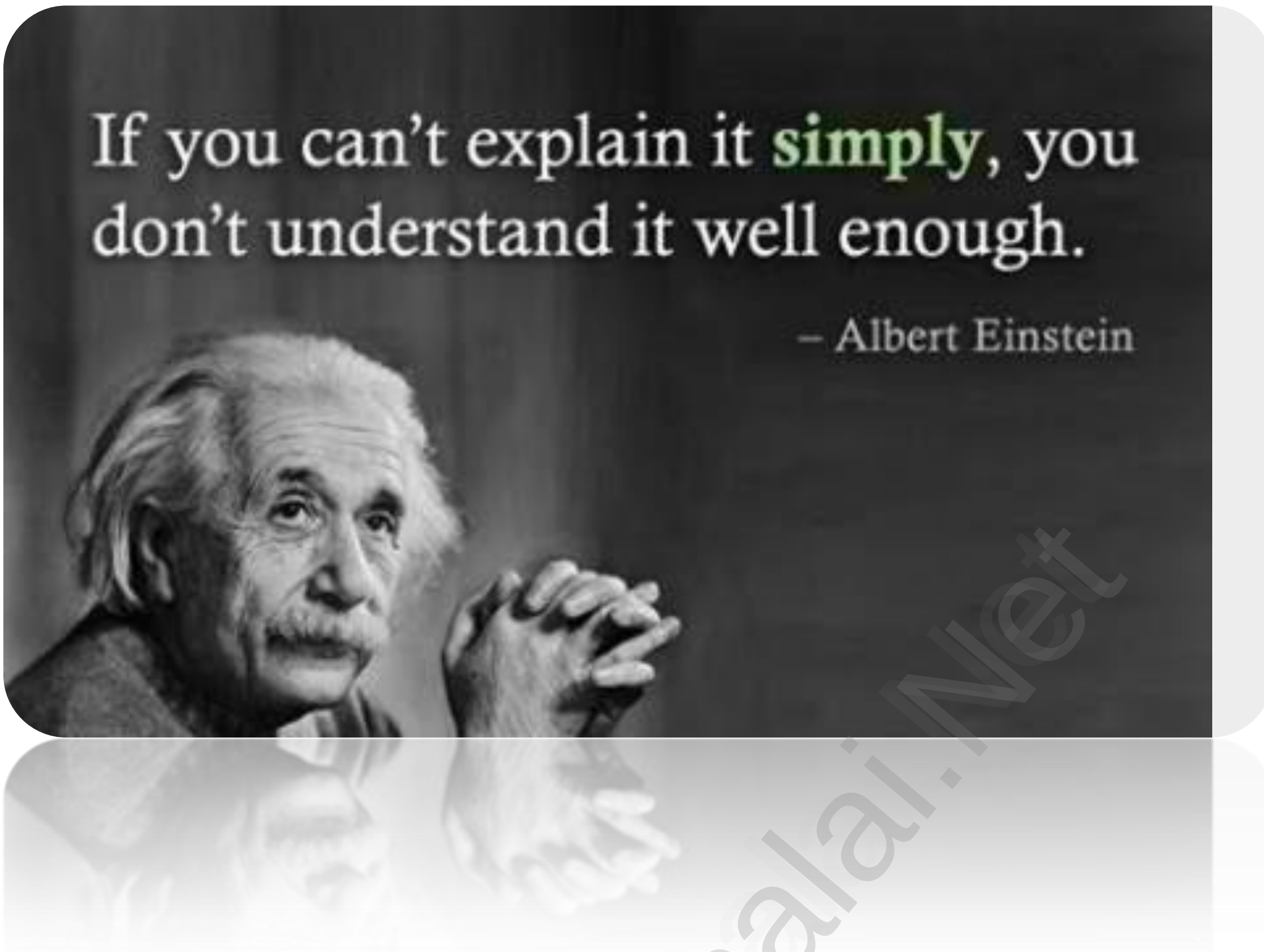


NAME

STD **SEC** **EXAM NO**

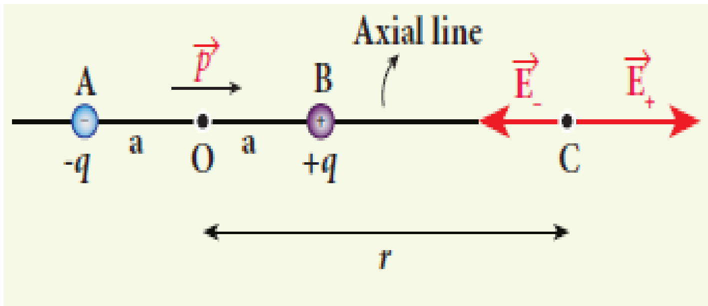
SCHOOL

CONTENTS

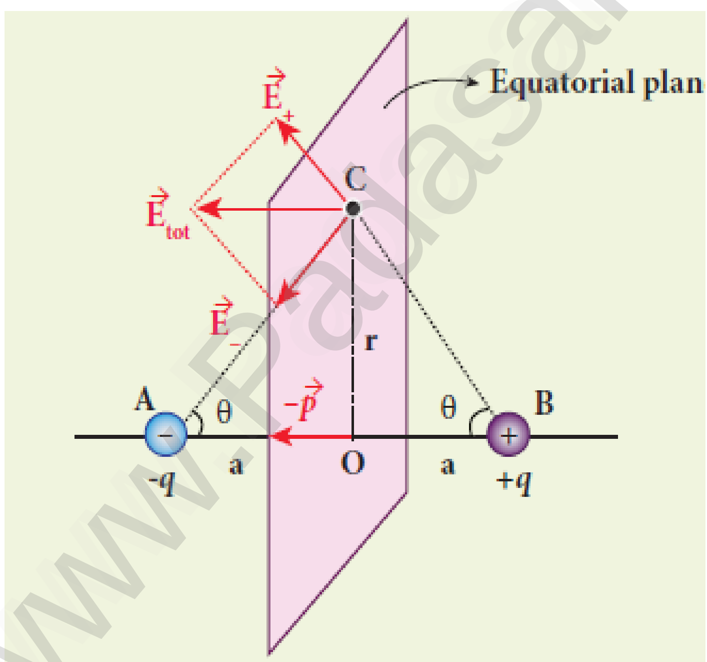
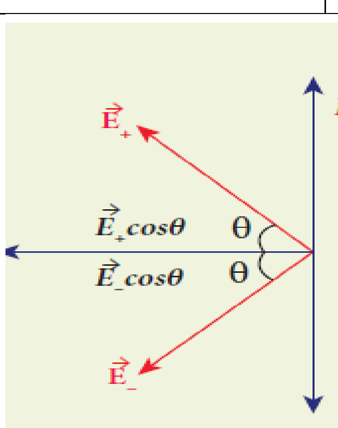
ELECTROSTATICS

FIVE MARKS

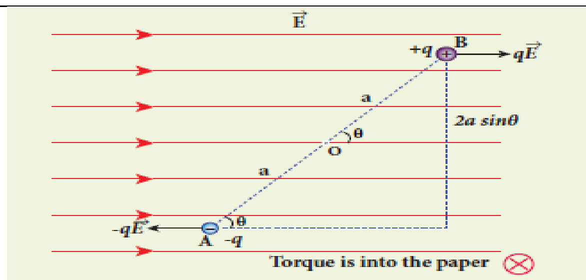
1. Calculate the electric field due to a dipole on its Axial line

Diagram		
E due to +q	$\vec{E}_+ = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-a)^2}\,\hat{p}$	
E due to –q	$\vec{E}_- = \frac{-1}{4\pi\epsilon_0}\frac{q}{(r+a)^2}\,\hat{p}$	
Resultant E	$\vec{E} = \vec{E}_+ + \vec{E}_-$	
	$\vec{E} = \frac{1}{4\pi\epsilon_0}\left\{\frac{2\vec{p}}{r^3}\right\}$	$2aq\hat{p} = \vec{p}$
Direction of E	$\vec{E}$ acts along $\vec{p}$	

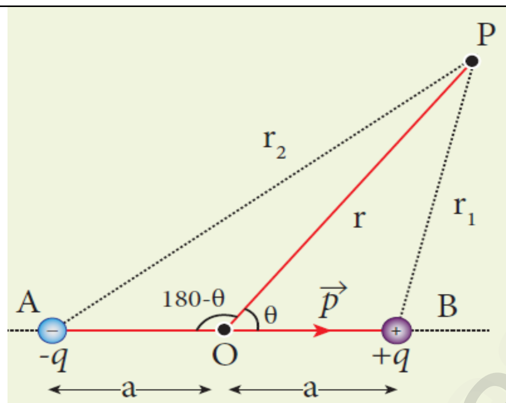
2. Calculate the electric field due to a dipole on its Equatorial line

Diagram			
E due to +q	$\lvert\vec{E}_+\rvert = \lvert\vec{E}_-\rvert = \frac{1}{4\pi\epsilon_0}\frac{q}{(r^2+a^2)}$		
