

FORMULA SHEET

ATDB.uno CLASS-12

As per the reduced syllabus



ELECTROSTATICS

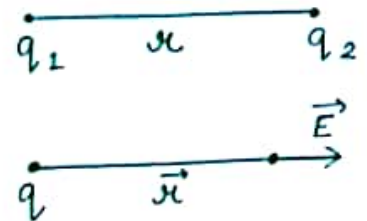
CHARGE : $e = 1.6 \times 10^{-19} \text{ C}$

$$Q = ne$$

COULOMB'S LAW:

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

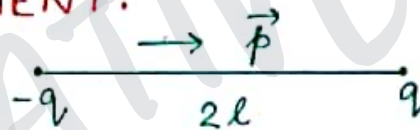


ELECTRIC FIELD:

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{u}$$

ELECTRIC DIPOLE MOMENT:

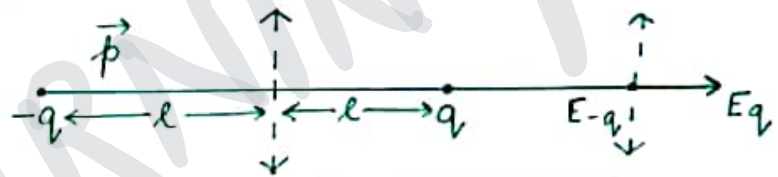
$$p = q \cdot 2l$$



ELECTRIC FIELD:

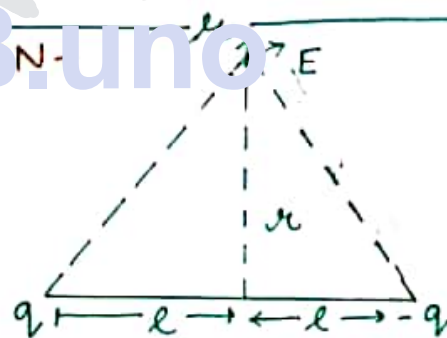
(A) ON AXIAL POSITION-

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



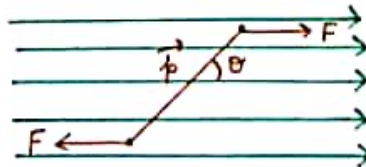
(B) ON EQUATORIAL POSITION-

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



TORQUE ON A DIPOLE-

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



POTENTIAL ENERGY OF A DIPOLE:

$$U = -\vec{p} \cdot \vec{E}$$

ELECTRIC FLUX:

$$\phi = E \cdot A$$

GAUSS LAW:

$$\phi = \oint \vec{E} \cdot d\vec{S}$$

• FIELD OF LINE CHARGE:

$$E = \frac{\lambda}{2\pi\epsilon_0 r}$$

• INFINITE SHEET:

$$E = \frac{\sigma}{2\epsilon_0}$$

• UNIFORMLY CHARGED RING:

$$E_p = \frac{kq x}{(a^2 + x^2)^{3/2}}$$

ELECTROSTATIC POTENTIAL:

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

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

POTENTIAL DUE TO DIPOLE:

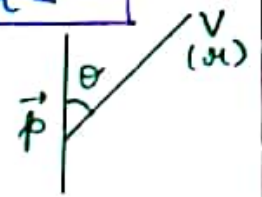
$$V = \frac{kp \cos \theta}{r^2}$$

(A) AT AXIAL POSITION -

$$V_A = \frac{kq}{r^2}$$

(B) AT EQUATORIAL POSITION -

$$V_B = 0$$



POTENTIAL DUE TO SYSTEM OF CHARGES:

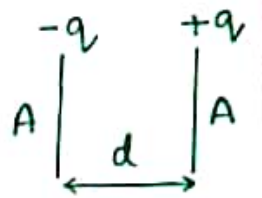
$$U = \frac{kq_A q_B}{r}$$

CAPACITANCE:

$$C = q/V$$

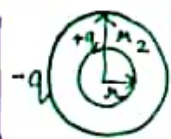
PARALLEL PLATE CAPACITOR:

$$C = \epsilon_0 A/d$$



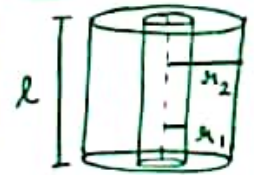
SPHERICAL CAPACITOR:

$$C = \frac{4\pi \epsilon_0 \mu_1 \mu_2}{\mu_2 - \mu_1}$$



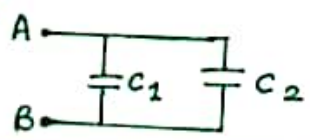
CYLINDRICAL CAPACITOR:

$$C = \frac{2\pi \epsilon_0 l}{\ln(b/a)}$$



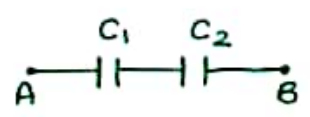
CAPACITORS IN PARALLEL:

$$C_{eq} = C_1 + C_2$$



CAPACITORS IN SERIES:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$



FORCE BETWEEN PLATES OF A PARALLEL PLATE CAPACITOR:

$$F = \frac{Q^2}{2A\epsilon_0}$$

ENERGY STORED IN CAPACITOR:

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

ENERGY DENSITY IN ELECTRIC FIELD:

$$E = \frac{1}{2} \epsilon_0 E^2$$

CAPACITOR WITH DIELECTRIC:

$$C = \frac{\epsilon_0 K A}{d}$$

ELECTROSTATIC POTENTIAL ENERGY

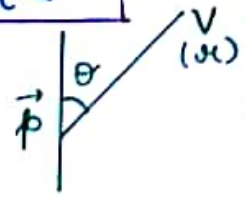
ELECTROSTATIC POTENTIAL: $V = \frac{kq}{\mu}$

$dV = -\vec{E} \cdot \vec{x}$

POTENTIAL DUE TO DIPOLE: $V = \frac{kp \cos \theta}{\mu^2}$

(A) AT AXIAL POSITION - $V_A = \frac{kq}{\mu^2}$

(B) AT EQUATORIAL POSITION - $V_B = 0$

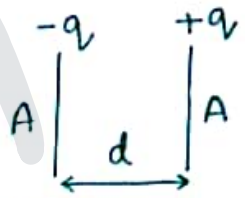


POTENTIAL DUE TO SYSTEM OF CHARGES:

$U = \frac{kq_A q_B}{\mu}$

CAPACITANCE: $C = q/V$

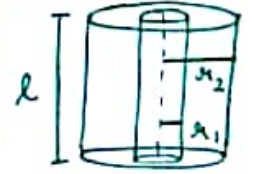
PARALLEL PLATE CAPACITOR: $C = \epsilon_0 A/d$



SPHERICAL CAPACITOR: $C = \frac{4\pi\epsilon_0 \mu_1 \mu_2}{\mu_2 - \mu_1}$

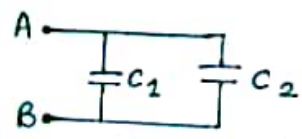


CYLINDRICAL CAPACITOR: $C = \frac{2\pi\epsilon_0 l}{\ln(b/a)}$

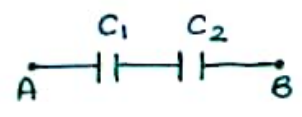


CAPACITORS IN PARALLEL:

$C_{eq} = C_1 + C_2$



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



FORCE BETWEEN PLATES OF A PARALLEL PLATE CAPACITOR:

$F = \frac{Q^2}{2A\epsilon_0}$

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

ENERGY DENSITY IN ELECTRIC FIELD: $E = \frac{1}{2} \epsilon_0 E^2$

CAPACITOR WITH DIELECTRIC: $C = \frac{\epsilon_0 KA}{d}$

CURRENT ELECTRICITY

OHM'S LAW: $V = IR$

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

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

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

TEMPERATURE DEPENDENCE OF RESISTANCE:

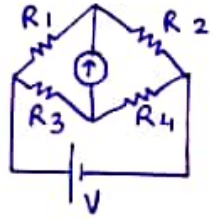
$$R = R_0(1 + \alpha \Delta T)$$

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

KIRCHOFF'S LAWS: (i) The Junction Law
(ii) The Loop Law

RE POWER: $P = VI = VR = I^2R$

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



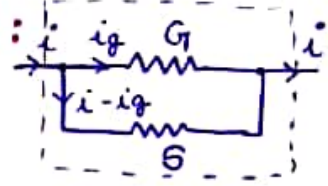
METER BRIDGE: $R = S \cdot \frac{l_1}{100 - l_1}$

