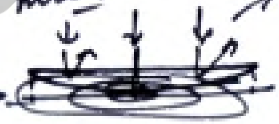
$= (2N\pm1)\lambda/2$ will be min

No fringe pattern

transmitted refracted light

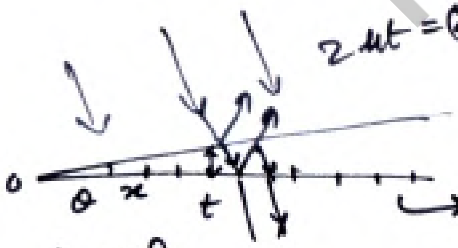
$2\mu t = N\lambda$ → int → max

$2\mu t = (2N\pm1)\lambda/2$ → min



→ cylindrical lens → st fringes

plano convex → cir fringes (Newton's rings)

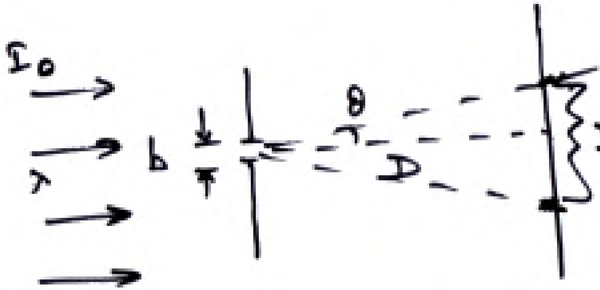


→ fringe pattern

$t = x\theta$.

QUESTIONS BASED ON

EFFECT ON CENTRAL DIFFRACTION MAXIMA BY SLIT WIDTH



1^{st} min $b\sin\theta = \lambda$

$D(2\theta)$ Small angle $\theta = \frac{\lambda}{b}$

intensity of Central diff max

Power of light $= I_0 b l$

length of Slit

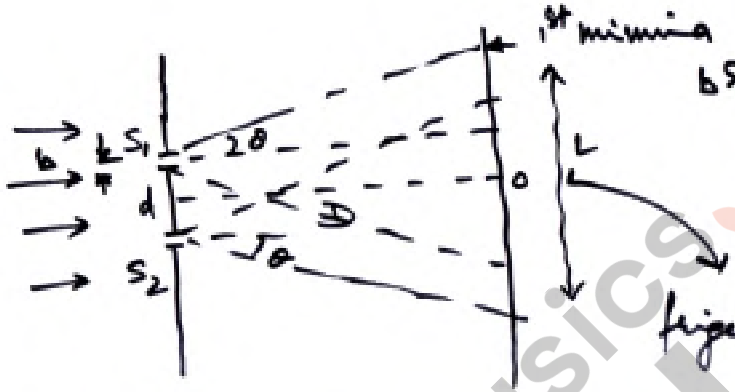
$I_{max} \propto \frac{I_0 b l}{\theta}$

$\Rightarrow I_{max} \propto \frac{b}{\theta}$

$\Rightarrow I_{max} \propto b^2/\lambda$

Questions Based on

YDSE Fringes in Diffraction Maxima



$b\sin\theta = \lambda$

$\theta \simeq \frac{\lambda}{b}$

fringe width of CM of diff $L = D(2\theta) + d.$

$d << D$

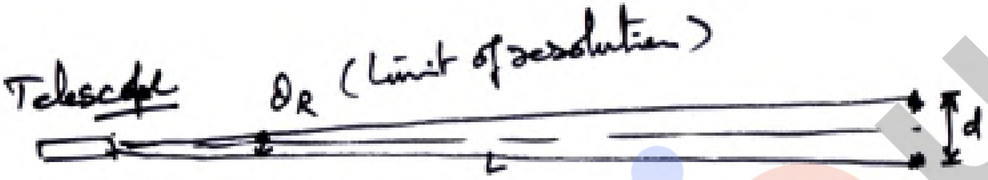
no of YDSE fringes on screen

$\beta = \frac{\lambda D}{d}$

$N = \frac{L}{\beta}$

Questions Based on

Resolution of Distant Stars

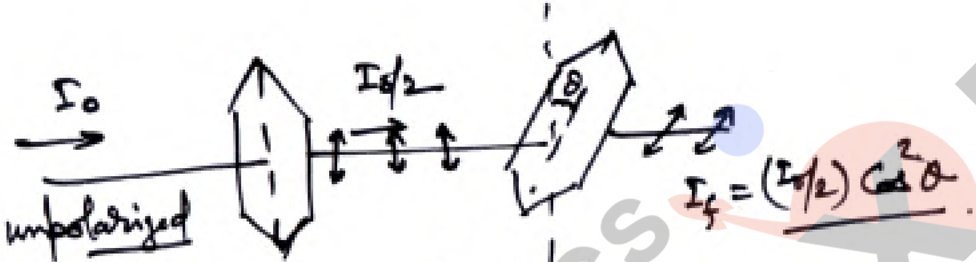


$$\theta_R = \frac{1.22\lambda}{D} = \frac{d}{L}$$

$$d = \frac{1.22\lambda L}{D} \leftarrow$$ min dist between stars for which these can be distinctly seen by this telescope