	Cos θ	Parallel to axis	Adds up
	Sin θ	Perpendicular to axis	Cancels out
Resultant E	$\vec{E} = \frac{-1}{4\pi\epsilon_0}\frac{\vec{p}}{r^3}$	$\vec{p} = 2qa\hat{p}$	
Direction of E	$\vec{E}$ acts opposite to $\vec{p}$		

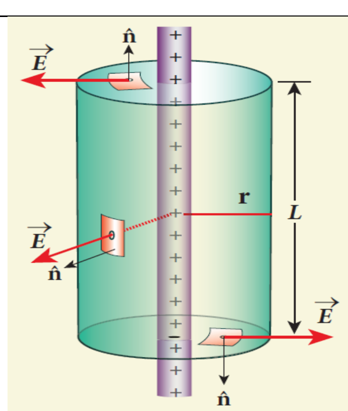
3. Torque experienced by the electric dipole

Diagram		
F on +q	F = qE (Direction of E)	
F on –q	F = -qE (opposite to E)	
Net Torque	$\tau = pE\sin\theta$	p = q X 2a
Vector form	$\vec{\tau} = \vec{p} \times \vec{E}$	

4. Electric potential due to an electric dipole

Diagram		
Potential due to +q	$\frac{1}{4\pi\epsilon_0}\frac{q}{r_1}$	
Potential due to –q	$\frac{-1}{4\pi\epsilon_0}\frac{q}{r_2}$	
	$\frac{1}{r_1} = \frac{1}{r}\{1 + \frac{a}{r}\cos\theta\}$	$\frac{1}{r_2} = \frac{1}{r}\{1 - \frac{a}{r}\cos\theta\}$
Net Potential	$V = \frac{q}{4\pi\epsilon_0}\left\{\frac{1}{r_1} - \frac{1}{r_2}\right\} - - - (1)$	
	$v = \frac{p\cos\theta}{4\pi\epsilon_0 r^2}$	

