INDEX

$W \neq -PdV$

NAME: K.Sreeman Reddy STD.: ______ SEC.: ______ ROLL NO.: 2017118 SUB.: Physics

S. No.	Date	Title	Page No.	Teacher's Sign / Remarks
		$\vec{W'} = \vec{W} - \vec{W_0} - 2[\vec{\omega}\vec{v'}] + \omega^2\vec{e} - [\vec{\beta}\times\vec{r}]$		
		W' = accleration in k' frame		
		W = accleration in k frame		
		v_0 = velocity of k' in K frame		
		Wave optícks & YDSE		
		Semiconductors		
		Modern physics		
		Gravitation		

Physics

1) Mechanics 2) Thermodynamics 3) Optics
4) Electricity and Magnetism 5) Modern Physics

Mechanics

1) Experimetal basics 2) Newton's laws of Motion for particles
3) Systems of particles & C.O.M 4) Rigid body dynamics
5) Gravitation 6) Laws of conservation

Optics

1) plane, curved mirrors 2) lenses & refraction 3) Prisms
4) Huygen's principle 5) Inteterence of 2 seperated coherent sources (YDSE) 6) Diffraction of single slit & circular hole

Thermodynamics

1) Expansions of objects, Calorimetry, Methods of heat tranfer
2) Work, heat & notion of internal energy 3) Ideal & Real gases
4) Processes for ideal gas 5) Entropy and 2nd law
6) Black body radiation, Kirchoff's, Wien's and Stefan's laws.

Thermodynamics

Heat and Temperature

Heat: The flow of energy between two bodies because of ΔT without any mechanical work.

$$\alpha = \frac{d\lambda}{\lambda\, dT} \qquad \beta = \frac{dA}{A\,dT} \qquad \gamma = \frac{dV}{V\,dT}$$

$$\boxed{\alpha \approx \frac{\beta}{2} \approx \frac{\gamma}{3}}$$

→ In general for isotropic media under no restrictions

⇒ Due to thermal expansions stresses and strains are not observed. (They are not mechanical)

$$\frac{C-0}{100-0} = \frac{F-32}{180} = \frac{K-273}{100}$$

→ Water has max density at $4°c$

→ The stress formed when we prevent expansion is called <u>thermal stress</u>

	$\alpha\ (10^{-5}\ ^{\circ}C^{-1})$	γ
Aluminium	2.5	7
Brass	1.8	6
Iron	1.2	3.55
Copper	1.7	
Silver	1.9	
Gold	1.4	
Glass (Pyrex)	0.32	1
Lead	0.29	

$\boxed{\gamma = \alpha v}$

Calorimetry

$\boxed{Q = ms\Delta\theta}$

$S_{wat} = 1 cal/gm = 4.186\ J/gm$ $(14.5°C \rightarrow 15.5°c)$

$S_{ice} = 0.9$

$S_{steam} = 0.46$

$$S = \frac{dQ}{m\,dT}$$

→ While changing phase T is constant

$$C = \frac{dQ}{n\,dT}$$

→ $L_{vap\ of\ Wat} = 540 cal/gm$

$\boxed{Q = mL}$

$L_{fus\ of\ ice} = 90 cal/gm$

→ Boiling point increases with increase in pressure.

→ Water equivalen $= \frac{m_A S_A}{S_W}$

→ Even if we do not supply heat T may ↑ due to work done.

Laws of Thermodynamics

<u>Zeroth</u>: If A & B are in eq & B & C are in eq then A & C are in eq

<u>Ist law</u>: Energy of an isolated system is always constant

or

Energy suplied to a system partly goes to increse the internal energy and partly to do work on surroundings.

$$\boxed{\begin{aligned}\Delta U &= Q_{supplied\ to\ sys} - W_{done\ by\ sys} \\ &= Q - W\end{aligned}}$$

$$\boxed{dU = dQ - PdV}$$

For a polytropic process PV^n = constant.

$$dQ = nC_V\,dT + \frac{nR\,dT}{1-n}$$

$$\Rightarrow \boxed{C = C_V + \frac{R}{1-n} = \frac{R}{\gamma-1} + \frac{R}{1-n}}$$

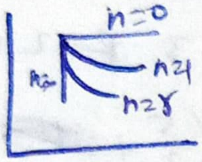
adiabatic process means not only $\Delta Q = 0$ but also $dQ = 0$

Internal energy of one mole of a real gas is

$$U = n\left(C_V T - \frac{a}{V_m}\right) = nC_V T - \frac{an^2}{V}$$

$$\boxed{C = \frac{dU + W}{n\,dT}} \quad \boxed{\frac{C_P}{C_V} = \gamma} \quad \boxed{C_P - C_V = R} \text{ (for ideal gas)}$$

→ Intensive → does not depend on amount Extensive depends



→ $W_{isobaric} > W_{isothe} > W_{adi} > W_{isochoric}$

→ quasi-static process means reversible

→ Heat can flow in isothermal due to infinitesimal dT

Kinetic Theory of gases

$$PV = nRT$$

$R = 0.0821$ atm L mol^{-1} K^{-1} = 8.314 J K^{-1} mol^{-1}
= 1.987 cal K^{-1} mol^{-1}

Boyle's ⇒ P, V GayLussac's ⇒ P, T

charles ⇒ V, T

$V_{m,STP} = 22.71$ Lit mol^{-1}

phase ≠ state of matter

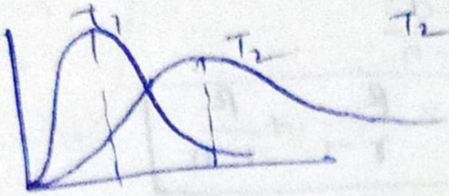
1) Gases contain large no. of molecules & actual molecular size is negligible
2) There is no force of attraction & gravity is neglected
3) They always move randomly.
4) Pressure is due to the collisions of molecules.
5) All collisions are elastic
6) Avg K.E is proportional to temperature.

$$PV = \frac{1}{3} mN\overline{v^2} = \frac{1}{3} Mn\overline{v^2}$$

$$v_{r.m.s} = \sqrt{\overline{v^2}} = \sqrt{\frac{3RT}{M}} \qquad v_{avg} = \sqrt{\frac{8}{\pi}\frac{RT}{M}}$$

$$v_{M.P} = \sqrt{\frac{2RT}{M}}$$

Maxwell's distribution



$T_2 > T_1$

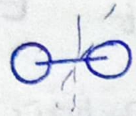
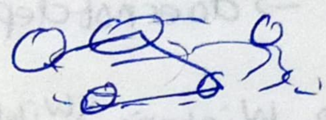
$$dN = 4\pi N \left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}} v^2 e^{-\frac{mv^2}{2kT}} dv$$

$$\boxed{n = n_0 e^{-\frac{(U-U_0)}{kT}} \quad \text{Boltzmann's formula}}$$

Law of equipartion of energy

$\varepsilon = \frac{f}{2} kT$ where f = sum of translational, rotational and $\boxed{\text{double}}$ the number of vibrational degrees of freedom

$\boxed{\text{Vibrational only at high } T}$

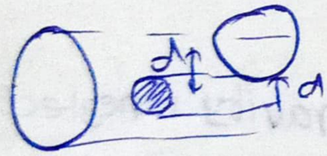
N

0000000 00

3 Traslation	3 Traslation 2 Rotational, 1 Vibrational	T=3 R=3 V=3N-6	T=3 R=2 V=3N-5
$\frac{3}{2}R$	$\frac{5}{2}R$	$\frac{6R}{2}$	$(\frac{5}{2} + \text{[illegible]})R$
$\gamma = \frac{5}{3}$	$\frac{7}{5}$	$\frac{8}{6}$	

Mean free path :

$$\lambda = \frac{1}{\sqrt{2}\, n\pi d^2} \qquad \tau = \frac{1}{\sqrt{2}\, n\pi \langle v\rangle d^2}$$



→ At ordinary pressures and temperatures, λ is 10 times the interatomic distance in solids & liquids. (interatomic distance in gas) But λ is 100 times interatomic distance and 1000 times the size of the molecule

λ = the avg distance between 2 successive collisions.

$$(K.E)_{\text{Traslational}} = \frac{1}{2} m n \frac{3RT}{m} = \frac{3}{2} nRT = N\left(\frac{3}{2} kT\right)$$

$$\boxed{P = P_0 e^{-\frac{Mgh}{RT}}}$$

Barometric formula

$$\frac{P}{d} = \frac{RT}{M} = \text{constant}$$

$$\Rightarrow \frac{dP}{dh} = -dg \Rightarrow \frac{d(d)}{dh} = -(\rho g)\,\text{constant}$$

$$\boxed{\left(P + \frac{a n^2}{V^2}\right)(V - nb) = nRT}$$

Vander Wals eqn

For solid

$$U = 3k_B T \times N_A = 3RT$$

$$C = \frac{\Delta Q}{\Delta T} = \frac{\Delta U}{\Delta T} = 3R$$

Heat Transfer

Conduction

$$\frac{dQ}{dt} = kA\frac{\Delta T}{x}$$

It is observed in solids

Convection

→ In fluids

→ no particular law

For small temperature diff

$$\boxed{P = kA(T - T_0)}$$

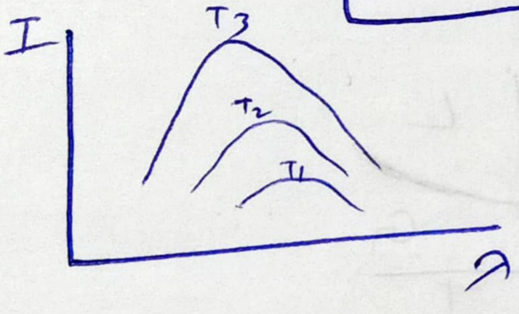
Radiation

→ no medium reauired

$$P = e\sigma A T^4$$

for black bodies $e = 1$

$$\boxed{\sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}}$$



$$\lambda_m T = b = 0.288\ cmK = 2.88 \times 10^{-3}\ mK$$

↳ Weien's displacement constant

→ In thermodynamic process if it is given free expansion it may not be adiabatic (Reversible) as the gas will be in intermediate stage. We can only understand final and initial stages of an irreversible process

→ when n_1 moles of mono & n_2 moles of dia are mixed.

$$C_V = \frac{n_1}{n_1+n_2}\times\left(\frac{3R}{2}\right) + \frac{n_2}{n_1+n_2}\left(\frac{5R}{2}\right)$$

$$M = \frac{n_1}{n_1+n_2}M_1 + \frac{n_2}{n_1+n_2}M_2$$

but $\boxed{\gamma \neq \frac{n_1}{n_1+n_2}\gamma_1 + \frac{n_2}{n_1+n_2}\times\gamma_2}$ × wrong

$$\Rightarrow \gamma - 1 = \frac{n_1+n_2}{\frac{n_1}{n_1+n_2}\left(\frac{1}{\gamma_1-1}\right) + \frac{n_2}{n_1+n_2}\left(\frac{1}{\gamma_2-1}\right)}$$

⇒ Emissive power =

$$E = \frac{\Delta U}{(\Delta A)(\Delta \omega)(\Delta t)}$$

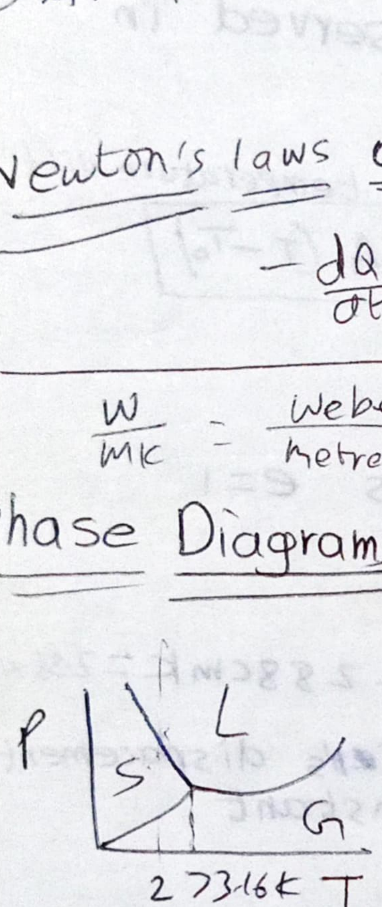
⇒ Absorptive Power = $a = \frac{\text{energy absorbed}}{\text{energy incident}}$

Newton's laws of cooling

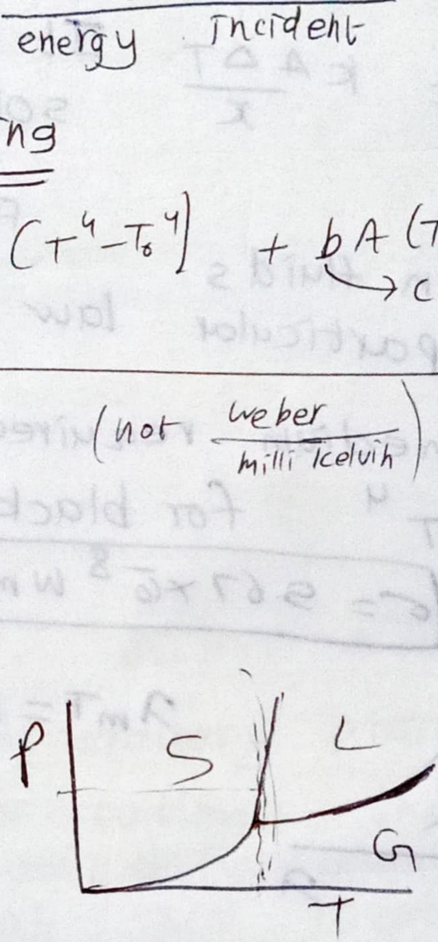
$$-\frac{dQ}{dt} = k\left(T^4 - T_0^4\right) + \underbrace{bA(T-T_0)}_{\text{convection.}}$$

$$\frac{W}{mK} = \frac{\text{weber}}{\text{metre kelvin}} \quad \left(\text{not } \frac{\text{weber}}{\text{milli kelvin}}\right)$$

Phase Diagrams



Water



CO_2

As pressure is increased $T_{m.p}$ will decrease.

As pressure is increased $T_{m.p}$ is increased

Electro Magnetism

Electro Statics

(For a particle to exhibit a circular stable orbit its T.E<0)

- → Charge is of 2 types unlike mass.
- → Net charge is always considered.
- → Charge is quantised (~~I mean~~ freely existable charge)
- → Electrostatic field is conservative. (but not induced)
- → Charge is relativistic invariant
- → Electric field has physical significance and it can be considered as an entity. It has momentum, mass e.t.c
- → Coloumbs law ⇒ $\boxed{E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{e}_r}$ $\boxed{1\ e.s.u = \frac{1\ \text{columb}}{3\times10^9}}$

$\boxed{\varepsilon_0 = 8.85\times10^{-12}}$, $\boxed{K = 9\times10^9}$ (SI units)

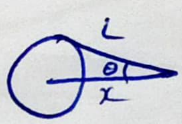
- → Guass's law ⇒ $\boxed{\oint \vec{E}\cdot ds = \frac{q_{in}}{\epsilon_0}}$ (outward positive) $\boxed{\varepsilon = \varepsilon_0\varepsilon_r}$
- → A charged particle can never be in a stable equilibrium in an electric field. (Earnshaws theorem) (from guass law)

Ring

$$E = \frac{kqx}{(x^2+R^2)^{\frac{3}{2}}} \qquad V = \frac{kq}{(x^2+R^2)^{\frac{1}{2}}}$$

Disk

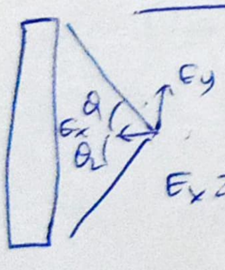
$$E = \frac{\sigma}{2\epsilon_0}(1-\cos\theta) \qquad V = \frac{\sigma}{2\epsilon_0}(1-\cos\theta)L$$



$$\cos\theta = \frac{x}{\sqrt{x^2+R^2}}$$

$$L = \sqrt{x^2+R^2}$$

Rod (uniform)

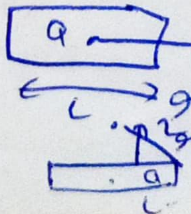


$$E_y = \frac{k\lambda}{r}(\cos\theta_1 - \cos\theta_2)$$

$$E_x = \frac{k\lambda}{r}(\sin\theta_1 + \sin\theta_2)$$

Large sheet

$$E = \frac{\sigma}{2\epsilon_0} \quad (\text{as } \cos\theta \to 0)$$



$$E = \frac{KQ}{r^2-(\frac{L}{2})^2}$$

$$\cancel{E = \frac{KQ}{(r^2+(\frac{L}{2})^2)^{\frac{3}{2}}}} = \frac{KQ}{2}$$

Hollow shere

	$r < R$	$r > R$
	$E = 0$	$\frac{kq}{r^2}$
	$V = \frac{kq}{R}$	$\frac{kq}{r}$

$r < R$ $\quad$ $r > R$

$E = 0$ $\quad$ $V = \frac{kq}{r^2}$

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

M, R

$E_p = \frac{GM}{2R^2}$

Solid sphere (uniform)

	$r < R$	$r > R$
	$\boxed{E = \frac{kqr}{R^3}}$	$\frac{kq}{r^2}$
very important	$\boxed{V = -\frac{kq}{2R^3}(3R^2 - r^2)}$	$\frac{kq}{r}$

→ In electrostatics conductors are equipotential surfaces.

→ $V = -\int_0^\infty \vec{E} \cdot d\vec{l}$

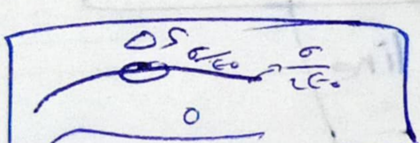
→ Field lines never intersect

→ Field lines end ⊥larly at the surface of a conductor.

→ Electric field near the surface of a conductor is

$E_n = \frac{\sigma}{\epsilon_0}$ $\quad$ ($n \Rightarrow$ ⊥lar)

→



$\Delta F = \sigma \Delta S \cdot \frac{\sigma}{2\epsilon_0} \Rightarrow \frac{\Delta F}{\Delta S} = \frac{\sigma^2}{2\epsilon_0}$

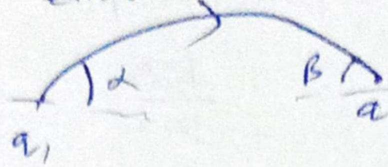
$\Rightarrow P = \frac{\sigma^2}{2\epsilon_0}$

→ Electrostatic pressure = Electrostatic Energy density $= \frac{\sigma^2}{2\epsilon_0}$

$\cancel{\left(\frac{1}{2}\epsilon_0 E^2\right)}$

⇒ A closed conducting shell divides the entire space into the inner and outer parts which are completely independent of one another in respect of electric fields.

→ field lines emit uniformly at the surface

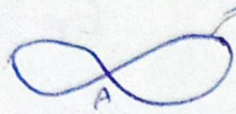


$$\frac{q_1}{\epsilon_0(4\pi)}2\pi(1-\cos\alpha) = \frac{q_2}{\epsilon_0 4\pi}\pi(1-\cos\beta)$$

→ Electrostatic field doesnot obey newton's 3rd law.

→ There will be no field lines in a cavity.

→ Equipotential surface



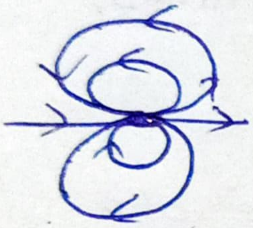
$\Rightarrow \boxed{(E)_A = 0}$

$(\vec{p}\cdot\vec{\nabla})$

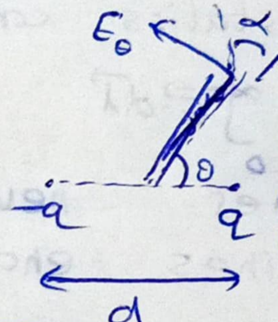
$$\boxed{\vec{F} = (\cancel{\nabla \cdot p})\vec{E}}$$

Dipole (~~for~~ Never forget ~~short~~ long dipoles)

$\vec{\tau} = \vec{p}\times\vec{E}$ $\quad P.E = -\vec{P}\cdot\vec{E}$ $\quad \vec{p} = |q|\vec{d}$



$$\boxed{V = \frac{kp\cos\theta}{r^2}}$$



$$\boxed{\tan\alpha = \frac{1}{2}\tan\theta}$$

$$\boxed{E_\theta = -\frac{\partial V}{r\,\partial\theta} = \frac{kp\sin\theta}{r^3} \qquad E_r = -\frac{\partial V}{\partial r} = \frac{2kp\cos\theta}{r^3}}$$

Note :

$\boxed{\longrightarrow \text{axial line}}$ $\quad \boxed{\uparrow \text{equitorial line}}$

Conductors

$$\boxed{\nabla^2\phi = 0} \quad \left(\because \nabla^2\phi = \frac{-\rho}{\epsilon_0}\right)$$

Self energy

Shell	Solid sphere
$\frac{ka^2}{2R}$	$\frac{3ka^2}{5R}$ Energy inside $= \frac{ka^2}{10R}$

⇒ Potential inside solid sphere

$\underline{V \neq} - \frac{GMm}{r}$ & $E \neq - \frac{GMm}{r^2}$

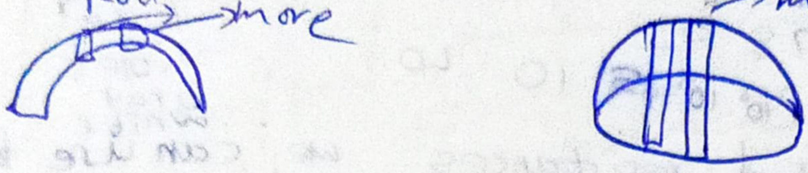
Self energy for a shell $= \frac{kq^2}{2r}$

Self energy for a uniform sphere $= \frac{3kq^2}{5r}$

⇒ If $\lambda = \lambda_0 \sin\theta$ then it is similar to half shell

Rod → more

→ more



Finite dipole

$-Q \quad Q \quad r$

$= \frac{kq(l)(2r)}{(r^2 - \frac{l^2}{4})^2}$

$= \frac{2kpr}{(r^2 - \frac{l^2}{4})^2}$

$\vec{F} = (\vec{p} \cdot \vec{\nabla}) \vec{E} = P_x \frac{\partial E_x}{\partial x} \hat{i} + \frac{P_y \partial E_y}{\partial y} \hat{j} + \frac{P_z \partial E_z}{\partial z} \hat{k}$

$\boxed{F_x = p \cdot \nabla E_x}$

Current electricity

⇒ $I = \frac{dQ}{dt}$ $\quad \oint j\, ds = -\frac{dq}{dt}$

⇒ ~~$\vec{J} = P_+ \vec{\mu_+} + P_- \vec{\mu_-}$~~ $\quad \vec{J} = e_+ \vec{V_+} + e_- \vec{V_-}$

⇒ $I = VR$ $\quad R = \frac{\rho l}{A}$

$I = nAeV_d$ & $\vec{J} = \frac{ne\tau \vec{E}}{m}$ $\quad \vec{V_d} = \frac{-e\vec{E}}{m}\tau$

Ohm's law $\quad I \propto V$ or $j \propto E$ $\quad \boxed{V = IR}$

$I \propto V$ or $j \propto E$ $\quad \boxed{\vec{J} = \sigma \vec{E}}$

Series

$\mathcal{E}_{net} = \mathcal{E}_1 + \mathcal{E}_2 \ldots$

$R_{net} = R_1 + R_2 \ldots$

Parallel

$\mathcal{E}_{net} = \frac{\frac{\mathcal{E}_1}{r_1} + \frac{\mathcal{E}_2}{r_2} + \ldots}{\frac{1}{r_1} + \frac{1}{r_2} + \ldots}$ $\quad \frac{1}{R_{net}} = \frac{1}{r_1} + \frac{1}{r_2} + \ldots$

$\rho_T = \rho_0 (1 + \alpha(T - T_0))$

Gold 10^{-1}

$\boxed{R = \frac{\rho l}{A}}$ $\boxed{10^{-1} \quad 10^{-2}}$

BB ROY GBVGW G S empty
0 1 2 3 4 5 6 7 8 9 5 10 20
$10^0\ 10^1\ 10^2\ 10^3\ 10^4\ 10^5\ 10^6\ 10^7\ 10^8\ 10^9$

Black
Brown
Red
Orange
Yellow
Green
Blue
Violet
Gray
White

Gold
Silver

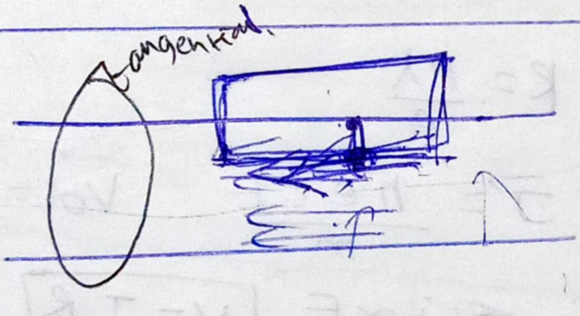
⇒ For infinitely extended resistances we can use both principle of super position and Kirchoff's law's

Kirchoff's laws

1) $\boxed{\Sigma I_k = 0}$

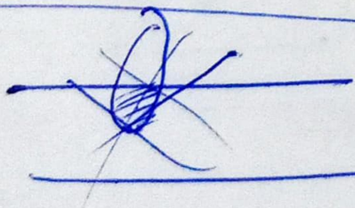
2) $\boxed{\Sigma I_k R_k = \Sigma \mathcal{E}_k}$

☆



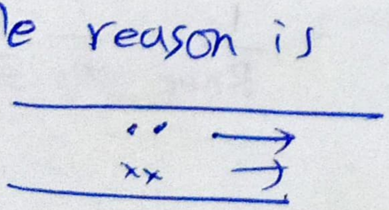
Here outside & inside tangential electric field is zero as there is no flux change.