QUESTIONS BASED ON

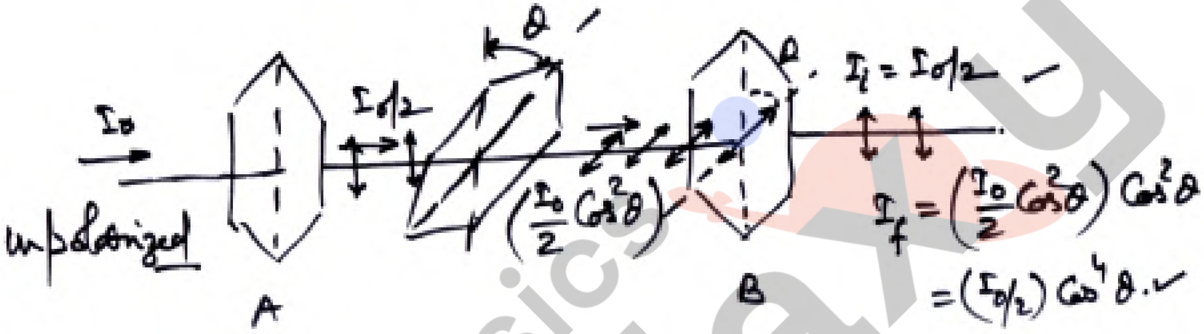
LIGHT PASSING THROUGH SUCCESSIVE POLAROIDS



by Malus' law

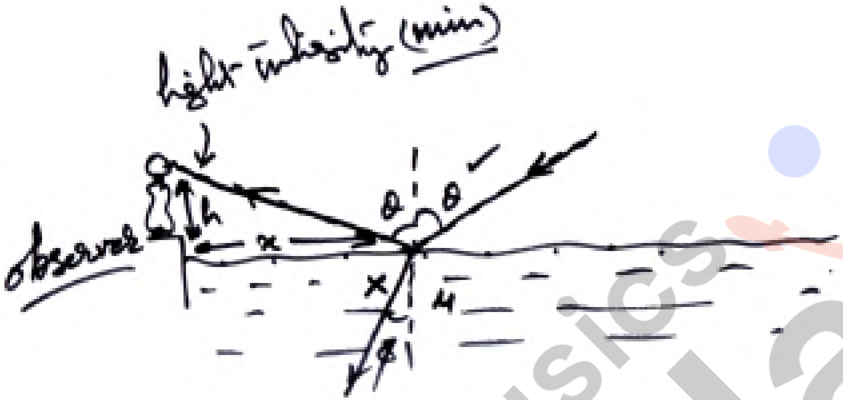
Questions Based on

Insertion of a Polarizer Between Two Polarizers



QUESTIONS BASED ON

LEAST INTENSITY OF REFLECTION FROM WATER



$\phi + \theta = 90°$

$\sin\theta = \mu \sin(90-\theta)$

$\mu = \tan\theta = \frac{x}{h} \Rightarrow x = h\tan\theta.$

Revision Booster WORKSHOP for NEET & JEE Main

Modern Physics

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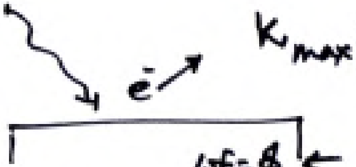
Questions Based on

Change in KE of Photoelectrons

$\frac{hc}{\lambda} = h\nu$



$h\nu > \phi$

$\lambda < \lambda_{th}$

$K_{max_1} = \frac{hc}{\lambda} - \phi$

$K_{max_2} = \frac{hc}{\lambda} - \phi'$

$K_{max_3} = \frac{hc}{2\lambda} - \phi'$

$\Delta K = |K_{m_1} - K_{m_2}|$

NOTE: if $\lambda \longrightarrow 2\lambda$

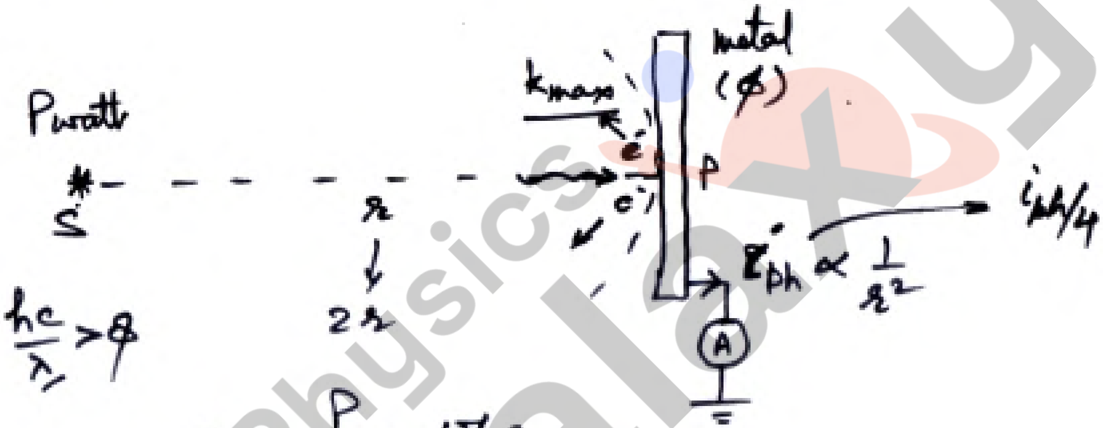
$\Rightarrow \nu \longrightarrow \nu/2$ $\Big] \Rightarrow \underline{K_f < \frac{K_i}{2}}$

