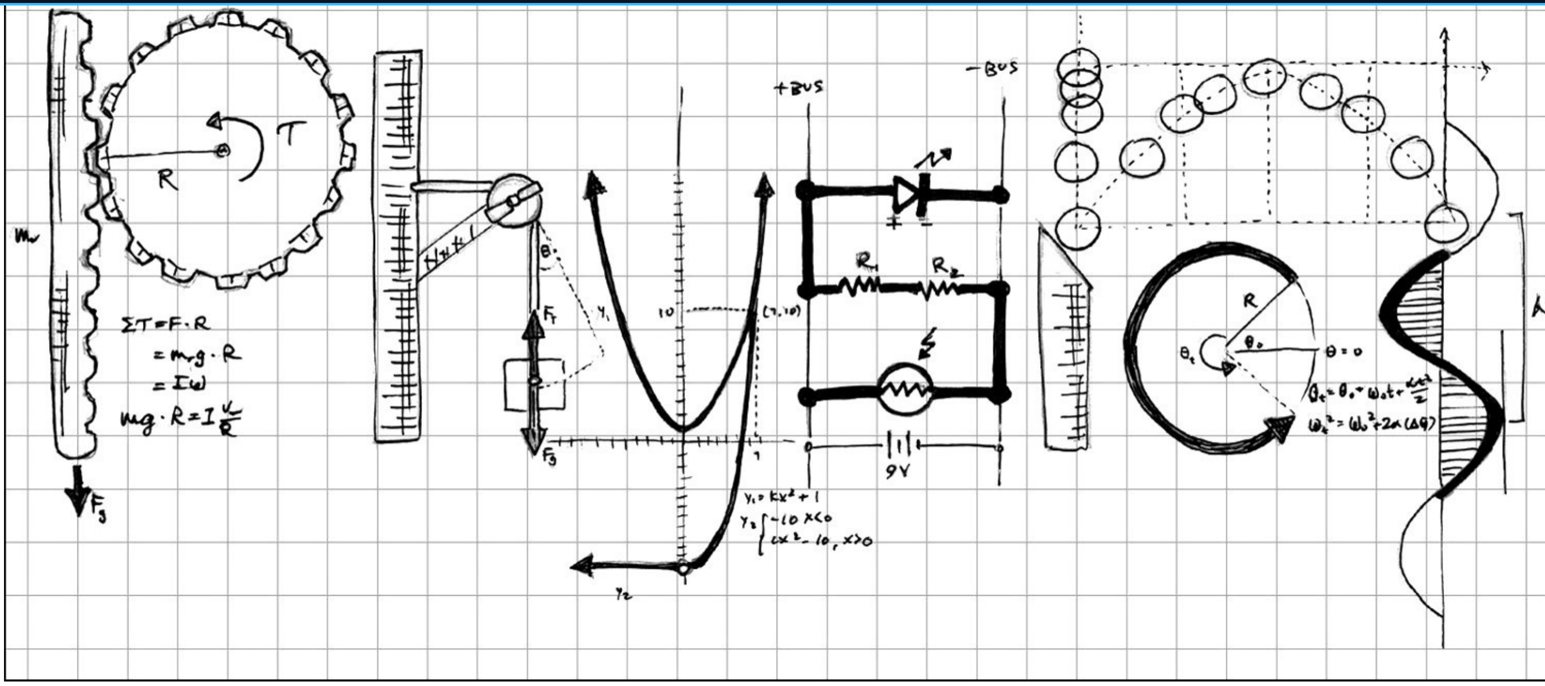


FORMULA SHEET

CLASS-12

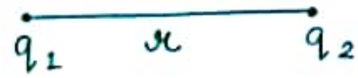
As per the reduced syllabus

[redacted]

ELECTROSTATICS

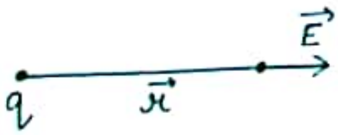
CHARGE : $e = 1.6 \times 10^{-19}\,C$ $\boxed{Q = ne}$

COULOMB'S LAW : $\boxed{F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}}$



