Electric charge and field.

① Quantization of charge

$$\boxed{Q = ne}$$

② Force b/w two charges q_1, q_2 Placed at Distance r from each other.

$$\boxed{F = K\frac{q_1 q_2}{r^2}} \quad \text{or} \quad \boxed{F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}}$$

③ effect of force b/w the charges in a medium

$$\boxed{F_m = \frac{F_{vac}}{K}} \qquad \boxed{K / \varepsilon_r = \frac{\varepsilon_m}{\varepsilon_0}}$$

Permitivity of medium

④ Net Force.

$$\boxed{F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}}$$

⑤ Electric field intensity due to charge q at r Distance

$$\boxed{E = \frac{Kq}{r^2}} \quad \text{or} \quad \boxed{E = \frac{F}{q_0}}$$

$q_0 \Rightarrow$ Test charge.

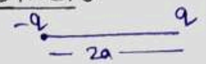
⑥ charge distribution (continuous)

$$\boxed{\lambda = \frac{dq}{dl}} \qquad \boxed{\sigma = \frac{dq}{dS}} \qquad \boxed{\rho = \frac{dq}{dV}}$$

Linear charge density — Surface " " — Volume " "

⑦ Electric Dipole moment

$$\boxed{P = q \times 2a}$$



⑧ Electric field Due to Dipole for short Dipole.

ⓐ at axial posⁿ

$$\boxed{E = \frac{2KP}{r^3}}$$

ⓑ at equitorial posⁿ

$$\boxed{E = \frac{KP}{r^3}}$$

$$\boxed{E_{axial} = 2E_{equitorial}}$$

⑨ Torque on a dipole in a uniform electric field.

$$\boxed{\vec{\tau} = \vec{P} \times \vec{E}} \quad \text{or} \quad \boxed{\tau = PE\sin\theta}$$

⑩ Electric flux

ⓐ $\boxed{\Delta\phi = \vec{E}\cdot\vec{ds}}$ ⓑ $\boxed{\phi = \oint_s \vec{E}\cdot\vec{ds}}$

⑪ Gauss's Theorem

$$\boxed{\phi = \oint_s \vec{E}\cdot\vec{ds} = \frac{q}{\varepsilon_0}}$$

⑫ Electric field Due to an infinitely long charged wire.

$$\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}}$$

⑬ Electric field Due to a uniformly charged sheet.

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$

⑭

(15) Electric field of a thin spherical shell of charge density σ & radius R.

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2} \qquad r > R$$

$$E = 0 \qquad r < R$$

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R^2} \qquad r = R$$

(16) Electric field of a solid sphere of uniform charge density ρ and radius R

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \qquad r > R$$

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{qr}{R^3} \qquad r < R$$

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R^2} \qquad r = R$$

Electrostatic Potential and Capacitance

Potential Difference.

$$\boxed{V = \frac{W}{q}} \Rightarrow V_{AB} = V_B - V_A = \frac{W_{AB}}{q}$$

Electric Potential Due to a Point charge.

$$\boxed{V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r}}$$

Electric Potential Due to a dipole.

$$V = \frac{1}{4\pi\varepsilon_0} \frac{P\cos\theta}{r^2} \qquad V_{axial} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{P}{r^2}$$

$$V_{equatorial} = 0$$

Electric field from Electric Potential.

$$E = -\frac{dv}{dr}$$

Electric potential from electric field

$$V = -\int_{\infty}^{r} \vec{E} \cdot d\vec{r}$$

Electric Potential energy of a system of two point charge.

$$U = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r_{12}}$$

Potential energy Due to a dipole.

$$U = -PE(\cos\theta_2 - \cos\theta_1)$$

if Dipole $\perp$ to E, $\theta_1 = 90^\circ$ $\theta_2 = \theta$ (say)

$$\boxed{U = -PE\cos\theta}$$

$\theta = 90^\circ$ $U = 0$

$\theta = 180^\circ$ $U = PE$

Capacitance of a conductor.

$$\boxed{C = \frac{q}{V}}$$

Capacitance of a spherical Conductor

$$C = 4\pi\varepsilon_0 R$$

Parallel plate capacitor

$$C = \frac{A\varepsilon_0}{d}$$

Reduce value of electric field.

$$\boxed{E = \frac{E_{ext}}{\varepsilon_0}}$$

applied electric field.