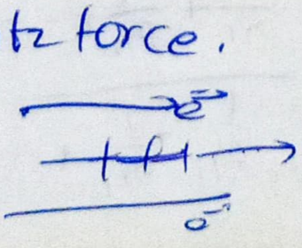
But inside normal $\vec{E}$ exists due to the existence of $\vec{B}$



~~Charge will acumulate at the curface due to flux~~

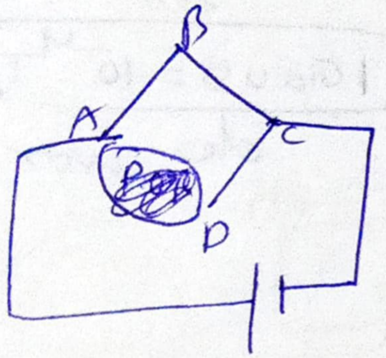
The reason is lorentz force.

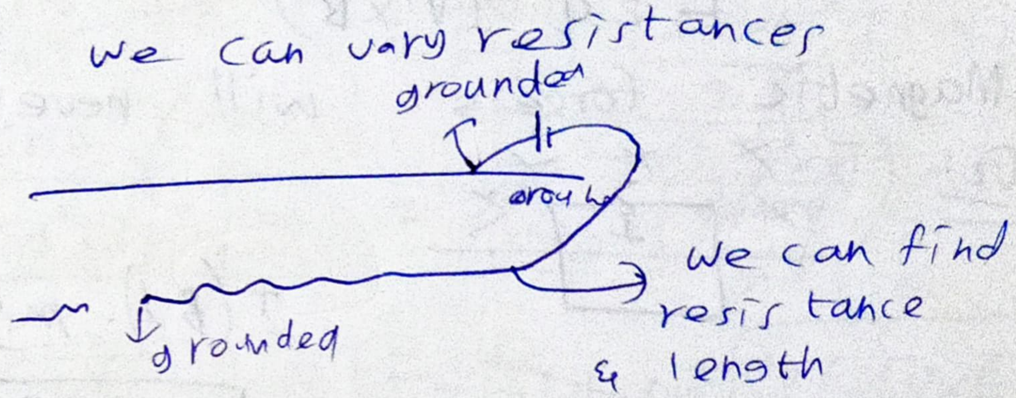




+ve will acumalate at centre
So normal E will come

→ In post office box





Magnetism

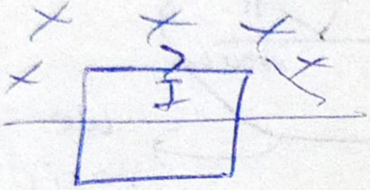
Weber = unit of magnetic flux

$\boxed{1\,\text{Gauss} = 10^{-4}\,T}$

$$\vec{F} = q(\vec{v} \times \vec{B})$$

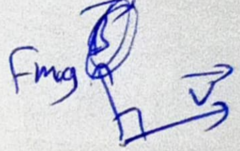
Magnetic forces will never do work

Ex:



$$I(Bl) = mg$$

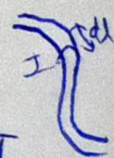
$$\boxed{I = \frac{mg}{Bl}}$$



If we increase the I magnetic force will do negative work on horizontal counterpart & same + work on upward counterpart. What actually drives the current is battery.

→ Magnetic force is non conservative.

→ $F_{Lorent} = q(\vec{E} + \vec{v} \times \vec{B})$



→ $dq(\vec{v} \times \vec{B}) = \lambda\, dl\, (\vec{v} \times \vec{B}) = (d\vec{l} \times \vec{B}) I$

$\lambda\, dl\, I$

(Another form of expressing that force)

→ $I = \lambda v$ (for linearly charged rod)

$= qf$ (for charge moving in circle)

$$K = \frac{dI}{dl_{\perp}} = \text{surface current density} = \sigma v$$

Biot - Savart's law (for steady currents)

$$B(r) = \frac{\mu_0}{4\pi}\int \cancel{I\times \vec{r}} = \boxed{\frac{\mu_0 i}{4\pi}\int\frac{\vec{dl}\times\vec{r}}{r^3}}$$

$\mu_0 = 4\pi\times10^{-7}$ (exact)

$$\boxed{v^2\varepsilon^2\mu^2 = 1}$$

$$= \frac{\mu_0 a}{4\pi}\int\left(\frac{\vec{V}\times\vec{r}}{r^2}\right)$$

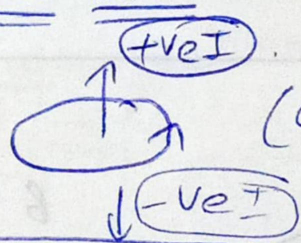
$$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$$

$$= \cancel{\mu_0\varepsilon_0}\int \cancel{dl} = \boxed{\mu_0\epsilon_0\,[V\times E]}$$

$$\boxed{\vec{B} = \frac{\mu_0 a}{4\pi}\left(\frac{\vec{V}\times\vec{r}}{r^3}\right)}$$

$$\boxed{1\ \text{Tesla} = 10^4\ \text{gauss}}$$

Ampere's circuital law

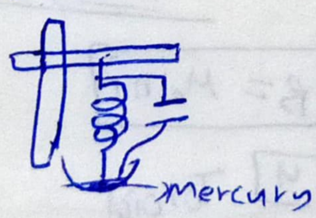


(assumed direction of B)

$$\boxed{\oint\vec{B}\cdot dl = \mu_0 I}$$

→ For time dependent currents and/or charges in motion, Newton's 3rd law may not hold but still Angular momentum is conserved. (Provided momentum carried by photons is considered).

→ Roget's spiral for attraction between parallel currents

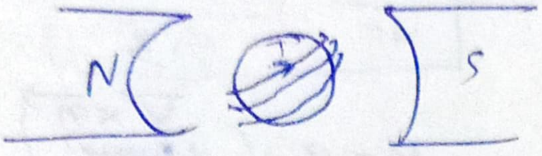


→ **Dipole** $\vec{T} = \vec{M}\times\vec{B}$

$$P.E = -\vec{M}\cdot\vec{B}$$

→ In magnetism dipole is the most elemental thing.

→ Moving coil galvanometer



$\tau = NIAB$ $(\mu = NIA)$

$C\theta = NIAB$

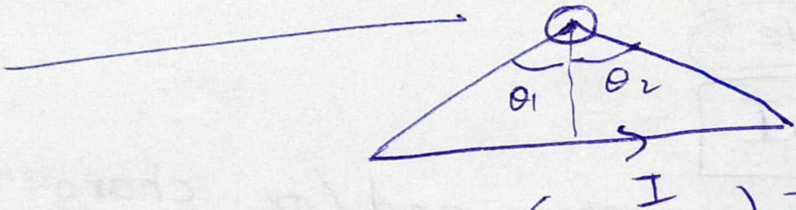
current sensitivity $= \frac{\theta}{I} = \frac{NAB}{C}$

$$\boxed{K = \frac{I}{\theta} = \frac{C}{NAB}}$$

voltage sensitivity $= \frac{\theta}{V} = \frac{\theta}{IR} = \frac{NAB}{RC}$

If we make $N \to 2N$ V.S will not change but C.S will become double.

1 For a wire



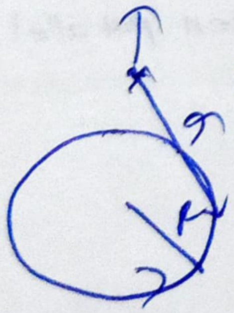
$B = \frac{\mu_0 I}{4\pi r}(\sin\theta_1 + \sin\theta_2)$

for $\theta_1 = \theta_2 = \frac{\pi}{2}$ (∞ly long)

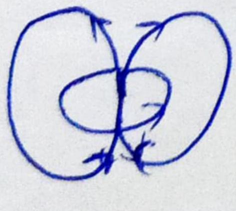
$\Rightarrow \boxed{B = \frac{\mu_0 I}{2\pi r}}$

4

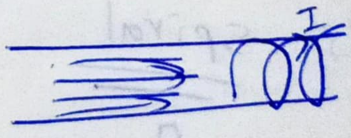
2 For a circular loop



$B = \frac{\mu_0 I}{2} \times \frac{R^2}{r^3}$



3 Solenoid



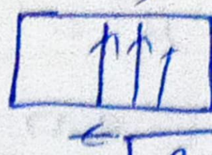
$\boxed{B = \mu_0 n i}$

4 Toroid

$B = \mu_0 n I$

$\boxed{5.}$

$$\boxed{\frac{|\vec{\mu}|}{|\vec{L}|} = \frac{q}{2m}}$$



$K = \frac{di}{dl}$

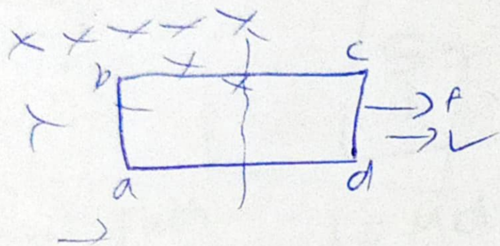
$$\boxed{B = \frac{\mu_0 K}{2}}$$

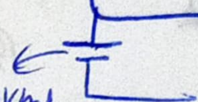
→ $\vec{\mu}$ of ~~an~~ an electron is actually 2 times that of classical one due to Q.E.D effects.

EMI

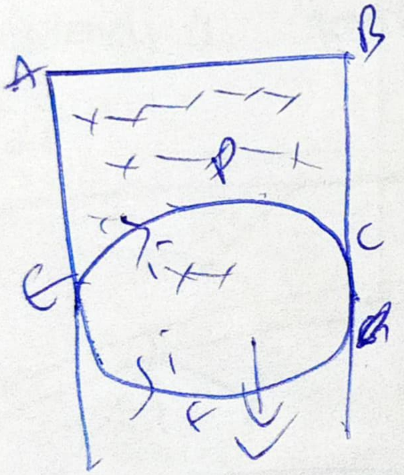
$$\boxed{\mathcal{E} = -\frac{d\phi}{dt}}$$

→

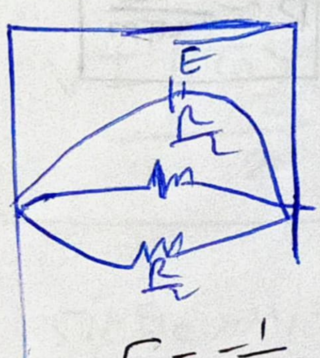




internal resistance = R_{ab}



=



$$\boxed{(\mathcal{E})_{CDEF} = 0}$$

$$\boxed{\mathcal{E}_{ABCDE} = \mathcal{E}_{ABCFE}}$$

$$E = -\frac{1}{4\pi}\int \frac{\frac{\partial B}{\partial t}\times r}{r^2}\, d\tau$$

$$\boxed{\vec{E}_{indu} = \cancel{\frac{-1}{4\pi}\int \frac{\frac{d\vec{\phi}}{dt}\times\vec{r}}{r^3}}}\ =$$

$\boxed{\phi \text{ is scalar}}$

$$E = \frac{-1}{4\pi}\frac{\partial}{\partial t}\int \frac{B\times r}{r^2}\, d\tau$$

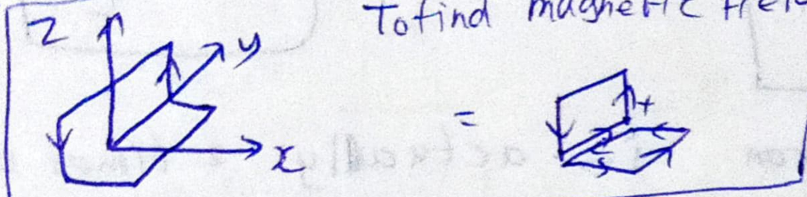
$$\oint \vec{E}_{ind}\cdot d\vec{l} = -\frac{\partial \phi}{\partial t}$$ → True both when Einduced is there

↳ or it is abscent.

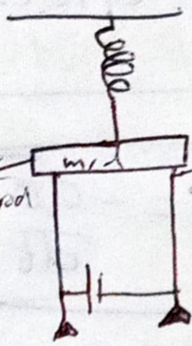
→ Mobility = $\mu = \frac{v}{|E|}$ & $\boxed{\sigma = ne\mu}$

→ $\mu_B = \frac{eh}{4\pi m} = 9.27 \times 10^{-24}$ J called Bohr magneton

→ To find magnetic field.



→ As it is conducting rod i will be large & idt will be comparable.



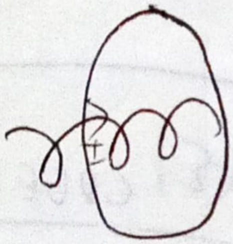
free (it can jump)

$B i l = m\frac{dv}{dt}$

$B\, dq\, l = m\, dv$

$\boxed{\frac{QBl}{m} = v}$

→



$\boxed{B \approx \frac{\mu_0 I}{2\pi r}}$

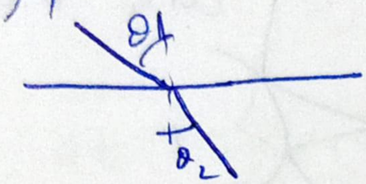
Optics

$$\boxed{\hat{r} = \hat{i} - 2(\hat{i}\cdot\hat{n})\hat{n}}$$

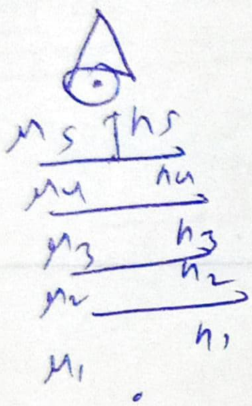
→ $i = 90$

→ Concave mirror = converging
convex mirror = diverging

Snell's law



$\mu_i \sin\theta_i =$ constant (at interface)



(for normal incidense)

$$\frac{h_{app}}{\mu_s} = \frac{h_1}{\mu_1}$$

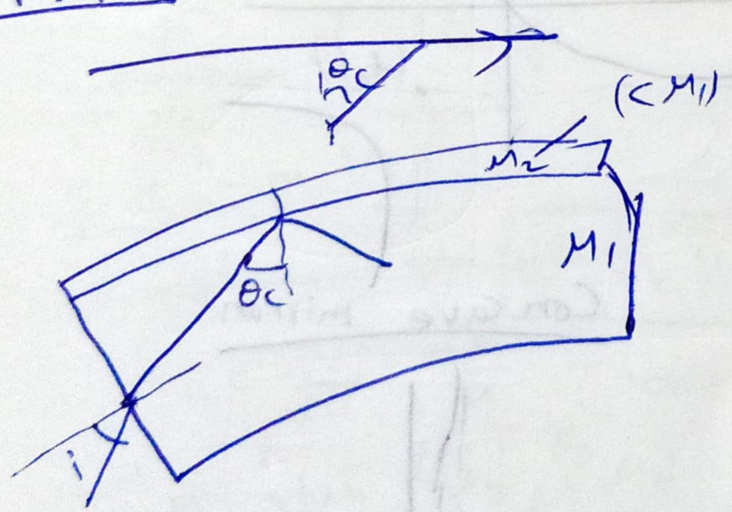
$$\boxed{S = t\left(1-\frac{1}{\mu}\right)}$$ (Normal shift)

⇒ Optical path: $l = \mu d$

⇒ frequency is constant

$$\boxed{\begin{array}{l}\mu = A + \dfrac{B}{\lambda^2} + \dfrac{C}{\lambda^4} \dots \\ \text{VIBGYOR} \\ \longrightarrow \lambda \text{ increases}\end{array}}$$

TIR

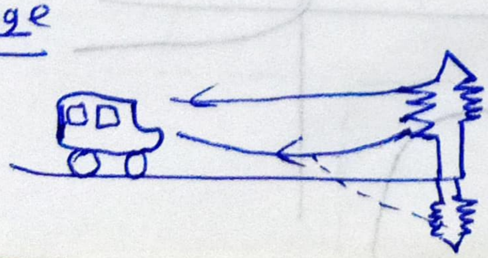


$\sin\theta_c \times \mu_1 = \mu_2$

$$\frac{\sin i}{\sin(90-\theta_c)} = \mu_1$$

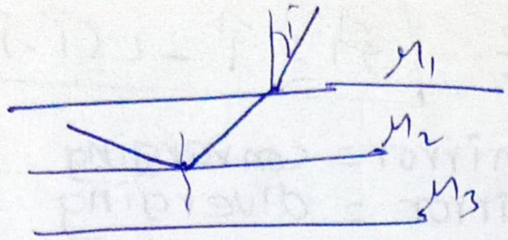
⇒ $i \le \sin^{-1}\left(\sqrt{\mu_1^2 - \mu_2^2}\right)$

Mirage

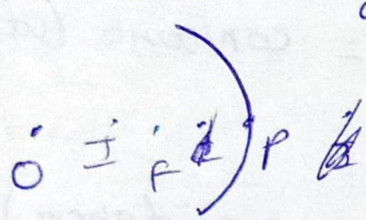


hot air → lesser optical density

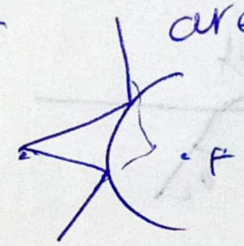
$\mu \sin i = $ cgstant



Sign Convention: 1) The direction in which ray is going is the +ve and distances are measured from pole.



μ	v	R	f
$-$	$-$	$-$	$-$



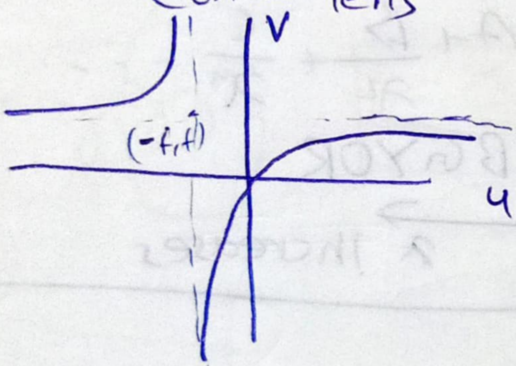
μ	v	R	F
$-$	$+$	$+$	$+$

For spherical mirrors

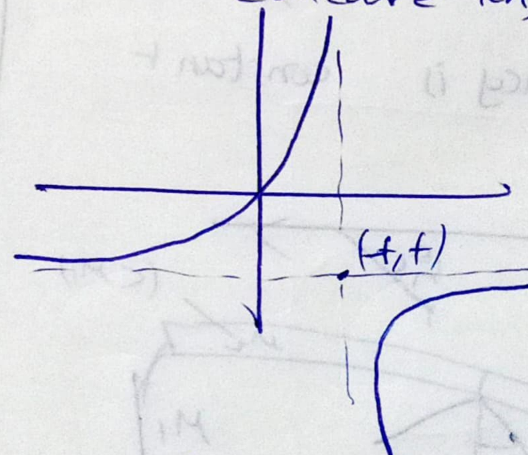
$$\frac{1}{\mu} + \frac{1}{v} = \frac{2}{R} = \frac{1}{f}$$

$\cancel{P = \frac{-1}{f}}$ $\quad \boxed{m = \frac{-v}{\mu}}$

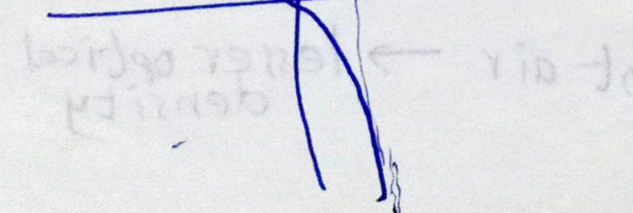
Convex lens $\quad P =$



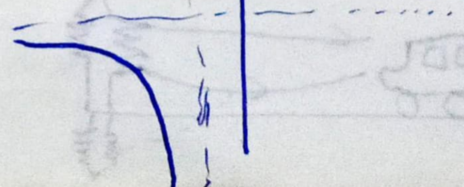
Concave lens

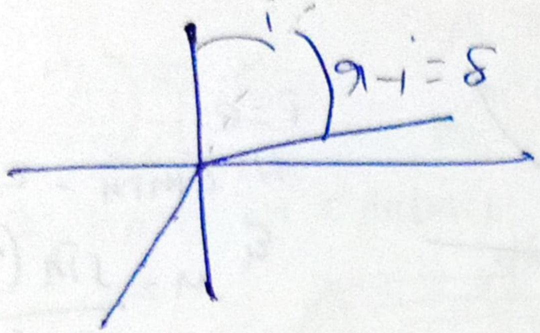


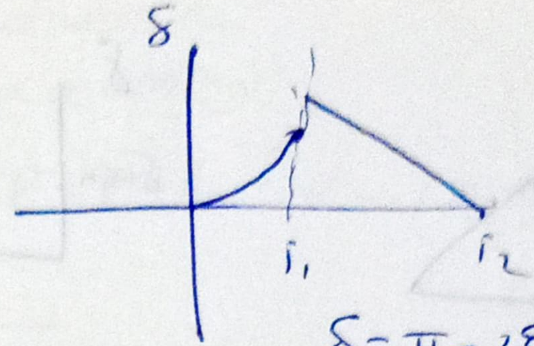
Convex mirror



Concave mirror

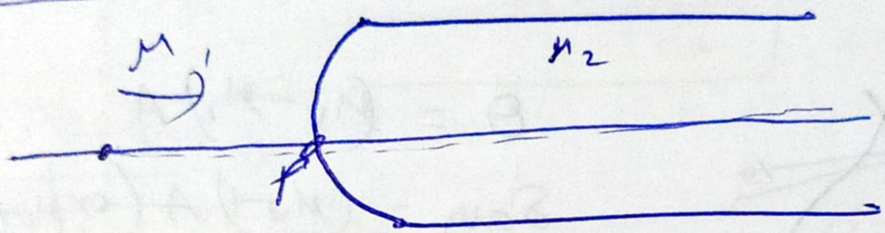






$\delta = \pi - 2\theta_c$

Refraction at spherical surface:



$(R > 0)$

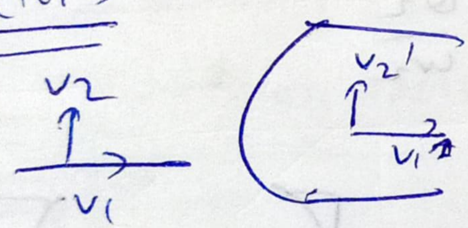
$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\boxed{m = \frac{\mu_1}{\mu_2} \times \frac{v}{u}} = \frac{h_i}{h_o}$$

$$P = \frac{\mu_2 - \mu_1}{R} = \frac{\mu_2}{f_2} = -\frac{\mu_1}{f_1}$$

Velocities

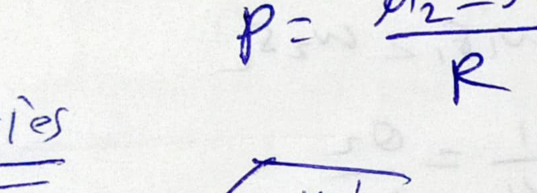
for mirrors



$V_2' = m V_2$

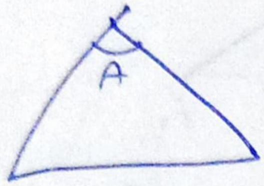
~~$V_1' = m_L V_1$~~ $\boxed{V_1' = m_L V_1}$

$m_L = \frac{dv}{du} = \frac{mv}{u}$ (longitudinal)