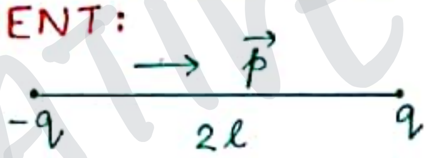
$\varepsilon_0 = 8.85 \times 10^{-12}\,C^2N^{-1}m^{-2}$

ELECTRIC FIELD : $\boxed{\vec{E}(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}}$



ELECTRIC DIPOLE MOMENT :

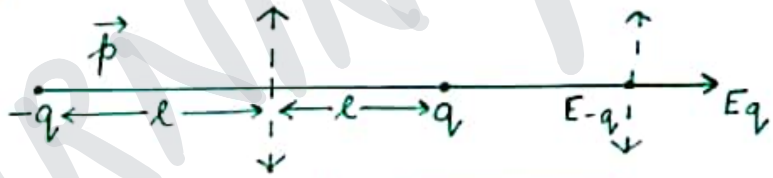
$\boxed{p = q \cdot 2l}$



ELECTRIC FIELD :

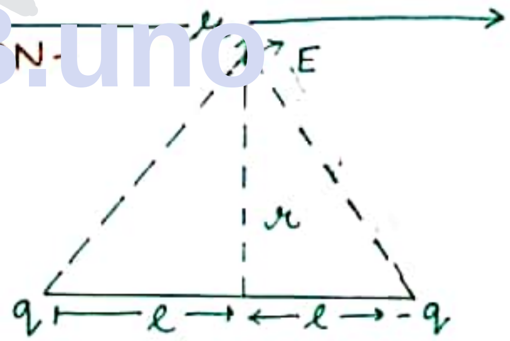
(A) ON AXIAL POSITION –

$\boxed{\vec{E} = \frac{2K\vec{p}}{r^3}}$



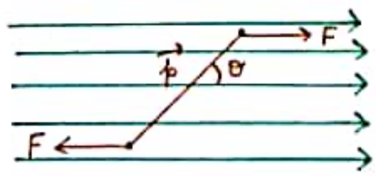
(B) ON EQUATORIAL POSITION –

$\boxed{\vec{E} = \frac{K\vec{p}}{r^3}}$



TORQUE ON A DIPOLE –

$\boxed{\vec{\tau} = \vec{p} \times \vec{E}}$



POTENTIAL ENERGY OF A DIPOLE : $\boxed{U = -\vec{p}\cdot\vec{E}}$

ELECTRIC FLUX : $\boxed{\phi = E \cdot A}$

GAUSS LAW : $\boxed{\phi = \oint E \cdot dS}$

- **FIELD OF LINE CHARGE :** $\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}}$
- **INFINITE SHEET :** $\boxed{E = \frac{\sigma}{2\varepsilon_0}}$
- **UNIFORMLY CHARGED RING :** $\boxed{E_P = \frac{Kqx}{(a^2+x^2)^{3/2}}}$

ELECTROSTATIC POTENTIAL ENERGY: $U = \frac{Kq_1q_2}{r}$

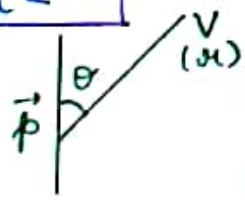
ELECTROSTATIC POTENTIAL: $\boxed{V = \frac{Kq}{r}}$

$\boxed{dV = -\vec{E}\cdot\vec{r}}$

POTENTIAL DUE TO DIPOLE: $\boxed{V = \frac{Kp\cos\theta}{r^2}}$

(A.) AT AXIAL POSITION - $\boxed{V_A = \frac{Kq}{r^2}}$

(B.) AT EQUITORIAL POSITION - $\boxed{V_B = 0}$

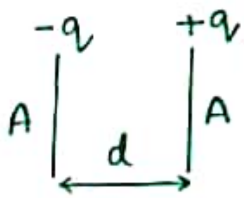


POTENTIAL DUE TO SYSTEM OF CHARGES:

$\boxed{U = \frac{Kq_Aq_B}{r}}$

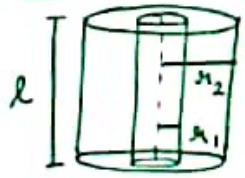
CAPACITANCE: $\boxed{C = q/V}$

PARALLEL PLATE CAPACITOR: $\boxed{C = \varepsilon_0 A/d}$



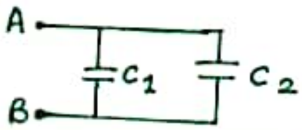
SPHERICAL CAPACITOR: $\boxed{C = \frac{4\pi\varepsilon_0 r_1 r_2}{r_2 - r_1}}$