5. Obtain the expression for electric field due to an infinitely long charged wire.

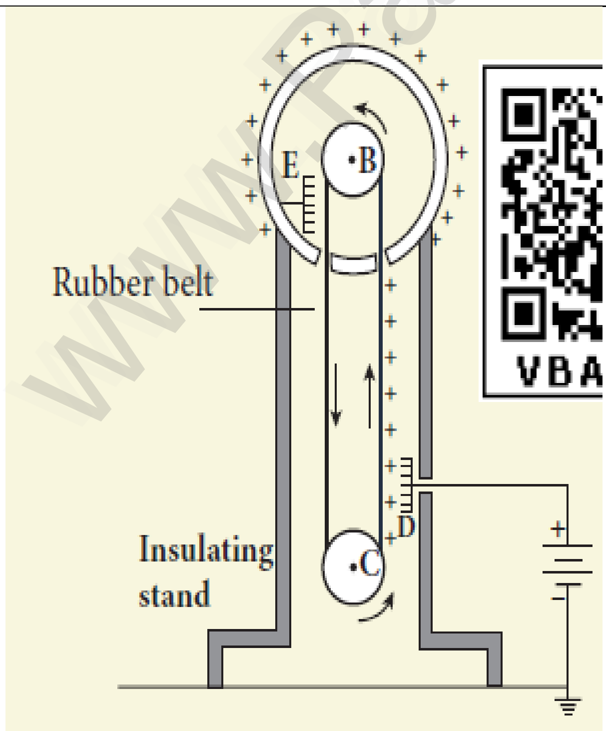
Gauss law	Gauss law states that the total flux enclosed by the surface is $\frac{1}{\varepsilon_0}$ times the net charge enclosed by the surface $\emptyset = \frac{q}{\varepsilon_0}$	(1M)
Diagram		(1M)

From flux definition	$\emptyset = E.2\pi rl$—(1)	
From Gauss law	$\emptyset = \frac{q}{\varepsilon_0} = \frac{\lambda l}{\varepsilon_0}$ – –(2)	
(1) = (2)	$E.2\pi rl = \frac{\lambda l}{\varepsilon_0}$	(1M)
Electric Field	$E = \frac{\lambda}{2\pi\varepsilon_0 r}$	(1M)
Direction	+ve Charge: Radially outward	
	-ve Charge: Radially inward	

6. Expression for energy of a capacitor

Capacitor	Stores charges
	Stores Electrostatic potential energy
work done	$dW = v.dq$
	$W = \int_0^q \frac{q}{C}.dq$
Energy	$U = \frac{Q^2}{2C}$
	$U = \frac{1}{2} C V^2$
Energy Density	$U = \frac{1}{2} \varepsilon_0 E^2$

7. Van de Graff generator

uses	➢ Produces a potential of 10^7 V ➢ To accelerate positive charges
Principle	Electrostatic induction & action of points
Diagram	
Construction	A ➔ hollow sphere on insulating stand B ➔ pulley at the centre of sphere C ➔ pulley at the bottom E & D ➔ metallic comb near the pulleys Comb D is at 10^4 V
Prevention	➢ By enclosing gas filled steel chamber at very high pressure.

THREE MARKS

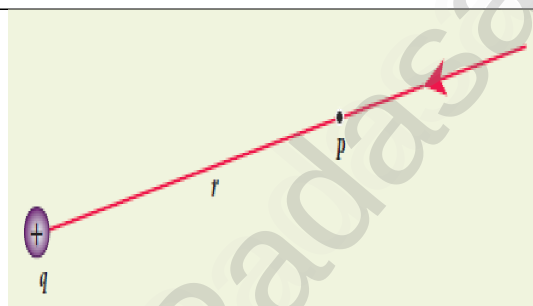
1. What are the differences between Coulomb force and gravitational force

	Coulomb	Gravitational
Nature of force	attractive and repulsive	Attraction
Constant	$K = 9 \times 10^{9}\ Nm^{2}C^{-2}$	$G = 6.67 \times 10^{-11}\ Nm^{2}Kg^{-2}$
Medium dependence	Dependent	Independent
By virtue of	Charges	Masses

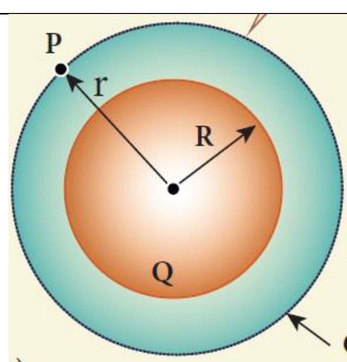
2. State the rules for drawing electric field line for the representation of electric field.

Electric field lines	Start	Positive charge
	End	Negative charge
	Direction	Direction of tangent
	More density	Strong E
	Less density	Weak E
	Two lines	Never intersect
	Positive charge	Radially outward
	Negative charge	Radially inward
	No of lines	Proportional with magnitude of Q

3. Derive an expression for electrostatic potential due to a point charge.

Diagram	
Electric potential at P	$V = -\int_{\infty}^{r} \vec{E}\,.\,\overrightarrow{dr}$
Electric Field at P	$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\,\hat{r}$
On integration	$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$

4. Obtain Electric field due to uniformly charged spherical shell

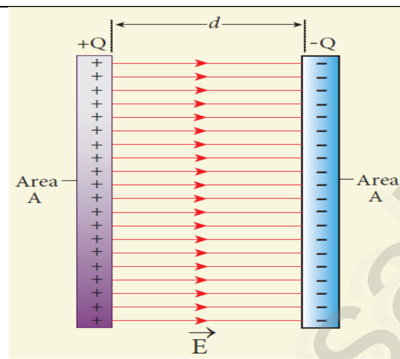
Diagram	
From flux definition	$\emptyset = E\,A = E\,.\,4\pi r^2 ---(1)$
From Gauss law	$\emptyset = \frac{q}{\varepsilon_0} ---(2)$
(1) = (2)	$E\,.\,4\pi r^2 = \frac{q}{\varepsilon_0}$

Electric Field at outside	$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$
Electric Field at the surface	$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2}\hat{r}$
Electric inside the surface	$E = 0$