Capacitor in series

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$$

Capacitor in Parallel.

$$C_P = C_1 + C_2 + C_3 + \cdots$$

Energy stored in capacitor.

$$U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$$

Energy Density

$$U = \frac{1}{2}\varepsilon_0 E^2$$

Common potential $V = \dfrac{C_1V_1 + C_2V_2}{C_1 + C_2}$

Loss of energy on sharing charges.

$$\Delta U = \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1 - V_2)^2$$

Capacitance affected by medium.

$$C = KC_0 = K\frac{A\varepsilon_0}{d}$$

Capacitance of a ∥ plate Capacitor with a dielectric slab

$$C = \frac{A\varepsilon_0}{(d - t + t/K)}$$

for Conducting slab (Metal)

$$C = \frac{A\varepsilon_0}{d - t}$$

Current Electricity Formula sheet

$$\boxed{i = \frac{q}{dt}} \qquad i_{inst} = \frac{dq}{dt}, \quad Q = \int i\,dt$$

Ohm's Law

$$V = Ri$$

Resistance $R = \rho \frac{l}{A}$ ρ = resistivity of the material.

Current Density

$$j = \frac{i}{A} \quad \text{or} \quad i = \vec{J} \cdot \vec{A}$$

Conductance $G = \frac{1}{R}$

Conductivity or specific conductance :-

$$\sigma = \frac{1}{\rho}$$

Drift velocity

$$V_d = \frac{eE\tau}{m}; \quad R = \frac{ml}{ne^2\tau A}; \quad \rho = \frac{m}{ne^2\tau}$$

Relation b/w V_d & i

$$i = V_d e n A$$

other form of ohm's Law $\vec{J} = \sigma \vec{E}$ or $\vec{E} = \rho \vec{j}$

Temperature coefficient (α) $\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$

Mobility

$$\mu = \frac{V_d}{E} = \frac{e\tau}{m}$$

Resistance
- in series $R = R_1 + R_2 + R_3 \cdots$
- in parallel. $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots$

Relation b/w $\mathcal{E}$(Emf) & V (P.D)

$$V = \mathcal{E} - Ir \text{ (Discharging)}$$
$$V = \mathcal{E} + Ir \text{ (Charging)}$$

internal resistance (r)

$$r = \left(\frac{\mathcal{E}}{V} - 1\right)R$$

Combination of cell.

Series $\mathcal{E}_{eq} = \mathcal{E}_1 + \mathcal{E}_2$ $r_{eq} = r_1 + r_2$

Parallel $\mathcal{E}_{eq} = \left(\frac{\mathcal{E}_1 r_2 + \mathcal{E}_2 r_1}{r_1 + r_2}\right)$ $r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$

Joule's Law $H = i^2 R t$

Electric Power $P = \frac{W}{t} = Vi = i^2 R = \frac{V^2}{R}$

Electric energy $W = P \times t$

Power Consumed
- in series $\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} \cdots$
- in parallel. $P = P_1 + P_2 + P_3 \cdots$

Efficiency of source of emf (η) $\eta = \frac{\text{output Power}}{\text{input Power}}$

$$= \frac{Vi}{\mathcal{E}i} = \frac{V}{\mathcal{E}} = \frac{R}{R+r}$$

Kirchhoff's Law

KCL

$\Sigma i = 0$

KVL

$\Sigma \Delta V = 0$

Potentiometer

$V \propto l$

$V = K l$

$K \Rightarrow$ Potential gradient

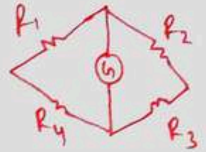
Compare emf of two cells.

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

internal resistance of a cell

$$r = \frac{\varepsilon - V}{V} \times R = \left(\frac{l_1 - l_2}{l_2}\right) \times R$$

Wheatstone Bridge.



$$\frac{R_1}{R_2} = \frac{R_4}{R_3}$$

metre bridge / slide wire bridge.

$$S = \left(\frac{100 - l}{l}\right) R$$

Magnetic effect of current
Formula sheet

Biot-Savart Law

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

vector form.

$\vec{dB} = \frac{\mu_0 i}{4\pi}\frac{\vec{dl}\times\vec{r}}{r^3}$

Magnetic field due to straight - current carrying conductor.