$\lambda \longrightarrow \lambda/2$

or $\nu \longrightarrow 2\nu$ $\Big] \Rightarrow K_f > 2K_i$

Questions Based on

Change in Photocurrent by Position of Source



$\frac{hc}{\lambda} > \phi$

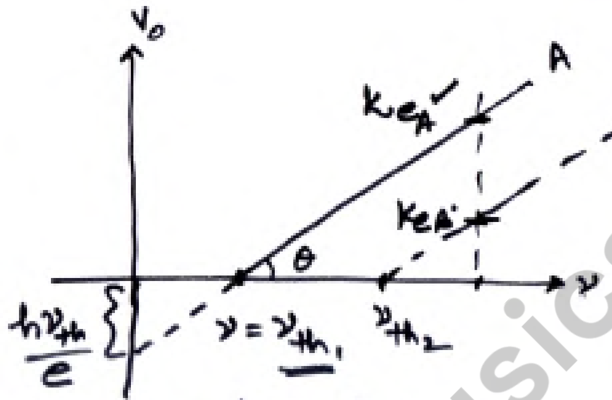
$$I_p = \frac{P}{4\pi r^2} \ W/m^2$$

photon flux $\phi_p = \frac{I_p \lambda}{hc}$ no of photons/s-m^2

$$\Rightarrow \phi_p \propto \frac{1}{r^2}$$

QUESTIONS BASED ON

STOPPING POTENTIAL VARIATION WITH FREQUENCY



$$\left(\tan\theta = \frac{h}{e}\right)$$

$$\phi = h\nu_{th}$$

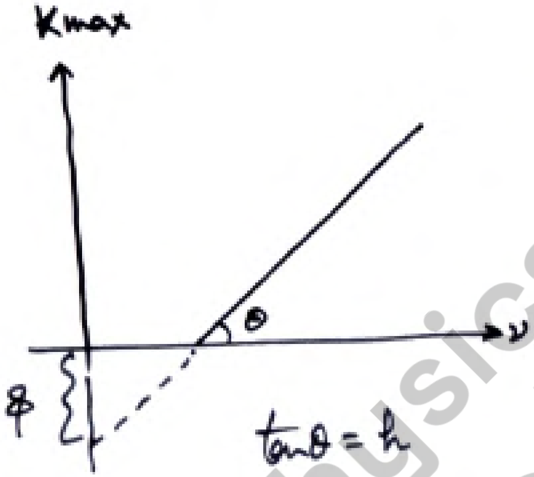
$$h\nu = h\nu_{th} + eV_0$$

$$V_0 = \frac{h\nu}{e} - \frac{h\nu_{th}}{e}$$

$$\phi_B > \phi_A$$

Questions Based on

Variation Curve of Maximum Kinetic Energy and Frequency



$\tan\theta = h$

$$\underset{eV_0}{K_{max}} = h\nu - \phi$$

QUESTIONS BASED ON

PHOTOELECTRIC ERRECT BY EQUATION OF EMW

$y = A \sin(\omega t - kx)$

$B = B_0 \sin[(3.14 \times 10^7 ct) - (\sim)x]$

$2\pi f = \omega = 3.14 \times 10^7 c$

$\nu = f = \frac{10^7 \times 3 \times 10^8}{2} = 1.5 \times 10^{15}$ Hz

$e^- \rightarrow k = ?$

$\phi = ?$

$K_{max} = h\nu - \phi$

Questions Based on

Photoelectrons Insertion in a Magnetic Field

$WF = \phi$

$h\nu > \phi$

$R = \frac{mv}{qB}$

$R_{max} = \frac{\sqrt{2mK_{max}}}{qB} = \frac{\sqrt{2m(h\nu - \phi)}}{qB}$

$h\nu - \phi = K_{max}$

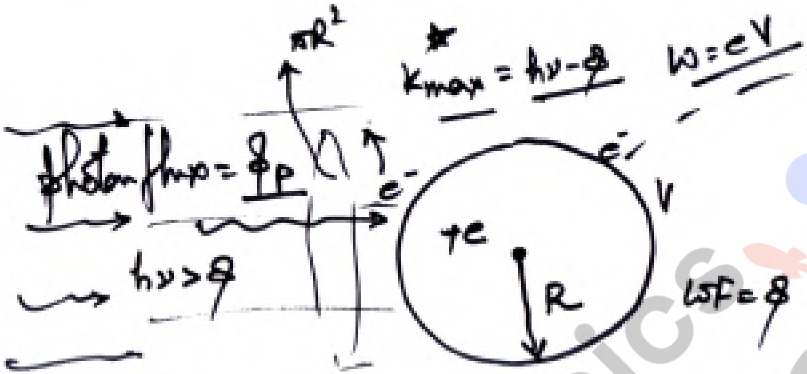
$\updownarrow$

$0 \le v \le v_{max}$

QUESTIONS BASED ON

STOPPING OF PHOTOELECTRIC EFFECT IN AN ISOLATED SPHERE

$\star\ K_{max} = h\nu - \phi \qquad W = eV \rightarrow \infty$



No of ph incident on sphere/sec

$N = \phi_p \pi R^2$

if quantum efficiency $= \eta$

$N_e = \phi_p \pi R^2 \eta$ e's/s.

charge/sec $= N_e e$.

after time t $\quad q = N_e e t$.

all ejected photoelectrons to be instantly removed from sphere surrounding!