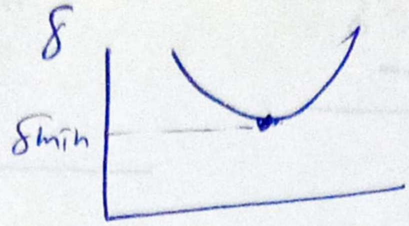


$$\frac{\mu_4}{v} - \frac{\mu_1}{u} = \frac{\mu_4 - \mu_3}{R_3} + \frac{\mu_3 - \mu_2}{R_2} + \frac{\mu_2 - \mu_1}{R_1}$$

Prism



$A = r_1 + r_2$



$i = e$

$\Rightarrow \delta_{min} = 2i - A$

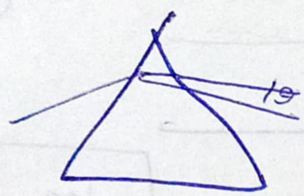
&

$\mu = \dfrac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\delta = i + e - A$

Note: $I + A > 2\theta_c \Rightarrow$ no emergent ray

Dispersion



$\theta = (\mu_v - \mu_r) A$

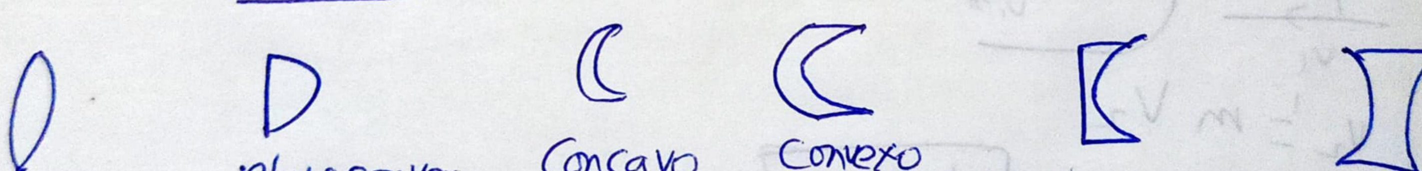
$\delta_{avg} = (\mu_y - 1) A \left(\text{or} \left(\frac{\mu_v + \mu_r}{2} - 1\right) A\right)$

$\omega = \dfrac{\theta}{\delta_{avg}} = \dfrac{\mu_v - \mu_r}{\mu_y - 1}$

Deviation without Dispersion $\Rightarrow$ $\omega_1 \delta_1 = \omega_2 \delta_2$

Dispersion " Deviation $\Rightarrow$ $\dfrac{\theta_1}{\omega_1} = \dfrac{\theta_2}{\omega_2}$

Lens



Biconvex, plano convex, Concavo convex, Convexo concave, plano concave, Biconcave.

more P

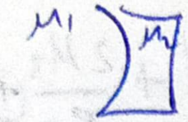
$\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f} = (\mu - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

$\boxed{m = \dfrac{v}{u}}$

$m_L = m^2 = \dfrac{dv}{du}$

$\cancel{P = \dfrac{1}{f}}$

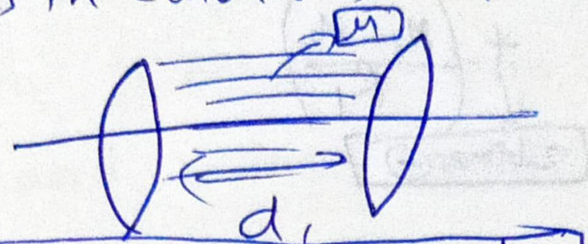
$\boxed{P = (\mu - \mu_{medium})\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)}$



$\mu_2 > \mu_1$, diverging

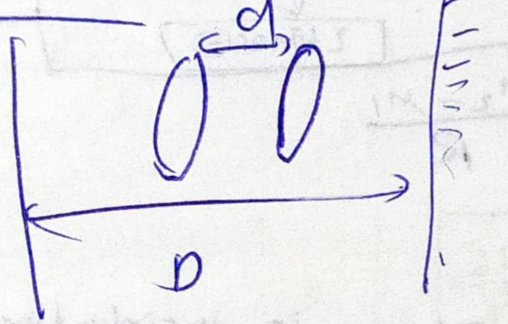
$\mu_2 < \mu_1$, converging

⇒ Thin lenses in contact ⇒ $P = P_1 + P_2$ - - - (note sometimes "2" times)



$$\boxed{\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{\frac{d}{\mu}}{f_1 f_2}}$$

L-D-Method



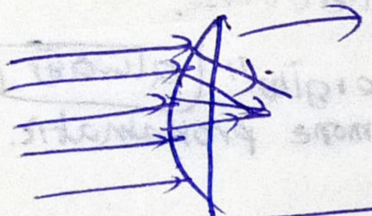
$$d = \sqrt{D(D-4f)}$$

$$D \geq 4f$$

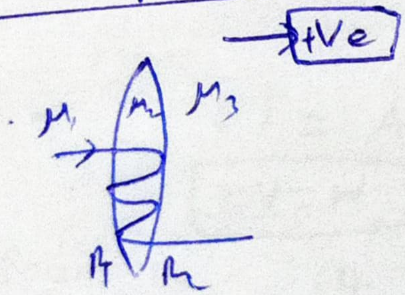
$$m = \frac{D+d}{D-d} \qquad m_1 m_2 = 1$$

$$\boxed{h_1 h_2 = h_0^2}$$

$$\boxed{f = \frac{D^2-d^2}{4D}}$$

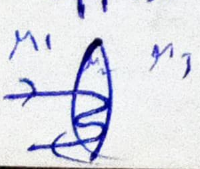


→ less abbreation.

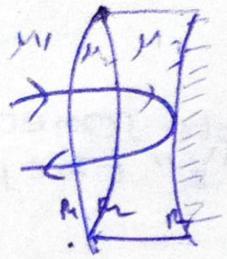


$$\frac{\mu_3}{v} - \frac{\mu_1}{u} = \frac{\mu_2-\mu_1}{R_1} - \frac{2\mu_2}{R_2} + \frac{2\mu_2}{R_1} - \frac{2\mu_2}{R_2} + \frac{2\mu_2}{R_1} + \frac{\mu_3-\mu_2}{R_2}$$

It is refraction (net) So all refractions have $\boxed{+ve}$ if they are in the same direction. If it is reflection in that direction then $\boxed{-ve}$. Opposite direction also implies $\boxed{-ve}$. 2 $\boxed{-ves}$ cancel



$$\frac{\mu_1}{v} + \frac{\mu_1}{u} = -\left(\frac{\mu_2-\mu_1}{R_1}\right) + \frac{2\mu_2}{R_2} - \frac{2\mu_2}{R_1} + \frac{2\mu_2}{R_2} + \left(\frac{\mu_1-\mu_2}{R_1}\right)$$



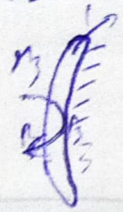
$$\frac{\mu_1}{v} + \frac{\mu_1}{u} = -\frac{(\mu_2-\mu_1)}{R_1} + -\left(\frac{\mu_3-\mu_2}{R_2}\right) + \frac{2\mu_3}{R_3} + \left(\frac{\mu_2-\mu_3}{R_2}\right)$$

2 times ⊖

$$+\left(\frac{\mu_1-\mu_2}{R_1}\right)$$

2 times ⊖

⇒ We can also consider reflection as



$$\Rightarrow \boxed{-\left(\frac{1-\mu_3}{R_3}\right) + \frac{2}{R_3} + \frac{\mu_3-1}{R_3}} = \boxed{\frac{2\mu_3}{R_3}}$$

2 times ⊖

Power of refractive surface $= \dfrac{\mu_2-\mu_1}{R}$

" mirror $= \dfrac{2\mu}{R}$

⇒ In the co-ordinate convention: If ray is incidenting in the direction of +ve convention then "+ve" power implies "converging". if ray is incidenting in the -ve direction it will reverse.

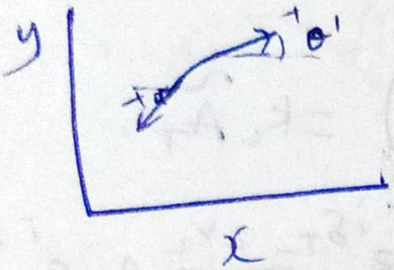
⇒ But in the usual ray conversion +ve power ⇒ "converging" $\boxed{\text{always}}$

But in this system directions of radius are more problamatic.

WAVES

$$\frac{\partial^2 f}{\partial t^2} = v^2 \frac{\partial^2 f}{\partial x^2} \qquad — (1)$$

Any function of the form $f(z,t) = g(z-vt)$ satisfies 1 and having finite amplitude is a physical wave.



$$\Delta F = T\sin\theta' - T\sin\theta$$

$$\Delta F \approx T(\tan\theta' - \tan\theta)$$

$$\approx T\left(\left(\frac{\partial y}{\partial x}\right)' - \frac{\partial y}{\partial x}\right)$$

$$\approx T\,\frac{\left(\left(\frac{\partial y}{\partial x}\right)' - \frac{\partial y}{\partial x}\right)}{\partial x} \times \partial x$$

$$\Rightarrow \boxed{\frac{\partial F}{\partial x} \approx T\,\frac{\partial^2 y}{\partial x^2}}$$

$$\frac{\partial F}{\partial x} = \mu \frac{\partial^2 y}{\partial t^2}$$

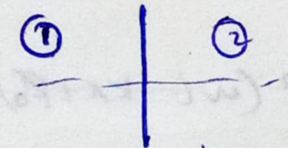
$$\Rightarrow T\frac{\partial^2 y}{\partial x^2} = \mu \frac{\partial^2 y}{\partial t^2}$$

$$\Rightarrow \boxed{T = \mu v^2}$$ (T, μ may be variables)

$$y(x,t) = A\cos(k(x-vt)+\phi_0)$$

$\boxed{kv = \omega}$ & $\boxed{k = \frac{2\pi}{\lambda}}$ $\boxed{\omega = 2\pi f}$

At Boundary



$$A_R = \left(\frac{v_2 - v_1}{v_2 + v_1}\right) A_I \qquad A_T = \frac{2v_2}{v_2 + v_1} A_I$$

$\Rightarrow$

$\cancel{y(x,t) = A_I e^{i(} A_I \cos(\omega}$

$$\tilde{f}(x,t) = \begin{cases} \tilde{A}_I e^{i(k_1 x - \omega t)} + \tilde{A}_R e^{i(-k_1 x - \omega t)} & x<0 \\ \tilde{A}_T e^{i(k_2 x - \omega t)} & x>0 \end{cases}$$

& f, $\frac{\partial f}{\partial x}$ are continous at $x=0$

If $\tilde{y}_I = \tilde{A}_I e^{i(k_1 x - \omega t)}$. $\tilde{y}_R = \tilde{A}_R e^{i(-k_1 x - \omega t)}$

$\tilde{y}_T = \tilde{A}_T e^{i(k_2 x - \omega t)}$

$\tilde{A}_I + \tilde{A}_R = \tilde{A}_T$ $\qquad k_1(\tilde{A}_I - \tilde{A}_R) = k_2 \tilde{A}_T$

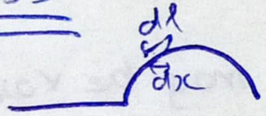
$\Rightarrow$ $A_R e^{i\delta_R} = \frac{v_2 - v_1}{v_2 + v_1} A_I e^{i\delta_0}$ $\qquad A_T e^{i\delta_T} = \frac{2v_2}{v_2 + v_1} A_I e^{i\delta_0}$

$\Rightarrow$ If reflection is inside lighter | otherwise

$\delta_0 = \delta_T = \delta_R + \pi$ | $\delta_0 = \delta_T = \delta_R$

$\Rightarrow$ $\boxed{A_R \cos\delta_R = \frac{v_2 - v_1}{v_2 + v_1} A_I \cos\delta_0}$ $\qquad \boxed{A_T \cos\delta_T = \frac{2v_2}{v_1 + v_2} A_I \cos(\delta_0)}$

Energy



$d(P) = T\, d(e) = T(dl - dx) = T dx\left(\sqrt{1+\left(\frac{\partial y}{\partial x}\right)^2} - 1\right)$

$\cong \frac{1}{2} T \left(\frac{\partial y}{\partial x}\right)^2 dx$

$\frac{d(K)}{\partial x} = \frac{1}{2}\mu\left(\frac{\partial y}{\partial t}\right)^2$

$\Rightarrow \frac{dT}{dl} = \mu\left(\frac{\partial y}{\partial t}\right)^2$

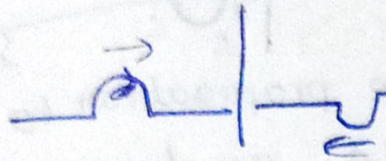
$\frac{dT}{d\lambda}$ or $\frac{dE}{d\lambda} = \cancel{\frac{1}{2}}\, T A^2 k^2 \cos^2(\omega t - kx + \phi_0)$

$\left(\frac{dT}{d\lambda}\right)_{avg} = \frac{1}{2} T A^2 k^2$

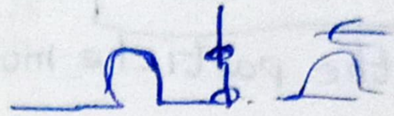
$P = \left(-F \frac{\partial y}{\partial x}\right) \frac{\partial y}{\partial t}$ $\qquad \langle P_{avg} \rangle = \frac{1}{2} \frac{w^2 A^2 F}{V}$

Wave front $\longrightarrow$ locus of points with same "ϕ"

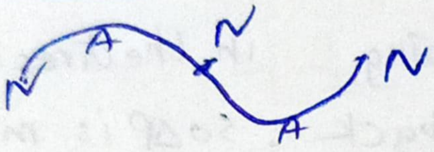
fixed boudary



free boundary



Standing wave



$y = 2A \cos kx \sin wt$

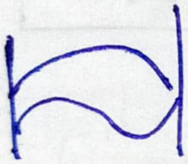
$\frac{\partial P}{\partial x} = \frac{1}{2} T \left(\frac{\partial y}{\partial x}\right)^2$

$= \frac{1}{2} T \left(2A k \cos kx \cos(wt+\phi)\right)^2$

$P.E = \frac{T}{2} \times (2A \cos kx)^2 \int_0^{\pi} \cos^2(wt+\phi)\, d\theta \quad \left(\text{for } \frac{\lambda}{2}\right) =$

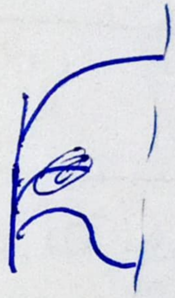
$= \pi \rho S A^2 v^2 k \cos^2(wt+\phi)$

$K.E = \pi \rho S A^2 v^2 k \sin^2(wt+\phi) \quad \left(\text{for } \frac{\lambda}{2}\right)$



$f_n = n\left(\frac{v}{2L}\right)$

nth harmory
or
$(n-1)$th overtone.



$f_{2n+1} = \frac{(2n+1)v}{4L}$

$(2n+1)$th harmony

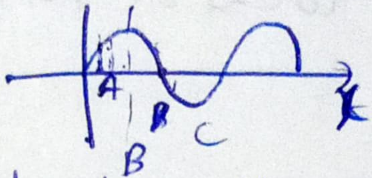
nth overtone.

→ We can remember the fixed boundary reflection case if we got confused about the direction of the reflected wave.

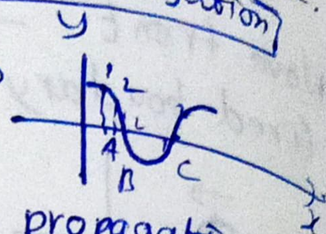
Sound waves

→ On surface of water transverse waves can propagate.

→ $$\boxed{\Delta P = -B\frac{\partial y}{\partial x}}$$



⇒



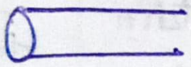
→ At x_{A_1} the particle moved along the wave propagation to a small distance y_{A_1}. y_{A_2} is less than y_{A_1} so due to compression $\boxed{\Delta P_A > 0}$

→ At x_{B_1} the particle is going in the direction of wave at x_{B_2} it is coming back. so ΔP is maxm. (compression)

→ At x_{C_1} the particle the particle is going against the wave. x_{C_2} it is going along it. ⇒ expansion ⇒ minimum (rarefraction)

Velocity

$$\boxed{\Delta P_0 = BkA}$$



For gases

$$V = \sqrt{\frac{B}{\rho}}$$

$$F = YA\frac{\partial y}{\partial x}$$

$$\frac{\partial F}{\partial x} = YA\left(\frac{\partial^2 y}{\partial x^2}\right)$$

$$\Rightarrow \rho A\frac{\partial^2 y}{\partial t^2} = YA\left(\frac{\partial^2 y}{\partial x^2}\right)$$

$$\boxed{V = \sqrt{\frac{Y}{\rho}}}$$

Newton's formula (Isothermal)

$$V = \sqrt{\frac{P}{\rho}} = \sqrt{\frac{RT}{M}}$$

Laplace's formula (Adiabatic)

$$V = \sqrt{\frac{\gamma RT}{M}} = \sqrt{\frac{\gamma P}{\rho}}$$

Energy

$$\frac{dE}{S\,\partial x} = \frac{1}{2}B\left(\frac{\partial y}{\partial x}\right)^2$$

$$\frac{\partial E}{\partial x} = \frac{BS}{2}\left(\frac{\partial y}{\partial x}\right)^2$$

$$\frac{dK}{dx} = \frac{1}{2}\rho S\left(\frac{\partial y}{\partial t}\right)^2$$

$$\frac{dT}{dx} = \frac{\Delta P_0^2}{B} \times S\cos^2(\omega t - kx)$$

$$\boxed{\text{Power} = (\Delta P S)\frac{\partial y}{\partial t}} = \frac{S\omega^2 A^2 B}{V}\cos^2\omega\left(t - \frac{x}{v}\right)$$

$$\boxed{\Delta P_0 = BkA}$$

$$\langle P \rangle = \cancel{\frac{1}{2}\frac{A\omega^2 S_0^2 B}{V}} =$$

$$= \cancel{\frac{\Delta P_0}{2Bk}\omega^2 S_0}$$

$$\langle P \rangle = \frac{1}{2}\frac{S\omega^2 A^2 B}{V} = \frac{\Delta P_0^2}{2B^2k^2} \times \frac{S\omega^2 B}{V}$$

$$= \frac{1\Delta P_0^2 S V}{2B}$$

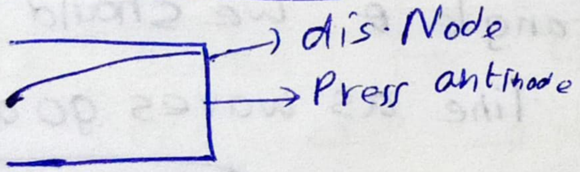
$$\langle P \rangle = \frac{\Delta P_0^2 V S}{2B}$$

$$\boxed{\langle I \rangle = \frac{\langle P \rangle}{S} = \frac{\Delta P_0^2 V}{2B}}$$

→ Amplitudes & phase angles together follow vector's addition. (Phasors)

Decibels $\beta = 10 \log\left(\frac{I}{I_0}\right)$ $\boxed{I_0 \approx 10^{-12}\frac{W}{m^2}}$

Closed organ pipe (like resonance tube method)

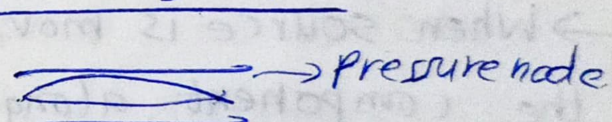


$$f = \frac{(2n+1)V}{4L}$$

$(2n+1)$th harmony $\forall\, n \geq 0$

nth overtone. $\forall\, n \geq 1$

Open organ pipe



$$f = n\left(\frac{V}{2L}\right)$$

nth harmony $\forall\, n \geq 1$

$(n-1)$th overtone. $\forall\, n \geq 2$

⇒ End correction $= 0.6r$ (both sides should be taken.)

Beats

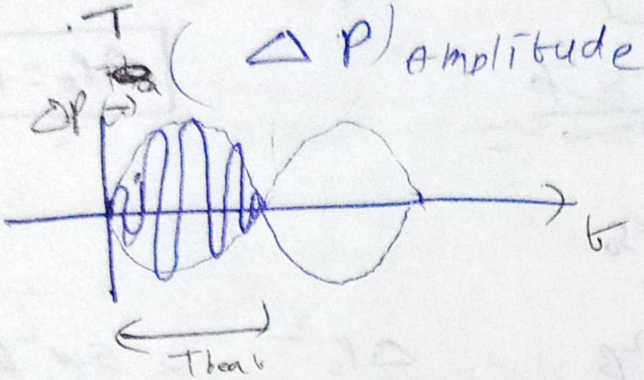
$$\Delta\phi = (\omega_2 - \omega_1)t$$

$$\omega_{beat} = \omega_2 - \omega_1$$

$$\Delta P = \Delta P_0 \sin(\omega_1 t + \phi_1) + \Delta P_0 \sin(\omega_2 t + \phi_2)$$

$$= 2\Delta P_0 \cos\left(\left(\frac{\omega_1 - \omega_2}{2}\right)t\right) \sin(\omega t + \phi_0)$$

$$(\Delta P)_{amplitude} = 2\Delta P_0 \cos\left(\left(\frac{\omega_1 - \omega_2}{2}\right)t\right)$$

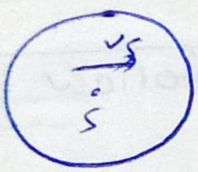


$$T_{beat} = \frac{T'}{2} = \frac{2\pi \times 2}{\omega_{beat} \times 2}$$

$$\boxed{T_{beat} = \frac{2\pi}{\omega_{beat}}}$$

Doppler effect (All velocities are w.r.t medium)

⇒ A train moving away (receeding) ⇒ $f\downarrow$



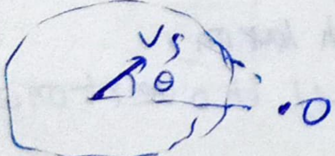
$$\boxed{f' = \frac{v}{v - v_s} f_0}$$

$$\lambda_{app} = \lambda - v_s T$$
$$= \left(\frac{v - v_s}{v}\right)\lambda$$

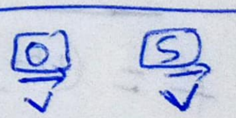
$$\boxed{f' = f_0 \frac{(v + v_0)}{v}}$$

$$\boxed{\lambda_{app} = \lambda}$$

→ When source is moving at angle θ we should take the component along their line as waves go at straight lines.



$$\lambda_{app} = \frac{(v - v_s\cos\theta)\lambda}{v}$$



→ $\overset{v_s}{\rightarrow}$ s $\overset{v_0}{\leftarrow}$ o

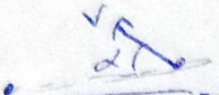
$$\boxed{f' = f_0 \frac{(v + v_0)}{v - v_s}}$$

or Sign convention
direction from observer to source is +ve.

v_o → v_s →

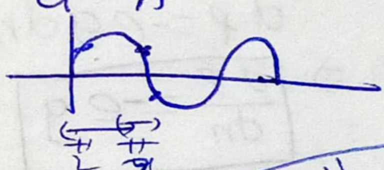
$$f' = \frac{f_0 (V + V_o)}{(V + V_s)}$$

For light $\quad \vartheta = \frac{\vartheta_0 \sqrt{1-\beta^2}}{1-\beta\cos\alpha}$ (when source is moving or observer is moving or any thing)



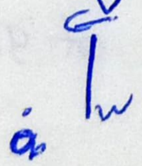
$\boxed{\text{relative velocity}}$

→ Wavelength is only changed due to source's motion
→ Human's can hear it $20\,Hz \le \vartheta \le 20\times10^3\,Hz$
→ Sound waves donot reflect like normal waves.
They donot reflect with "π phase difference".
i.e compression is reflected as compression.
and raretraction is reflected as raretraction.
→ If it is given that for a standing every after a distance d "A" is same.
⇒ $\boxed{d = \frac{\lambda}{4}}$



→ In sound for y → "π phase" is applicable
but for ΔP → "no" π phase difference.

→ While calculating intensity by phasor diagrams we should add only pressures to get intensity.

→  no. of waves hitting wall per sec = f_w (not to obs.)

→ At open surfaces $(\Delta P_0)_{net} = 0$ reflected wave & incident wave are in out of phase

Fluids

Statics

→ Fluid is incompressible and non-viscous

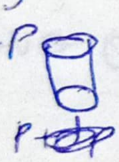
Pressure: at a point is defined as the component of force per unit area parallel to the area vector

$P = \lim_{A \to 0} \frac{F_{\parallel}}{A}$ or $\boxed{d\vec{F}_{\parallel} = P d\vec{A}}$

→ Two points in a fluid are said to be connected if it is possible to find a continous path from one point to the other.

