CIRCULAR MOTION

$\omega = \frac{d\theta}{dt}$; $v = r\frac{d\theta}{dt}$; $v = r\ \omega$; $\omega = 2\pi n$;

$T = \frac{2\pi}{\omega}$; $n = \frac{1}{T} = \frac{\omega}{2\pi}$; $a = r\ \alpha$; $a = \frac{v^2}{r} = r\omega^2$

C.P. force = $\frac{mv^2}{r} = m\, r\, \omega^2$; $v = \sqrt{\mu\ r\ g}$; $\tan\theta = \frac{v^2}{rg}$

GRAVITATION

$V = \frac{-GM}{r}$; $V_c = \sqrt{\frac{GM}{R+h}} = \sqrt{g_h\ (R+h)}$

$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}} = 2\pi\sqrt{\frac{(R+h)}{g_h}}$; $T^2 \propto r^3$

$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$; B.E. = $\sqrt{\frac{GMm}{R}}$;

For orbiting satellite; B.E. = $\frac{GMm}{2\ (R+h)}$

ROTATIONAL MOTION

$I = \sum m\ r^2 = \int r^2\ d\ m$; $I = M\ K^2$; $\tau = I\ \alpha$

KE $= \frac{1}{2} I \omega^2$; For rolling body, K.E. $= \frac{1}{2} MV^2 \left(1 + \frac{K^2}{r^2}\right)$

Conservation of angular momentum $I_1 \omega_1 = I_2 \omega_2$

M.I.of (i) ring $= Mr^2$, (ii) disc $= \frac{Mr^2}{2}$,

(iii) hollow sphere $= \frac{2}{3} Mr^2$ (iv) solid sphere $= \frac{2}{5} Mr^2$,

(v) thin rod $= \frac{MI^2}{12}$, (vi) rect.bar $= M \left(\frac{I^2}{12} + \frac{b^2}{12}\right)$

Equation of motion, (i) $\omega = \omega_0 + \alpha t$; (ii) $\theta = \omega_0 t + \frac{1}{2} \alpha t^2$;

(iii) $\omega^2 = \omega_0^2 + 2 \alpha \theta$

OSCILLATIONS

Differential Equation, (i) of Lin. S.H.M. $\frac{d^2 x}{d t^2} + \frac{k}{m} x = 0$

or $\frac{d^2 x}{d t^2} + \omega^2 x = 0$

(ii) of Ang. S.H.M. :- $\frac{d^2\theta}{d t^2} + \frac{K}{I}\theta = 0$,

$\frac{d^2 x}{d t^2} = - \omega^2 x$; $\frac{dx}{dt} = \pm \omega \sqrt{a^2 - x^2}$;

$x = a \sin (\omega t + \alpha)$

$T = \frac{2\pi}{\omega} = 2\pi \sqrt{\frac{m}{k}} = \frac{2\pi}{\sqrt{\text{acc,per unit displacement}}}$

$= 2\pi \sqrt{\frac{\text{mass}}{\text{force per unit displacement}}}$

K .E. $= \frac{1}{2}\ m\ \omega^2\ (a^2 - x^2)$; P.E. $= \frac{1}{2}\ M\ \omega^2\ x^2$;

Total Energy = $\frac{1}{2}$ m $a^2\ \omega^2 = 2\pi^2$ m $a^2\ n^2$

For simple pendulum, $T = 2\pi \sqrt{\frac{1}{g\ ;}}$

For oscillating magnet, $T = 2\pi \sqrt{\frac{1}{MB}}$

$R = \sqrt{a_1^2 + a_2^2 + 2a_1\, a_2 \cos(\alpha_1 - \alpha_2)}$;

$$tan\ \emptyset = \frac{a_1 \sin\ \alpha_1 + a_2 \sin \alpha_2}{a_1 \cos \alpha_1 + a_2 \cos \alpha_2}$$

ELASTICITY AND PROPERTIES OF FLUIDS

Tensile Strain $= \frac{I}{L}$; Tensile stress $= \frac{F}{A}$; $Y = \frac{M\,g\,L}{\pi\, r^2 I}$

Volume Strain $= \frac{d\,V}{V}$; Volume stress $= \frac{F}{A}$ = dP ;

$K = -\ V\ \frac{dP}{dV}$

Shearing strain $= \frac{\Delta\, x}{I} = \Delta\ \theta$; Shearing stress $= \frac{F}{A}$;

$n = \frac{F}{A \; \Delta\theta}$; $\sigma = \frac{r/R}{l/L} = \frac{Rl}{lR}$

Work done in stretching a wire = $\frac{1}{2}$ x load x extension.