CYLINDRICAL CAPACITOR: $\boxed{C = \frac{2\pi\varepsilon_0 \ell}{\ln(b/a)}}$

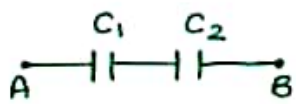


CAPACITORS IN PARALLEL:

$\boxed{C_{eq.} = C_1 + C_2}$



CAPACITORS IN SERIES: $\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}}$



FORCE BETWEEN PLATES OF A PARALLEL PLATE CAPACITOR: $\boxed{F = \frac{Q^2}{2A\varepsilon_0}}$

ENERGY STORED IN CAPACITOR: $\boxed{U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV}$

ENERGY DENSITY IN ELECTRIC FIELD: $\boxed{E = \frac{1}{2}\varepsilon_0 E^2}$

CAPACITOR WITH DIELECTRIC: $\boxed{C = \frac{\varepsilon_0 KA}{d}}$

ELECTROSTATIC POTENTIAL ENERGY: $\boxed{U = \frac{Kqq}{r}}$

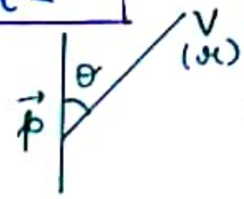
ELECTROSTATIC POTENTIAL: $\boxed{V = \frac{Kq}{r}}$

$\boxed{dV = -\vec{E}\cdot\vec{r}}$

POTENTIAL DUE TO DIPOLE: $\boxed{V = \frac{Kp\cos\theta}{r^2}}$

(A.) AT AXIAL POSITION – $\boxed{V_A = \frac{Kq}{r^2}}$

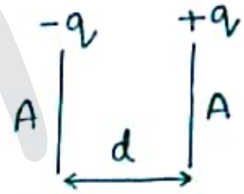
(B.) AT EQUITORIAL POSITION – $\boxed{V_B = 0}$



POTENTIAL DUE TO SYSTEM OF CHARGES:

$$\boxed{U = \frac{Kq_Aq_B}{r}}$$

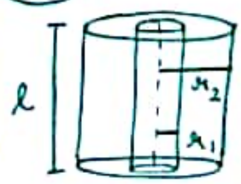
CAPACITANCE: $\boxed{C = q/V}$



PARALLEL PLATE CAPACITOR: $\boxed{C = \varepsilon_0 A/d}$

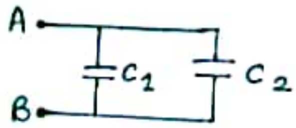
SPHERICAL CAPACITOR: $\boxed{C = \frac{4\pi\varepsilon_0 r_1 r_2}{r_2 - r_1}}$

CYLINDRICAL CAPACITOR: $\boxed{C = \frac{2\pi\varepsilon_0 \ell}{\ln(b/a)}}$

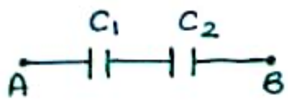


CAPACITORS IN PARALLEL:

$$\boxed{C_{eq.} = C_1 + C_2}$$



CAPACITORS IN SERIES: $\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}}$



FORCE BETWEEN PLATES OF A PARALLEL PLATE CAPACITOR: $\boxed{F = \frac{Q^2}{2A\varepsilon_0}}$

ENERGY STORED IN CAPACITOR: $\boxed{U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV}$

ENERGY DENSITY IN ELECTRIC FIELD: $\boxed{E = \frac{1}{2}\varepsilon_0 E^2}$

CAPACITOR WITH DIELECTRIC: $\boxed{C = \frac{\varepsilon_0 KA}{d}}$

CURRENT ELECTRICITY

OHM'S LAW: $\boxed{V = IR}$

CURRENT DENSITY: $\boxed{J = \frac{I}{A} = \sigma E}$

DRIFT VELOCITY: $\boxed{\vec{v}_d = -\frac{e\vec{E}}{m}\tau_{av}}$

MOBILITY: $\boxed{\mu = \frac{|\vec{v}_d|}{E}}$

TEMPERATURE DEPENDENCE OF RESISTANCE:

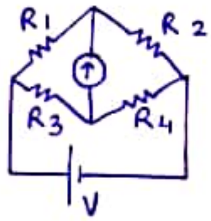
$\boxed{R = R_0(1 + \alpha \Delta T)}$

RESISTANCE OF A WIRE: $\boxed{R = \rho l / A}$ where $\rho = 1/\sigma$

KIRCHOFF'S LAWS: (i) The Junction Law

(ii) The Loop Law

RE POWER: $\boxed{P = VI} = V^2/R = I^2R$



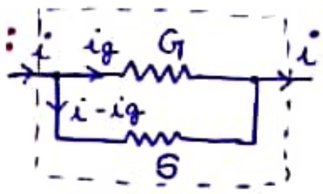
WHEATSTONE BRIDGE: Balanced if $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

METER BRIDGE: $\boxed{R = S \cdot \frac{l_1}{100 - l_1}}$

POTENTIOMETER: $\boxed{\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}}$ (comparing EMFs of two cells)

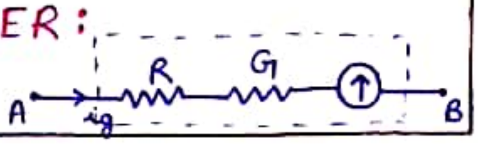
- $r = R\left(\frac{l_1}{l_2} - 1\right)$ (calculating internal resistance of a cell)

GALVANOMETER AS AN AMMETER:



$\boxed{i_g G = (i - i_g) S}$

GALVANOMETER AS A VOLTMETER:



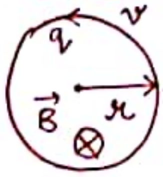
$\boxed{V_{AB} = i_g (R + G)}$

MAGNETISM

LORENTZ FORCE : $\boxed{\vec{F} = q\vec{v} \times \vec{B} + q\vec{E}}$

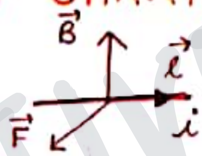
CHARGED PARTICLE IN MAGNETIC FIELD:

$\boxed{r = \dfrac{mv}{qB}}$, $\boxed{T = \dfrac{2\pi m}{qB}}$



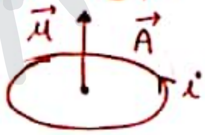
FORCE ON A CURRENT CARRYING WIRE :

$\boxed{\vec{F} = i\vec{l} \times \vec{B}}$



MAGNETIC MOMENT OF A CURRENT LOOP:

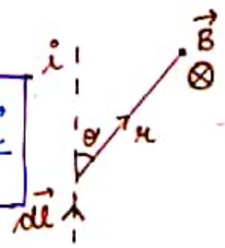
$\boxed{\vec{\mu} = i\vec{A}}$



TORQUE ON A MAGNETIC DIPOLE PLACED IN $\vec{B}$: $\boxed{\vec{\tau} = \vec{\mu} \times \vec{B}}$

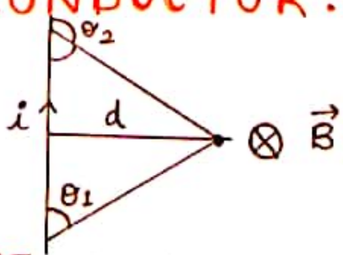
ENERGY OF A MAGNETIC DIPOLE PLACED IN $\vec{B}$: $\boxed{U = -\vec{\mu} \cdot \vec{B}}$

BIOT - SAVART LAW : $\boxed{d\vec{B} = \dfrac{\mu_0}{4\pi} \dfrac{i\, d\vec{l} \times \vec{r}}{r^3}}$



FIELD DUE TO A STRAIGHT CONDUCTOR:

$\boxed{B = \dfrac{\mu_0 i}{4\pi d}(\cos\theta_1 - \cos\theta_2)}$

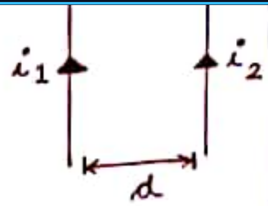


FIELD DUE TO AN INFINITE STRAIGHT WIRE:

$\boxed{B = \dfrac{\mu_0 i}{2\pi d}}$

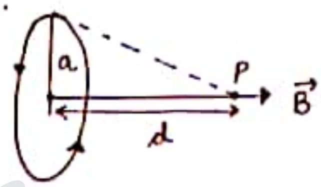
FORCE BETWEEN PARALLEL WIRES:

$$\boxed{\frac{dF}{dl} = \frac{\mu_0 i_1 i_2}{2\pi d}}$$



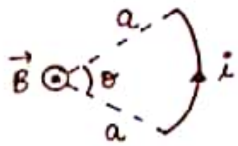
FIELD ON THE AXIS OF A RING:

$$\boxed{B_P = \frac{\mu_0 i a^2}{2(a^2 + d^2)^{3/2}}}$$



FIELD AT THE CENTRE OF AN ARC:

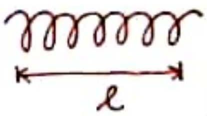
$$\boxed{B = \frac{\mu_0 i \theta}{4\pi a}}$$



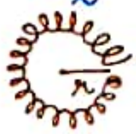
FIELD AT THE RING: $\boxed{B = \frac{\mu_0 i}{2a}}$

AMPERE'S LAW: $\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{in}$

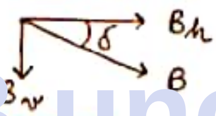
FIELD INSIDE A SOLENOID: $\boxed{B = \mu_0 n i}$, $n = \frac{N}{l}$



FIELD INSIDE A TOROID: $\boxed{B = \frac{\mu_0 N i}{2\pi r}}$



ANGLE OF DIP: $\boxed{B_h = B \cos\delta}$

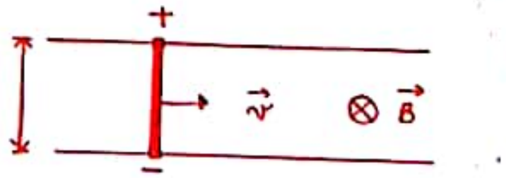


MOVING COIL GALVANOMETER: $NiAB = k\theta$

ELECTROMAGNETIC INDUCTION

MAGNETIC FLUX: $\boxed{\phi = \oint \vec{B} \cdot \vec{ds}}$

FARADAY'S LAW: $\boxed{e = -\frac{d\phi}{dt}}$



MOTIONAL EMF: $\boxed{e = Blv}$

SELF INDUCTANCE: $\boxed{\phi = Li}$, $e = -L\frac{di}{dt}$

SELF INDUCTANCE OF A SOLENOID: $\boxed{L = \mu_0 n^2 (\pi r^2 l)}$

ENERGY STORED IN AN INDUCTOR: $\boxed{U = \frac{1}{2} L i^2}$

ENERGY DENSITY OF B FIELD: $\boxed{u = \frac{B^2}{2\mu_0}}$

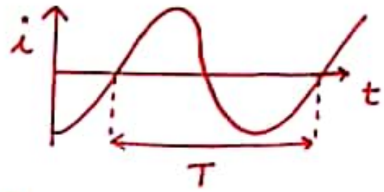
MUTUAL INDUCTANCE: $\boxed{\phi = Mi}$, $e = -M\frac{di}{dt}$

EMF INDUCED IN A ROTATING COIL: $\boxed{e = NAB\omega \sin \omega t}$

ALTERNATING CURRENT

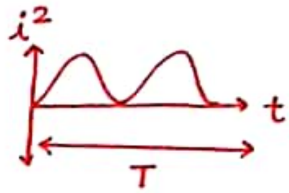
ALTERNATING CURRENT:

$$\boxed{i = i_0 \sin(\omega t + \phi),\ T = \frac{2\pi}{\omega}}$$



AVERAGE CURRENT IN AC: $\bar{i} = \frac{1}{T}\int_0^T i\,dt = 0$

RMS CURRENT: $i_{rms} = \left[\frac{1}{T}\int_0^T i^2 dt\right]^{1/2} = \boxed{\frac{i_0}{\sqrt{2}}}$



ENERGY: $\boxed{E = i_{rms}^2 RT}$

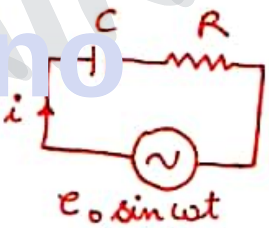
CAPACITIVE REACTANCE: $X_C = \frac{1}{\omega C}$