For simple liquids

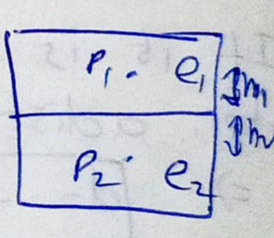
1) Since height's are small gravity is constant practically.
2) density is also a constants as we consider only incompressible.



$(P+dP)A - PA = \rho A dh g$

$dP = -\rho g dh$

$\Rightarrow \boxed{\frac{dP}{dh} = -\rho g}$



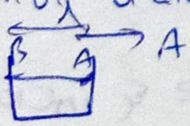
$\boxed{P_2 - P_1 = \rho_1 g h_1 + \rho_2 g h_2}$

Pascal's

If the pressure is applied at a point it is transmitted to all the points without diminishing in magnitude

Variation of P in an accelerated container

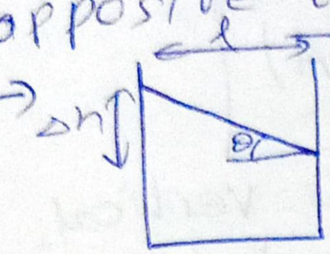
→ Pressure decreases in the direction of gravity and acceleration



$\boxed{P_B = P_A + \rho a l}$

→ In ground frame it has high pressure due to its pushing nature in the acleration direction.

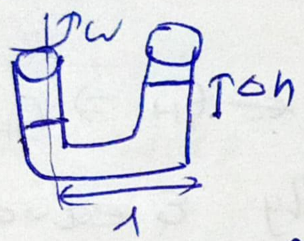
→ In C.O.M frame of liquid it is due to the pseudo force which pulls the liquid in the direction opposite to accleration.

→ 

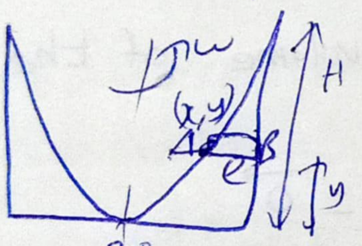
$$\frac{\Delta h}{l} = \tan\theta = \frac{a}{g}$$

∴ liquid surface will be ~~par ⊥lar~~ ||lel to area vector effective accleration. (Including gravity)

→ If we move ⊥lar to direction of effective a p will not change.

→ 

$$\boxed{\Delta h = \frac{l^2\omega^2}{2g}}$$

→ 

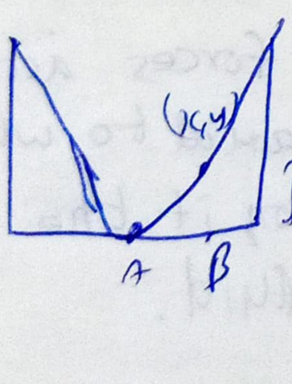
Method 1

$$\rho g(H-y)\times A = \rho A\,(R-x)\left(\frac{R+x}{2}\right)$$

$$\Rightarrow \quad y = \frac{x^2\omega^2}{2g} + H - \frac{R^2\omega^2}{2g}$$

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

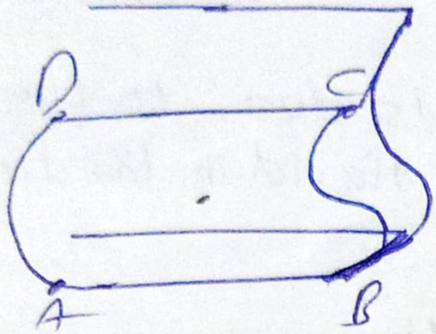
Method 2



$$P_B - P_A = \rho g y$$

$$\int_0^x \rho x\omega^2 dx = \rho g y \quad \Rightarrow \quad \boxed{y = \frac{x^2\omega^2}{2g}}$$

Force due to fluid on a vertical face of any shape



$$y_{cm} = \frac{\int y(l\,dy)}{\int l\,dy}$$

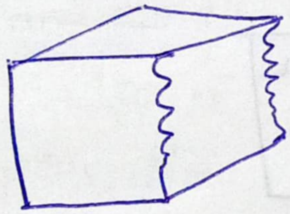
$$\int dF = \rho g \int y\, l\, dy$$

$$\boxed{F = \rho g\, y_{cm}\,(A)}$$

→ When ρ is constant and the surface is vertical.

→ Even if accleration is varied in multiple directions we should take y as effective direction of accleration.

→ For a complex surface.

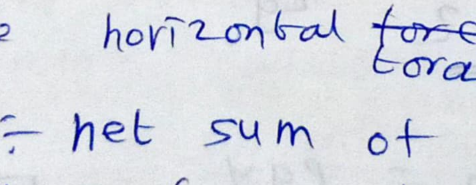


F-B-D of wate

$F_{1H} \rightarrow \quad \leftarrow F_{1H} \Rightarrow F_{1H} = F_{2H} =$ Parallel eq

→ We can also write F·B·D vertically & equate net force ~~$\vec{F}$~~ $= 0$ if we know the volume of the element.

⇒ Note :

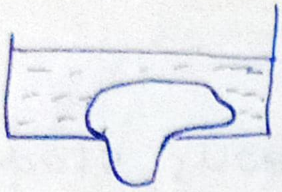


$\tau_{net} = \vec{0}$

because all forces are radial. (It is not needed to calucualate horizontal ~~force~~ torque & verital torque separately

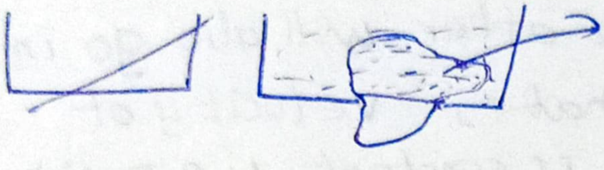
Broyant force :- net sum of pressure forces acting on the body from all sides. It is equal to wt of displaced liquid in upward direction if the body is surrounded by connected fluid.

Ex:

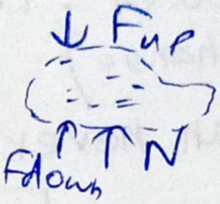


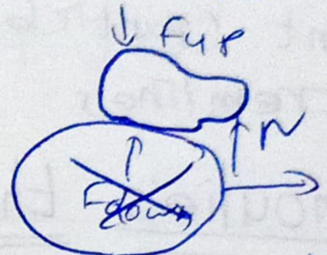
$\rightarrow F \neq$ wt displaced.

→ It we cut like this & fill with water



This water will be in equilibrium and net force on this due to water is its volume



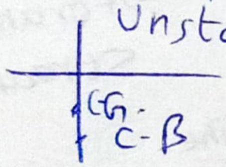


→ So these 2 are not identical

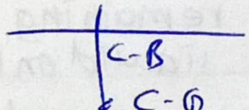
→ Rotational properties

→ The ~~bou~~ buoyant force acts at the C.O.M of the displaced fluid

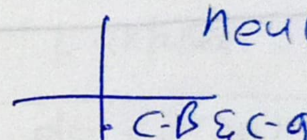
→ Unstable



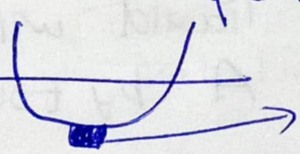
stable



neutral



→ In ships

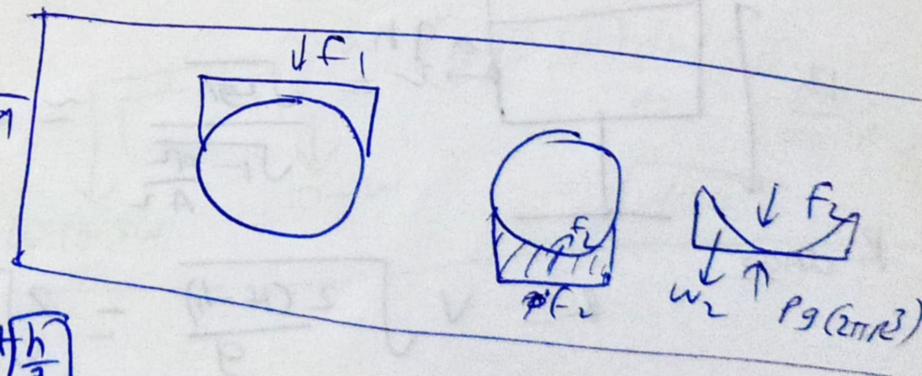


→ High wt

→ Buoyance due $\bar{a}$ will be on same side of the acceleration

Ex:

$\rightarrow \bar{a}$



→

→ Tourque will act at $\boxed{\frac{h}{3}}$

Fluid Dynamics

→ Incompressible, non viscous, homogeneous, stedy and streamline flow.

→ Streamline: The path followed by a particle

→ Any particle coming there after will also go in ~~a simi~~ the same path. That is velocity of a point (particle will change) is constant W.R.T time.

→ 2 stremlines can never intersect.

→ **Bernoulie's theorem**: $\boxed{P + \rho g h + \frac{1}{2}\rho v^2 = \text{constant}}$

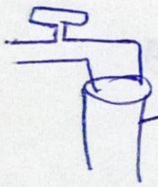
Work done by the remaining liquid on this streamline.

P.E per unit volume

K.E "

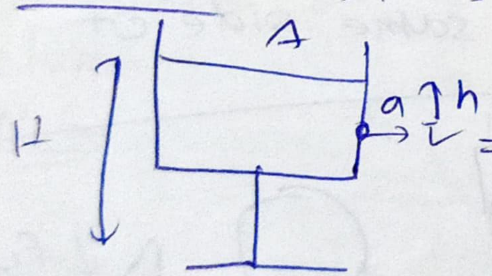
for any given streamline.

$\boxed{AV = \text{constant}}$ is the continuity eqn

⇒ 

→ Pipe ⇒ for pipe liquid will come with uniform A by touching.

⇒ Efflux ~~assuming very small hole~~



$$v = \frac{\sqrt{2gh}}{\sqrt{1-\frac{a^2}{A^2}}} \simeq \sqrt{2gh} \quad (a \ll A)$$

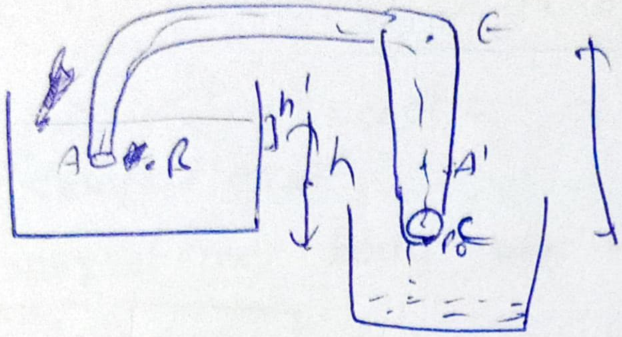
(Toricelli's theorem)

Range

$$R = v\sqrt{\frac{2(H-h)}{g}} = 2\sqrt{\frac{h(H-h)}{1-\frac{a^2}{A^2}}} \Rightarrow R' = R \text{ if } h' = H-h$$

⇒ The top layer has constant acceleration of $\frac{a^2 g}{A^2 - a^2}$

Siphon



$h-h'$

$P_C = P_0 - \rho g H$

$\Rightarrow H \le \frac{P_{atm}}{\rho g}$

$P_C = P_0 \Rightarrow P_A + \frac{1}{2}\rho v^2 = P_B$

$V = \sqrt{2gh}$

$P_A = P_{atm} - \rho g (h-h')$

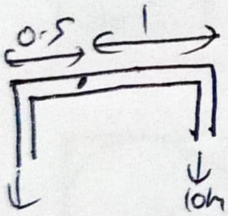
$P_B = P_{atm} + \rho g h'$

Renold's number $= \frac{\rho v d}{\eta}$

< 1000 laminar

$1000 <$ 2000 unsteady

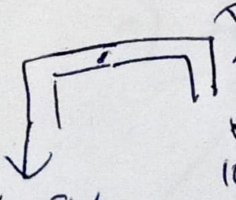
> 2000 turbulent



10m/s (relative to tube) (relative to tube)

Then we can do either in rotation frame ((Coriolis force will act)
or
Ground frame.

In ground frame



$(10+0.5\omega)\frac{dm}{dt}(0.5) = \frac{dm}{dt}(10-\omega)\times 1$

$\Rightarrow \boxed{\omega = 4}$

C.O.M & Collisions

→ If net force acts at C.O.M then it would be purely translational.

→ In translation body can be replaced by C.O.M.

$$\boxed{\vec{r}_{C.O.M} = \frac{\Sigma m_i \vec{r}_i}{\Sigma m_i}}$$

⇓

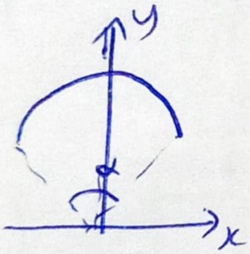
$$x_{cm} = \frac{\Sigma m_i x_i}{\Sigma m_i}$$

$$y_{cm} = \frac{\Sigma m_i y_i}{\Sigma m_i}$$

for continous distribution

$$\vec{r}_{C.O.M} = \frac{\int \vec{r}\, dm}{\int dm}$$

1) For an arc

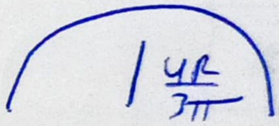


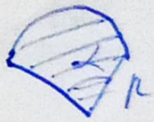
$$y_{cm} = \frac{R \sin\frac{\alpha}{2}}{\frac{\alpha}{2}}$$

2) For Semi ~~circle~~ Ring

$$\boxed{y_{cm} = \frac{2R}{\pi}}$$

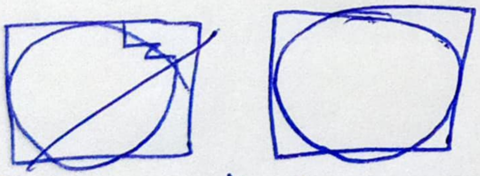
3) For ~~So hollo hemisphere~~ Semi disk



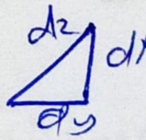


$$\frac{2R}{3}\frac{\sin\frac{\alpha}{2}}{\frac{\alpha}{2}}$$

⇒



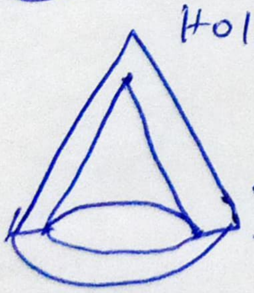
$\pi \neq 4$



~~$dz \neq dx$~~

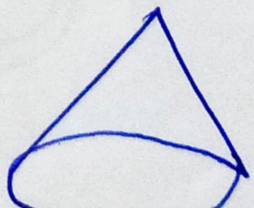
~~$dz \neq dy$~~

⇒ 4) Hollow cone



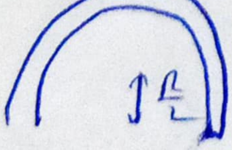
$\uparrow \frac{H}{3}$

5) Solid cone



$\uparrow \frac{H}{4}$

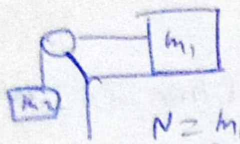
6) Hollow hemisphere



7) Solid Hemisphere

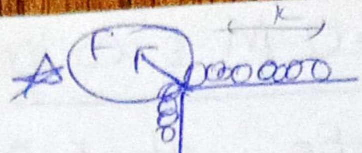
$\updownarrow \frac{3R}{8}$

$\boxed{\text{elastic} = \text{perfectly elastic}}$ $\boxed{\text{inelastic} \neq \text{perfectly inelastic}}$



$N = m_1 g$

$\neq (m_1 + m_2) g$



$N = \frac{x}{l} mg$

$\neq mg$

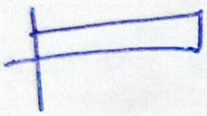
These 2 cases are analogous

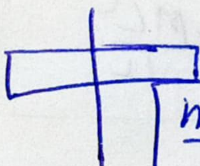
Rotation $\boxed{d\vec{\theta} = \text{vector}}$ $\theta = \text{scalar}$

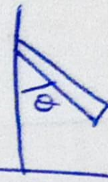
→ If orientation of a body w.r.t. a frame is not changing it is said to be in translatory motion in that frame. (In this frame it can be replaced by c-o-m)

→ Torque of a force about a given axis is the component of the torque along the axis about any point on the axis.

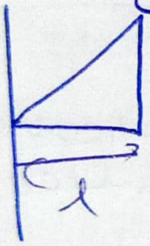
→ $I = \int dm\, r^2$

①  $\boxed{\dfrac{ml^2}{3}}$

②  $\boxed{\dfrac{ml^2}{12}}$

③  $\boxed{\dfrac{ml^2}{3}\sin^2\theta}$

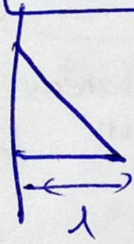
$\boxed{4}$ $\boxed{\approx x = kx}$



l

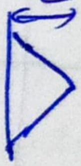
$\boxed{I = \dfrac{ml^2}{\cancel{\ }}}$ → $\boxed{2}$

$\boxed{5}$ $\boxed{\approx x = k(L-x)}$



l

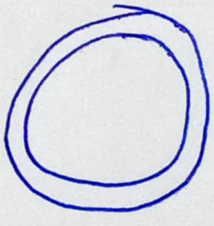
$\boxed{\dfrac{Ml^2}{6}}$

$\boxed{6}$ 

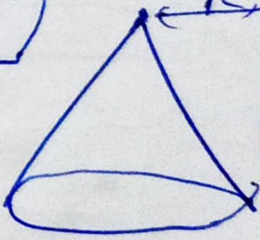
L

$\boxed{\dfrac{ML^2}{6}}$

$\boxed{7}$  $\dfrac{MR^2}{2}$

$\boxed{8}$  MR^2

$\boxed{9}$ hollow

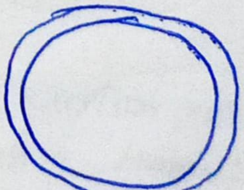


R

$\boxed{\dfrac{MR^2}{2}}$

$\boxed{10}$ $\boxed{\text{Solid}}$

$\boxed{\dfrac{3}{10}MR^2}$

⑪ 

$\boxed{\dfrac{2}{3}Mr^2}$

$\boxed{12}$ 

$\boxed{\dfrac{2}{5}Mr^2}$

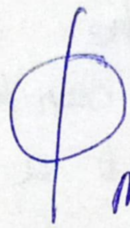
→ **Parallel axis Theorem** $I = I_{cm} + Md^2$

→ **Perpendicular axis theorem** $I_z = I_x + I_y$ (for $\boxed{\text{planar}}$ bodies only)

13

$\frac{Ma^2}{6}$

14



Ring

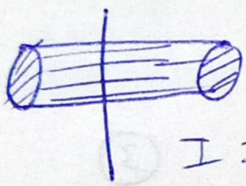
$\frac{MR^2}{2}$

15

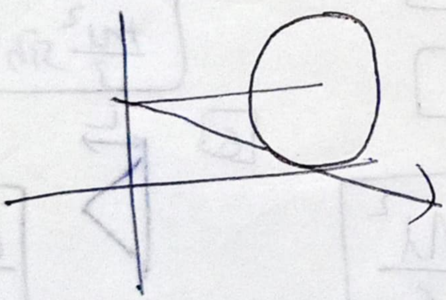
Disk

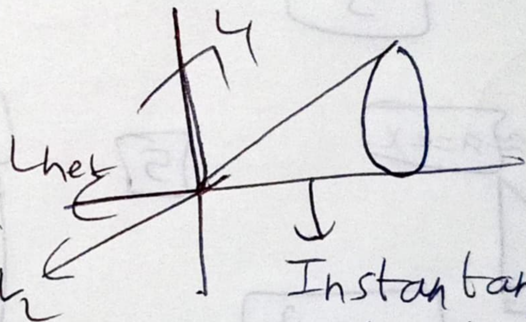
$\frac{MR^2}{4}$

16



$I = \frac{MR^2}{4} + \frac{ML^2}{12}$





(not square)

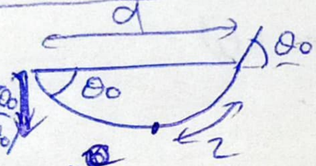
Newton's laws

1) Law of inertia : Without external force momentum is not changed

2) Law II $\dfrac{d\vec{p}}{dt} = \vec{F}_{ext}$ (Conservation law's are more general than Newton's laws)

3) Law III $\boxed{\vec{F}_{12} + \vec{F}_{21} = 0} \Leftarrow$ forces are of same nature

→ Pseudo force ; It is just added in Non-inertial frames to get correct equations

→ 

$h = \frac{l}{2}\left(\frac{1-\cos\theta_0}{\sin\theta_0}\right)$

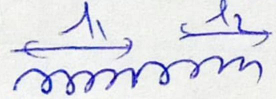
$= \frac{l}{2}\left(\tan\frac{\theta_0}{2}\right)$

$T = \frac{mg}{2}\,\frac{\cot\theta_0}{\cos\theta}$

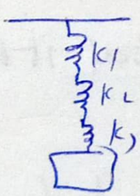
$z = \frac{l}{2}\,\frac{\cot\theta_0}{\cot\theta}$

$d = l\cot\theta_0 \log(\sec\theta_0 + \tan\theta_0)$

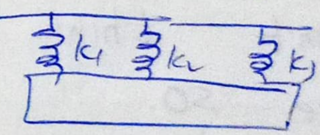
→ Hooke's law $F = kx$ (Ideal spring without mass)

→ 

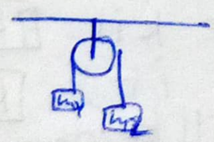
$k_1 = k \times \frac{l_1 + l_2}{l_1}$ $k_2 = k\left(\frac{l_1+l_2}{l_2}\right)$

→ 

$\Rightarrow \frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3}$



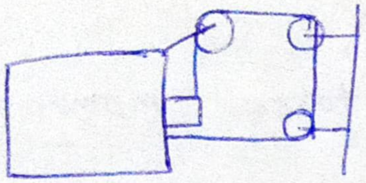
$k = k_1 + k_2 + k_3$

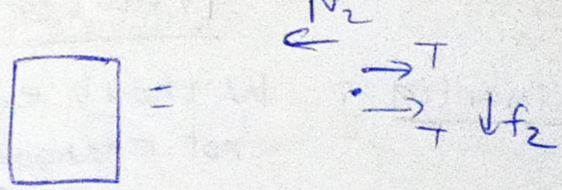
→ 

→ If $a_1 \neq a_2$ the string can only contracts (slags)

→ Power delivered & Work done by Tension is always zero (In any reference frame)

→ $\Sigma \vec{T}\cdot\vec{a} = \vec{0}$ only when bodies are not moving initially. If their initial velocities are not along the thread then $\boxed{\Sigma \vec{T}\cdot\vec{a} \neq \vec{0}}$

→ 

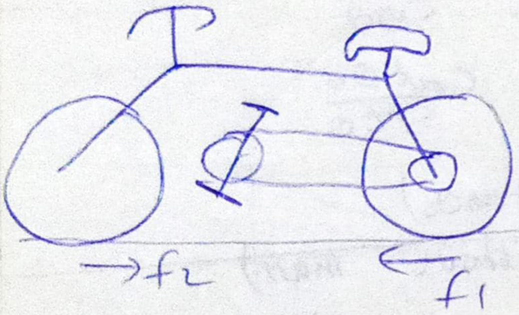


don't forget N_2 & f_2 which will act on them.

→ If 2 bodies are moving in contact. Then accleration along normal is same (i-e relative velocity is only along tangential direction)

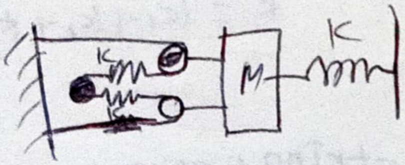
⇒ <u>Friction</u>: $f \le \mu_s N$

$f = \mu_k N$ (for moving points)



→ Find minimum friction to move 

Don't think force is always horizontal it need to be so.