Work done per unit volume = $\frac{1}{2}$ x stress x strain

$\text{Cos}\,\theta = \frac{T_1 - T_2}{T}$ $\qquad h = \frac{2\,T\cos\theta}{r\;\rho\;g}$

WAVE MOTION

Equation of progressive wave :-

In + ve x - direction, $y = a \sin 2\pi \left(\frac{t}{T} - \frac{x}{\lambda}\right)$

In - ve x - direction , $y = a \sin 2\pi \left(\frac{t}{T} + \frac{x}{\lambda}\right)$

Phase difference between two points x apart = $\frac{2\pi\, x}{\lambda}$

Number of beats per sec. = $n_1 \sim n_2$

Doppler effect : $n = n \left(\frac{V + u_o}{V - u_s}\right)$ when both are approaching each other.

$n = n \left(\frac{V - u_o}{V + u_s}\right)$ When both are receeding away from each other.

$n = n \left(\frac{V}{V - u_s}\right)$ when source is approaching towards stationary listner

$n = n \left(\frac{V}{V + u_S}\right)$ when source is receeding from stationary listner

$n = n \left(\frac{V + u_O}{V}\right)$ when listner is approaching stationary source

$n = n \left(\frac{V - u_O}{V}\right)$ when listner is receeding from stationary source

STATIONARY WAVES

Transverse Waves along a string , $V = \sqrt{\frac{T}{m}}$,

$n = \frac{P}{2I} \sqrt{\frac{T}{m}}$

Melde's Experiment :

Parallel position, $N = 2n = \frac{P}{I} . \sqrt{\frac{T}{m}}$

Perpendicular position , $N = n = \frac{P}{2I} \sqrt{\frac{T}{m}}$

For both positions , Tp^2 = a constant

Air columns : closed at one end, $n = \frac{V}{4\ I}$ and odd harmonics.

Open at both ends , $n = \frac{V}{2\,I}$ and integer multiples of n.

Resonance tube : $V = 4n\ (I + 0.3\ d)$

R A D I A T I O N

a + r + t + 1 ;

Stefan's law , $\frac{Q}{At} = \sigma\ T^4$

Newton's law , $\frac{dQ}{dt} = k\ (\theta - \theta_0)$

Radiation correction $\Delta\ \theta = \frac{1}{2}\ (\theta - \theta)$

KINETIC THEORY

Regnault's method: $m_o c_p \left(\theta - \frac{\theta 1 + \theta 2}{2}\right) = (m + w)\ (\theta_1 - \theta_2)$

$C_p - C_v = \frac{R}{J}$, $c_p - c_v = \frac{R}{MJ}$, $\frac{cp}{cv} = \frac{Cp}{Cv} = \gamma$

$L = Li + Le$, $Le = \frac{PdV}{J}$

$\overline{c} = \frac{\sum c}{n}$, $\overline{c^2} = \frac{\sum c^2}{n}$,

R.M.S. vel, $C = \sqrt{\overline{c^2}} = \sqrt{\frac{\sum c^2}{n}}$

$P = \frac{1}{3} \rho \; C^2 = \frac{1}{3} \frac{M}{V} C^2 = \frac{I \; n \; m \; C^2}{3 \quad V}$

K.E. per unit vol. $= \frac{3}{2}$ p ; K.E. per mole $= \frac{3}{2}$ RT

$C = \sqrt{\frac{3RT}{M}}$; K.E. PER MOLECULE $= \frac{3}{2} \frac{RT}{N} = \frac{3}{2}$ Kt

THERMODYNAMICS

Van der Waals' equation, $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

covolume, b = 4 × actual volume occupied by molecules.

WAVETHEORY AND

INTERFERENCE OF LIGHT

$n = \frac{c1}{c2} = \frac{\lambda 1}{\lambda 2}$; $n = \frac{\sin i}{\sin r}$

Bright Point :- Path Difference = $n\lambda$; $x_n = \frac{D}{d} n\lambda$

Dark Point :- Path Difference = $(2n - 1)\frac{\lambda}{2}$,

$x_n = \frac{D}{d}(2n - 1)\frac{\lambda}{2}$

$X = \frac{D}{d}\lambda$; $\lambda = \frac{D}{d} X$; $d = \sqrt{d_1 - d_2}$

ELECTROSTATICS

T.N.E.I. = $\sum q$;