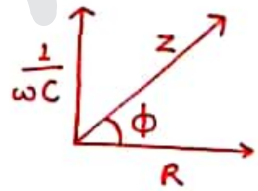
INDUCTIVE REACTANCE: $\boxed{X_L = \omega L}$

IMPEDANCE: $\boxed{Z = e_0 / i_0}$

RC CURRENT: $\boxed{Z = \sqrt{R^2 + (1/\omega C)^2}}$

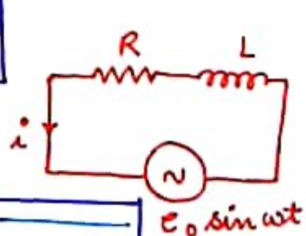
$$\tan\phi = \frac{1}{\omega CR}$$

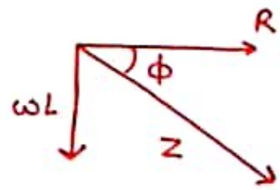




LR CIRCUIT: $\boxed{Z = \sqrt{R^2 + \omega^2 L^2}}$

$$\tan\phi = \frac{\omega L}{R}$$

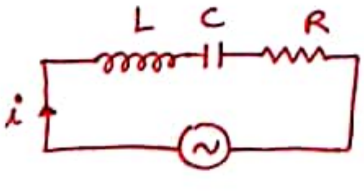


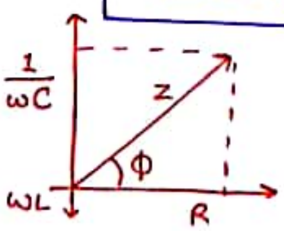


LCR CIRCUIT: $\boxed{Z = \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}}$

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

$$\boxed{\nu_{resonance} = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}}$$





$\frac{1}{\omega C} - \omega L$

SPEED OF EM WAVES IN VACUUM: $\boxed{c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}}$

EM WAVES

DISPLACEMENT CURRENT: $\boxed{I_D = \varepsilon_0 \frac{d}{dt} \phi_E}$

MAXWELL'S EQUATION:

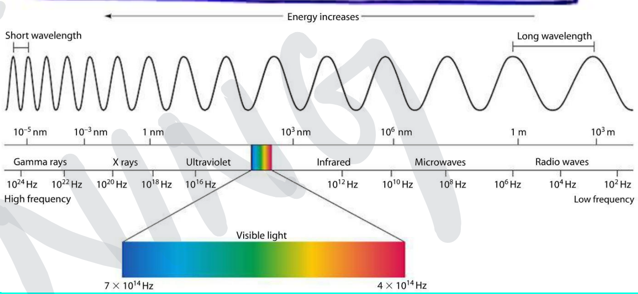
① $\boxed{\oint \vec{E} \cdot d\vec{s} = \frac{q}{\varepsilon_0}}$

② $\boxed{\oint \vec{B} \cdot d\vec{s} = 0}$

③ $\boxed{\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \phi_B}$

④ $\boxed{\oint \vec{B} \cdot d\vec{l} = \mu_0 \left(I_c + \varepsilon_0 \frac{d\phi_E}{dt} \right)}$

- $\boxed{E_y = E_0 \sin(\omega t - Kx)}$ and $\boxed{B_z = B_0 \sin(\omega t - Kx)}$
- $\frac{E_0}{B_0} = \frac{E_{RMS}}{B_{RMS}} = \frac{E}{B} = c$



RAY OPTICS

REFRACTION OF LIGHT:

- SNELL'S LAW – $\boxed{\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2}$
- μ – $\frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$
- $\boxed{{}^1\mu_2 = \frac{1}{{}^2\mu_1}}$
- $\boxed{{}^1\mu_2 \times {}^2\mu_3 = {}^1\mu_3}$
- CAUCHY'S FORMULA $\boxed{\mu = A + \frac{B}{\lambda^2}}$
- LATERAL SHIFT = $\frac{t \sin(i - r)}{\cos r}$
- LONGITUDINAL SHIFT = $\boxed{t\left(1 - \frac{1}{\mu}\right)}$