$B = \frac{\mu_0 i}{4\pi a}(\sin\phi_1 + \sin\phi_2)$

for infinite wire

$B = \frac{\mu_0 i}{2\pi a}$

for semi-infinite wire.

$B = \frac{\mu_0 i}{4\pi a}$

Magnetic field of a circular current loop

at centre of loop : $B = \frac{\mu_0 i}{2a}$

at an axial point at distance r

$B = \frac{\mu_0 i a^2}{2(r^2+a^2)^{3/2}}$

Ampere's circuital Law

$\oint \vec{B}\cdot\vec{dl} = \mu_0 i$

Magnetic field of a straight solenoid.

(i) ⇒ $B = \mu_0 n i$ (at a point well inside the solenoid)

(ii) $B_{end} = \frac{1}{2}\mu_0 n i$

$\boxed{n = \frac{N}{l}}$

Magnetic field of a toroidal solenoid.

$B = \mu_0 n i$ $\quad n = \frac{N}{2\pi r}$

Force on a charge moving in a magnetic field.

$F = qvB\sin\theta$ or $\vec{F} = q(\vec{v}\times\vec{B})$

Lorentz Force :- $\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$

Motion of charge inside a magnetic field.

when $\vec{v}\perp\vec{B}$ circular path

$r = \frac{mv}{qB}$, $v = \frac{qBr}{m}$ $\quad \omega = \frac{v}{r} = \frac{qB}{m}$

$T = \frac{2\pi m}{qB}$, $\nu = \frac{1}{T} = \frac{qB}{2\pi m}$

Pitch $= \frac{2\pi m v\cos\theta}{qB}$

Magnetic force Due to straight current carrying Conductor.

$F = Bil\sin\theta$ or $\vec{F} = i(\vec{l}\times\vec{B})$

Magnetic force in b/w two parallel straight current carrying conductor.

$F_{12} = F_{21} = \left(\frac{\mu_0 i_1 i_2}{2\pi d}\right)l$

Cyclotron

$(K.E)_{max} = \frac{q^2B^2r^2}{2m}$

Torque on current carrying coil in a magnetic field

$\tau = BiNA\sin\theta$

m = magnetic moment $= NiA$

$\tau = MB\sin\theta$ or $\boxed{\vec{\tau} = (\vec{M}\times\vec{B})}$

Galvanometer

Deflection $\propto$ current in the coil

$$\alpha = \frac{BiNA}{K}$$

Current sensitivity of Galvanometer

$$I_s = \frac{\alpha}{i} = \frac{BNA}{K}$$

Voltage sensitivity of a Galvanometer

$$V_s = \frac{\alpha}{V} = \frac{BNA}{KR}$$

Conversion of Galvanometer into Ammeter

$$S = \left(\frac{I_g}{I - I_g}\right) G$$

$S \Rightarrow$ shunt

$$\frac{1}{R_{eq}} = \frac{1}{S} + \frac{1}{G} = \frac{S+G}{SG}$$

$$\boxed{R_{eq} = \frac{SG}{S+G}}$$

Conversion of Galvanometer into Voltmeter

$$V = I_g(G+R)$$

$$\boxed{R = \frac{V}{I_g} - G}$$

$$R_{eq} = R + G$$

Magnetism and Matter
Formula sheet.

Coulomb's law of magnetic force.

$$F = \frac{\mu_0}{4\pi} \cdot \frac{q_{m_1} q_{m_2}}{r^2}$$ q_m (Pole strength)

Magnetic Dipole moment.

$$m = q_m \times 2l$$

$q_m \; \xleftrightarrow{2l} \; q_m$

Magnetic field of a bar magnet at an axial Point.

$$B = \frac{\mu_0}{4\pi} \cdot \frac{2mr}{(r^2 - l^2)^2}$$

for short Dipole.

$$B_{axial} = \frac{\mu_0}{4\pi} \cdot \frac{2m}{r^3}$$

Magnetic field of a bar magnet at an equatorial Point.

$$B = \frac{\mu_0}{4\pi} \cdot \frac{m}{(r^2 + l^2)^{3/2}}$$

for short Dipole.

$$B_{equa} = \frac{\mu_0}{4\pi} \cdot \frac{m}{r^3}$$

Torque on a magnet in a magnetic field.

$$\tau = mB\sin\theta \qquad \vec{\tau} = \vec{m} \times \vec{B}$$

Potential energy of a magnetic dipole in a magnetic field.