→ 

If it is displaced towards right effective k is $\boxed{9k}$ but left ward it is $\boxed{k}$ (string will become slag)

$$\left(T = \frac{1}{2}\times 2\pi\sqrt{\frac{m}{9k}} + \frac{1}{2}\times 2\pi\sqrt{\frac{m}{k}}\right)$$

$$mw' = F - mW_0 + mew^2 + 2m[v'w] - m[\beta r]$$

→ Radius of curvature $= \dfrac{v^2}{a_\perp} = \dfrac{\left(1+\left(\dfrac{dy}{dx}\right)^2\right)^{\frac{3}{2}}}{\dfrac{d^2y}{dx^2}}$

$$= \frac{v^2}{\dfrac{v_y a_x - a_y v_x}{v}}$$

$$= \boxed{\frac{v^2}{a_\perp}}$$

Kinematics & Projectiles

→

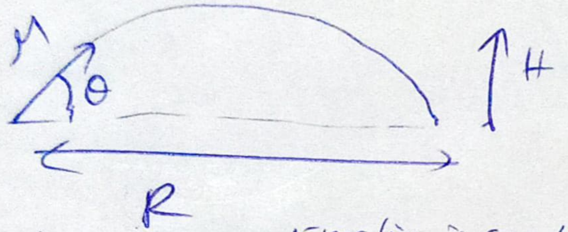
OPM $\quad T_f = \frac{2u}{g} \quad H = \frac{u^2}{2g}$

→ $\boxed{S = ut + \frac{1}{2}at^2}$ $\boxed{v = u + at}$

$$\boxed{\begin{aligned} S_n &= s(n) - s(n-1) \\ &= u + \tfrac{1}{2}a(2n-1) \\ &= u + a\left(n - \tfrac{1}{2}\right) \end{aligned}}$$

$\boxed{v^2 - u^2 = 2\vec{a}\cdot\vec{s}}$

→ Projectiles



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

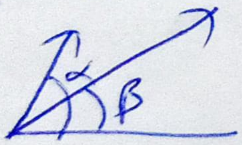
$$\boxed{\begin{aligned} T_f &= \frac{2u\sin\theta}{g} \\ H &= \frac{u^2\sin^2\theta}{2g} \\ R &= \frac{u^2\sin 2\theta}{g} \end{aligned}}$$

⇒ Velocity in x-direction is constant.

$$\boxed{y = x\tan\theta\left(1 - \frac{x}{R}\right)}$$

Projectiles on inclined plane.

a) Up the incline



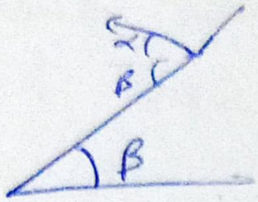
$$T_f = \frac{2u\sin(\alpha-\beta)}{g\cos\beta}$$

$$R = \frac{2u^2\cos\alpha\sin(\alpha-\beta)}{g\cos^2\beta}$$

$$= \frac{u^2}{g}\left[\frac{\sin(2\alpha-\beta) - \sin\beta}{\cos^2\beta}\right]$$

$$\boxed{R_{max} = \frac{u^2}{g(1+\sin\beta)}}$$

b) Down the incline



$$T = \frac{2u\sin(\alpha+\beta)}{g\cos\beta}$$

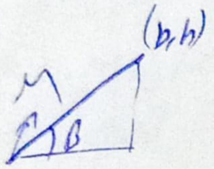
$$R = \frac{2u^2\sin(\alpha+\beta)\cos\alpha}{g\cos^2\beta}$$

$$= \frac{u^2}{g\cos^2\beta}\left[\sin(2\alpha+\beta)+\sin\beta\right]$$

$$R_{max} = \frac{u^2}{g\cos^2\beta}(1+\sin\beta) = \frac{u^2}{g(1-\sin\beta)}$$

⇒ Example

Find min u to hit (b,h)



$$\tan\beta = \frac{h}{b} \qquad \frac{b}{\cos\beta} = \frac{u^2}{g(1+\sin\beta)}$$

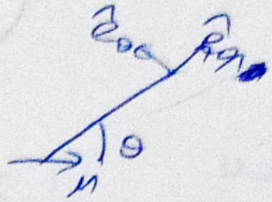
→ for u_{min} max range is (b,h) $\qquad u_{min} = \sqrt{g\left(\sqrt{b^2+h^2}+h\right)}$

→ for $v > u_{min}$ max range $> (b,h)$ ⇒ b,h is possible for some θ.

→ but for $v < u_{min}$ $\quad R_{max} < \frac{b}{\cos\beta}$ ⇒ for any θ it will not hit

Magnetism & matter (Not for adv)

→ Two bar magnets attract or repel due to the force which is caused by $\frac{\mu dB}{dl}$



→ $\vec{B} = 2 \to \frac{\mu_0}{4\pi} \times \frac{M\cos\theta}{r^3}\hat{e}_r + \frac{\mu_0}{4\pi} \times \frac{M\sin\theta}{r^3}\hat{e}_\theta$

→ Magnetic meridian = Plane containg the point & N & S Poles

→ $U = -\vec{\mu}\cdot\vec{B}$ $\quad \vec{\tau} = \vec{\mu}\times\vec{B}$

→ If $\mu \neq 0$ then N & S poles exist.

→ $\oint \phi_B = 0 \Rightarrow \oint \vec{B}\cdot d\vec{s} = 0$

→ For a bar magnet there is no torque acting on it due to its own field.

→ Decliniation : Angle bwn Magnetic & geographic meridian

→ dip or inclination ; In the magnetic meridian

$$\tan I = \frac{B_V}{B_H}$$

→ In a plane making θ with magnetic meridian

$$\tan I_2 = \frac{B_V}{B_H\cos\theta}$$

$$\boxed{\tan I = \frac{\tan\theta}{2}}$$

θ = latitude

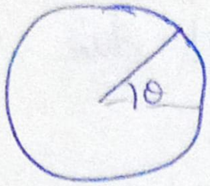
→ $\vec{M} = \lim_{V\to 0}\frac{m_{net}}{V}$ (magnetisation)

→ $H = \frac{B}{\mu_0} - M$ (Magnetic Intensity) or (magnetic field strength)

→ B = Magnetic field or Magnetic Induction or Magnetic flux density

$$B = \mu_0(H+M) = \mu_0(1+\chi)H = \mu H$$

χ = Magnetic suspectability

→ 

$\tan I = 2\tan\theta$

θ = latitude.

→ Dia | Para | Ferro

$-1 \le \chi < 0$ | $1 >> \chi > 0$ | $\chi >> 1$

$0 \le \mu_r < 1$

$\mu < \mu_0$ | $\mu > 1$ | $\mu >> 1$

→ Diamagnetic substances move from stronger to the weaker part of the external magnetic field. (the tendency is weak)

→ Meissner effet : superconductor show perfect diamagnetism

→ $M = C\frac{B_0}{T} \Rightarrow \chi = \frac{C}{T}\frac{B_0}{(H)}$ $B_0 = \mu_0 H$

$$\boxed{\chi = \frac{C\mu_0}{T}}$$ (curie's law) (for paramagnetic material)

→ If T is decreased χ will increase upto some value & then it will saturate. Beyond that curie's law is no longer valid.

→ Typical domain (ferromagnetism) is 1mm & it contains 10^{11} atoms.

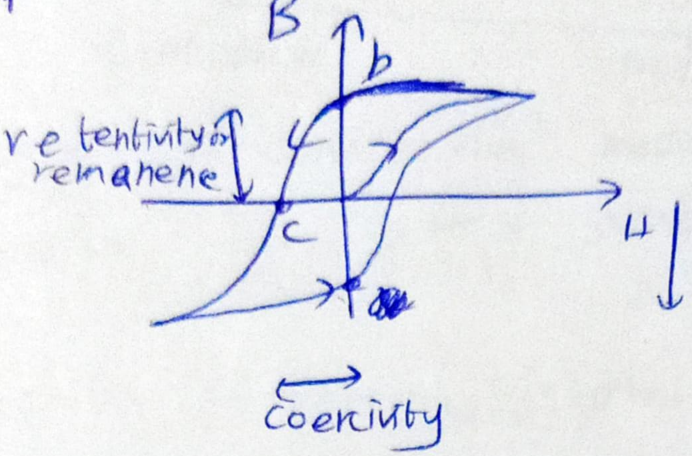
→ $\mu_r > 1000$ for ferromagnetic materials.

→ At high temperature Ferro → Para

→ Curie temperation : The temperature of transition from ferro to paramagtism

$$\chi = \frac{C}{T - T_c} \quad (T > T_c) \quad (\text{for paramagnetic})$$

→ The relation btwn $\vec{B}$ & $\vec{H}$ in ferromagnetic material is complex and depends on the magnetic history of the sample

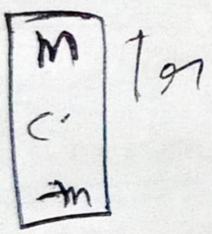


→ Permanent Magnets should have high retentivity (so that higher fraction of B_{max} is present) and high co-ercivity (so that it is not erased easily).

*It should also have high μ_r (so that it will strengthen field which will easily allign domains.)

→ At Neutral point $(B_H)_{net} = \vec{0}$

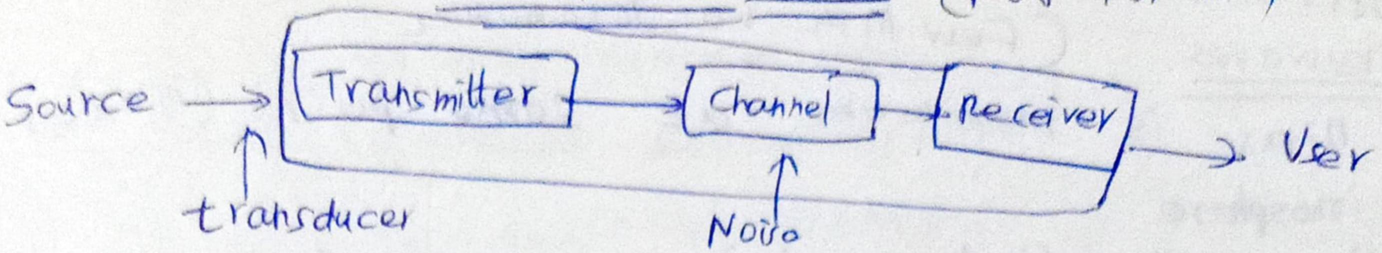
→



$$H_c = \frac{1}{4\pi} \times \frac{m}{r^2} \times 2$$

$$\boxed{\mu_c \neq \frac{\mu_0}{4\pi} \times \frac{m}{r^2} \times 2}$$

Communication System (Not for adv)



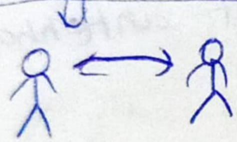
Transmitter: To convert the message signal produced by the source of information into a form suitable for transmission through the channel.

Transducer: to transform information into another form (like electrical)

Channel → media for transfer

Receiver: It reconstructs a recognisable form of the original message signal for delivering

Point to point



broadcast

Noise: Unwanted information

Attenuation: loss of strength of signal when travelling in attenuation. $(I = I_0 e^{-ax})$

Amplification: Increasing the amplitude

Modulation: If the wave cannot be transmitted then it is superimposed on a transmittable wave (high frequency)

Demodulation retrieval of information from the carrier wave

→ **Repeater:** (receiver + transmitter) → They extend the range.

→ Rectangular digital waves can be approximated as superimposition of 4 or 5 different frequencies.

→ Uplink & downlink ~~are~~ have different frequencies so that they don't interfere.

→ **Ground wave** ($<$ few MHz)

$l(\text{antenna}) \approx \frac{\lambda}{4} \approx \left(\frac{\lambda}{4}\right)$

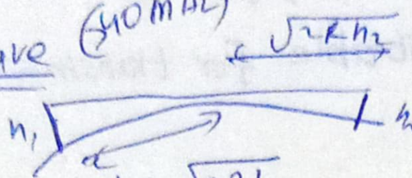
→ Attenuation increases rapidly with frequency

⇒ <u>Skywaves</u> (few MHz to 30 to 40 MHz

→ nions is maximum at some point (middle) in ionosphere

→ they will reflect certain frequencies (T.I.R

→ <u>Space wave</u> (40 MHz)



$R = 6400 km$

$d = \sqrt{2Rh_1}$

→ Used for line of sight communication

→ It is used in Television brodcast, Satellite communication

→ <u>Modulation</u>

→ 1) <u>Size of antenna</u> : If $\lambda \downarrow$ $f \uparrow$ but size of antenna $\approx \frac{\lambda}{4}$. So the frequency is increased

2) <u>Power</u> : Power $\propto \left(\frac{1}{\lambda}\right)^2$

for good communication power need to be high.

⇒ frequency should be high

3) <u>Mixing up of signals from different transmitters</u>

Since all callings have approximately same frequency they should be seperated. So they have to increase their frequency at at large frequencies they will allot bandwiths.

It is of 3 types (Analog modulation)

⇒ Amplitude Modulation → Frequency Modulation

⇒ Pulse Modulation → Pulse amplitude M

→ Pulse Duration M & Pulse position M

→ Pulse Width M

Amplitude Modulation

$c(t) = A_c \sin w_c t$ carrier wave

$m(t) = A_m \sin w_m t$ modulating wave

$c_m(t) = (A_c + A_m \sin w_m t) \sin w_c t$

or

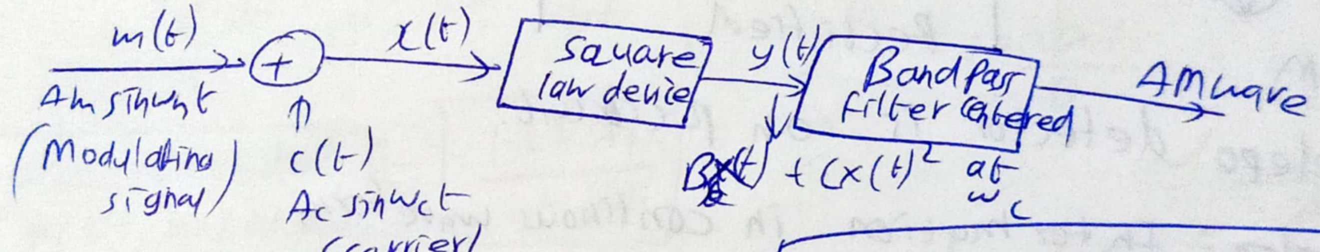
$= (A_c + kA_m \sin w_m t) \sin w_c t$ (k is generally $\boxed{1}$)

δ_A = deviation of amplitude = $A_m \sin w_m t$

μ = modulation index = $\dfrac{A_m}{A_c}$

$$c_m = A_c \sin w_c t + \frac{\mu A_c}{2} \cos((w_c - w_m)t) - \frac{\mu A_c}{2} \cos(w_c + w_m)t$$

Production of A-M-wave



$$\boxed{\frac{P_{cm}}{P_c} = \frac{2+m^2}{2} = 1 + \frac{m^2}{2}}$$

$$\boxed{P_{cm} \propto \frac{A_c^2}{2} + \left(\frac{A_m}{2}\right)^2 \times \frac{1}{2} + \left(\frac{A_m}{2}\right)^2 \frac{1}{2}}$$

η = efficiency = $\dfrac{\frac{m^2}{2}}{1 + \frac{m^2}{2}}$

$x(t) = A_m \sin w_m t + A_c \sin w_c t$

$y(t) = B x(t) + C x^2(t)$

$= BA_m \sin w_m t + \frac{CA_m^2}{2} + A_c^2 - \frac{CA_m^2}{2} \cos 2w_m t$ - - -

It has frequencies w_m, $2w_m$, w_c, $2w_c$, $w_c - w_m$, $w_c + w_m$.

→ A band pass filter is used which will only pass w_c, $w_c - w_m$, $w_c + w_m$

→ Before transmitting AM wave is sent to Power Amplifier

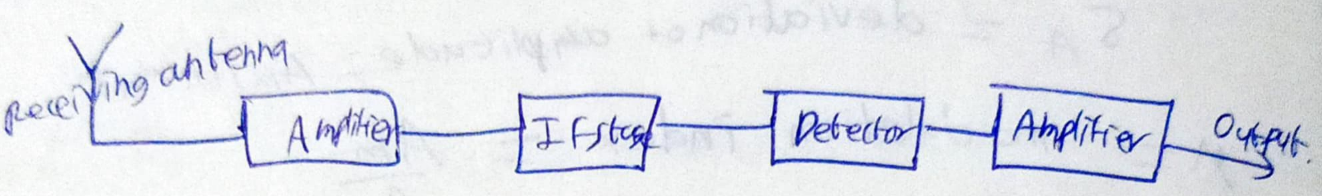
Detection of AM wave

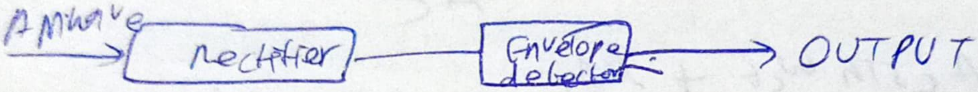
→ Before detector an amplifier is placed.

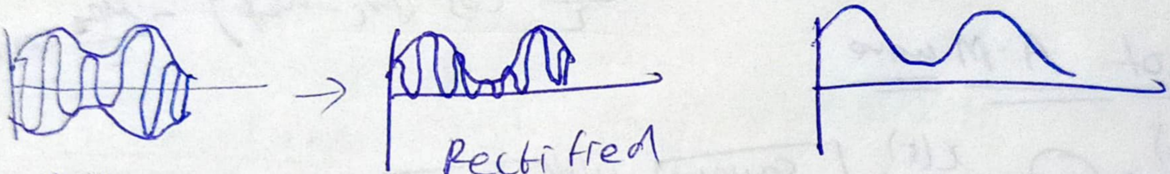
→ It is changed to a lower freauency called Intermediate frequency (IF)

→ At low freauency it is detected & transmits

→ After IF stage there is again an amplifier







Envelepo detector is an RC circuit.

→ Analog : Information in continous waveform

Digital ; discrete quantised levels

→ ~~Side bands~~ means either higher or lower freauenoies (which are ~~not~~ heeded)

→ Audible range = 20Hz to 20kHz   speech sighals – 300Hz – 3100Hz

→ Band width of pictures 4.2 MHz

→ TV. signal (voice + picture) 6 MHz

Optical instruments (Not for adv)

Resolving power

→ 1) For telescope

$$R.P = \frac{1}{\Delta\theta_{min}} = \boxed{\frac{D}{1.22\lambda}}$$

D = diameter (not radius) of objective

$$\Delta\theta_{min} = \frac{1.22\lambda}{D}$$

→ 2) For microscope

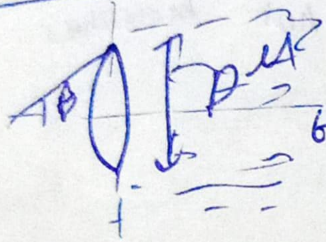
→ microscope generally used to magnify only

→ telescope is used both to magnify & resolve

$$R.P = \frac{1}{\Delta d_{min}} = \boxed{\frac{2\mu\sin\beta}{1.22\lambda}}$$

$$\Delta\theta = \frac{r}{v} = \frac{\Delta d}{u}$$

$$\Delta d = \frac{ru}{v} = \left(\frac{1.22\lambda}{D}\right)u$$



$$\tan\beta = \frac{D}{2f}$$

$$= \frac{1.22\lambda}{D} \times \frac{v}{m}$$

$$= \frac{1.22\lambda f}{D} = \frac{1.22\lambda}{2\tan\beta}$$

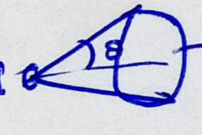
$$\approx \frac{1.22\lambda}{2\sin\beta}$$

2β = angle subtended by the lens at the focus

$$d_{min} = \boxed{\frac{1.22\lambda f}{2\mu\sin\beta}}$$

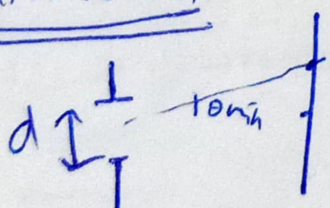
Diffraction through O slit

$$\sin\theta_{min} = \frac{1.22\lambda}{D}$$

D  → central region

D = Diameter of slit

Single slit diffraction



$$\left(\frac{d}{2}\right)\theta_{min} = \frac{\lambda}{2}$$

$$\boxed{\theta_{min(1)} = \frac{\lambda}{d}}$$ 1st minima

$\cancel{\theta_{2\,min} = \frac{3\lambda}{d}}$

Note: Second minima is not the one ~~θ_{2min}~~ which will cause 3π difference for the 2 half slits second minima is obtained by dividing it into 4 parts.

$\left(\frac{d}{4}\right)\theta_2 = \frac{\lambda}{2} \Rightarrow \boxed{\theta_{2min} = \frac{2\lambda}{d}}$

The minima which will be obtained for 2 halts with 3π is actually the 3rd minima

$\theta_{min} = \frac{n\lambda}{d}$ or $\boxed{d\sin\theta_{min} = n\lambda}$ for minima's

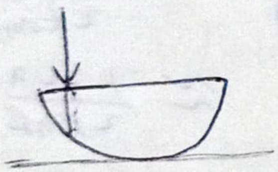
↳ This equation is analogous to $\boxed{2d\sin\theta = n\lambda}$ (Bragg's eqn) (θ is made with the plane)

$$\boxed{I = I_{max}\frac{\left(\sin\frac{\beta}{2}\right)^2}{\left(\frac{\beta}{2}\right)^2}}$$

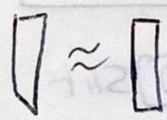
$\boxed{d\sin\theta_{max} = \left(n+\frac{1}{2}\right)\lambda}$ (approximate)

→ minimas calculated above are exact but not maxima's

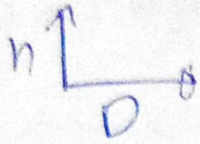
$$\boxed{\beta = \left(\frac{\Delta x}{d}\right)(2\pi)}$$

→ 

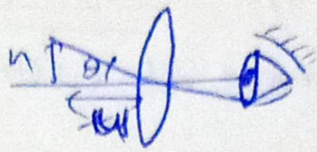
we should take it as a slab



Simple microscope



$\theta_0 = \frac{h}{D}$



$\theta = \frac{h}{u}$

$\theta_0 = \frac{h}{D}$

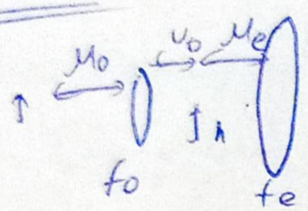
$\Rightarrow m = \frac{\theta}{\theta_0}$

$= \frac{D}{u}$

m (image at ∞) $= \frac{D}{f}$

m (image at D) $= 1+\frac{D}{f}$

Compound Microscope



$\boxed{m = \frac{v_0}{u_0} \times \frac{D}{u_e}}$

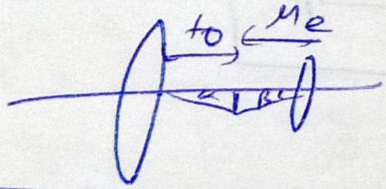
$\boxed{L = \text{tubelength} = \text{distance between foci}}$

$m(\infty) = \frac{v_0}{u_0}\left(\frac{D}{f}\right)$

$m(D) = \frac{v_0}{u_0}\left(1+\frac{D}{f}\right) \approx \boxed{\frac{-L_0}{f_0}\left(1+\frac{D}{f_e}\right)}$

→ Here h is magnified by $\frac{v_0}{u_0}$ times then its angula size is increased by the eyepiece.

Astromical tescope



(at D) $m = -\frac{f_0}{f_e}\left(1+\frac{f_e}{D}\right) = \frac{-f_0}{D} \times \left(1+\frac{D}{f_e}\right)$

(at ∞) $m = -\frac{f_0}{f_e}$

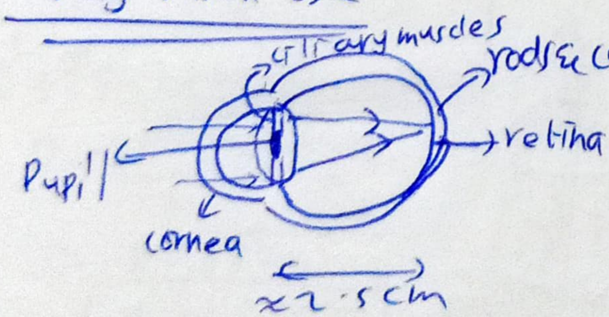
$\boxed{m = -\left|\frac{\beta}{\alpha}\right| = -\left|\frac{f_0}{u_e}\right|}$

~~Hea~~

$= -\frac{f_0}{D} \times \frac{D}{f_e}$

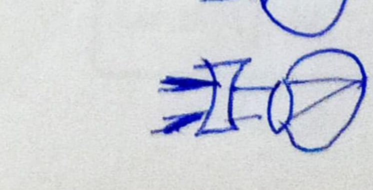
$\boxed{\text{technique}}$

Healthy Human Eye



focal length ≈ 2.5cm

Myopia (for me) (near sighedness)



∞ should be formed at L

farsighted ness (hypormetropia)

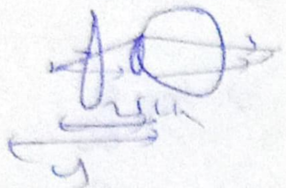
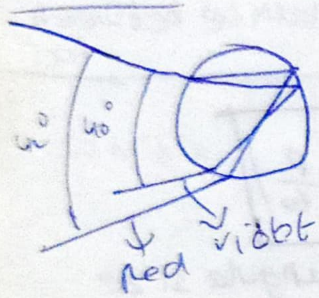


Image at 25cm should appear at y

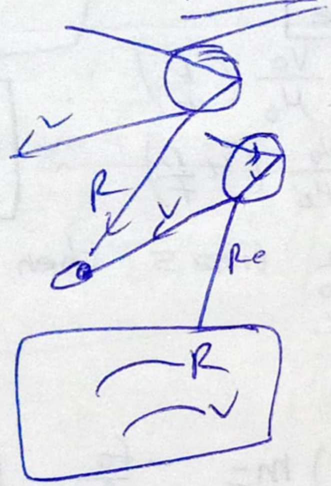
→ **Astimatism** : Due to imperfect sperical eyelens.