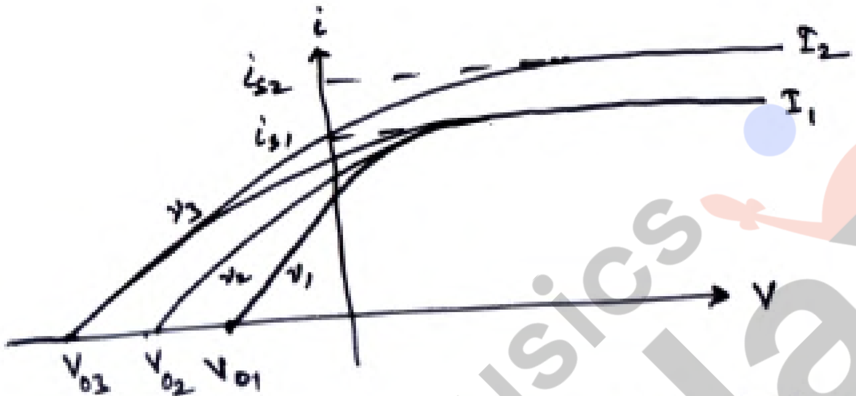
Pot^n of sphere at time t $\quad V_t = \frac{kq}{R} = \frac{1}{4\pi\epsilon_0}\cdot\frac{q}{R}$

To stop PEE $\quad \star\ K_{max} = eV_t$

$t = - - - -$ [at this time PEE will stop]

Questions Based on

Experimental Analysis of Photocurrent Variation

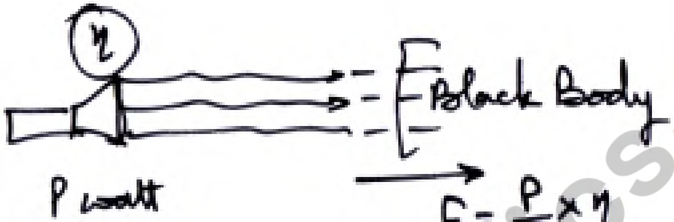


for diff freq → V_0 will be diff & i_s will be same if I → remains same (photon flux)

for diff I → i_s will be diff & V_0 will remain same if ν → constant

QUESTIONS BASED ON

RADIATION FORCE BY LIGHT ON A SURFACE



$$F = \frac{P}{c} \times \eta$$

$$F = \frac{\Delta p}{\Delta t} = \frac{2P}{c}$$

if Mirror is free to move ⇒ Some momentum will be gained by Mirror

$$F < \frac{2P}{c}$$

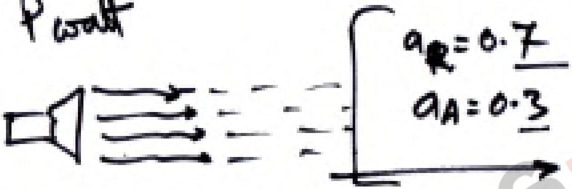
Questions Based on

Radiation Force on a Partly Reflecting Surface

P watt

$a_R = 0.7$

$a_A = 0.3$



$$F = \frac{0.3P}{c} + \frac{1.4P}{c} = \frac{1.7P}{c}$$

$$\text{No of photons} = \frac{P\lambda}{hc}\ \text{ph/s} \times \frac{h}{\lambda}$$

QUESTIONS BASED ON

MATTER WAVES OF ACCELERATED ELECTRONS

p.d = V

e^- ⟶ K = eV

★ deBroglie WL $\lambda = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2meV}}$ ✓

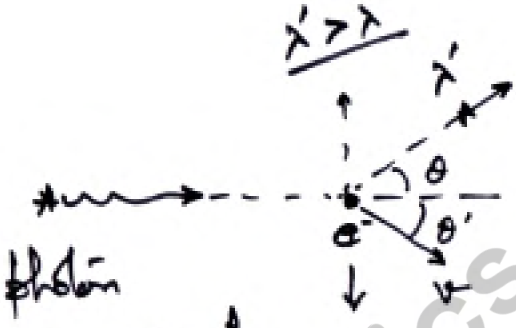
★ → YDSE ✓

→ Diffraction by single slit

$$\left\{ \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} \right\}$$

Questions Based on

Scattering of a Photon by an Electron



$\lambda \longrightarrow p = \frac{h}{\lambda}$

by Cons of energy

$$\frac{hc}{\lambda} = \frac{hc}{\lambda'} + \frac{1}{2}mv^2 \quad -(1)$$

by Cons of momentum

$$x \text{ dir} \rightarrow \frac{h}{\lambda} = \frac{h}{\lambda'}\cos\theta + mv\cos\theta' \quad -(2)$$

$$y \text{ dir} \rightarrow \frac{h}{\lambda'}\sin\theta = mv\sin\theta' \quad -(3)$$

QUESTIONS BASED ON

de BROGLIE WAVELENGTH OF THERMAL MOTION

In thermal motion $K = \frac{3}{2}kT$ (Translational KE)

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m\left(\frac{3}{2}kT\right)}} = \frac{h}{\sqrt{3mkT}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{T_2}{T_1}}$$

