Physics formulae

Rotational Dynamics.

1. $I = \sum_{i=1}^{n} m_i r_i^2$

2) M.I of a uniform rod

i) Centre and perpendicular

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

ii) End of the Rod

$$I = \frac{Ml^2}{3}$$

iii) Circular Ring

$$I = MR^2$$

iv) thin circular disc,

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

3) Radius of gyration.

$$K = \sqrt{\frac{r_1^2 + r_2^2 + \dots + r_n^2}{n}}$$

4) Angular Momentum,

$$L = mr^2\omega = I\omega$$

5) $\tau = \frac{dL}{dt}$

6) $P = \tau\omega$

7) $I\omega = \text{constant}$

8) K.E of rotating body $= \frac{1}{2} I\omega^2$

9) K.E of rolling body,

$$E = \frac{1}{2} I\omega^2 + \frac{1}{2} mv^2$$

Periodic Motion / SHM

1. $f = \frac{1}{T}$
2. $y = r\sin\omega t$ or $y = r\sin(\omega t \pm \phi)$
3. $u = r\omega\cos\omega t = \omega\sqrt{r^2 - y^2}$
4. $a = -\omega^2 r\sin\omega t = -\omega^2 y$
5. $T = 2\pi\sqrt{\frac{l}{g}}$
6. $T = 2\pi\sqrt{\frac{m}{k}}$
7. In angular S.H.M

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

8) K.E in S.H.M $= \frac{1}{2} m\omega^2(r^2 - y^2)$

9) P.E in SHM $= \frac{1}{2} m\omega^2 y$

Total energy in S.H.M

$$E = \frac{1}{2} m\omega^2 r^2 = 2m\pi^2 f^2 r^2.$$

Fluid Statics.

1) $U = W_{air} - W_{liq}$

$U = \rho g V =$ weight of displaced liquid

2) For floating body,

$$\frac{V_1}{V} = \frac{\rho}{\rho_1}$$

3) Newton's law of viscocity

$$F = -\eta A\frac{dv}{dx}$$

4) Poiseuille's formula $V = \frac{\pi P r^4}{8\eta l}$

5) Stoke's law $F = 6\pi\eta r v$

6) Terminal velocity

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

7) Bernoulli's theorem

$$E = \frac{P}{\rho} + gh + \frac{v^2}{2} = \text{constant}$$

8) surface tension $T = \frac{F}{l}$

9) $\sigma = \frac{\text{work done in increasing area}}{\text{Increase in surface area}}$

10) Ascent formula

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

First law of Thermodynamics.

1) $W = \int_{V_1}^{V_2} P dV$

2) $dQ = dU + dW = dU + PdV$

3) $C_P - C_V = R$

4) $c_P - c_V = \gamma$

5) $W = nRT \cdot \ln \frac{V_2}{V_1}$

6) $PV^{\gamma} = \text{constant}$

7) $TV^{\gamma-1} = \text{constant}$

8) $P^{1-\gamma} T^{\gamma} = \text{constant}$

9) $W = \frac{1}{\gamma - 1}(P_1V_1 - P_2V_2)$

10) $dU = nC_v dT$

11) $dQ = C_v dT + PdV$

2nd law of Thermodynamics.

1) Efficiency of Heat engine,
$$\eta = \frac{W}{Q_1} = 1 - \frac{Q_2}{Q_1}$$

2) Efficiency of Carnot engine,
$$\eta = 1 - \frac{T_2}{T_1}$$

3) Coef of performance in fridge.
$$B = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

4) Efficiency of Petrol
$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma - 1}$$

5) change in entropy $dS = \frac{dQ}{T}$

WAVE MOTION

1) Relation bet^n frequency and time Period. $f = \frac{1}{T}$

2) Wave velocity v, frequency f and wave length λ are :- $V = \lambda f$

3) Equation of a progressive wave
$$y = a \sin \frac{2\pi}{\lambda}(Vt - x)$$

4) Differential equation of wave motion
$$\frac{d^2y}{dt^2} = v^2 \frac{d^2y}{dx^2}$$

5) Equation of stationary wave,
$$y = 2a \cos \frac{2\pi}{\lambda} x \sin \omega t.$$

6) Condition for nodes,
$$x = (n + \tfrac{1}{2}) \frac{\lambda}{2}$$

7) condition for antinodes
$$x = \frac{n\lambda}{2}$$

Mechanical Wave.