: line in 1 direction are normally seen but ⊥lar to that line distorted image is formed.

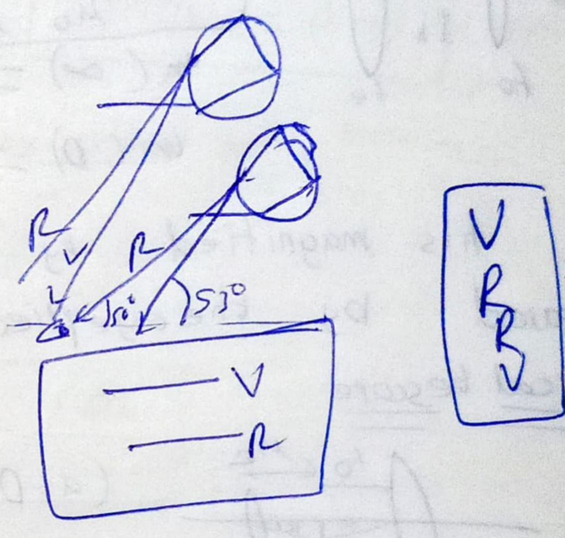
Rainbow



Primary

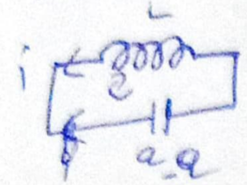


Secondary



Electric Oscillations (Not for adv)

→ **Free Undamped**



$$\frac{q}{C} + L\frac{di}{dt} = 0 \qquad \frac{dq}{dt} = i$$

$$\frac{d^2q}{dt^2} + \frac{q}{LC} = 0$$

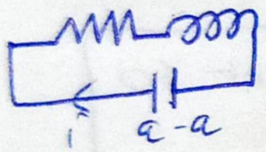
$$\Rightarrow \boxed{\ddot{q} + \omega_0^2 q = 0} \Rightarrow \boxed{q = Q_0 \cos(\omega_0 t + \phi)}$$

→ It is analogous to S.H.M (without damping)

$$\text{Energy} = \frac{1}{2}Li^2 + \frac{1}{2}\frac{q^2}{C} = \boxed{\frac{Q_0^2}{2C}} = \text{constant}$$

→ **Free damped Oscillations**

Even in forced oscillations they will present at the starting and then they will die.



$$\frac{q}{C} - L\frac{di}{dt} - iR = 0 \qquad \frac{dq}{dt} = -i$$

$$\frac{q}{C} + \frac{dq}{dt}R + L\frac{d^2q}{dt^2} = 0$$

$$\Rightarrow \boxed{\frac{d^2q}{dt^2} + \frac{R}{L}\frac{dq}{dt} + \frac{1}{LC}q = 0}$$

$$\boxed{\ddot{q} + \frac{R}{L}\dot{q} + \omega_0^2 q = 0}$$

$$\boxed{\ddot{q} + 2\beta\dot{q} + \omega_0^2 q = 0}$$

$$D^2 + 2\beta D + \omega_0^2 = 0$$

$$D = \frac{-2\beta \pm \sqrt{4\beta^2 - 4\omega_0^2}}{2}$$

$$= -\beta \pm \sqrt{\beta^2 - \omega_0^2}$$

$$= \boxed{-\beta \pm i\sqrt{\omega_0^2 - \beta^2}}$$

$$\ddot{q} = x_1 e^{-\beta \pm i\sqrt{\omega_0^2 - \beta^2}} + x_2 e^{-\beta - i\sqrt{\omega_0^2 - \beta^2}}$$

$$= Q_0 e^{-\beta} \cos(\omega t + \phi)$$

$$\boxed{\omega = \sqrt{\omega_0^2 - \beta^2}}$$

Damping factor (β) = $\beta = \frac{1}{\tau}$

τ = relaxation time : time in which amplitued decrease e times.

Q-factor = $\frac{\omega_0 L}{R}$

Forced - Electric Oscillations

$$\mathcal{E} = \mathcal{E}_0 \cos\omega t \text{ or } V = V_0 \cos\omega t$$

ω = driving frequency

$$L\frac{d^2q}{dt} + R\frac{dq}{dt} + \frac{q}{C} = V_0 \cos\omega t$$

$$\boxed{\ddot{q} + 2\beta\dot{q} + \omega_0^2 q = \frac{V_0}{L}\cos\omega t}$$

The solution of this type of non-homogeheous eqns have the solution of homogeneou equation + a perticular solution of this eqn. i.e until some time ~~both~~ free oscillations will occur.

★ Capacitor has more capacity to produce current so current leads voltage by $\frac{\pi}{2}$

Inductor runs slow, its current lags by $\frac{\pi}{2}$

$$Q_0 = \frac{\frac{V_0}{L}}{\sqrt{(\omega^2-\omega_0^2)^2+4\beta^2\omega^2}}$$

⇒ for max Amplitude (charge)

$$\omega = \sqrt{\omega_0^2 - 2\beta^2}$$

$$= \frac{\frac{F}{m}}{\sqrt{(\omega^2-\omega_0^2)^2+4\beta^2\omega^2}}$$

$\boxed{\beta = \frac{b}{2m}}$ $\boxed{= \frac{R}{2L}}$

for max energy

$\omega = \omega_0$

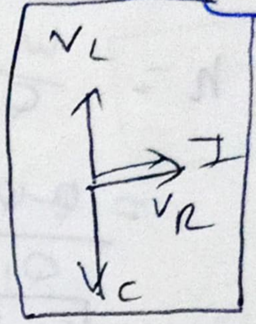
A.C

$Z = \sqrt{R^2+X^2}$ $\quad X = \omega L - \frac{1}{\omega C}$ = reactance

$\tan\phi = \dfrac{\omega L - \frac{1}{\omega C}}{R}$

$\cancel{i \sin\phi}$ ~~wattless~~ current

let $i = i_0 \sin(\omega t)$ $\Rightarrow$ $V = V_0 \sin(\omega t + \phi)$



$V_C = \frac{q}{C} = i_0 \sin(\omega t - \frac{\pi}{2})\left(\frac{1}{\omega C}\right)$

$V_R = i_0 R \sin(\omega t)$

$V_L = i_0 (\omega L) \sin(\omega t + \frac{\pi}{2})$

Power along any element = Voltage × i

for any resistor $\quad P = i_0^2 R \sin^2 \omega t$

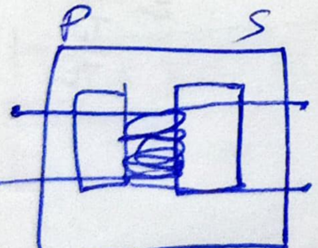
$\langle P \rangle = \frac{i_0^2 R}{2} = i_{r.m.s}^2 R$

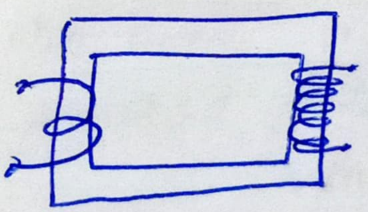
for L & C $\quad \boxed{\langle P \rangle = 0}$ $\quad$ (as $\langle \sin\theta \cos\theta \rangle = 0$)

$i_0 = \dfrac{V_0}{\sqrt{R^2+X^2}}$ $\qquad i_{r.m.s} = \dfrac{V_{r.m.s}}{\sqrt{R^2+X^2}}$

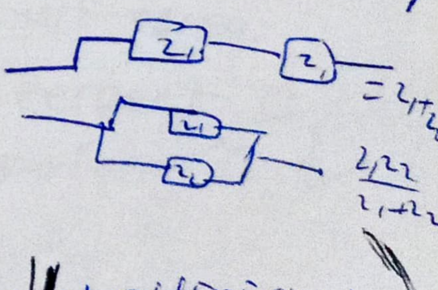
for maximum current $\boxed{X=0}$

In transformers





$\frac{1}{Z} = \frac{1}{R} + j\left(\frac{1}{X_L} - \frac{1}{X_C}\right)$



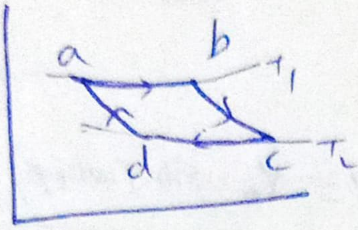
$V_P = -N_P \frac{d\phi}{dt}$ $\qquad V_S = -N_S \frac{d\phi}{dt}$

$\dfrac{V_S}{V_P} = \dfrac{N_S}{N_P} = \dfrac{i_P}{i_S}$

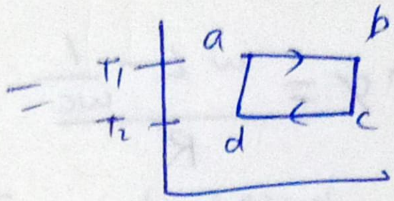
(generally efficiency is higher than 95%

Second law of thermodynamics

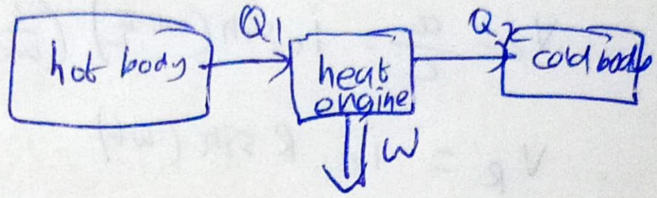
Heat engine



$=$



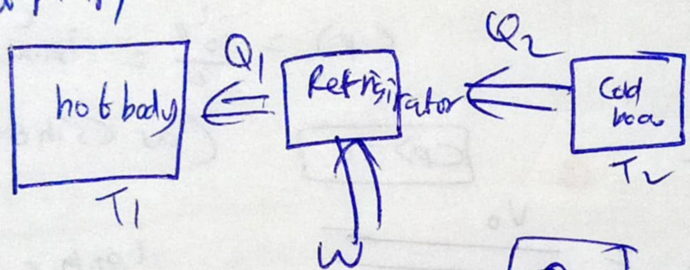
$$\eta = \frac{W}{Q_1}$$



$$= \frac{Q_1 - Q_2}{Q_1}$$

$$= \boxed{1 - \frac{T_2}{T_1}} = 1 - \frac{T_L}{T_H}$$

Refrigirator (heat pump)



Coefficience of performance $= \boxed{\frac{Q_2}{W}} = \frac{Q_2}{Q_1 - Q_2} = \boxed{\frac{1}{\frac{T_1}{T_2} - 1}}$

$$= \frac{1}{\frac{T_H}{T_L} - 1}$$

$$\boxed{ds \geq \frac{dQ_{rev}}{T}}$$

Properties of matter

Longitudinal stress : $\frac{F_{\perp}}{A}$ Longitudinal strain = $\frac{\Delta l}{l}$

Transverse strain : $\frac{F_{\parallel}}{A}$ (parallel to the surface) transverse strain = $\frac{\Delta y}{y} = \theta$ (Transverse = shear)

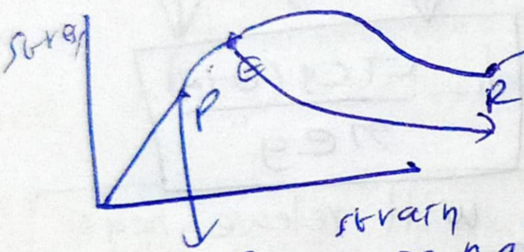
Volume stress : ΔP → Young's Modulus

$$\boxed{\frac{F_{\perp}}{A} = Y\frac{\Delta l}{l}}$$

$$\boxed{\frac{F_{\parallel}}{A} = \eta\frac{\Delta y}{y}}$$ → shearmodulus

$$\boxed{\Delta P = -B\frac{dV}{V}}$$ Bulk modulus

Elastic P.E density : $\frac{1}{2} \times$ stress $\times$ strain (when stress & strain are constants)



→ rupture/Breaking point

Elastic limit (after that permanent deformation)

Proportionality limit.

Surface tension : It is the force per unit length acting on a liquid or change is surface energy per unit area.

$$\Delta P = T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

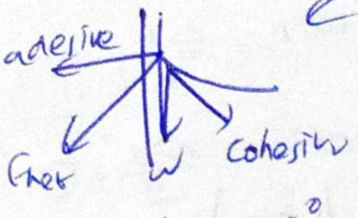
When detergent is added surface T ↓

$\Rightarrow \Delta P = \frac{2T}{r}$

$\Delta P = \frac{4T}{r}$

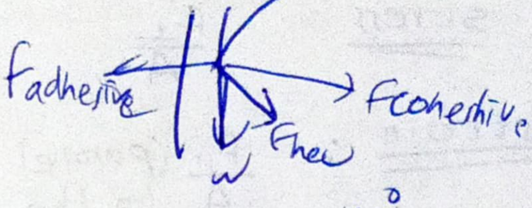
$T = 2\pi R$

adesive is ~~weak~~ strong



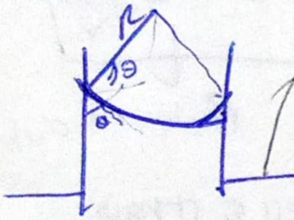
water $\approx 0°$

adhesive is ~~strong~~ weak



mercury $\approx 140°$

Capilary



Some layers raised above all those will lose their surface energy

$\Delta P = \frac{2T}{R} = \frac{2T\cos\theta}{r}$

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

$R\cos\theta = r$

$\Rightarrow \boxed{h = \frac{2T\cos(\theta+\alpha)}{r\rho g}}$

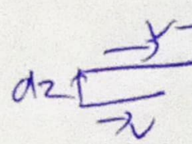
will release heat

surface energy losed > P.E gained

If height is less than h then θ will adjust for full length

Viscosity

$F = \eta A \frac{dv}{dz}$



~~units~~

Poiseullile's eqn

$$\boxed{\dot{V} = \frac{\pi p r^4}{8\eta l}}$$

Stoke's theorem

$$\boxed{F = 6\pi\eta r v}$$

Units of η

SI units = 1 poiseuille (PL)

cgs 1 poise = 0.1 PL

η of liquids decreases with temperature while it increases in the case of gases.

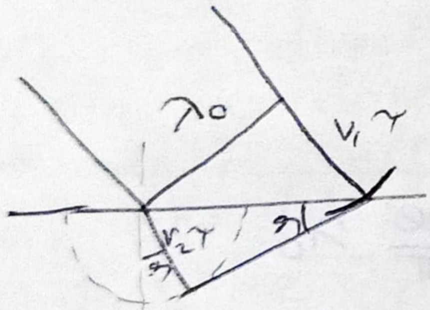
Wave Optics : Youngs Double Slit Experiment

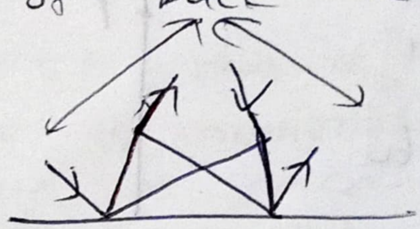
→ In corpuscular picture of refraction, particles of light incident from a rarer to a denser medium experience a force of attraction normal to the surface. This results in increase in normal component (tangential is same)

⇒ $\boxed{v_1 \sin i_1 = v_2 \sin i_2}$ ~~⇒~~ $\boxed{\mu \propto v}$

→ The locus of points which are in phase is called wavefront.

→ Each point of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are usually refered to as secondary wavelets and if we draw a common tangent to all these it will give the new wave. (amplitude of back wave = 0)





→ n coherent sources in phase ⇒ $A = nA_0$

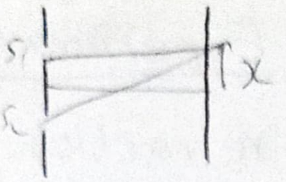
$I = n^2 I_0$

→ n incoherent ⇒ $\boxed{I = nI_0}$ (Average)

→ ~~I~~ If A_1, A_2 have $\Delta\phi$ phase difference

$$A^2 = A_1^2 + A_2^2 + 2A_1A_2 \cos\Delta\phi$$

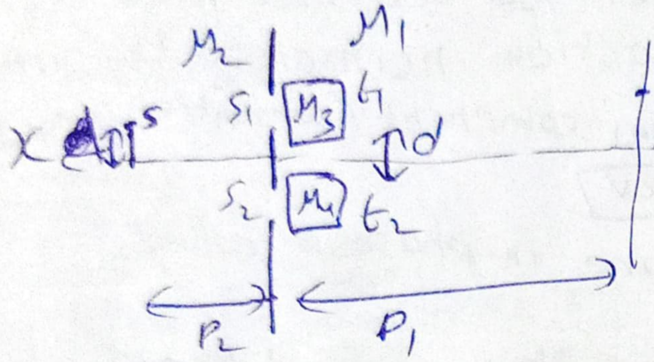
$$\boxed{I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Delta\phi}$$



$$(S_1P)^2 - (S_2P)^2 = 2xd$$

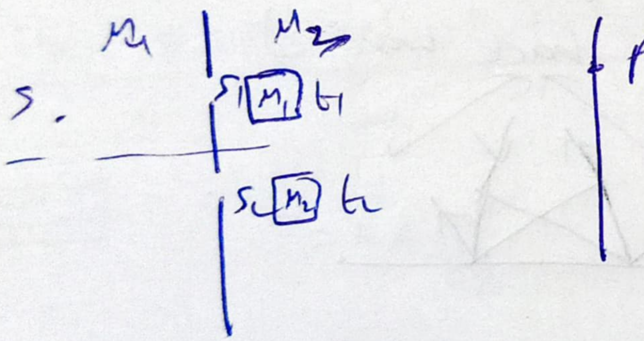
$$S_1P - S_2P = \frac{2xd}{(S_1P + S_2P)}$$

$$\approx \frac{x\,d}{D}$$



$$\mu_2\left(\frac{d \times x}{D_2}\right) + \left(\mu_1(S_2P - t_2) + \mu_4(t_2)\right) - \left((S_1P - t_1)\mu_1 + \mu_3 t_1\right) = \left(\frac{\Delta\phi}{2\pi}\right)\lambda_0$$

or



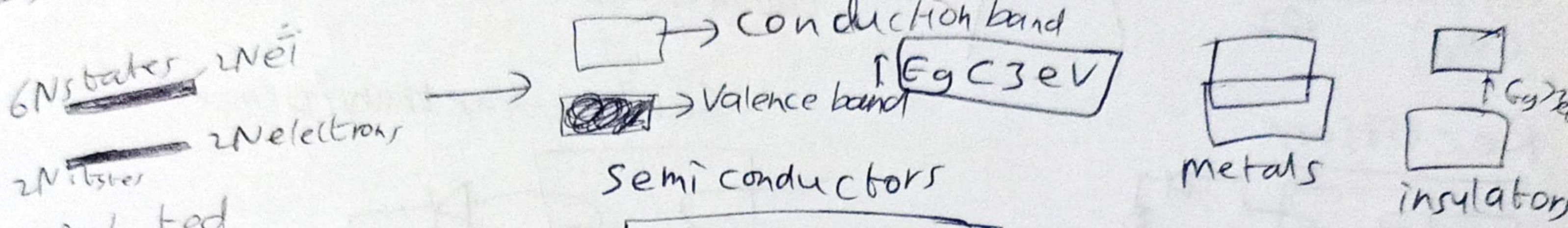
$$\mu_4(SS_2 - SS_1) + \mu_3(S_2P - t_2) + \mu_2(t_2) - \left(\mu_3(S_1P - t_1) + \mu_1 t_1\right) = \frac{\Delta\phi}{2\pi}\lambda_0$$

Semiconductors (Not for adv)

→ Vaccum tubes
bulky, consume high power,
operate at high voltages

→ semiconductors
small, low power, long life

→ Semiconductors allow a controlled flow of electrons



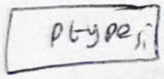
$$\boxed{I = I_e + I_h}$$

$$\boxed{n_e \times n_h = n_i^2}$$

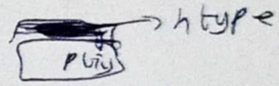
→ At T=0K all intrinsic semiconductors behave as insulators

Extrinsic → n-type – (e^- are charge carriers) (P, As, Sb etc)
Extrinsic → p-type – (holes) (B, Al, In etc)

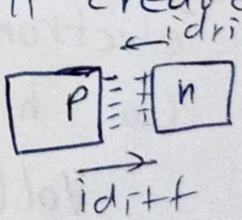
<u>p-n Junction diode</u>

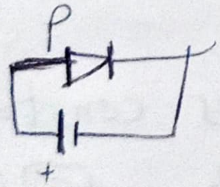


→ add Phosphours for above layes →



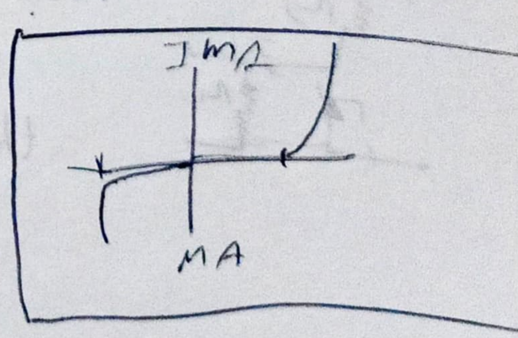
→ If we directly join p & n then pn is not formed
→ Diffusion current is due to concentration gradient
→ drift current is due to space-charges formed at the $\boxed{\text{depletion region}}$ ($\approx 0.1\mu m$)
→ On n-side P^+ & on p-side Al^- will create space charges.



→ 

(F-B)

→ f-b = minority carrier injection
⇒ $V_0 - V$ thickness ↓ (mA)



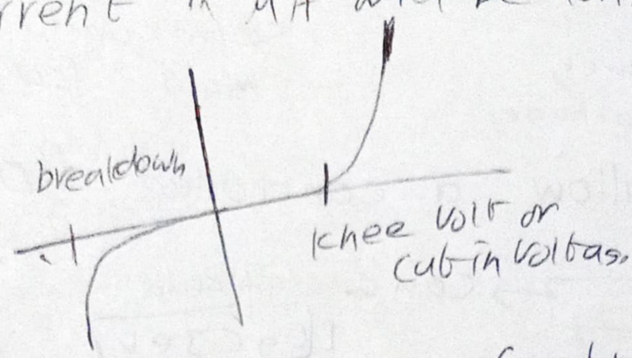
→ <u>Reverse bias</u> (μA)

$V_0 + V$ thickness ↑

All potential ≈ drops over the depletion region

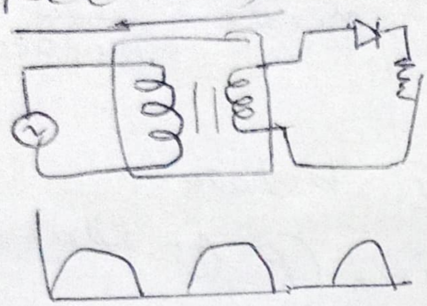
→ diffusion current drops to zero
→ drift current in μA will be dominating

dynamic resistance $= \frac{\Delta V}{\Delta I}$ (r_d)

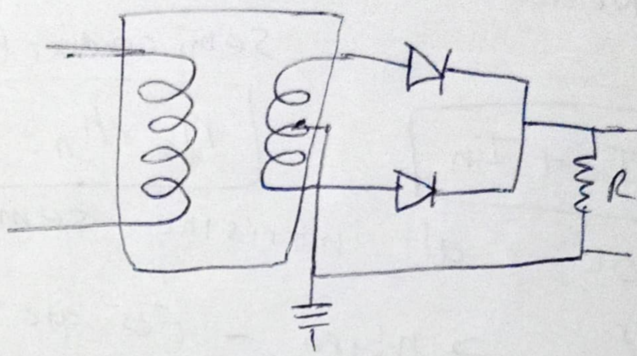


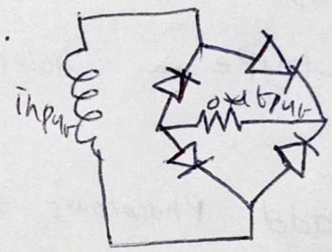
0.2V for Ge
0.7V for Si

Rectifiers

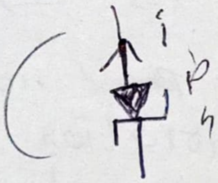


Centre-tap transformer

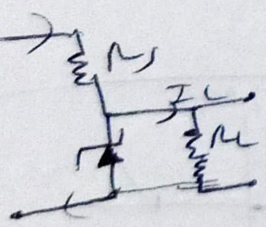




Zener diode



both p & n junctions are heavily doped. depletion layer is very thin ($<10^{-6}$ m)
→ Valence electrons from host atoms are pulled from p side to n side.