5. Distinguish between Polar and Non polar molecules

	POLAR	NON POLAR
Centre of gravities of positive & negative charges	Doesn't coincide	Coincide
Example	H_2O, N_2O, HCl	H_2, N_2, O_2
Permanent dipole moment	Yes	No

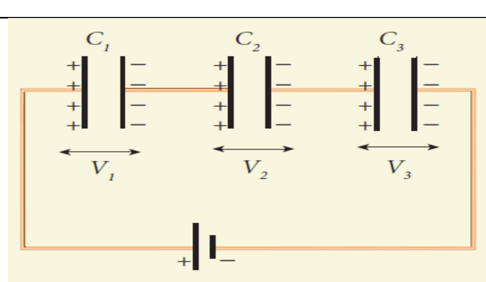
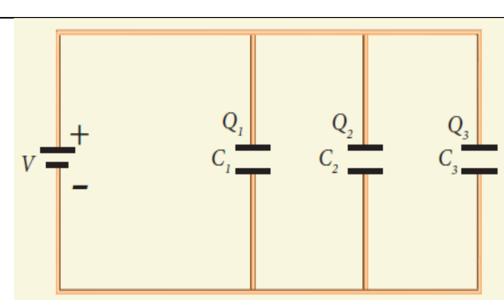
6. Obtain the expression for capacitance of a parallel plate capacitor

Diagram	
Electric field between the plates	$E = \frac{Q}{A\varepsilon_0}$
Potential difference between the plates	$V = Ed = \frac{Qd}{A\varepsilon_0}$
Capacitance	$C = \frac{Q}{V} = \frac{\varepsilon_0 A}{d}$

7. Write down the applications of capacitor

Applications of a capacitor	Flash in camera
	Defibrillator
	Ignition system
	Power transmission

8. Derive the expression for capacitance in series and parallel

	Series	Parallel
Diagram		
Conservation theorem	$V = V_1 + V_2 + V_3$	$Q = Q_1 + Q_2 + Q_3$
Effective capacitance	$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$	$C_p = C_1 + C_2 + C_3$

TWO MARKS

1. State Coulomb's law

Force is	Directly proportional to	Product of charges
	Inversely proportional to	Square of distance between the charges
Vector form		$\vec{F} = \frac{K q_1 q_2}{r^2} \hat{r}$

2. Define Electric dipole.

- Two equal and opposite charges
- Separated by a small distance

Water, ammonia, HCl

3. What is the general definition of electric dipole moment?

- Product of any one charge and distance between the charges

$$\boxed{p = 2qa}$$

4. Write the properties of equipotential surface.

- The work done to move a charge in an equipotential surface is zero.
- The electric field is normal to an equipotential surface

5. Define electric Flux

- No of electric lines of force
- Crossing given area
- Normal to field lines

$$\boxed{\emptyset = E\,A\cos\theta}$$

6. State Gauss law

Gauss law states that the total flux enclosed by the surface is $\frac{1}{\varepsilon_0}$ times the net charge enclosed by the surface

$$\boxed{\emptyset = \frac{q}{\varepsilon_0}}$$

7. What is Polarization?

Total dipole moment per unit volume of the dielectric

$$\boxed{\vec{P} = \aleph \vec{E}_{ext}}$$

8. Define Capacitance. Write its unit.

Ratio of charge to the potential developed between the plates

$$\boxed{c = \frac{Q}{V}}$$

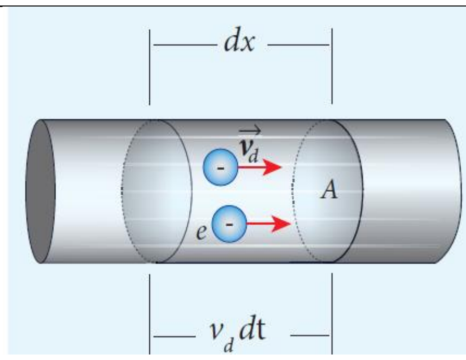
9. What is corona discharge or action of points?

- Leakage of charges from sharp points of charged conductor
- The total charge of the conductor reduces near the sharp edge

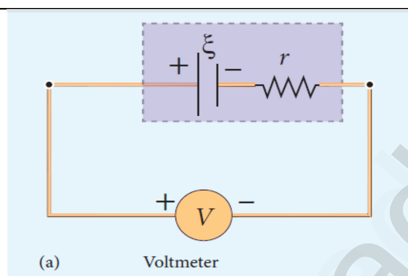
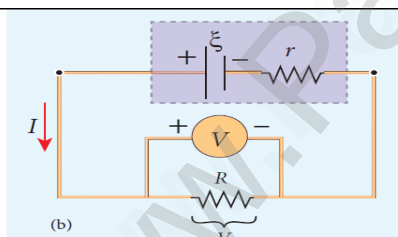
2 CURRENT ELECTRICITY

FIVE MARKS

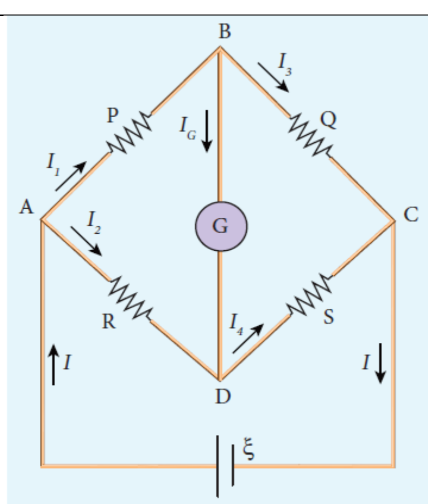
1. Microscopic model of current

Diagram	
Total charge in volume element	$dQ = (Av_d dt)ne$
Current	$I = \frac{dQ}{dt} = \frac{(Av_d dt)ne}{dt}$
	$I = nAeV_d$
Microscopic form of ohms law	$\vec{J} = \sigma \vec{E}$
Conductivity	$\sigma = \frac{ne^2 \tau}{m}$
Resistivity	$\rho = \frac{m}{ne^2 \tau}$