1) Velocity of longitudinal wave in gas, $V = \sqrt{\frac{B}{\rho}}$

2) Velocity of longitudinal wave in solid, $V = \sqrt{\frac{Y}{\rho}}$

3) Velocity of transverse wave
$$V = \sqrt{\frac{T}{\mu}}$$

4) Velocity of electromagnetic wave.
$$V = \sqrt{\frac{1}{\mu \varepsilon}}$$

5) Newton's formula for V.O.S
$$V = \sqrt{\frac{P}{\rho}} \cong 280 ms^{-1}.$$

6) Laplace formula
$$V = \sqrt{\frac{\gamma P}{\rho}} = 331.2 ms^{-1}$$

Waves in Pipe and Strings.

1) closed organ Pipe
$$f = \frac{v}{4L}$$

2) Open Organ Pipe
$$f = \frac{v}{2L}$$

3) Velocity of sound at 0°C
$$v_0 = v\sqrt{\frac{T_0}{T}} = v\sqrt{\frac{273}{273+\theta}}$$

4) velocity of sound at STP
$$v_0 = v - 0.61\theta$$

5) Velocity on streched string,
$$V = \sqrt{\frac{T}{\mu}}$$

6) Frequency, $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

7) Frequency, $f = \frac{1}{Ld}\sqrt{\frac{T}{\pi\rho}}$

Acoustic Phenomena:

1) Pressure Amplitude
$$\Delta P_m = BAk = v^2\rho k a$$

2) Intensity of sound
$$I = \frac{1}{2}\rho v \omega^2 a^2$$

3) Intensity level,
$$\beta = (10\log 3)\log_{10}\frac{I}{I_0}$$

4) Doppler effect.

i) Source in motion
$$f' = \frac{v}{v \pm u_s} f$$

ii) Observer in motion
$$f' = \left(\frac{v \pm u_0}{v}\right) f$$

5) Source and observer in motion
$$f' = \frac{v \pm u_0}{v \pm u_0} f$$

6) Effect of motion of the medium
$$f = \frac{(v \pm v_m) - u_0}{(v \pm v_m) - u_s} f$$

7) Beat frequency $= f_1 - f_2$

Nature and Propagation of light

1) Energy of photon
$$E = hf$$

2) Snell's law
$$\frac{\sin i}{\sin r} = \frac{c}{v} = \mu$$

Interference

1) Relation beth path difference and phase difference,
$$\phi = \frac{2\pi}{\lambda} \times x$$

2) Optical path, $\alpha = \mu \cdot d$

3) $\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2}$

4) $R = \sqrt{a_1^2 + a_2^2 + 2a_1 a_2 \cos\phi}$

5) Breadth of the fringe,
$$B_a = \frac{\lambda a D}{d} \text{ (in air)}$$
$$B_m = \frac{\lambda_m D}{d} = \frac{B_a}{\mu} \text{ (in medium}$$

6) Condition for maxima
$$\phi = 2n\pi \quad (n = 0, 1, 2 \ldots)$$
$$x = n\lambda$$

7) Condition for minima
$$\phi = (2n+1)\pi, \; n = 0, 1, 2 \ldots$$
$$\phi = (2n-1)\pi, \; n = 1, 2 \ldots$$
$$x = (2n \pm 1)\frac{\lambda}{2}$$

Diffraction

1) condition for secondary minima
$$a\sin\theta = n\lambda, \; n = \pm 1, \pm 2, \pm 3$$

2) Secondary Maxima
$$a\sin\theta = (2n+1)\frac{\lambda}{2}, \; n = \pm 1, \pm 2, \pm 3$$

3) Width of secondary maxima or minima.
$$\beta = \frac{\lambda D}{a}$$

4) Width of central maxima
$$\beta_0 = \frac{2\lambda D}{a}$$

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

6) Resolving power of microscope
$$\frac{1}{d} = \frac{2\mu \sin\theta}{\lambda}$$
7) Resolving power of telescope
$$\frac{1}{d\theta} = \frac{1}{1.22}\frac{D}{\lambda}$$

Polarisation.

1) $\tan\theta_p = \mu$
2) $\theta_p + r = 90^\circ$
3) $I \propto \cos^2\theta$ (Malus law)

Electrical Circuit.