Questions Based on

de Broglie Wavelength In Different Reference Frame

Y

X

$\frac{h}{mv_1} = \lambda_1$

$v_1 = \frac{h}{m\lambda_1}$ ✓

e_1

$\cdot$ com

$\vec{V}_c = \frac{v_2\hat{i} + v_1\hat{j}}{2}$

e_2 $\quad \lambda_2$

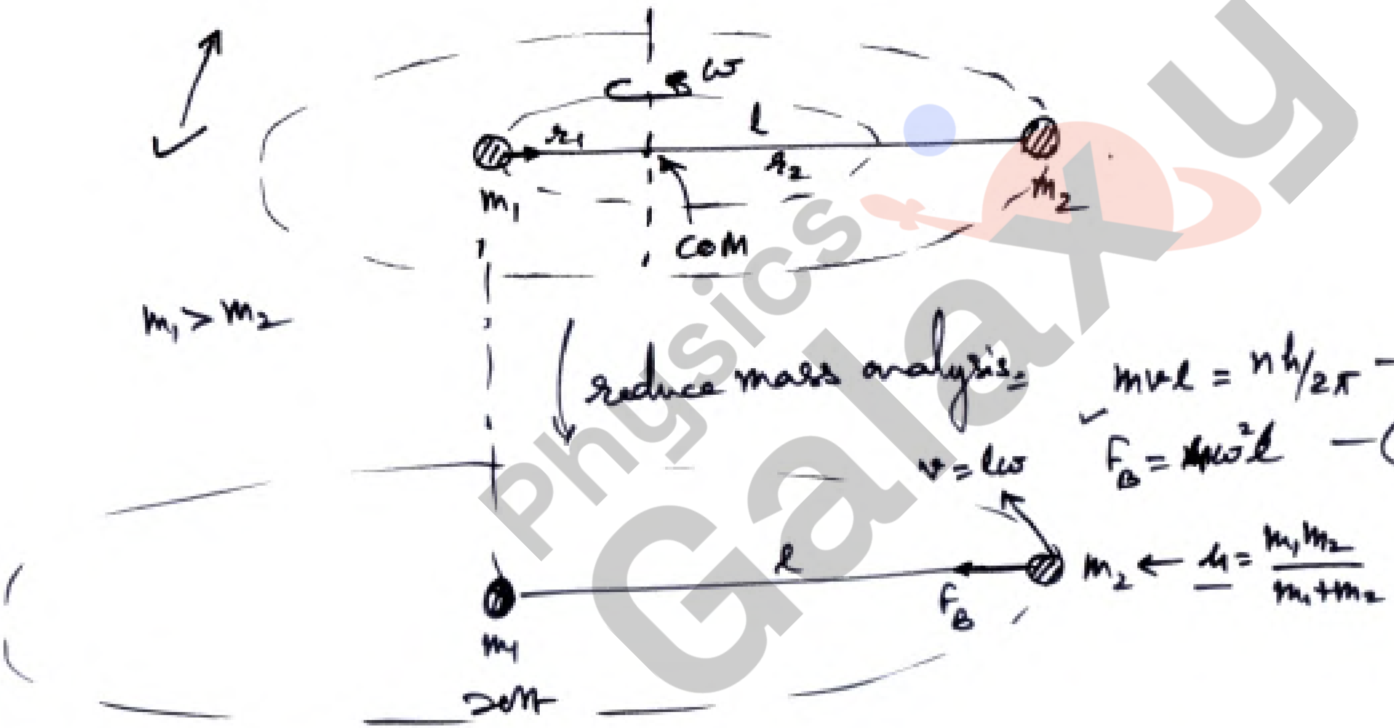
$v_2 = \frac{h}{m\lambda_2}$ ✓

$$\vec{V}_{e,c} = \vec{V}_1 - \vec{V}_c = v_1\hat{j} - \left(\frac{v_2\hat{i} + v_1\hat{j}}{2}\right) = \frac{v_1\hat{j} - v_2\hat{i}}{2} = \frac{\sqrt{v_1^2 + v_2^2}}{2}$$

dBWL of e_1 in frame of com $\quad \lambda_{1c} = \frac{h}{mV_{1c}} = \frac{2h}{m\sqrt{v_1^2 + v_2^2}} = \_\_\_$

Questions Based on

Bohr's II Postulate in Diatomic Molecule



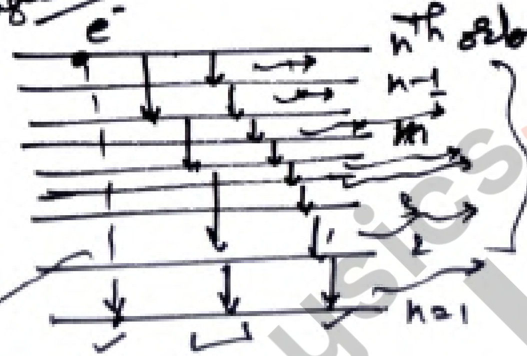
$$m v l = \frac{nh}{2\pi} \quad \text{--- (1)}$$

$$F_B = \mu \omega^2 l \quad \text{--- (2)}$$

Questions Based on

Emission of Spectral Lines by Excited H-atom

Single e^-



upto $(n-1)$ photons

$\Delta E_{n\to 1}$

one photon

"spectral lines"

$\downarrow$

we talk about "gas"

System of multiple atoms

$\Rightarrow$ from $n^{th} \to 1^{st}$ orbit

Spectral lines $N = {}^{n}C_2 = \frac{n(n-1)}{2}$

Questions Based on

Ionization Energy Difference of H and D

$$IP = \underset{(Z=1)}{\underline{13.6\, Z^2 = 13.6\, eV.}} \quad (\text{Same for } \underline{H \,\&\, D})$$

As H and D nuclear masses are diff $\Rightarrow$ IP expression will be given as

$$IP_n = \frac{2\pi^2 k^2 Z^2 e^4 m_e}{n^2 h^2} \longrightarrow \mu_e = \frac{m_e m_H}{m_e + m_H}$$

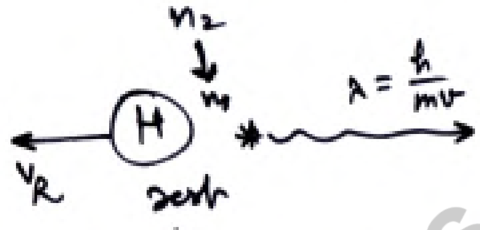
$$\mu = \frac{m_e m_H}{m_e + m_H}$$

$$IP_H = 13.6 \times \frac{m_H}{m_e + m_H}\, eV$$

$$IP_D = 13.6 \times \frac{m_D}{m_e + m_D}\, eV$$

QUESTIONS BASED ON

RECOILING OF AN ATOM DURING TRANSITION



$$\Downarrow$$

$$m v_R = \frac{h}{mv} = \frac{h}{\lambda}$$

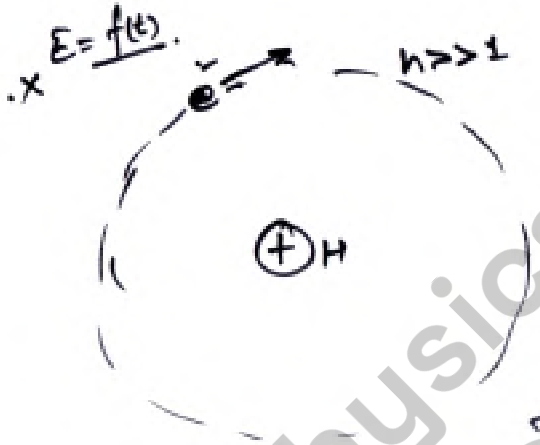
$v_R = \text{-----}$ [considering total energy goes into photon]