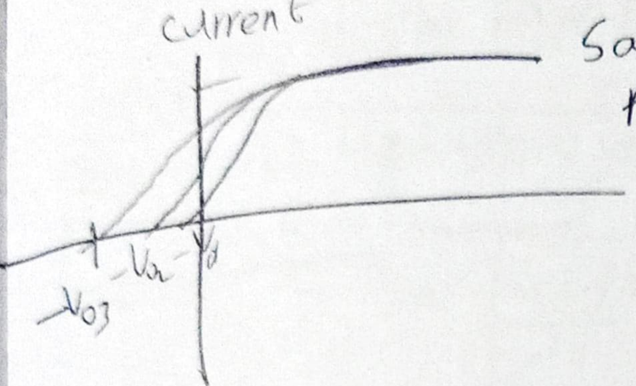


Voltage regulator (makes constant)
Zener current should be ≈ $\boxed{5}$ times the load current.

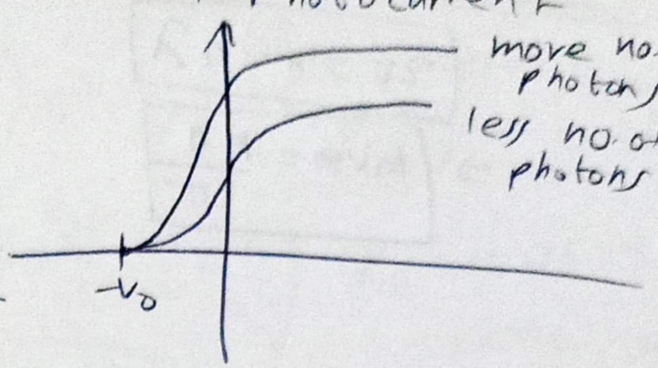
Modern Physics

Photo electric effect

→ $K.E_{max} = h\vartheta - h\vartheta_0$



Same no. of photons different frequencies



→ For ~~p~~particles $\lambda = \frac{h}{p}$

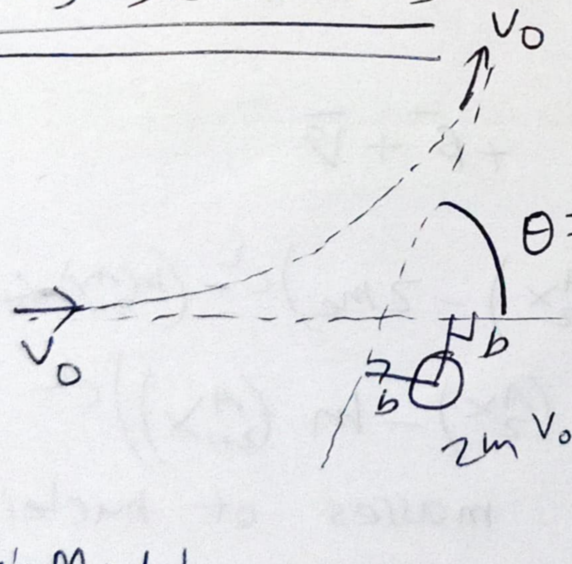
λ is physicalley meaning full

$E = h\vartheta$ $\quad$ ϑ is not physically meaning full

$\boxed{V_p = \lambda\vartheta}$ is not meaning full.

$$\frac{dE}{dp} = \cancel{\frac{d(\vartheta)}{d(\frac{1}{\lambda})}} = \_\_\_\_ \qquad \boxed{\frac{d\vartheta}{d(\frac{1}{\lambda})} = \frac{dE}{dp} = \frac{p}{m}}$$

α Ray scattering



θ = scattering angle $\quad \boxed{\tan\frac{\theta}{2} = \frac{kq_1q_2}{mbV_0^2}}$

$$2mV_0\sin\frac{\theta}{2} = \int \frac{kq_1q_2}{r^2}\cos\alpha\,dt \;,\; dt = \frac{d\alpha r^2}{bV_0}$$

Bohr's Model

$$E = \frac{-me^4}{8h^2\epsilon_0^2 n^2} \qquad r = \frac{h^2 4\pi\epsilon_0}{2\pi me^2} \times n^2 \qquad E_n = \frac{-13.6Z^2 eV}{n^2}$$

$$r = 0.529Å \times \frac{n^2}{Z}$$

De Broglie's Hypothesis

$$\boxed{2\pi r_n = n\lambda}$$

$$\Rightarrow \boxed{mvr = \frac{nh}{2\pi}}$$

Nuclei & Nuclear reactions

$$\boxed{\Delta E = \Delta m c^2}$$

Nuclear binding energy = The energy difference between isolated & bound nucleus
(all nuclear constituents are isolated)

The n-p, p-p, n-n nuclear forces are equal.

⇒ Always read carefully Binding energy per nucleon.

Beta decay ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + \beta^- + \bar{\nu}$

$$Q = U_i - U_f = \left(m({}^{A}_{Z}X) - Zm_e\right)c^2 - \left(m({}^{A}_{Z+1}Y) - (Z+1)m_e + m_e\right)c^2$$

$$= \left(m({}^{A}_{Z}X) - m({}^{A}_{Z+1}Y)\right)c^2$$

we have to subtract only masses of nuclei

β^+ decay

$${}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + \beta^+ + \nu$$

$$Q = \left(m({}^{A}_{Z}X) - m({}^{A}_{Z-1}Y) - 2m_e\right)c^2$$

K electron capture

$$p + e \rightarrow n + \nu$$ (just analogous to the production of β^+)

$$Q = \left(m\left({}^{A}_{Z}X\right) - m\left({}^{A}_{Z-1}Y\right)\right)c^2$$

$$\boxed{hc = 1240 \text{ (eV)(nm)}}$$

$= 1242$ eV nm

$$\frac{1}{\lambda} = R_H (Z^2)\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$R_H = 109677 \text{ cm}^{-1}$

$= 1.09677 \times 10^7 \text{ m}^{-1}$

$$\Rightarrow \boxed{\frac{91.1 \text{ nm}}{\lambda} = Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

$\frac{1}{R_H} = 91.1 \text{ nm} = 911 \text{ Å}$

Gravitation

$|\vec{F}| = \frac{G m_1 m_2}{r^2}$ $G = 6.67 \times 10^{-11} Nm^2/kg^2$

→ It is a basic law nature whose origin is not known

→ 1) Point

$E = -\frac{GM}{r^2}$

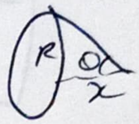
$V = -\frac{GM}{r}$

2) Ring

$V = -\frac{GM}{\sqrt{r^2+x^2}}$

$E = \frac{GMx}{(r^2+x^2)^{\frac{3}{2}}}$

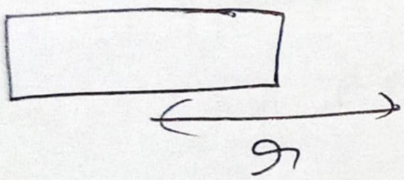
3) Uniform dist



$E = \frac{\sigma}{2\epsilon_0}(1-\cos\alpha)$

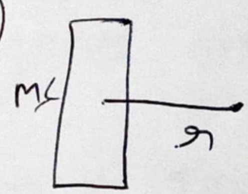
$V = -EL = \frac{-\sigma}{2\epsilon_0}(1-\cos\alpha)\sqrt{R^2+x^2}$

4) m, L



$E = \frac{GM}{r^2 - \frac{L^2}{4}}$

5)

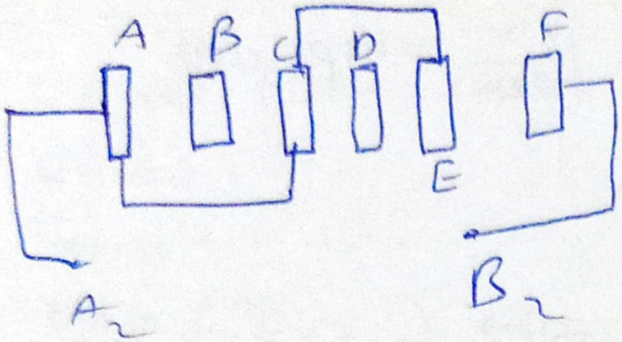


$E = \frac{GM}{r\sqrt{r^2+\frac{L^2}{4}}}$

Self energy ⇒ Outside solid sphere $= -\frac{GM^2}{2R}$

Inside uniform sphere $= -\frac{GM^2}{10R}$

$\boxed{\text{P.E = Interaction energy + self energy.}}$



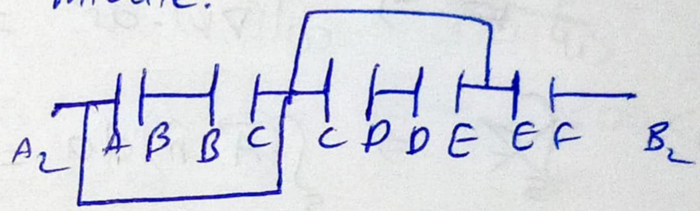
$\Rightarrow$ **Method-I**

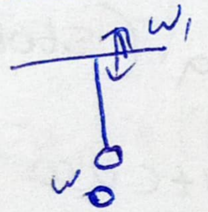
Write all the plates with same potential in an order & connect them to their respective opposite plates

$\Rightarrow$ **Method-II**

divide each plate into two parts and connect the wires at the middle.

i.e





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

$$\frac{\Delta W}{W} = -\frac{1}{2}\frac{\Delta g}{g}$$

$$= -\frac{1}{2} \cancel{\times} \frac{A w_1^2}{g} \quad \left(\frac{1}{2}\frac{A w_1}{g}\right)$$

1 Curie = 3.7×10^{10} dps

1 Rutherford = rd = 10^6 dps

1 Becquerel = 1 Bq = 1 dps

$$d\phi = \frac{\partial\phi}{\partial x}dx + \frac{\partial\phi}{\partial y}dy + \frac{\partial\phi}{\partial z}dz$$

$$d\phi = (\vec{\nabla}\phi)\cdot d\vec{r} \qquad \vec{\nabla}\phi = \frac{\partial\phi}{\partial x}\hat{i} + \frac{\partial\phi}{\partial y}\hat{j} + \frac{\partial\phi}{\partial z}\hat{k} \text{ (gradient)}$$

$$\vec{\nabla}\cdot\vec{A} = \frac{\partial a_x}{\partial x} + \frac{\partial a_y}{\partial y} + \frac{\partial a_z}{\partial z} = \text{divergence}$$

$$\vec{\nabla}\times\vec{A} = \left(\frac{\partial a_z}{\partial y} - \frac{\partial a_y}{\partial z}\right)\hat{i} + \left(\frac{\partial a_x}{\partial z} - \frac{\partial a_z}{\partial x}\right)\hat{j} + \left(\frac{\partial a_y}{\partial x} - \frac{\partial a_x}{\partial a_y}\right)\hat{k}$$

a) $\vec{\nabla} \cdot \vec{\nabla}\phi = \nabla^2\phi = \frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} + \frac{\partial^2\phi}{\partial z^2}$ = laplacian

b) $\vec{\nabla} \times (\vec{\nabla} T) = 0$

c) $\vec{\nabla}(\vec{\nabla} \cdot \vec{A})$ = a vector field

d) $\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0$

e) $\vec{\nabla} \times (\vec{\nabla} \times \vec{A}) = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - (\vec{\nabla}^2)\vec{A}$ $\left(= \nabla(\nabla \cdot \vec{A}) - \nabla^2 \vec{A}\right.$

f) $(\vec{\nabla} \cdot \vec{\nabla})\vec{A} = \nabla^2 \vec{A}$ = a vector field

$\Rightarrow$ $\cancel{\int_{(1)}^{(2)}}$ $\Rightarrow$ $\int_{(1)}^{(2)} (\nabla\psi) \cdot \vec{ds} = \psi(2) - \psi(1)$

$\Rightarrow$ $\cancel{\oint_S}$ $\Rightarrow$ $\int_S (\vec{A} \cdot \hat{n})\, da = \int_V (\vec{\nabla} \cdot \vec{A})\, dV$ (Gauss' Theorem)

$$\oint_L \vec{A} \cdot \vec{ds} = \int_S (\vec{\nabla} \times \vec{A})_n\, da$$

$$= \int_S (\vec{\nabla} \times \vec{A}) \cdot \hat{n}\, da$$ (Stoke's theorem)

$\vec{\nabla} \times \vec{A} = 0 \Leftrightarrow \vec{A} = \vec{\nabla}\psi$ ($\psi + c$ also satisfies)

(doubt) $\vec{\nabla} \cdot \vec{A} = 0 \Leftrightarrow \vec{A} = \vec{\nabla} \times (\vec{B})$

$\rightarrow$ $\oint \vec{E} \cdot \vec{dA} = \frac{Q_{in}}{\epsilon_0} \Rightarrow \vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$

$\rightarrow$ $\oint \vec{E} \cdot \vec{dl} = \frac{-d\phi_B}{dt} \Rightarrow \vec{\nabla} \times \vec{E} = \frac{-\partial \vec{B}}{\partial t}$

$\rightarrow$ $\oint \vec{B} \cdot dA = 0 \Rightarrow \vec{\nabla} \cdot \vec{B} = 0$

$\rightarrow$ $\oint \vec{B}\, \vec{dl} = \mu_0 i + \mu_0 \epsilon_0 \frac{d\phi_E}{dt} \Rightarrow \vec{\nabla} \times \vec{B} = \mu_0 J + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$

$\vec{H} = \frac{\vec{B}}{\mu} = \frac{\vec{B}}{\mu_0} - \vec{J}$

$\vec{D} = \epsilon_0 \vec{E} + \vec{P} = \epsilon \vec{E}$

$\vec{J} = \chi \vec{H}$

2nd mains

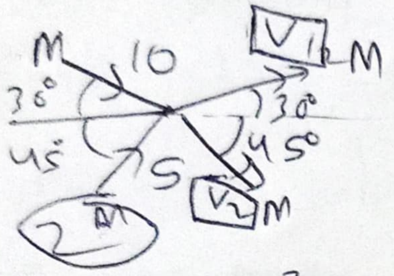
→ Optical fibre communications – Infrared

Radar – ~~Radio~~ Micro

Sonar: – Ultrasound

Mobile phones – ~~Microwaves~~ Radio

→ (5)



$V_1 = 6.5$

$V_2 = 6.3$

~~$V_1 = \frac{5(2\sqrt{2}+\sqrt{3}-1)}{\sqrt{3}+1}$~~

~~$V_2 = \frac{5(\sqrt{2}-\sqrt{6})(\sqrt{3}}{\sqrt{3}+1}$~~

→ $V = 25 \times 10^{-3}\,m^3$ $n = 1$ mole of O_2 $V_{r.m.s} = 200\,m/s$ 300K

σ = collision diameter = 0.3 nm

→ (5) $E = E_0 \cos(kz) \cos(\omega t)\hat{i}$

$B = \frac{E_0}{c} \sin(kz) \sin(\omega t)\hat{j}$

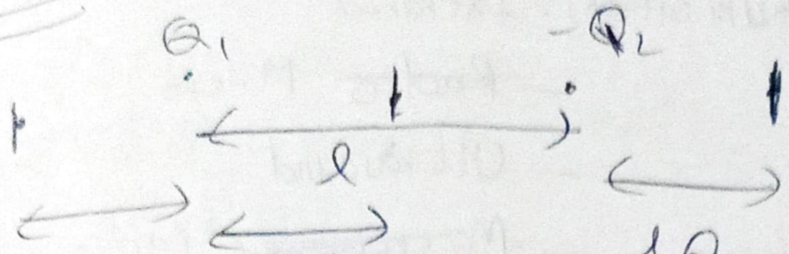
→ (5) $\boxed{y = mx + c}$

R	l
1000	60
100	13
10	1.5
1	1

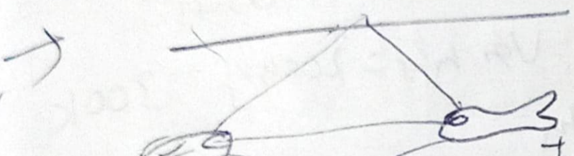
(100, 7) or (200, 13)

$\boxed{\text{(100, 7) or (200, 13) are correct}}$

Appolonius theorem

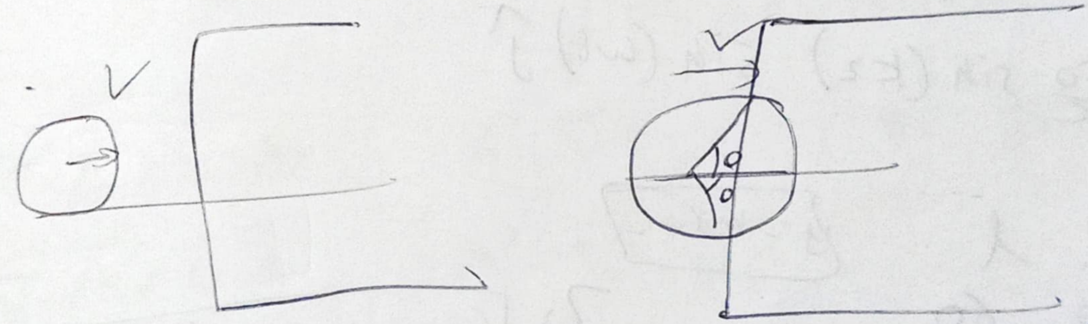


$$\frac{lQ_1}{Q_2-Q_1} \quad (I\ Q_2 > Q_1) \qquad \frac{Q_1 l}{Q_1+Q_2} \qquad \frac{l Q_2}{Q_1-Q_2} \quad (I\ Q_1 > Q_2)$$



It sends 1 compression wave

It recieves a rarefraction & 2 compression



Intially $w=0$. Finally it will rotate with pure rolling

Energy = constant

Find τ for θ in terms of v then substitute $v = \frac{d}{dt}(R\cos\theta - R)$

$$\boxed{w = \frac{V_0}{R\sqrt{2}}}$$

$$\tau = \frac{d\alpha}{2\pi} QVB \int_{-\theta}^{\theta} R\cos\theta\, d\theta$$

$$v = R\sin\theta \frac{d\theta}{dt}$$

$$= \frac{QVBR}{\pi} \sin\theta$$

$$\Delta L = \frac{QBR^2}{2} \qquad dL = \frac{QBR}{\pi} \int \sin\theta\, v\, dt$$

$$\Rightarrow I(w) = \frac{QBR^2}{I}$$

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

$$\Rightarrow \boxed{Q = \frac{\sqrt{2} m V_0}{B\,r}}$$

→ 

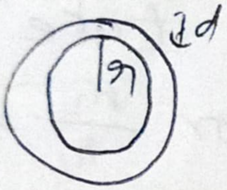
shift = $t\left(1-\frac{1}{\mu}\right)$ (not $(\mu-1)t$)

→ In Nuclear reaxns the masses given are only neutral atomic masses (some times electron mass is not considered)

→ Take gravity whenever they said "Ground"

→ Read shell, disk, sphere carefully

→ For a shell tensile strength means $\boxed{\frac{F}{A}}$ like for ~~ma kom~~ normal rod.



Maximum tensile strength = σ

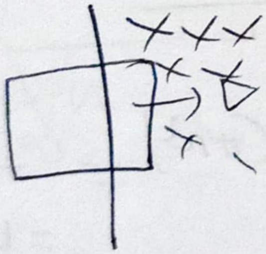
$$\sigma = \frac{T}{2\pi r(d)} = \frac{\Delta P(\pi r^2)}{2\pi r d}$$

→ frequency of amplitude $\boxed{2\omega_1}$

$\boxed{\omega_2 \gg \omega_1}$

$y = A\cos(\omega_1 t)\cos(\omega_2 t)$ (amplitude is alway +ve)

It stops before completely entering

→ 

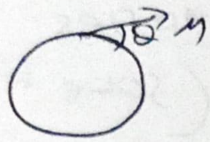
$$\frac{dv}{dt} = -\frac{B^2a^2}{mR}v$$

$$v\frac{dv}{dx} = -\frac{B^2a^2}{mR}\cancel{v}$$

$$dv = -\frac{B^2a^2}{mR}dx$$

$$\boxed{v_0 = \frac{B^2a^2}{mR}l} \qquad \boxed{l < a}$$

→ A particle of velocity V (comparable to escape velocity) is given at surface.



$\boxed{\mu \cos\theta \neq \text{constant}}$

(as gravity is not vertical)

→ both
Reflection
Refraction
Dispersion

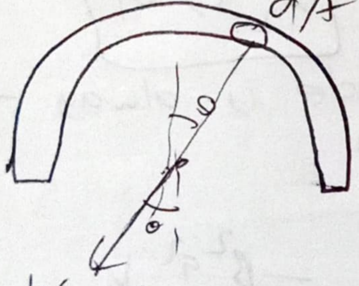
Particle
Photo electric effect
Black body radiation
Compton effect
Low temperature specific heats (Debye)

Wave
Double refraction
Interference
Diffraction

→ n_1 M.S.D = n_2 V.S.D ~~take~~ take fraction $\frac{n_1}{n_2}$ s.t $(n_2 > n_1)$ or $\frac{n_2}{n_1}$ s.t $(n_1 > n_2)$

⇒ $L.C = \frac{1}{n_2}$ $\qquad L.C = \frac{1}{n_1}$

→



dA

$\frac{k(\sigma dA)}{R^2}$

$$F = \int \frac{k\sigma dA \cos\theta}{R^2}$$

$$= \frac{k\sigma}{R^2}(\pi R^2) = k\sigma\pi$$

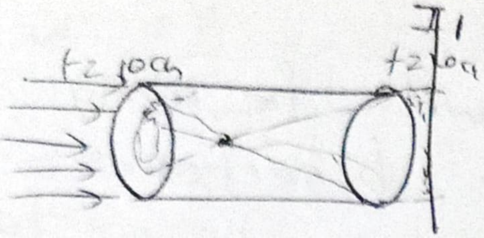
$$= \frac{k\pi \times Q}{2\pi R^2}$$

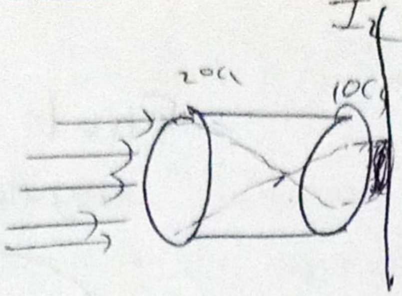
$$\frac{2KQ}{2R^2}$$

→ If initial velocity is given don't take it as zero

→ Don't take potential as $\boxed{V = \frac{kq}{r^2}}$

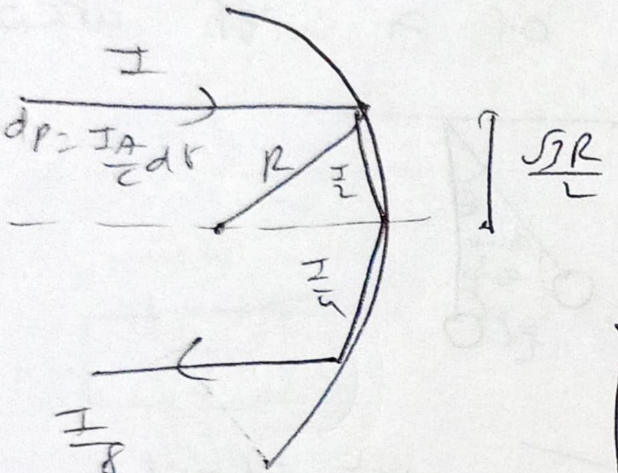
→ $k = \frac{1}{4\pi\epsilon_0}$ ~~don't~~ some times answer will be written after cancellation of 4.