2. Determine the internal resistance of a cell using voltmeter.

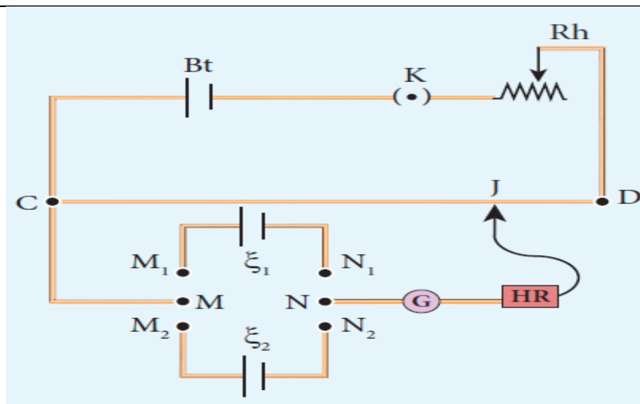
Without R		$\boxed{voltmeter = E}$
With R		$\boxed{v = IR} -- (1)$ $v = E - Ir$ $\boxed{E - V = Ir} -(2)$
(2) / (1)	$\frac{E - V}{v} = \frac{Ir}{IR}$	
Internal r	$\boxed{r = R\left(\frac{E - V}{V}\right)}$	

3. Wheatstone bridge

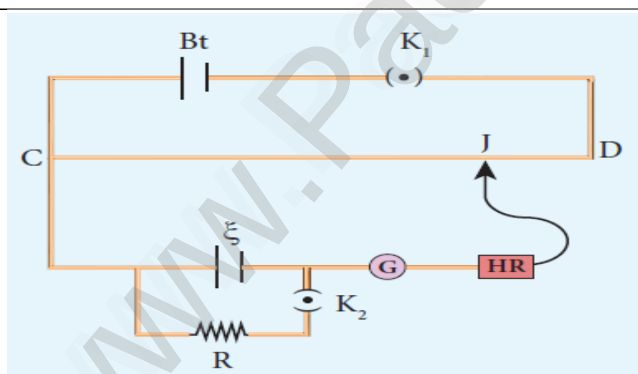
Diagram	

KCL	at junction B	$I_1 - I_g - I_3 = 0 - - - (1)$
	at junction D	$I_2 - I_g - I_4 = 0 - - - (2)$
KVL	Loop ABDA	$I_1P - I_gG - I_2R = 0 - - (3)$
	Loop ABCDA	$I_1P + I_3Q - I_4S - I_2R = 0 - - (4)$
Condition	$V_B = V_D$	$I_G = 0$
(6) / (5)	$\boxed{\frac{P}{Q} = \frac{R}{S}}$	

4. How the emf two cells are compared using potentiometer?

Diagram (1 M)		
Construction (1 M)	Primary circuit	Battery, key and potentiometer wire are in series.
	Secondary circuit	DPDT, Galvanometer, jockey and high resistance Cell of emf E_1 is connected between M_1 and N_1 Cell of emf E_2 is connected between M_2 and N_2
Working (1 + 1M)	$E_1 \alpha\, l_1$	$E_2 \alpha\, l_2$

5. Measurement of internal resistance

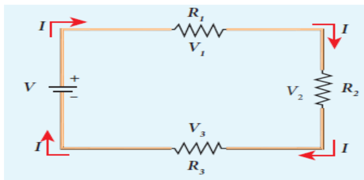
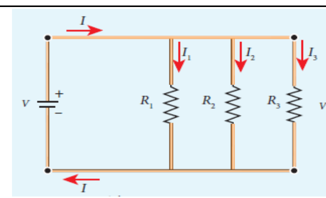
Diagram		
Construction	primary circuit	Potentiometer wire, battery and key K_1
	secondary circuit	Cell of emf E, galvanometer, high resistance and jockey A resistance R and Key K_2 are connected across the cell
Working	K_2 is open	$\boxed{E\, \alpha\, l_1 - - - (1)}$
	K_2 is closed	$\frac{ER}{R + r} \alpha\, l_2 - - - (2)$
Internal resistance	$\boxed{r = R \left\{ \frac{l_1 - l_2}{l_2} \right\}}$	

THREE MARKS

1. Distinguish between mobility and drift velocity

drift velocity	Mobility
Average velocity acquired by electron inside the conductor in an electric field	Magnitude of drift velocity acquired per unit electric field.
$\vec{V_d} = \frac{e\tau}{m}\vec{E}$	$\mu = \frac{V_d}{E}$
Unit : ms^{-1}	Unit : $m^2\,V^{-1}\,s^{-1}$

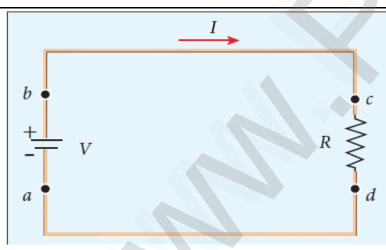
2. Resistors in series and parallel

Diagram		
Conservation theorem	$V = V_1 + V_2 + V_3$	$I = I_1 + I_2 + I_3$
From ohms law	$IR_s = IR_1 + IR_2 + IR_3$	$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$
Effective resistance	$R_s = R_1 + R_2 + R_3$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

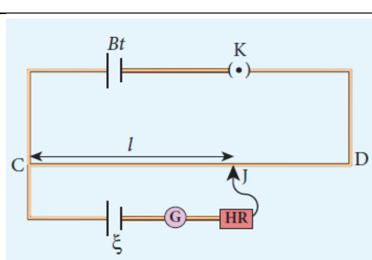
3. What is electric power and electric energy?