- $\mu = \dfrac{\text{real depth}}{\text{apparent depth}}$

CRITICAL ANGLE: $\boxed{C = \sin^{-1}\left(\dfrac{1}{\mu}\right)}$

REFRACTION AT CURVED SURFACE:

- $\boxed{\dfrac{\mu_2}{v} - \dfrac{\mu_1}{u} = \dfrac{\mu_2 - \mu_1}{R}}$

THIN LENSE FORMULA: $\boxed{\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}}$

POWER: $P = \dfrac{1}{f}$ [+ve for convex lens, −ve for concave lens]

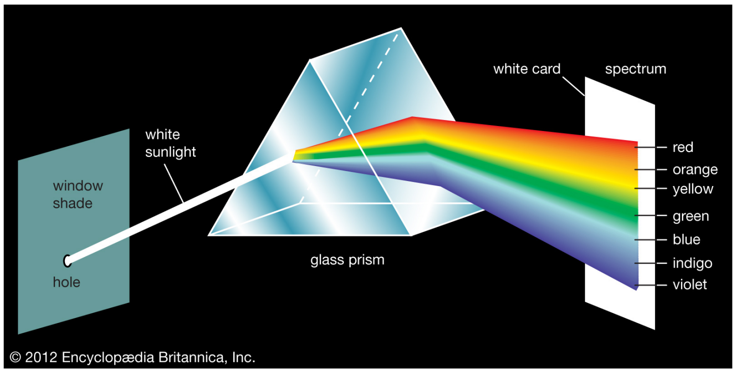
LENS FORMULA (LENS MAKER'S): $\boxed{P = \dfrac{1}{f} = \left(\dfrac{\mu_2}{\mu_1} - 1\right)\left[\dfrac{1}{R_1} - \dfrac{1}{R_2}\right]}$

THIN LENS LATERAL OR TRANSERSE MAGNIFICATION:

$$\boxed{m = \frac{v}{u} = \frac{f}{u+f} = \frac{f-v}{f}}$$

LONGITUDINAL MAGNIFICATION: $\left(\dfrac{v}{u}\right)^2$

REFRACTION IN A PRISM:



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(a.) For triangular prism:

$$r_1 + r_2 = A$$

$$(i + e) = A + \delta$$

$$\mu = \frac{\sin i}{\sin r_1} = \frac{\sin e}{\sin r_2}$$

(b.) For thin prism:

$$\delta = (\mu - 1)A$$

$$\boxed{\theta = (\delta_V - \delta_R) = (\mu_V - \mu_R)A}$$

$$\omega = \frac{\mu_V - \mu_R}{(\mu - 1)} \quad \left(\mu = \frac{\mu_V + \mu_R}{2} \approx \mu_y\right)$$

WAVE OPTICS

YOUNG'S DOUBLE SLIT EXPERIMENT:

Position of n^{th} bright fringe $x_n = \dfrac{n\lambda D}{d}$ $(n = 0, 1, 2, 3 \ldots)$

Position of n^{th} dark fringe $x_n = \dfrac{(2n-1)\lambda D}{2d}$ $(n = 1, 2, 3 \ldots)$

Fringe width (linear) $\beta = \lambda D/d$

Fringe width (angular) $\alpha = \beta/D = \lambda d$

Width of the central bright $W = \lambda D/d$

Resultant wave amplitude $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

Resultant wave intinsity $I = I_1 + I_2 + 2\sqrt{I_1I_2}\cos\phi$

$I = I_0\cos^2(\phi/2)$

FOR CONSTRUCTIVE INTERFERENCE:

Phase difference $\phi = 2n\pi \equiv 0, 2\pi, 4\pi, 6\pi \ldots$

or path difference $\Delta = n\lambda = 0, \lambda, 2\lambda, 3\lambda$

$A_{max.} = A_1 + A_2$

$I_{max.} \propto (A_1 + A_2)^2$

$\boxed{I_{max.} = 4I_0 \text{ if } I_1 = I_2 = I_0}$

FOR DESTRUCTIVE INTERFERENCE:

Path difference $\phi = (2n-1)\pi \equiv \pi, 3\pi, 5\pi \ldots$

or path difference $\Delta = (2n-1)\dfrac{\lambda}{2} \equiv \dfrac{\lambda}{2}, \dfrac{3\lambda}{2}, \dfrac{5\lambda}{2} \ldots$