$$\Delta E_{n_2 \to n_1} = \frac{hc}{\lambda} + \frac{1}{2} m v_R^2 + \Delta E_{n \to n_{1s}}$$

This v_R is slightly more than actual recoil speed!

QUESTIONS BASED ON

REVOLUTION FREQUENCY OF e⁻ IN HIGHER ORBITS



$$f_n = \frac{v_n}{2\pi r_n}\Bigg|_{n>>1} = \underline{\qquad}$$

This freq is equal to the rad freq emitted for transition of e^- from

$n \longrightarrow (n-1)$

adjoining orbit transition

Questions Based on

Energy Levels of Hypothetical Bohr's Model

$$U_n / E_n = f(r)$$

$$F(r) = \frac{d}{dr}(f(r)) = \frac{mv^2}{r} \Rightarrow v = \text{—} \quad \text{— (1)}$$

using Bohr's quantization postulate

$$mvr = n\left(\frac{h}{2\pi}\right) \quad \text{— (2)}$$

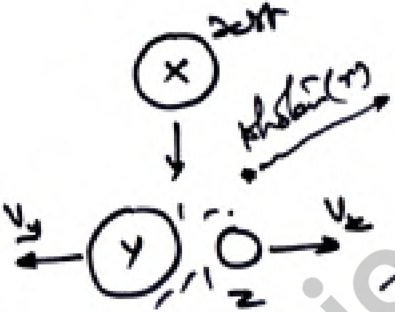
$v_n = \text{—}$

$r_n = \text{—}$

$E_n = U_n + K_n = \text{—}$

Questions Based on

Nuclear Disintegration in Two Elements



Nuclear radii

$R \propto A^{1/3}$

$$\frac{R_y}{R_z} = \left(\frac{m_y}{m_z}\right)^{1/3} = \left(\frac{v_z}{v_y}\right)^{1/3}$$

$m_y v_y = m_z v_z$

$$\left[Q = E_{released} = \frac{1}{2} m_y v_y^2 + \frac{1}{2} m_z v_z^2 + E_\gamma \right]$$

QUESTIONS BASED ON

SIMULATANEOUS DECAY OF TWO RADIOACTIVE ELEMENTS

(A) $N_A = N_{0A}(2)^{-t/T_A}$

(B) $N_B = N_{0B}(2)^{-t/T_B}$

$N_A = N_{0A}e^{-\lambda_A t}$; $N_B = N_{0B}e^{-\lambda_B t}$

after $t = t_1$

$N_A = N_B$

$t_1 = \_\_\_\_$

$$\frac{N_A}{N_B} = \left(\frac{N_{0A}}{N_{0B}}\right) 2^{-t\left[\frac{1}{T_A} - \frac{1}{T_B}\right]}$$

QUESTIONS BASED ON

SIMULATANEOUS DECAY MODES OF ONE RADIOACTIVE ELEMENTS

at $t=0$ N_0

at $t=t \rightarrow N_x$

$$X \xrightarrow{\lambda_1} Y \qquad \text{Prob} = p_1$$

$$X \xrightarrow{\lambda_2} Z \qquad \text{Prob} = p_2$$

$A_{cy} = \lambda_1 N_x \leftarrow$ production rate of Y.

$A_{cz} = \lambda_2 N_x \leftarrow$ production rate of Z.

$$\lambda_{eqx} = \lambda_1 + \lambda_2$$

$\lambda_1 = p_1 \lambda_{eqx}$ & $\lambda_2 = p_2 \lambda_{eqx}$

$$N_x = N_0 e^{-\lambda_{eqx} t}$$

$$\left.\begin{aligned} X &\xrightarrow{\lambda_1} Y + \Delta E_1 \\ X &\xrightarrow{\lambda_2} Z + \Delta E_2 \end{aligned}\right\}$$

Nuclear power production by X at any time t -

efficiency

$$P = (\lambda_1 N_x \Delta E_1 + \lambda_2 N_x \Delta E_2)\, \eta \times \frac{1}{100}$$

Questions Based on

Production of a Radioactive Element

RA element inject / produced ✓ → (α atoms/s) $\boxed{X \; (N_x)} \xrightarrow{\lambda} Y + \Delta E$

at time $t = t$.

Y production rate $= \lambda N_x$ dis/sec

$\text{Power}_t = \lambda N_x \Delta E$

Accumulation rate of X: $\dfrac{dN_x}{dt} = \alpha - \lambda N_x$

$$\int_0^{N_x} \frac{dN_x}{\alpha - \lambda N_x} = \int_0^t dt \longrightarrow N_x = f(t)$$

QUESTIONS BASED ON

PROCESS OF CARBON DATING

↓

used to calculate age of any old substance (RA)

Present Sample $A_c(t)$

original Activity A_0.