Electric power	Electric Energy
Rate at which the electric potential energy is delivered.	The rate at which the charge losses its electrical potential energy
$P = VI$	$H = VIt$
unit : W	Unit : J

4. Derive the expression for power $P = VI$ in electrical circuit.

Diagram	
Potential energy	$du = v.dq$
Power	$P = \frac{du}{dt} = V\frac{dQ}{dt}$
	$P = VI$

5. Explain the Principle of Potentiometer

Diagram		
Construction	Primary circuit	Battery, key and potentiometer wire in series.

	Secondary circuit	Battery of emf "e", jockey, galvanometer & high resistance
Working	$E \alpha l$	

6. State the applications of see beck effect
   - They are used in thermoelectric generators.
   - Used in power plants to convert heat into electricity.
   - Utilized in automobile for increasing fuel efficiency.
   - Used to measure the temperature difference between the object.

TWO MARKS

1. Define current

Net charge passes through any cross section of a conductor in a time.

- Scalar quantity
- Unit : A

$$I = \frac{Q}{t}$$

2. Why current is a scalar quantity?

$$I = \vec{J} . \vec{A}$$

Current is a scalar product of the current density and area vector in which the charge crosses.

3. Ohms law

At the constant temperature , the steady current flowing through a conductor is directly proportional to its potential difference between its ends

$$V = IR$$

4. Electrical resistivity (or) specific resistance
   - Resistance offered to current flow
   - By a conductor of
   - Unit length & unit area of cross section

$$\rho = \frac{RA}{l}$$

Unit : Ωm

5. Kirchhoff's current law

Algebraic sum of current at any junction is zero

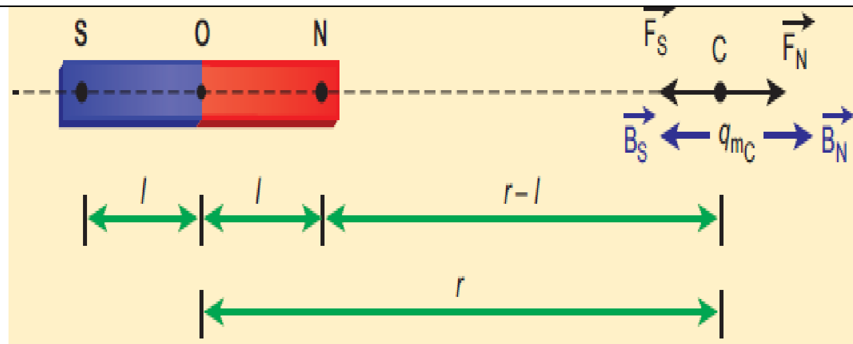
6. Kirchhoff's Voltage rule

Algebraic sum of product of current and resistance in a closed circuit is equal to algebraic sum of emf in the circuit.

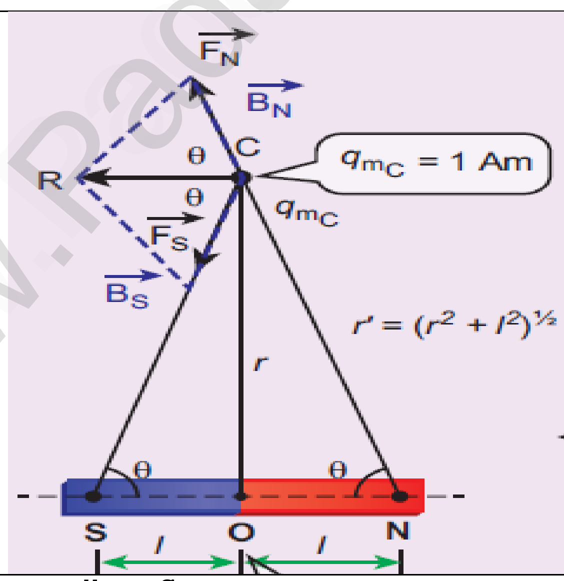
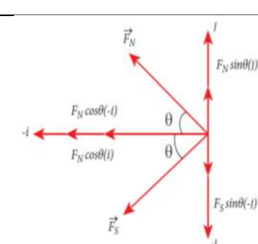
7. Which metal wire is used for meter bridge wire and why?
   - Magnanin and constantan wire
   - Low specific resistance
   - High temperature co efficient
8. Why nichrome is used as a heating element?
   - High specific resistance
   - High melting point
   - Not easily oxidized

03. MAGNETISM & MAGNETIC EFFECTS OF CURRENT

1 Axial line

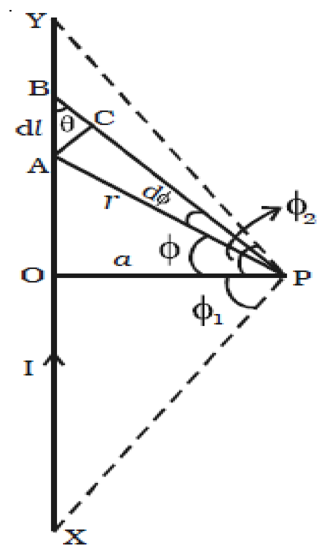
Diagram		
Field due to North pole	$\vec{B}_N = \frac{\mu_0}{4\pi}\frac{q_m}{(r-l)^2}\ \hat{i}$	
Field due to South pole	$\vec{B}_s = -\frac{\mu_0}{4\pi}\frac{q_m}{(r+l)^2}\ \hat{i}$	
Resultant B	$\vec{B} = \vec{B}_N + \vec{B}_s$	
	$\vec{B} = \frac{\mu_0}{4\pi}\left\{\frac{2rp_m}{(r^2 - l^2)^2}\right\}\hat{i}$	
	$\vec{B} = \frac{\mu_0}{4\pi}\left\{\frac{2p_m}{r^3}\right\}\hat{i}$	r >>>> l
	$\vec{B} = \frac{\mu_0}{4\pi}\left\{\frac{2\vec{p_m}}{r^3}\right\}$	$\vec{p_m} = p_m\ \hat{i}$