$$W = U = -mB(\cos\theta_2 - \cos\theta_1)$$

$$\vec{m} \perp \vec{B} \Rightarrow P.E = 0 \qquad U = -mB\cos\theta = -\vec{m} \cdot \vec{B}$$

Magnetic dipole moment of a revolving electron.

$$\mu_e = \frac{evr}{2}$$

Gauss law in magnetism

$$\phi_B = \oint_S \vec{B} \cdot \vec{ds} = 0$$

Horizontal component of earth $\vec{B}$

$$B_H = B\cos\delta$$

Relation b/w the elements of earth's magnetic field

$$B_H = B\cos\delta$$

$$B_V = B\sin\delta$$

$$\boxed{B = \sqrt{B_H^2 + B_V^2}}$$

$$\boxed{\frac{B_V}{B_H} = \tan\delta}$$

magnetic permeability (μ)

$$\mu_r = \frac{\mu}{\mu_0}$$

μ — Permeability of material

μ_0 — " " free space

relative

relative magnetic permeability.

$$\mu_r = \frac{B}{B_0} = \frac{\mu}{\mu_0}$$

B Total magnetic field inside magnet

B_0 external magnetic field.

Magnetising force or magnetic intensity

$$\boxed{H = \frac{B_0}{\mu_0}}$$

Gauss law in magnetism

$$\phi_B = \oint_S \vec{B} \cdot \vec{ds} = 0$$

Horizontal component of earth $\vec{B}$

$$B_H = B\cos\delta$$

Relation b/w the elements of earth's magnetic field

$$B_H = B\cos\delta$$

$$B_V = B\sin\delta$$

$$\boxed{\frac{B_V}{B_H} = \tan\delta}$$

$$\boxed{B = \sqrt{B_H^2 + B_V^2}}$$

Magnetic permeability (μ)

$$\mu_r = \frac{\mu}{\mu_0}$$

μ — permeability of material

μ_0 — " " free space

relative magnetic permeability.

$$\mu_r = \frac{B}{B_0} = \frac{\mu}{\mu_0}$$

B Total magnetic field inside magnet

B_0 external magnetic field.

Magnetising force or magnetic intensity

$$\boxed{H = \frac{B_0}{\mu_0}}$$

Electromagnetic Induction (EMI)
Formula Sheet

Magnetic flux :- $\phi = BA\cos\theta$

$\phi = \vec{B}\cdot\vec{A}$

$$\boxed{\phi = \int \vec{B}\cdot d\vec{A}}$$

Faraday's law of EMI

induced emf $\boxed{\varepsilon = -\frac{d\phi}{dt}}$ for N no. of turns $\varepsilon = -N\frac{d\phi}{dt}$

Motional emf

$\varepsilon = Blv$, $i = \frac{Blv}{R}$

$$\boxed{\varepsilon = Blv\sin\theta}$$

Rotational emf

$$\varepsilon = \frac{1}{2}B\omega R^2$$

Self Inductance

$\phi = LI$ $L \rightarrow$ Coefficient of self inductance.

$\varepsilon = -L\frac{di}{dt}$

$\boxed{L = \frac{\mu_0 N^2 A}{l}} \longrightarrow$ Self-inductance of a long solenoid $\boxed{N = nl}$

Energy stored in Inductor

$$U_m = \frac{1}{2}LI^2$$

Energy Density $U_d = \frac{1}{2}\frac{B^2}{\mu_0}$

Mutual Inductance :-

$$\boxed{\phi = Mi}$$

$$\boxed{\varepsilon = -M\frac{di}{dt}}$$

Mutual inductance of two long solenoids.

$$\boxed{M = \frac{\mu_0 N_1 N_2 A}{l}}$$

A.C Generator :-

$\varepsilon = BNA\omega\sin\omega t$ $\boxed{\varepsilon = \varepsilon_0\sin\omega t}$