$\rightarrow A_c(t) = A_0(2)^{-t/T}$

$t =$ —— Age of substance

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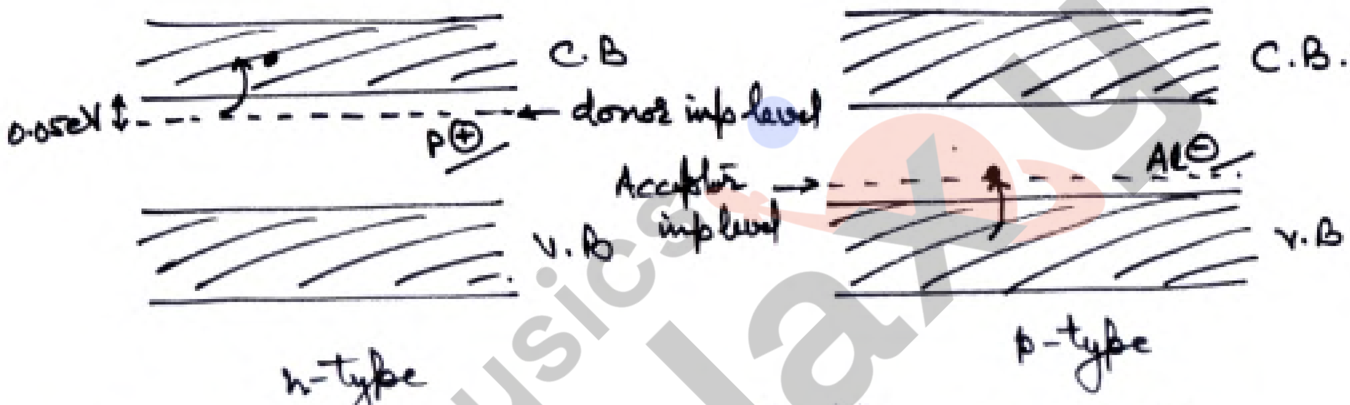
QUESTIONS BASED ON

BAND GAPS IN p-TYPE AND n-TYPE SEMICONDUCTORS

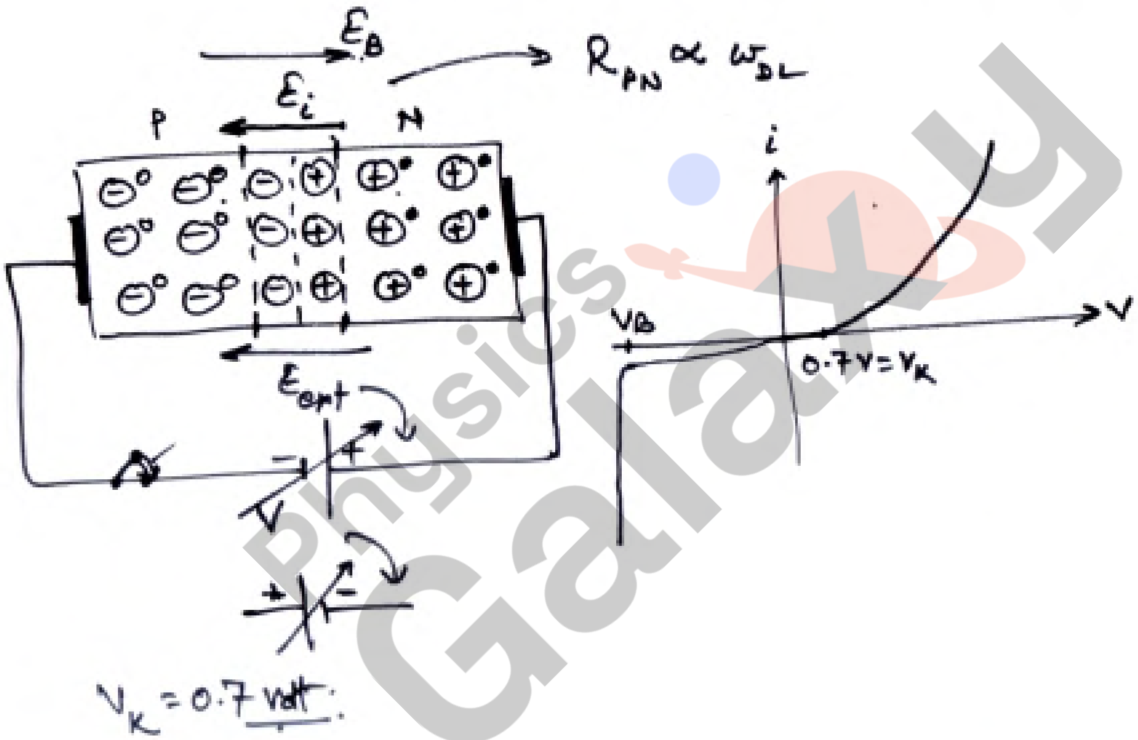


donor Conc. → 1 in 10^3 to 10^5 Si

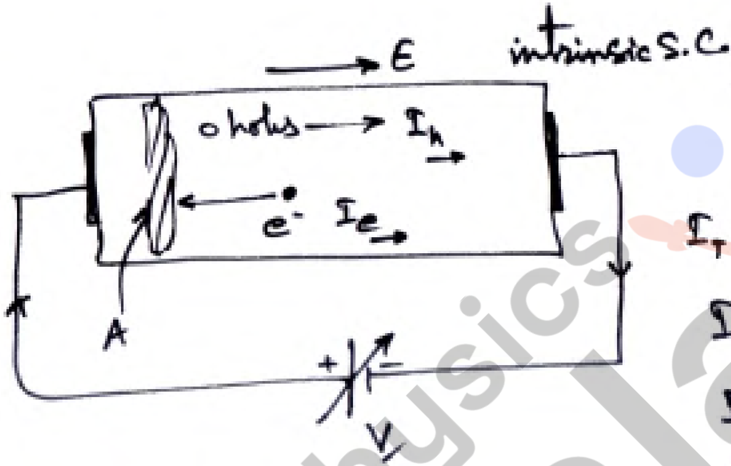
Acceptor Conc → 1 in 10^3 to 10^5 Si.