2 Equatorial line

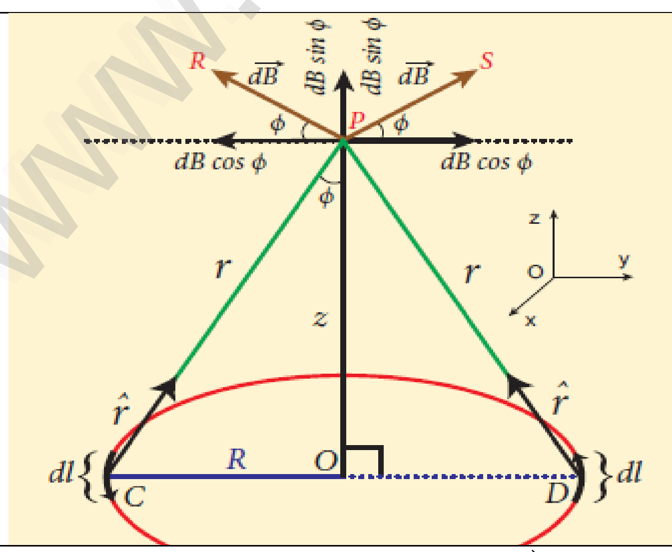
Diagram	
Field due to North pole	$\vec{F}_N = \frac{\mu_0}{4\pi}\frac{q_m}{r^2 + l^2}$ along NC
Field due to South pole	$\vec{F}_s = -\frac{\mu_0}{4\pi}\frac{q_m}{r^2 + l^2}$ along cs
$\vec{B} = -\lvert\vec{B}_N\rvert\cos\theta\ \hat{\imath} - \lvert\vec{B}_s\rvert\cos\theta\ \hat{\imath}$	
$\vec{B} = \frac{-\mu_0}{4\pi}\frac{p_m}{(r^2 + l^2)^{\frac{3}{2}}}\ \hat{\imath}$	$p_m = 2l\ X\ q_m$

$\vec{B} = \frac{-\mu_0}{4\pi}\frac{\vec{p_m}}{r^3}$	

3 Magnetic field due to long straight conductor carrying current

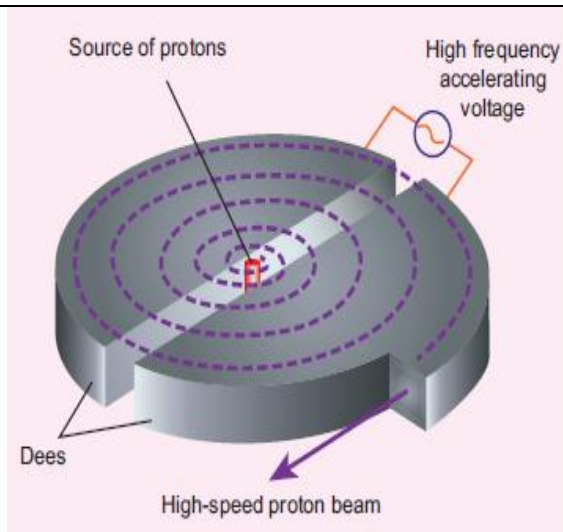
Diagram		
By Biot Savat law	$\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\,\vec{dl}\sin\theta}{r^2}$ – –(1)	
	$dl \sin\theta = r\, d\phi$ − − − −(4)	
	$\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\, d\phi}{r}$ − − − −(5)	
(6) in (5)	$dB = \frac{\mu_0 I}{4\pi a}\cos\phi\, d\phi$	On integrating
infinitely long	$B = \frac{\mu_0 I}{4\pi a}(\sin\phi_1 + \sin\phi_2)$	$\emptyset_1 = \frac{\pi}{2}$ and $\emptyset_2 = \frac{\pi}{2}$
Magnetic field	$B = \frac{\mu_0 I}{2\pi a}$	

4 Magnetic field due to circular current carrying conductor

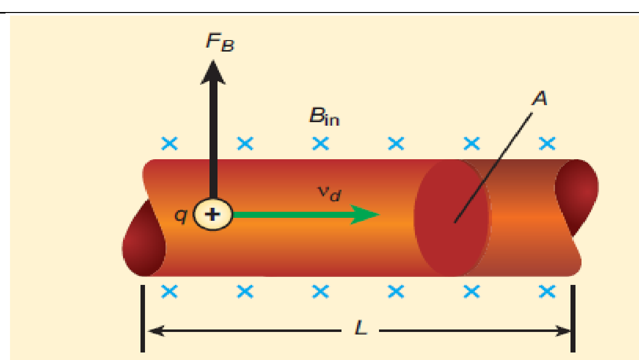
Diagram		
By Biot Savat law	$\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\,\vec{dl}\sin\theta}{r^2}$ – –(1)	
Resolving dB	dB cos θ (Along y axis)	Cancels out
	dB sin θ (Along z axis)	Integrating
Magnetic field	$\vec{B} = \int dB \sin\theta\ \hat{K}$	

vector	$\vec{B} = \frac{\mu_0 I}{2} \frac{R^2}{(R^2 + Z^2)^{\frac{3}{2}}} \hat{K}$
At centre	$\vec{B} = \frac{\mu_0 n I}{2R} \hat{K}$

5 Cyclotron

Use	To accelerate charge particles to a greater kinetic energies	
Principle	Magnetic Lorentz force	
Diagram		
Derivations	Centripetal force is provided by the Lorentz force $\frac{mv^2}{r} = qvB$	
	Radius of the circular path	$r = \frac{mv}{Bq}$
	Time period	$T = \frac{2\pi m}{Bq}$
	Frequency	$f = \frac{Bq}{2\pi m}$
	Kinetic energy	$KE = \frac{q^2 B^2 r^2}{2m}$