(The cylinder is perfect energy observer)

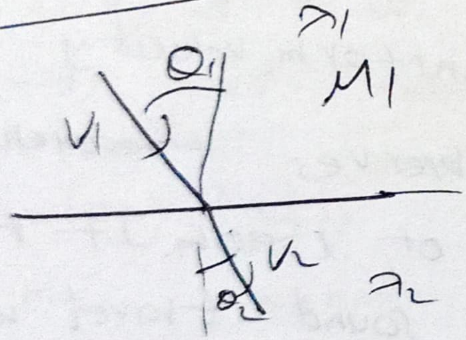
$$I_1 = \frac{\frac{E}{4}}{A} \qquad I_2 = \frac{E}{\frac{A}{4}}$$



$\overleftarrow{dp} = \frac{IA}{8c} dr$

Find net force on the semi-cylinder if at each ~~reflectr~~ surface 0.5 is reflected & 0.5 is obsorbed.

$$\boxed{F = \frac{9}{8}\frac{IA}{c}}$$

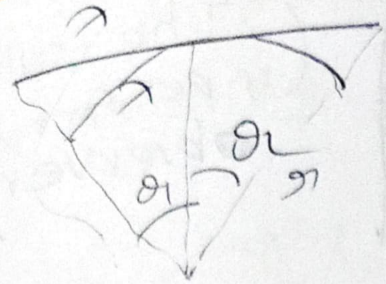


$P_1 \qquad P_1 = \frac{h}{\lambda_1} = \frac{h\mu_1}{\lambda_0}$

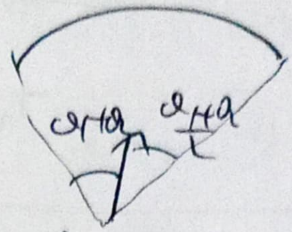
$P_2 \qquad P_2 = \frac{h}{\lambda_2} = \frac{h\mu_2}{\lambda_0}$

$$\frac{h\mu_1 \sin\theta_1}{\lambda_0} = \frac{h\mu_2 \sin\theta_2}{\lambda_0}$$

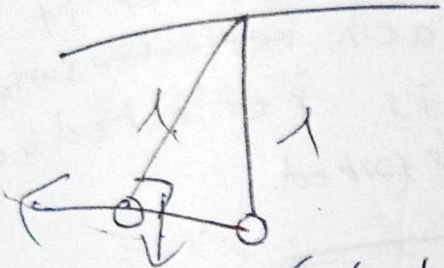
$$\boxed{\mu_i \sin\theta_i = \text{constant}} \Longrightarrow P_1 \sin\theta_1 = P_2 \sin\theta_2$$



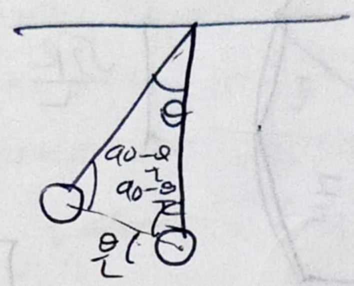
E_{net} will be along angular bisector

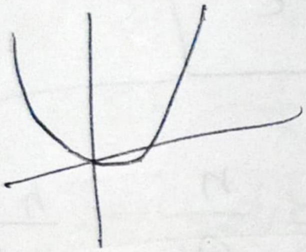


we can replace rod of λ with arc of λ



Wrong (not $\perp$





$\cancel{y^2 = 4ax}$ $x^2 = 4ay$

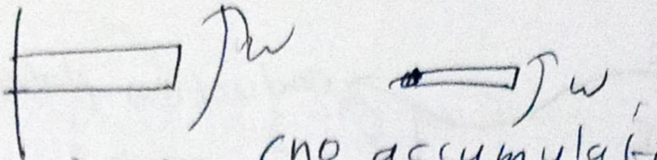
An observer moving with uniform velocity towards a stationary sound source observes frequency $f = 170$ Hz over a distance of $x = 90$m. If frequency of sound is $f_0 = 160$ Hz and sound travel with speed $c = 340\ ms^{-1}$. Then duration of beep is

$340+v$

$$\boxed{v\left(\frac{340+v}{340+v}\right) = 90}$$ (wrt ground 90)

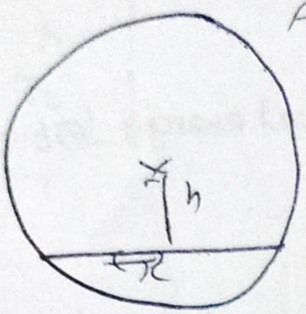
super cooled water at $-10°C$ will first come to $0°C$ as water & the becomes ice.

→ $\omega = \frac{eB}{m}$ & $\vec{\omega} \parallel \vec{B}$

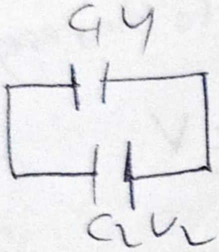


charge inside cylinder is zero (no accumulation) but on the charge there exist a net force which causes a tension.

→ An insect is moving such that the rod is always in equilibrium



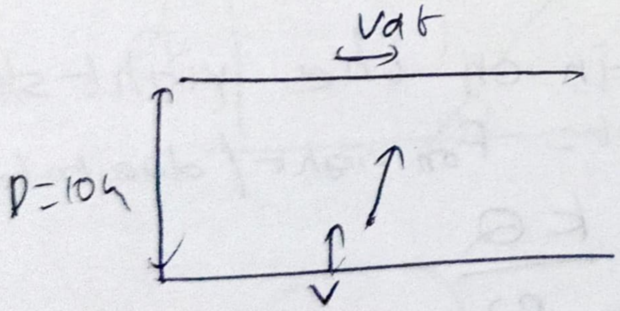
→



Total energy lost $= \frac{1}{2}C(V_{rel})^2$

$$\boxed{C = \frac{C_1C_2}{C_1+C_2}}$$

→ A man crosses a river of width d=10m. Current flow speed is V. Speed of swimmer relative to water is V. Man always heads towards the point exactly opposite to the starting point at the another bank (relative to water). Radius of curvature of the path followed by the swimmer just after he start swimming is



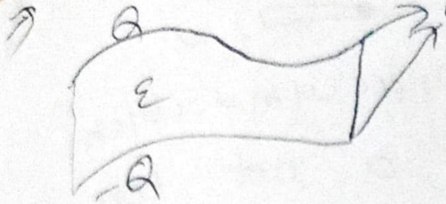
$$a = \frac{v\,d\theta}{dt}$$

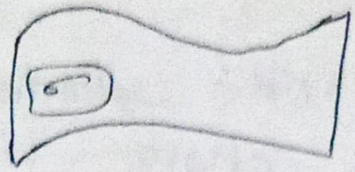
$$a = \frac{v}{dt} \times \left(\frac{v\,dt}{D}\right) = \frac{v^2}{D}$$

$$D = \frac{v^2}{a}$$

$$R_{\text{ground}} = \frac{v_{net}^2}{a_\perp} = \frac{(\sqrt{2}v)^2}{\frac{a}{\sqrt{2}}} = \frac{2\sqrt{2}v^2}{a} = \boxed{2\sqrt{2}D}$$

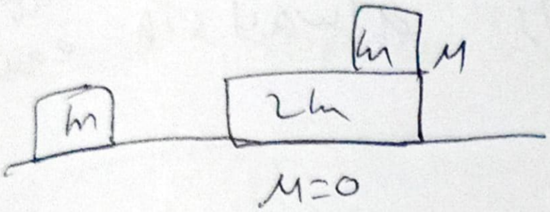
conducting plates



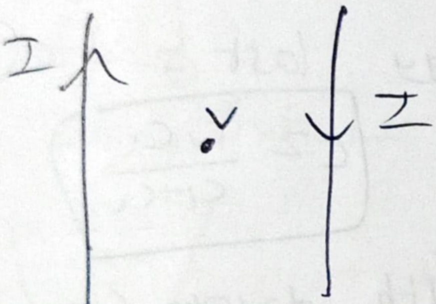


R

$$\boxed{RC = \frac{\epsilon}{\sigma}}$$



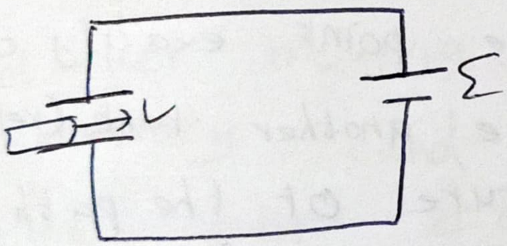
Total energy lost = Energy lost in collision + energy lost in friction.



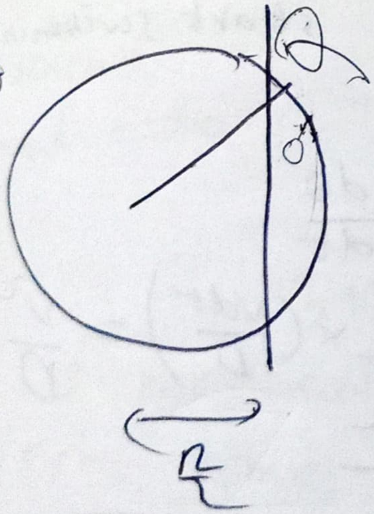
(v is ⊥lar to the page)

$$F \neq \frac{2\mu_0 I v}{\pi d}$$

$$\boxed{F=0}$$



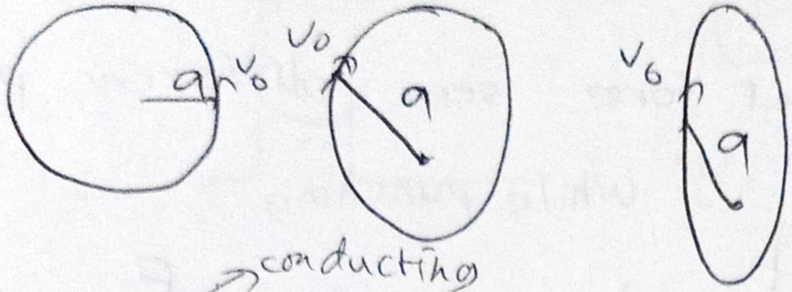
Generally constant force but if they mentioned constant speed (read it)



Force actin on the right shell due to left = F on right / due to total

But $E \neq \frac{KQ}{R^2}$

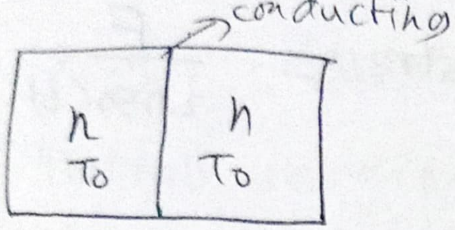
$$\boxed{E = \frac{KQ}{2R^2}}$$



$L_1 > L_2 > L_3$

$E_1 = E_2 = E_3$

$T_1 = T_2 = T_3$

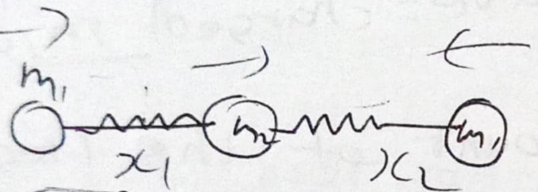


$$\int (P_2 - P_1)\, dV = \Delta U = 2 n C_v\, dT$$

$\boxed{\text{2 is important}}$

$$nR\left(\frac{1}{V_2} - \frac{1}{V_1}\right) dV = 2nC_v \frac{dT}{T}$$

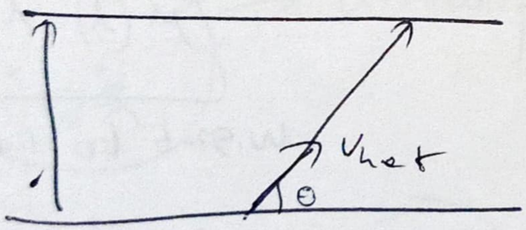
$$\boxed{nR \int \frac{dV}{T}\left(\frac{1}{V_2} - \frac{1}{V_1}\right) = 2nC_v \int \frac{dT}{T}}$$



(1 is compression & 1 is elongation)

$$\boxed{\frac{d^2x_1}{dt^2} = k\left(\frac{1}{m_1} + \frac{2}{m_2}\right) x_1}$$

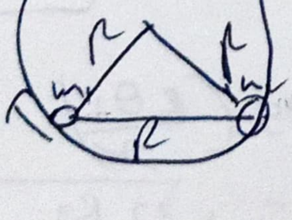
(Write individual accelerations & add)



$t \neq \frac{d}{V_{net}}$

$t = \frac{d}{V_{net} \sin\theta}$

V1

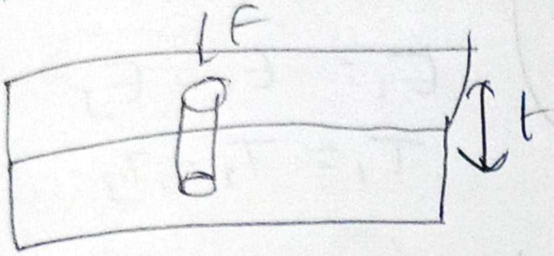


If they said V_1 is given to m_1 then same V_1 is also given to m_2 otherwise not possible

→ $\cos 30 = \frac{\sqrt{3}}{2}$ $\sin 30 = \frac{1}{2}$

→ Whenever writing net force see all forces properly

→



while punching

Shear stress $= \frac{F}{2\pi r(t)}$

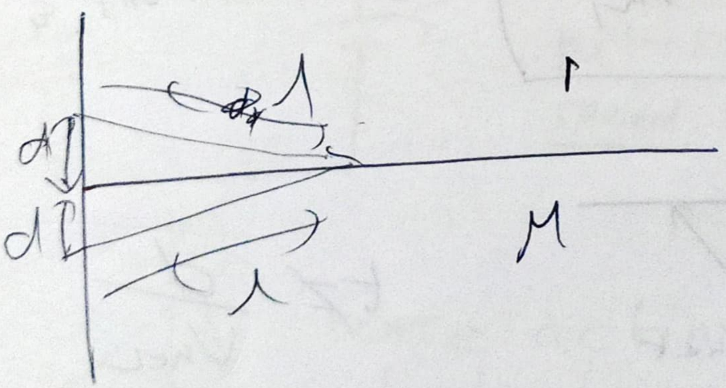
→ E induce will cause current in the conductor but it will not rotate neutral conductor

→ It will rotate = charged insulator.

→ lamina = sheet

→ pitch ≠ Least ~~count~~ count of the linear scale of the screw gauge

→



w.r.t to air λ_0

→ $\boxed{\mu(\lambda) - \lambda = \frac{\Delta\phi}{2\pi} \times \lambda_0}$

w.r.t to liquid λ

$\lambda - \frac{\lambda}{\mu} = \frac{\Delta\phi}{2\pi} \lambda$

$\boxed{\lambda = \frac{\lambda_0}{\mu}}$

→

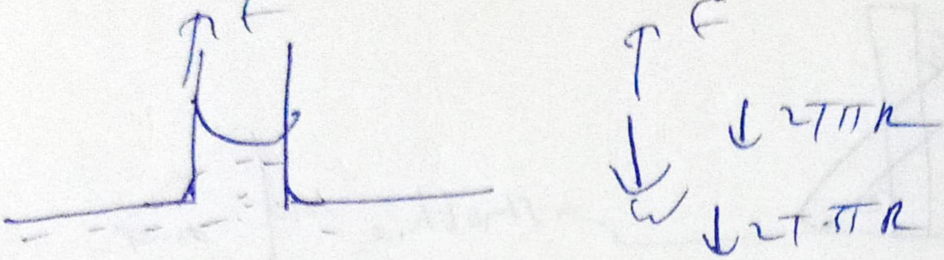
$\uparrow R\theta_L$

$\uparrow \frac{R\theta_L}{2}$

$T = \frac{2\pi}{\sqrt{12Rg}} \times L = \boxed{\frac{\pi L}{\sqrt{3Rg}}}$

$\frac{1}{2} \times \frac{\cancel{m} L^2}{12} w^2 = \cancel{m} g \left(\frac{R\theta_L}{2}\right)$

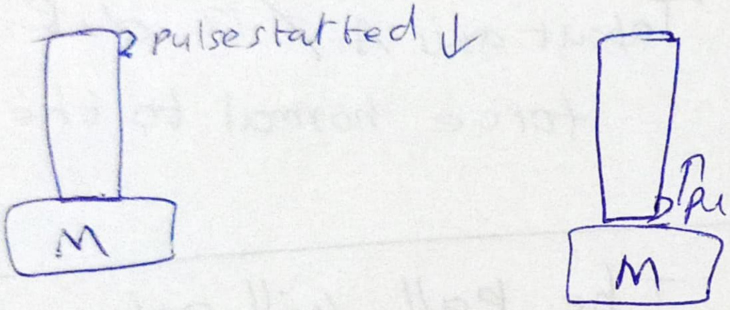
$Lw = \sqrt{12Rg}$ θ

→ 

(force acts 2 times)

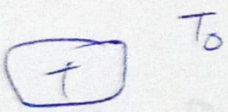
→ A sensor displays powers as $\log_2\left(\frac{P}{P_0}\right)$

If initial reading is 1 & P is increased 2^8 times then new reading ~~is 8~~ = ~~8~~ $\boxed{9}$ $\left(1 + \lg\left(\frac{P_f}{P_i}\right)\right)$

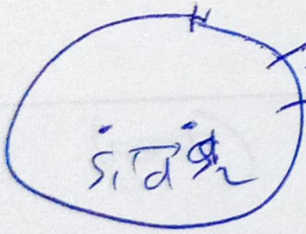
→ 

Velocities are not equal at the mid point.

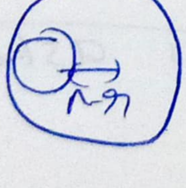
→ Amount of heat radiated by a body = ~~$\sigma A (T^4 - T_0^4)$~~



$\sigma A T^4$

→ 

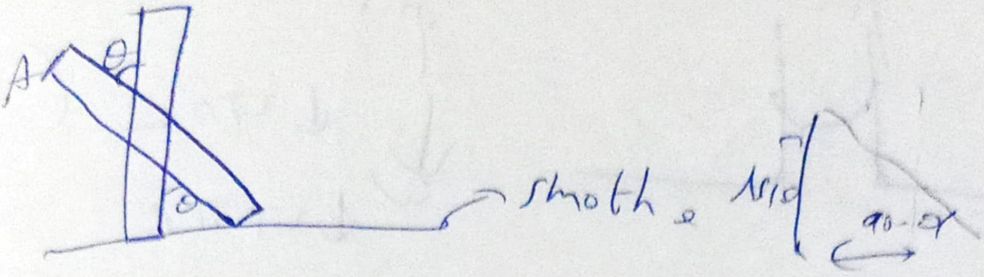
→ distance between fringes increases.

→  

$I = mr^2 + m(r-g)^2$

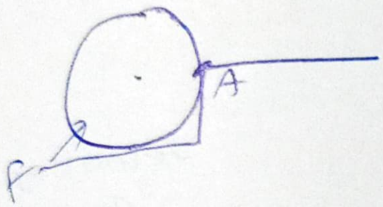
$K = \frac{1}{2}\omega_0^2\left(mr^2 + m(r-g)^2\right)$

→

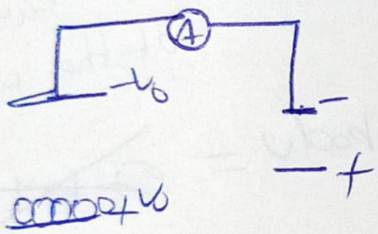


$x = -\frac{l}{2}\cos\theta \qquad y = l\sin\theta$

$$\boxed{\left(\frac{x}{l/2}\right)^2 + \left(\frac{y}{l}\right)^2 = 1}$$ ellipse



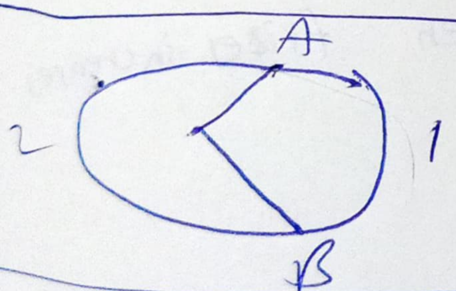
τ about axis $A \neq 0$ due to a force normal to the sphere.



The ball will get same potential & get repelled

$$\frac{kq}{r} = V_0$$

average current ↑ (not zero)



$T_{AB_1} > T_{AB_2}$ (area)

→ Whenever velocity is asked see w.r.t which frame.

Normal force is always along the common normal

Did you know?

If all our newspapers were recycled, we could save about 250,000,000 trees each year.

It takes 90% less energy to recycle aluminium cans than to make new ones.

Point of application of pseudo force is not C.O.M

Work done by conservative force is independent of F.O.Reference.

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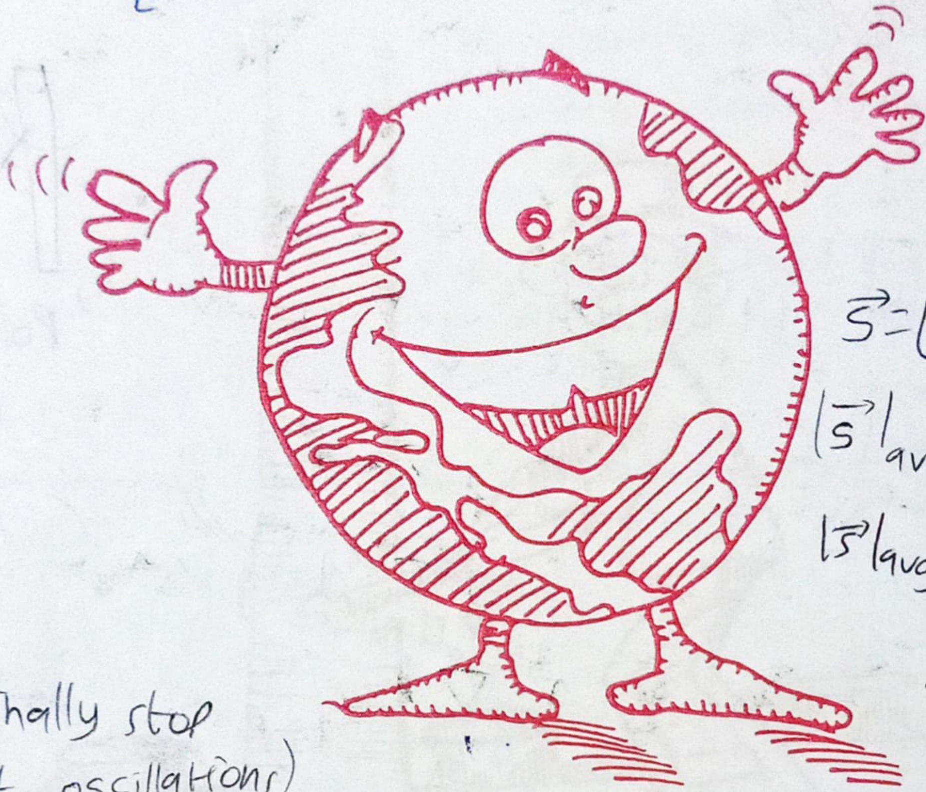
ω_{max} which can be detected $= \frac{\sqrt{1+m^2}}{m} \times \frac{1}{RC}$

m = modulation index

$$\boxed{\frac{d\vec{A}}{dt} = \vec{\omega} \times \vec{A}}$$

Earth Facts!

$I = \frac{1}{2}\epsilon_0 E_0^2 c$



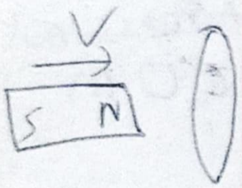
$\vec{S} = [\vec{E} \times \vec{H}]$

$|\vec{S}|_{avg} = \frac{1}{2}\epsilon_0 E_0^2 c$

$|\vec{S}|_{avg} = \frac{1}{2}\epsilon E^2 v$

$\mu = \sqrt{\mu_r \epsilon_r}$

$\boxed{\mu_r \approx 1}$ ↓ for most objects



It will finally stop (Not oscillations)

The Earth is the only planet on the solar system to have the three forms of water—liquid, gas, and solid.

$Z = \sqrt{\frac{\mu}{\epsilon}}$

impendence of interface.

A day on Earth is 23 hours, 56 minutes, and four seconds.

mobility of e^- is more than holes
holes will move in valence band
e^- will move in conduction band (empty)

colour Me

$= C_{AB} = \frac{\epsilon_0 A}{d}$

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