$$\boxed{i = i_0\sin\omega t}$$

Alternating current (A.C)
Formula sheet

Alternating current

$i = i_0 \sin\omega t$

Alternating voltage

$V = V_0 \sin\omega t$

Mean or Average value of AC

$i_{avg} = \frac{2}{\pi} i_0$ or $\boxed{i_{avg} = 63.69\% \, i_0}$

$\boxed{V = 63.69\% \, V_0}$

RMS value of AC

$i_{rms} = \frac{i_0}{\sqrt{2}}$ or $\boxed{i_{rms} = 70.7\% \, i_0}$

$\boxed{V_{rms} = \frac{V_0}{\sqrt{2}}}$

Ac circuit containing R only :-

$V = V_0 \sin\omega t$

$i = i_0 \sin\omega t$

Ac circuit containing L only :-

$V = V_0 \sin\omega t$

$i = i_0 \sin(\omega t - \pi/2)$

Phase Diff. $= \pi/2$

$X_L \Rightarrow$ Inductive Reactance

$\boxed{X_L = \omega L}$

$\boxed{X_L = 2\pi \nu L}$

AC circuit containing C only :-

$V = V_0 \sin\omega t$

$i = i_0 \sin(\omega t + \pi/2)$

$X_C = \frac{1}{\omega C}$

$\boxed{X_C = \frac{1}{2\pi\nu C}}$

Power in an a.c circuit :-

$P = Vi$

$\boxed{P = \frac{V_0 i_0}{\sqrt{2}} \cos\phi}$ $\boxed{P = V_{rms} \, i_{rms} \cos\phi}$

Resistor $P = i_{rms}^2 R$

Inductor $P = 0$ Capacitor $P = 0$

AC circuit containing (L-R) :-

$\mathcal{E}_R = \sqrt{V_L^2 + V_R^2}$

$\mathcal{E}_R \Rightarrow$ Resulting emf

impedance

$Z = \sqrt{X_L^2 + R^2}$

Phase angle

$\phi = \tan^{-1}\left(\frac{X_L}{R}\right)$

$\cos\phi = \frac{R}{\sqrt{X_L^2 + R^2}}$

AC circuit conteing R-C

$\mathcal{E}_R = \sqrt{V_C^2 + V_R^2}$

$\phi = \tan^{-1}\left(\frac{X_C}{R}\right)$

$Z = \sqrt{X_C^2 + R^2}$

$\cos\phi = \frac{R}{\sqrt{X_C^2 + R^2}}$

LCR Circuit

$$\mathcal{E}_R = \sqrt{(V_L - V_C)^2 + V_R^2}$$

$$\boxed{Z = \sqrt{(X_L - X_C)^2 + R^2}}$$

$$\boxed{\cos\phi = \frac{R}{\sqrt{(X_L - X_C)^2 + R^2}}}$$

$$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

Resonance condition

$$X_L = X_C \qquad \boxed{Z = R} \qquad i_{max.} = \frac{E}{R}$$

~~Resonatir~~ Resonating frequency

$$\omega_r = \frac{1}{\sqrt{LC}}, \quad \nu_r = \frac{1}{2\pi\sqrt{LC}}$$

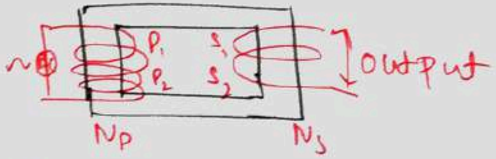
Q-Factor :-

$$Q\text{-Factor} = \frac{\text{Resonant frequency}}{\text{Band width.}}$$

$$= \frac{\omega_r}{\omega_2 - \omega_1} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Transformer

$$\boxed{\frac{\mathcal{E}_s}{\mathcal{E}_p} = \frac{N_s}{N_p}}$$



$$\eta\,(\text{Efficiency}) = \frac{\mathcal{E}_s I_s}{\mathcal{E}_p I_p} \times 100$$

$$\boxed{\frac{\mathcal{E}_s}{\mathcal{E}_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}}$$

Formula sheet
Ray optics

Relation b/w focal length & radius of curvature

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

Mirror formula

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

Linear magnification (Mirror)

$$m = \frac{h'}{h} = -\frac{v}{u}$$

Snell's law

$$\frac{\sin i}{\sin r} = \mu \text{ — Refractive index} \qquad \left[\mu_1 \sin i = \mu_2 \sin r \right]$$

Refractive index

$$\mu = \frac{c}{v} = \frac{\lambda_{vacuum}}{\lambda_{medium}}$$

$${}^1\mu_2 = \frac{1}{{}^2\mu_1}$$

Relative Refractive index

$${}^1\mu_2 = \frac{v_1}{v_2}$$

Lateral shift / Displacement

$$d = \frac{\sin(i_1 - r_1)}{\cos r_1} \times t$$

$i_1 \to$ angle of incidence
$r_1 \to$ angle of refraction.