POTENTIOMETER: $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ (comparing EMFs of two cells)

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

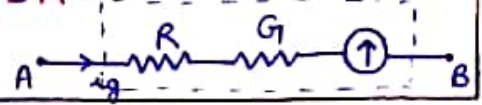
GALVANOMETER AS AN AMMETER:

$$i_g G = (i - i_g) S$$



GALVANOMETER AS A VOLTMETER:

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

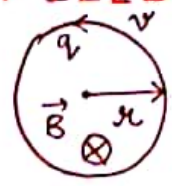


MAGNETISM

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

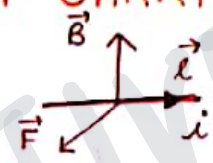
CHARGED PARTICLE IN MAGNETIC FIELD:

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



FORCE ON A CURRENT CARRYING WIRE:

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



MAGNETIC MOMENT OF A CURRENT LOOP:

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

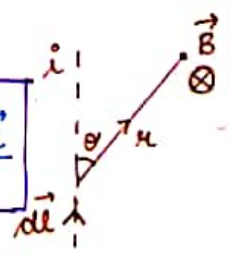


TORQUE ON A MAGNETIC DIPOLE PLACED IN \vec{B} : $\vec{\tau} = \vec{\mu} \times \vec{B}$

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

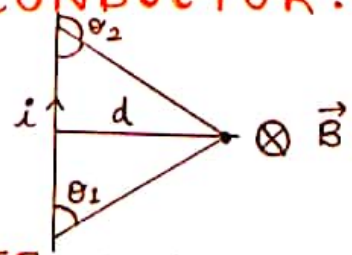
BIOT - SAVART LAW:

$d\vec{B} = \frac{\mu_0}{4\pi} \frac{i d\vec{l} \times \vec{r}}{r^3}$



FIELD DUE TO A STRAIGHT CONDUCTOR:

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

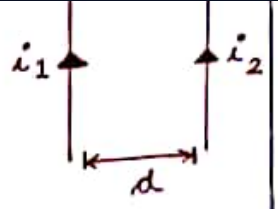


FIELD DUE TO AN INFINITE STRAIGHT WIRE:

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

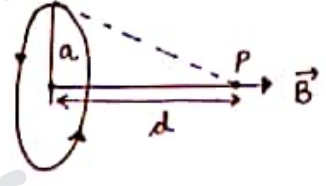
FORCE BETWEEN PARALLEL WIRES:

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



FIELD ON THE AXIS OF A RING:

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



FIELD AT THE CENTRE OF AN ARC:

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



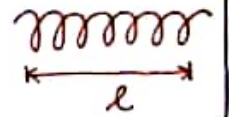
FIELD AT THE RING:

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

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

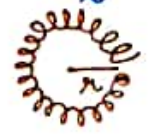
FIELD INSIDE A SOLENOID:

$$B = \mu_0 n i, \quad n = \frac{N}{l}$$



FIELD INSIDE A TOROID:

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



ANGLE OF DIP:

$$B_h = B \cos \delta$$



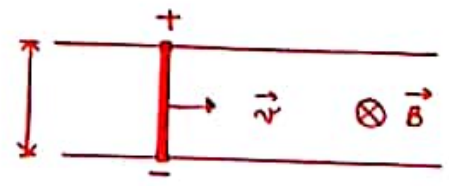
MOVING COIL GALVANO METER: $n \cdot A \cdot B = k \theta$

ELECTROMAGNETIC INDUCTION

MAGNETIC FLUX: $\phi = \oint \vec{B} \cdot d\vec{s}$

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

MOTIONAL EMF: $e = Blv$



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

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

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

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

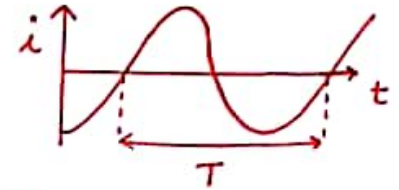
MUTUAL INDUCTANCE: $\phi = Mi, \quad e = -M \frac{di}{dt}$

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

ALTERNATING CURRENT

ALTERNATING CURRENT:

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



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

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



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

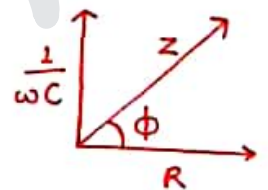
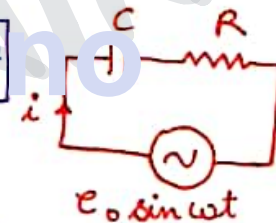
CAPACITIVE REACTANCE: $X_c = \frac{1}{\omega C}$

INDUCTIVE REACTANCE: $X_L = \omega L$

IMPEDANCE: $Z = e_0 / i_0$

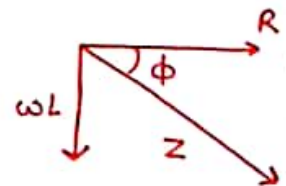
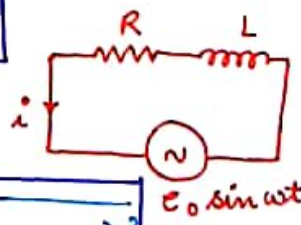
RC CURRENT: $Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$

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



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

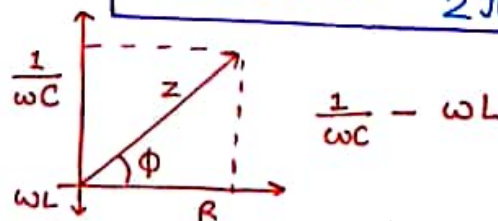
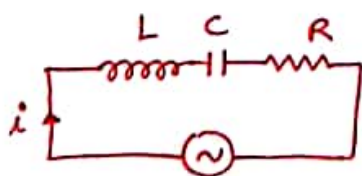
$$\tan \phi = \frac{\omega L}{R}$$



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

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

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



SPEED OF EM WAVES IN VACUUM: $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

EM WAVES

DISPLACEMENT CURRENT: $I_D = \epsilon_0 \frac{d}{dt} \phi_E$

MAXWELL'S EQUATION:

①. $\oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$

②. $\oint \vec{B} \cdot d\vec{s} = 0$

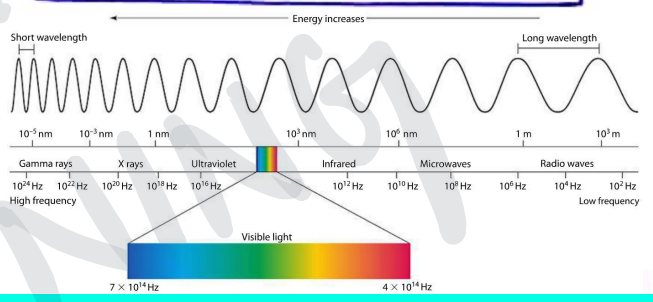
③. $\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \phi_B$

④. $\oint \vec{B} \cdot d\vec{l} = \mu_0 (I_c + \epsilon_0 \frac{d\phi_E}{dt})$

$E_y = E_0 \sin(\omega t - kx)$

and $B_z = B_0 \sin(\omega t - kx)$

$\frac{E_0}{B_0} = \frac{E_{RMS}}{B_{RMS}} = \frac{E}{B} = c$



RAY OPTICS

REFRACTION OF LIGHT:

• SNELL'S LAW - $\mu_1 \sin \theta_1 = \mu_2 \sin \theta_2$

• $\mu = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$

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

${}^1\mu_2 \times {}^2\mu_3 = {}^1\mu_3$

• CAUCHY'S FORMULA $\mu = A + \frac{B}{\lambda^2}$

• LATERAL SHIFT = $\frac{t \sin(i - r)}{\cos r}$

• LONGITUDINAL SHIFT = $t \left(1 - \frac{1}{\mu} \right)$

• $\mu = \frac{\text{real depth}}{\text{apparent depth}}$

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

REFRACTION AT CURVED SURFACE:

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

THIN LENS FORMULA: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

POWER: $P = \frac{1}{f}$ [+ve for convex lens
-ve for concave lens]

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

THIN LENS LATERAL OR TRANSVERSE MAGNIFICATION:

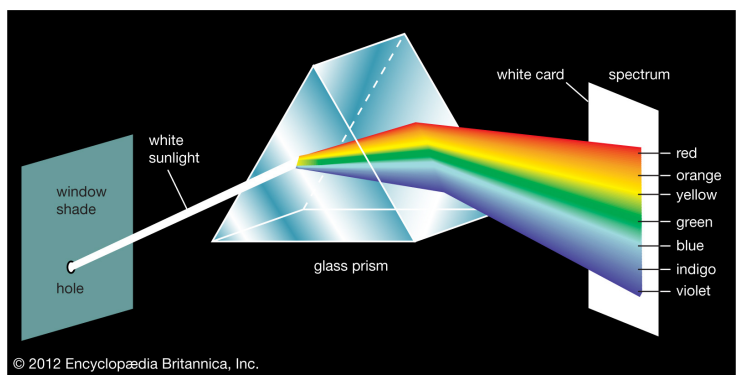
$m = \frac{v}{u} = \frac{f}{u+f} = \frac{f-v}{f}$

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

REFRACTION IN A PRISM:

(a.) For triangular prism:

$i_1 + i_2 = A$
 $(i+e) = A + \delta$
 $\mu = \frac{\sin i}{\sin r} = \frac{\sin e}{\sin r_2}$



(b.) For thin prism:

$\delta = (\mu - 1)A$
 $\theta = (\delta_v - \delta_R) = (\mu_v - \mu_R)A$
 $\omega = \frac{\mu_v - \mu_R}{(\mu - 1)} \quad (\mu = \frac{\mu_v + \mu_R}{2} = \mu_y)$

WAVE OPTICS

YOUNG'S DOUBLE SLIT EXPERIMENT:

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

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

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 intensity $I = I_1 + I_2 + 2\sqrt{I_1I_2} \cos \phi$
 $I = I_0 \cos^2(\phi/2)$

FOR CONSTRUCTIVE INTERFERENCE:

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

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

$$A_{\text{max}} = A_1 + A_2$$

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

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

FOR DESTRUCTIVE INTERFERENCE:

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

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

$$A_{\text{min}} = A_1 - A_2$$

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

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

DIFFRACTION:

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

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

ATDB.uno

MODERN PHYSICS

1. Dual Nature of radiation and matter

PHOTO-ELECTRIC EFFECT

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

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

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

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

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

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

2. Atoms

ENERGY IN n^{th} Bohr's orbit: $E_n = -\frac{mZ^2e^4}{8\epsilon_0^2h^2n^2}, E_n = -13$
 $E_n = -\frac{13.6Z^2}{n^2} eV$

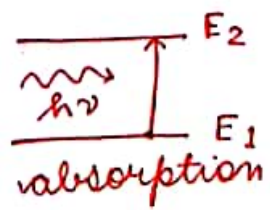
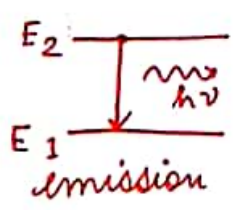
RADIUS OF THE n^{th} Bohr's orbit:

$r_n = \frac{\epsilon_0 h^2 n^2}{\pi m Z e^2}, r_n = \frac{n^2 a_0}{Z}, a_0 = 0.529 \text{ \AA}$

QUANTIZATION OF THE ANGULAR MOMENTUM:

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

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



WAVELENGTH OF EMITTED RADIATION:

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

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

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

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

HEISENBERG UNCERTAINTY PRINCIPLE:
 $\Delta p \Delta x \geq \frac{h}{2\pi}$ $\Delta E \Delta t \geq \frac{h}{2\pi}$

3. Nuclei

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

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

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

Q-value: $Q = U_i - U_f$

Energy released in nuclear reaction: $\Delta E = \Delta mc^2$
 where $\Delta m = m_{reactants} - m_{products}$

SEMICONDUCTORS

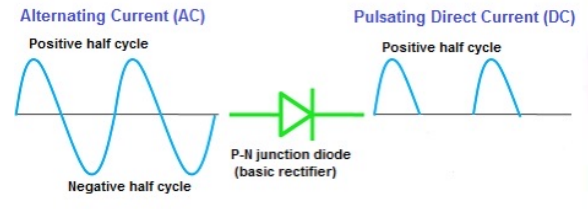
• COMMON EMITTER AMPLIFIER: $\beta = \frac{I_c}{I_b}$; $\beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right)$

• AC VOLTAGE GAIN: $\beta_{ac} \times \frac{R_{out}}{R_{in}}$

• POWER GAIN: voltage gain \times current gain

• HALF WAVE RECTIFIER:

image \rightarrow



• FULL WAVE RECTIFIER:

image \rightarrow