1) $\Sigma I = 0$ (current law)
2) $\Sigma E = \Sigma IR$ (voltage law)
3) Wheatstone bridge principle,
$$\frac{P}{Q} = \frac{X}{R}$$
4) Meter bridge,
$$X = \frac{(100-l)R}{l}$$
5) Internal Resistance
$$r = \frac{R(l_1 - l_2)}{l_2}$$
6) Comparison of emf $\frac{E_1}{E_2} = \frac{l_1}{l_2}$
7) Shunt Resistance $S = \frac{I_g}{I - I_g} \times G$

Thermoelectric Effect

1) $E = a\theta + \frac{1}{2}b\theta^2$
2) $\theta_n = \frac{\theta_i + \theta_c}{2}$
3) $\theta_n = -\frac{\alpha}{\beta}$
4) $\theta_i = -\frac{2\alpha}{\beta}$
5) $P = \frac{dE}{d\theta} = \alpha + \beta\theta$
6) $\pi = T\frac{dE}{dT}$

Magnetic Field.

1) $\vec{F} = q(\vec{v} \times \vec{B})$ [Lorentz M. Force]
2) $\vec{F} = I(\vec{l} \times \vec{B})$ [current carrying conductor]
3) $T = BINA\sin\theta$
4) Moving coil galvanometer
i) $I = G\phi$
ii) $G = \frac{K}{BNA}$
iii) Current sensitivity
$$\frac{\phi}{I} = \frac{BNA}{K}$$
iv) Voltage sensitivity
$$\frac{\phi}{V} = \frac{BNA}{KR}$$
5) Hall constant, $R_H = \frac{E_H}{J_x B_z} = -\frac{1}{ne}$
6) Biot and Savart law
$$dB = \frac{\mu_0}{4\pi}\frac{Id\,d\sin\theta}{r^2}$$
7) Biot and Savart law in vector law,
$$\vec{dB} = \frac{\mu_0}{4\pi}\frac{I(\vec{dl} \times \vec{r})}{r^3}$$
8) Magnetic field at the centre of a circular coil,
$$B = \frac{\mu_0 nI}{2r}$$
9) Magnetic field on the axis of a circular coil,
$$B = \frac{\mu_0 nIa^2}{2(a^2+x^2)^{3/2}}$$
10) Magnetic field due to a straight conductor,
$$B = \frac{\mu_0 I}{4\pi d}(\sin\theta_1 + \sin\theta_2)$$
11) long conductor,
$$B = \frac{\mu_0 I}{2\pi d}$$
12) Magnetic field due to long solenoid
$$B = \mu_0 nI$$
13) Force bet^n two parallel current
$$F = \frac{\mu_0 I_1 I_2}{2\pi r}$$
14) Ampere's circuit law,
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I$$

15) Magnetic field at mid point,
$B = 0.72 \frac{\mu_0 N I}{a}$

16) Magnetic field $\vec{B}$
$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}$

Magnetic Properties of Materials

1) Intensity of magnetism,
$I = \frac{M}{V} = \frac{m}{A}$

2) Magnetic field intensity,
$B = B_0 + \mu_0 I$

3) Magnetic permeability
$\mu = \frac{B}{H}$

4) Relative permeability,
$\mu_r = \frac{\mu}{\mu_0}$

5) Magnetic susceptibility,
$\chi = \frac{I}{H}$

6) $\mu = \mu_0 (1 + \chi)$

7) Curie law, $\chi = \frac{C}{T}$

8) Coulomb's law, $F = \frac{\mu_0}{4\pi} \frac{m_1 m_2}{r^2}$

9) Magnetic field, $B = \frac{\mu_0 m}{4\pi r^2}$

10) $\vec{T} = \vec{M} \times \vec{B}$

11) Potential energy
$U = -\vec{M} \cdot \vec{B}$

12) Tangent law, $H = B \tan\theta$

Electromagnetic Induction

1) Magnetic flux area A,
$\Phi = BA\cos\theta$

2) Induced e.m.f $\mathcal{E} = -N \frac{d\phi}{dt}$

3) Motional e.m.f $\mathcal{E} = BlV$

4) Induced e.m.f in a coil rotating,
$\mathcal{E} = E_0 \sin\omega t$

5) Self induction $\phi = LI$, $\mathcal{E} = -L \frac{dI}{dt}$

6) Self inductance of a solenoid,
$L = \frac{\mu_0 N^2 A}{l}$

7) Mutual induction, $\phi_S = MI_p$
$\mathcal{E}_0 = -M \frac{dI_p}{dt}$

8) Mutual inductance of two long co-axial solenoid,
$M_{12} = M_{21} = \mu_0 \frac{N_1 N_2 A}{l}$

9) Energy stored in an inductor
$U = \frac{1}{2} L I^2$

10) Transfer ratio,
$\frac{E_S}{E_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$