Relation b/w apparent height & Actual height

$$\boxed{h' = \frac{h}{\mu}}$$

$h \to$ actual height
$h' \to$ apparent height

apparent shift $\Delta h = h - h'$

$$\Delta h = h\left(1 - \frac{1}{\mu}\right)$$

TIR :-

$$i_c = \sin^{-1}\left(\frac{1}{\mu}\right)$$

critical angle.

Refraction at a spherical surface

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

$\mu_1 \Rightarrow$ Rarer med.
$\mu_2 \to$ Denser med.

Lens Maker's formula

$$\frac{1}{f} = \left(\frac{\mu_2 - \mu_1}{\mu_1}\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

Lens formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

magnification (m)

$$m = \frac{h'}{h} = \frac{v}{u}$$

Power of lens

$$P = \frac{1}{f} \quad , \quad P = \frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

Combination of lens

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} \quad , \quad \boxed{P = P_1 + P_2}$$

Refraction through Prism

$$\boxed{A = r_1 + r_2} \qquad \boxed{\delta = (i_1 + i_2) - (r_1 + r_2)}$$

$$\boxed{\delta = (n-1)A}$$

Angle of Prism

Angle of deviation

$$n = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Microscope :-

Simple Microscope

$$m = \frac{\beta}{\alpha} = \frac{\text{angle substended by image}}{\text{'' '' by object}}$$

$$\boxed{m = 1 + \frac{d}{f}} \qquad \boxed{v = d}$$

Compound microscope

$$m = -\frac{v_o}{u_o}\left(1 + \frac{d}{f}\right)$$

Length of tube (L)

$$\boxed{L = v_o + u_e}$$

Telescope

Normal Adjustment

$$m = -\frac{f_o}{f_e}$$

$f_o \Rightarrow$ focal length ~~ob~~ of objective.

Special Adjustment

$$m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{d}\right)$$

$f_e \Rightarrow$ focal length of eye piece.

Formula sheet
wave optics

Resultant amplitude and intensity of interfering

$$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$$

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

$\boxed{I_{max} = 4I}$ $\boxed{I_{min.} = 0}$

$$\boxed{I_{net} = 4I\cos^2\phi/2}$$

Relation b/w Phase Diff. & Path Diff.

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda}\Delta x}$$

$\Delta\phi$ = Phase Diff.
Δx = Path Diff.

Young Double slit Experiment

Position of friges :-

$$\boxed{y_n = \frac{n\lambda D}{d}}$$ n^{th} Bright frige

$D \Rightarrow$ Distance ~~b/w~~ from Slit to Screen
$d \Rightarrow$ Distance b/w two slits.

$$\boxed{y_n = (2n-1)\frac{\lambda D}{2D}}$$ — n^{th} Dark frige.

frige width (β)

$$\beta_{Dark} = \beta_{Bright} = \frac{\lambda D}{d}$$

Diffraction :-

Path Diff. $= a\sin\theta$

Linear width of central maximum

$$\boxed{\beta_0 = \frac{2\lambda D}{a}}$$

Linear width.

Angular position of n^{th} minimum

$$\theta_n = \frac{n\lambda}{a}$$

Angular position of n^{th} secondary maximum

$$\theta_n = (2n-1)\frac{\lambda}{2a}$$

Linear width of n^{th} secondary maximum

$$\beta = \frac{\lambda D}{a}$$

$$\boxed{\beta_0 = 2\beta}$$

Law of Malus :-

$I \propto \cos^2\theta$
$I = I_0\cos^2\theta$

Brewster angle i_p

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

$$\boxed{\mu = \tan i_p}$$

Formula Sheet
Dual Nature of Radiation & Matter

Energy gained by electron $\{1eV = 1.6\times10^{-19} J\}$

$E = qV$

$$\boxed{E = eV}$$

Maximum K.E of electron

$$\boxed{K_{max.} = \frac{1}{2} m v_{max.}^2 = eV_0}$$

$V_0 \rightarrow$ Stopping Potential

Einstein's Photo electric equation

$$h\nu = \frac{1}{2} m v_{max.}^2 + \phi_0$$

$h \Rightarrow$ plank constant

ϕ_0 work function of metal

ν frequency of incident Photons.