Questions Based on

Electric Field in Depletion Layer of a p-n Junction



QUESTIONS BASED ON
CONDUCTION IN SEMICONDUCTOR



$$I_T = I_e + I_h$$

$$I = A[J_e + J_h]$$

$$I = A n_i e (v_{de} + v_{dh})$$

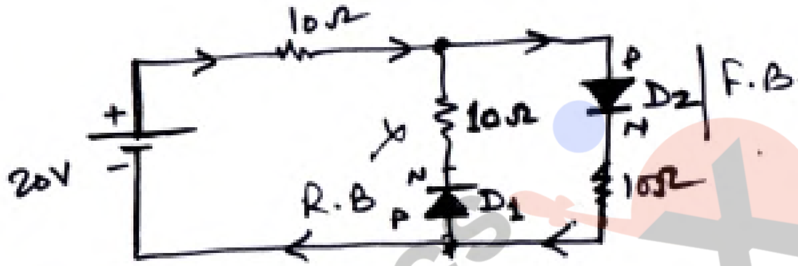
$$I = A n_i e E (\mu_e + \mu_h)$$

$$I = A E (\sigma_e + \sigma_h)$$

$$v_d = \mu E.$$

QUESTIONS BASED ON

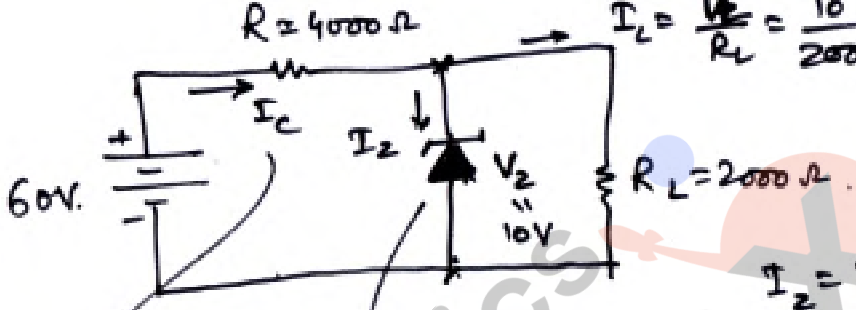
IDEAL DIODES IN CIRCUITS



$$I = \frac{20}{10+10} = 1A.$$

QUESTIONS BASED ON

CIRCUITS WITH ZENER DIODE



$I_L = \frac{V_z}{R_L} = \frac{10}{2000} = 0.005\,A$

$I_z = I_c - I_L = \frac{1}{80} - \frac{1}{200} = $ ——— ✓

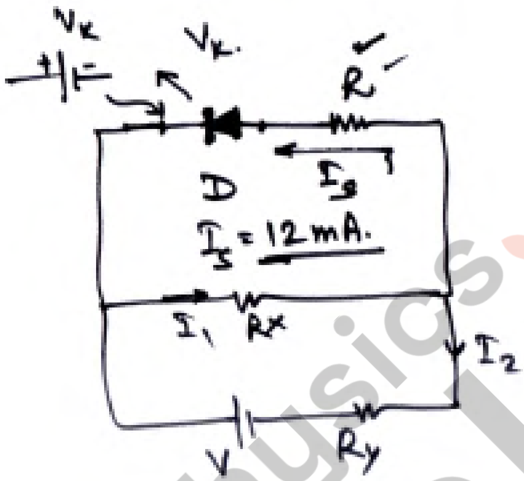
in B/D state it acts like a voltage stabilizes

$I_c = \frac{50}{4000}$

$I_c = \frac{1}{80}\,A$

QUESTIONS BASED ON

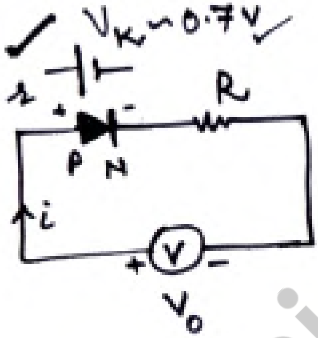
SAFE CURRENT LIMIT OF A DIODE



For safe limit of a diode Series Resistance is used

Questions Based on

Forward Biased Real Diode in Circuit



Ckt current

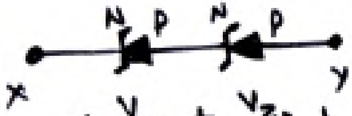
$i = \frac{V_0 - V_K}{R}$ (if there is no resistance in diode)

otherwise

$i = \frac{V_0 - V_K}{R + r_0}$

Questions Based on

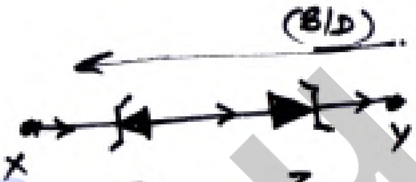
Zener Diodes in Series



$\underbrace{V_{z_1} + V_{z_2}}$

If $V_{z_1} = V_{z_2} = V_z$

$V_{z_{xy}} = \underline{\underline{2V_z}}$



$\underline{Z_1}$ $\underline{\underline{B/D.}}$

$\underline{Z_2}$ (F.B)

$V_{xy} = V_{z_1}$ or V_{z_2}