$A_{min.} = A_1 - A_2$

$I_{min.} \propto (A_1 - A_2)^2$

$\boxed{I_{min} = 0 \text{ if } I_1 = I_2 = I_0}$

DIFFRACTION:

Position of n^{th} dark fringe $x_n = \dfrac{n\lambda f}{a}$ $(n = 1, 2, 3 \ldots)$

$f \rightarrow$ focal length of lens $a \rightarrow$ aperture

MODERN PHYSICS

1. Dual Nature of radiation and matter

PHOTO - ELECTRIC EFFECT

Photon's energy = $\boxed{E = h\nu = hc/\lambda}$

Photon's momentum = $p = h/\lambda = E/c$

Max. KE of ejected photo e^- = $\boxed{K_{max.} = h\nu - \phi}$

Threshold frequency in photo-electric effect : $\boxed{\nu_0 = \phi/h}$

Stopping potential : $V_0 = \frac{hc}{e}\left(\frac{1}{\lambda}\right) - \frac{\phi}{e}$

de-Broglie wavelength: $\boxed{\lambda = h/p}$

2. Atoms

ENERGY IN n^{th} Bohr's orbit: $E_n = -\frac{mZ^2e^4}{8\varepsilon_0^2h^2n^2}$, $\cancel{E_n = 13}$

$$\boxed{E_n = -\frac{13.6\,Z^2}{n^2}\,eV}$$

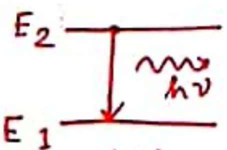
RADIUS OF THE n^{th} Bohr's orbit:

$$\boxed{r_n = \frac{\varepsilon_0 h^2 n^2}{\pi m Z e^2}}, \quad r_n = \frac{n^2 a_0}{Z}, \quad a_0 = 0.529\ \text{Å}$$

QUANTIZATION OF THE ANGULAR MOMENTUM:

$$\boxed{l = \frac{nh}{2\pi}}$$

PHOTON ENERGY IN STATE TRANSITION: $E_2 - E_1 = h\nu$



emission

absorption

WAVELENGTH OF EMITTED RADIATION:

$$\boxed{\frac{1}{\lambda} = RZ^2\left[\frac{1}{n^2} - \frac{1}{m^2}\right]}$$

X-ray SPECTRUM: $\lambda_{min.} = \frac{hc}{eV}$

MOSELEY'S LAW: $\boxed{\sqrt{\nu} = a(Z-b)}$

X-ray DIFFRACTION: $2d \sin\theta = n\lambda$

HEISENBERG UNCERTAINITY PRINCIPLE:

$\boxed{\Delta p \Delta x \geq h/(2\pi)}$ $\boxed{\Delta E \Delta t \geq h/(2\pi)}$

3. Nuclei

NUCLEAR RADIUS: $\boxed{R = R_0 A^{1/3}}$, $R_0 \approx 1.1 \times 10^{-15}$ m

DECAY RATE: $\frac{dN}{dt} = -\lambda N$

MASS DEFECT: $\Delta m = [Z m_p + (A-Z) m_n - M] c^2$

Q - value: $\boxed{Q = U_i - U_f}$

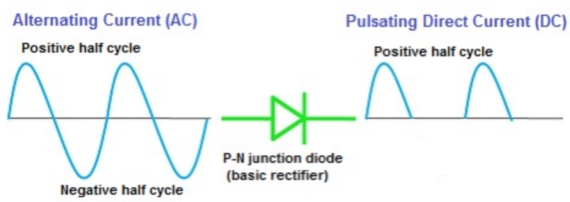
Energy released in nuclear reaction: $\boxed{\Delta E = \Delta mc^2}$

where $\Delta m = m_{reactants} - m_{products}$

SEMICONDUCTORS

- COMMON EMITTER AMPLIFIER: $\beta = \frac{I_c}{I_b}$; $\beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right)$
- AC VOLTAGE GAIN: $\beta_{ac} \times \frac{R_{out}}{R_{in}}$
- POWER GAIN: voltage gain × current gain
- HALF WAVE RECTIFIER:

image →



- FULL WAVE RECTIFIER:

image →