$$\boxed{K_{max} = h\nu - \phi}$$

$$\boxed{\phi = h\nu_0}$$

Energy of Photons

$E = h\nu$

momentum of Photons

$$P = \frac{h\nu}{c} = \frac{h}{\lambda}$$

De-broglie wavelength

$$\boxed{\lambda = \frac{h}{mc}}$$

$\lambda = \frac{h}{mv}$ $\quad P = mv$

$$\boxed{\lambda = \frac{h}{P}}$$

Relation b/w K.E & P (momentum) of electron.

$$\boxed{P = \sqrt{2mK.E}}$$

$$\lambda = \frac{h}{\sqrt{2meV_0}}$$

$$\boxed{\lambda = \frac{12.3}{\sqrt{V_0}} \text{ Å}}$$

De-broglie wavelength of the electron.

$V_0 \rightarrow$ accelerating Potential.

Bragg's law

$$\boxed{\lambda = 2d\sin\theta}$$

$\theta \Rightarrow$ glancing angle.

$d \Rightarrow$ interatomic separation

$$\boxed{\lambda = 1.65 \text{Å}}$$

wavelength of e^- from Dawision & Germer Exp.

$\theta =$

Formula sheet

Atom

Distance of closest approach.

$$r_0 = \frac{4kZe^2}{mv^2}$$

Impact parameter (b)

$$b = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2 \cot(\theta/2)}{K.E}$$

Electron orbit

$$K.E = \frac{Ze^2}{8\pi\varepsilon_0 r} \qquad U/P.E = -\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r}$$

(E_T) Total Energy $T.E = -\dfrac{Ze^2}{8\pi\varepsilon_0 r}$

$$\boxed{T.E = -K.E} \quad \boxed{U = 2E_T} \quad \boxed{U = -2K.E}$$

Angular momentum of electron

$$\boxed{L = mv_n r_n = \frac{nh}{2\pi}} \qquad n = 1, 2, 3 \ldots$$

Energy

$$\boxed{\Delta E = E_2 - E_1 = h\nu}$$

Velocity of n^{th} orbit

$$v_n = \frac{2kZe^2\pi}{nh} \qquad \boxed{v_n \propto \frac{Z}{n}}$$

for H-atom $\boxed{v_n \propto \frac{1}{n}}$

Radius of n^{th} orbit

$$r_n \propto \qquad r_n = \frac{n^2h^2}{4\pi^2 m kZe^2}$$

$$r_n \propto \frac{n^2}{Z}$$

for H-atom $\boxed{r_n \propto n^2}$

1 : 4 : 9 : 16 ...

Energy of n^{th} orbit

$$\boxed{E_n = -\frac{13.6 Z^2}{n^2} eV} \qquad E_n \propto \frac{1}{n^2}$$

$$\Delta E = E_2 - E_1 = h\nu$$

$$\boxed{\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]}$$

Rydberg's constant.

Formula Sheet

Nuclei

1 amu $= 1.66 \times 10^{-27}$ kg   1 amu = 931 MeV

Nuclear Size.

$R \propto A^{1/3}$ R → radius of nucleus
A → mass number

$$\boxed{R = R_0 A^{1/3}}$$ $R_0 = 1.2 \times 10^{-15}$ m $= 1.2$ fm

Nuclear Density

$$\rho = \frac{3m}{4\pi R_0^3} = 2.30 \times 10^{17} \text{ kg/m}^3$$

Mass Defect (Δm)

$$\Delta m = Zm_p + (A-Z)m_n - m$$

Packing fraction

P.F of nucleus $= \Delta m / A$

Binding energy

$$\Delta E_b = \Delta m \times c^2$$

Radioactivity decay law

$$R = -\frac{dN}{dt} = \lambda N$$

R → Acitivity

λ → Decay constant

$N_0 \Rightarrow$ no. of Nuclei at $t = 0$

$N \Rightarrow$ no. of Nuclei at t

$$\boxed{N = N_0 e^{-\lambda t}}$$

Half life.

$$\boxed{T_{1/2} = \frac{0.693}{\lambda}}$$

no. of half life. (n)

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

Mean life. (τ)

$$\boxed{\tau = \frac{1}{\lambda}}$$

$$\boxed{\tau = 1.44\, T_{1/2}}$$

K.E of α-particle.

$$\boxed{(K.E)_\alpha = \frac{(A-4)}{A} \times Q\text{-Energy}}$$