E due to (i) charged sphere = $\frac{q}{4\pi\varepsilon_0 k r^2}$

(ii) charged cylinder = $\frac{q}{2\pi\varepsilon_0 k r} = \frac{a\ \sigma}{k\varepsilon_0 r}$

(iii) any charged conductor at the point near it = $\frac{\sigma}{k\varepsilon_0}$

Mech. Force per unit area of charged conductor = $\frac{\sigma^2}{2k\varepsilon_0}$

Energy per unit volume $= \frac{1}{2}\ k\ \varepsilon\ {}_{0}\ E^2$

$C = \frac{Q}{V}$; For parallel plate condenser, $C = \frac{A\ E_0\ k}{d}$

Energy of a charged condenser $= \frac{1}{2}\ QV\ = \frac{1}{2}\ CV^2\ = \frac{1}{2}\ \frac{Q^2}{C}$

In series, $\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \ldots\ldots\ldots\ldots. + \frac{1}{Cn}$

In parallel, $C = C_1 + C_2 + C3 + \ldots\ldots\ldots\ldots + C_n$

CURRENT ELECTRICITY

Wheatstone's Net Work, $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

Meter Bridge, $\frac{X}{R} = \frac{l_X}{l_R}$

Potentiometer, $\frac{E_1}{E_2} = \frac{l_1}{l_2}$

While assistin & opposing, $\frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 + l_2}$

Internal resistance of a cell, $r = \left(\frac{l_1 - l_2}{l_2}\right) R$

MAGNETIC EFFECT OF CURRENT

Moving coil Galvanometer : $I = \frac{k}{nAB}\theta$

AMMETER, $s = \frac{I_g G}{I - I_g}$; voltmeter, $R = \frac{V}{I_g}$

Tangent Galvanometer, $I = \frac{2 r B_H}{\mu_0 n} \tan\theta = k \tan\theta$

MAGNETISM

M= 2ml; $B_{axil} = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$; $B_{eqa} = \frac{\mu_0}{4\pi}\frac{M}{r^3}$

For any point, $B = \frac{\mu_0}{4\pi}\frac{M}{r^3}\sqrt{3\cos^2\theta + 1}$;

$\alpha = \tan^{-1}\left(\frac{1}{2}\tan\theta\right)$ OR $\tan\alpha = \frac{1}{2}\tan\theta$

$V_{axial} = \frac{\mu_0}{4\pi}\frac{M}{r^2}$, $V_{eqn} = 0$, Any point, $V = \frac{\mu_0}{4\pi}\frac{M\cos\theta}{r^2}$

ELECTRO MAGNETIC INDUCTION

$e = -\frac{d\emptyset}{dt}$; charge induced = $\frac{\emptyset_1 - \emptyset_2}{R}$

Straight conductor, e = B l V

Earth Coil $B_H = \left(\frac{kR}{2nA}\right) \alpha_1$, $B_v = \left(\frac{kR}{2nA}\right) \alpha_2$

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

$e = e_0 \sin\omega t = 2\pi fnAB \sin 2\pi nt$

$I = \frac{e}{R} = I_0 \sin\omega t$; $e_{rms} = \frac{e_0}{\sqrt{2}},$ $I_{rms} = \frac{I_0}{\sqrt{2}}$

$X_L = \omega L = 2\pi f L$

$X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

ATOMS, MOLECULES AND NUCLEI

$r_n = \frac{\varepsilon_0 n^2 h^2}{\pi m e^2}$, $E_n = \frac{m e^4}{8 \varepsilon_0^2 n^2 h^2}$,

$\bar{v} = \frac{1}{\lambda} = \frac{m e^4}{8 \varepsilon_0^2 ch^3} \left(\frac{1}{p^2} - \frac{1}{n^2}\right)$

$\frac{\mu \varepsilon^4}{8 E_0^2 \chi \eta^3} = P$

$$\frac{dN}{dt} = -\lambda N = N_{0e}^{-\lambda t}$$

$$T = \frac{\log_e 2}{\lambda} = \frac{0.693}{\lambda} \; ; \; \lambda = \frac{0.693}{T} \; ; \; \lambda = \frac{\left|\frac{dN}{dt}\right|}{N}$$

ELECTRONS AND PHOTONS

$$A \text{ photon} = hv = \frac{hc}{\lambda} \; ; \; w = hv_0 = h\frac{c}{\lambda_0}$$

$$\frac{1}{2} m V^2{}_{max} = h(v - v_0) = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$