11) Efficiency of transformer,
$\eta = \frac{E_S I_S}{E_P I_P}$

Alternating Current

1) Mean value of A.C.
$I_m = \frac{2I_0}{\pi} = 0.637 I_0$

2) Rms value of A.C,
$I_r = \frac{I_0}{\sqrt{2}} = 0.707 I_0$

3) Inductive Resistance
$X_L = \omega L = 2\pi f L$

4) Capacitive Reactance
$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

5) Impedance $(Z) = \sqrt{R^2 + X_L^2}$

6) In LR circuit, $\tan\theta = \frac{L\omega}{R}$

7) Impedance in circuit (CR),
$Z = \sqrt{R^2 + X_C^2}$

8) In CR circuit, $\tan\theta = \frac{X_C}{R}$

9) Impedance in LCR circuit,
$Z = \sqrt{R^2 + (X_L - X_C)^2}$

10) LCR circuit $\tan\theta = \frac{(L\omega - \frac{1}{C\omega})}{R}$

11) Resonance frequency,
$f_r = \frac{1}{2\pi\sqrt{LC}}$

12) Quality factor, $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

13) Average power over a complete
$P = E_v I_v \cos\theta$

Electrons

1) Quantization of charge
$Q = \pm ne$

2) Millikan's Oil drop experiment
i) Radius $(r) = \sqrt{\frac{9\eta v_1}{2(\rho-\sigma)g}}$
ii) Charge of the oil drop,
$q = 6\pi\eta\frac{(v_1+v_2)}{E} \times \sqrt{\frac{9\eta v_1}{2(\rho-\sigma)g}}$

3) Motion of charge particle,
i) Acceleration $(a) = \frac{eE}{me}$
ii) Relation b/t horizontal distance, x and y.
$y = \left(\frac{1}{2}\frac{eV}{med v^2}\right)x^2$
iii) vertical velocity.
$v_y = \frac{eV}{med} \times \frac{D}{V}$
iv) The angle θ, $\tan\theta = \frac{v_y}{v_x}$
$= \frac{eVD}{dmev^2}$

4) Radius $(r) = \frac{mv}{Be}$

5) Thomson's formula, $\frac{e}{m} = \frac{v'^2}{2Vd^2B^2}$

Photons

1) Energy $(E) = hf$

2) Relation b/w stopping potential v_0 and maximum K.E
$ev_0 = \frac{1}{2}mv_{max}^2$

Einstein's photoelectric eqn,
$hf = \phi + \frac{1}{2}mv^2$

work function $\phi = hf_0$

Semiconductor

In intrinsic semiconductor,
$n_e = n_h = n_i$

In extrinsic semiconductor.
$n_e \times n_h = n_i^2$

1) Electric current in a semiconductor
$I = I_e + I_h = eA(n_e v_e + x_h v_h)$

In transistor,
$I_e = I_b + I_c$

Quantisation of Energy

1) Bohr atomic model
i) $mvr = \frac{nh}{2\pi}$ ii) $hf = E_{n_2} - E_{n_1}$

2) Radius, $r_n = \frac{\varepsilon_0 n^2 h^2}{\pi m e^2}$

3) Velocity, $v_n = \frac{e^2}{2\varepsilon_0 nh}$

4) Energy, $E_n = \frac{me^4}{8\varepsilon_0^2 n^2 h^2}$

5) Wave no., $\bar{f} = \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

6) $E_n = -\frac{13.6}{n^2}eV$

7) De Broglie wavelength, $\lambda = \frac{h}{mv}$

8) De Broglie length of an electron
$\lambda = \frac{h}{\sqrt{2mE}}$

9) Electron accelerated via potential difference V, $\lambda = \frac{1}{\sqrt{2mev}}$

10) Heisenberg uncertainty principle,
$\Delta x \Delta P \geq \frac{h}{4\pi}$

11) $f_{max} = \frac{eV}{h}$ $\lambda_{min} = \frac{hc}{eV}$

12) Bragg's eqn = $2d\sin\theta = n\lambda$ $n = 1, 2,$

Radioacity and Nuclear ~~Physics~~ Reaction

1) $\frac{dN}{dt} = -\lambda N$ 2) $N = N_0 e^{-\lambda t}$

3) $T_{1/2} = \frac{0.693}{\lambda}$ 4) $T_{mean} = \frac{1}{\lambda} = \frac{T_{1/2}}{0.696}$

5) $R = R_0 e^{-\lambda t}$

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

Recent Trends in Physics

Internal body wave

1) Velocity of P-wave
$v_p = \sqrt{\frac{\lambda+2\mu}{\rho}}$

2) Eqn for speed of swave
$v_s = \sqrt{\frac{\mu}{\rho}}$