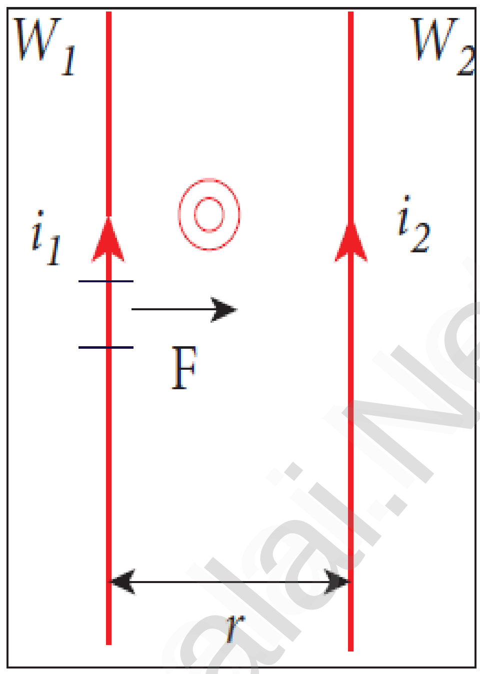
6 Force on a current carrying conductor

Diagram	
Force acting on an electron	$\vec{dF} = -enAdl\,(\vec{V_d}\ X\ \vec{B})$
From relation between I & V_d	$I = nAeV_d$
Force experienced by the wire	$\vec{dF} = (\vec{Idl}\ X\ \vec{B})$
	$\vec{F} = \vec{Il}\ X\ \vec{B}$
Flemings Left hand rule	Middle finger, thumb and fore finger of left hand are kept mutually perpendicular

	Finger	Direction
	Fore Finger	Magnetic Field
	Middle finger	Current
	Thumb	Force on the current carrying conductor

7 Force between two parallel current carrying conductors

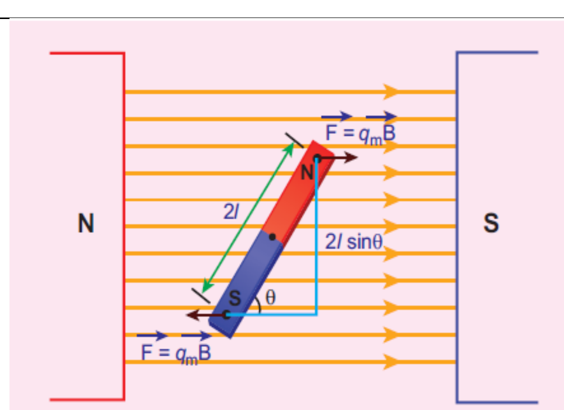
MARCH 2020

Diagram		
	Wire 1	Wire 2
Magnetic field	$\overrightarrow{B_1} = -\frac{\mu_o I_1}{2\pi r}\hat{\imath}$	$\overrightarrow{B_2} = \frac{\mu_o I_2}{2\pi r}\hat{\imath}$
Force	$\overrightarrow{dF} = I_2\overrightarrow{dl}\ X\ \overrightarrow{B_1}$ $= -\frac{\mu_o I_1 I_2 dl}{2\pi r}\hat{\jmath}$	$\overrightarrow{dF} = I_1\overrightarrow{dl}\ X\ \overrightarrow{B_2}$ $= \frac{\mu_o I_1 I_2 dl}{2\pi r}\hat{\jmath}$
Force per unit length	$\frac{\vec{F}}{l} = \frac{\mu_o I_1 I_2}{2\pi r}\hat{\jmath}$	

Direction of force	Current	Force
	Two wires same direction	attractive
	Two wires opposite direction	Repulsive

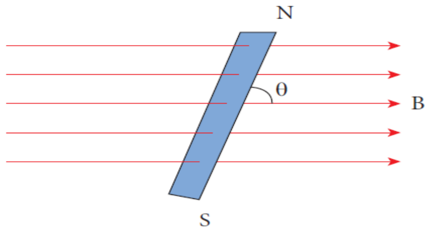
THREE MARKS

1 Torque on a bar magnet

Diagram	

F experienced by north pole	$\vec{F_N} = q_m \vec{B}$	
F experienced by south pole	$\vec{F_s} = -q_m \vec{B}$	
Net Torque	$\tau = q_m B\, 2l \sin\theta$	
	$\tau = P_m B \sin\theta$	$p_m = 2l\, X\, q_m$
Vector form	$\vec{\tau} = \vec{p_m}\, x\, \vec{B}$	

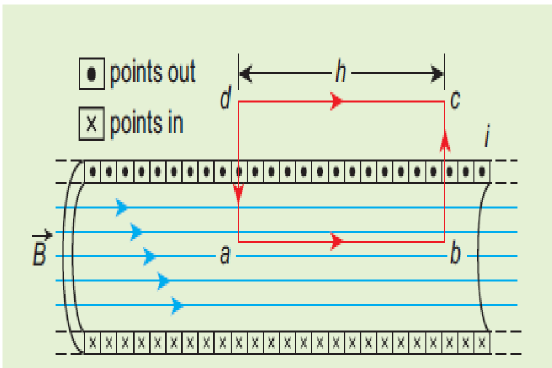
2 Potential energy of a bar magnet in a uniform magnetic field

Diagram		
Work done	$w = \int_{\theta_1}^{\theta_2} \tau\, d\theta$	
	$= \int_{\theta_1}^{\theta_2} p_m B \sin\theta\, d\theta$	$\tau = p_m B \sin\theta$
	$U = -p_m B\ \ Cos\,\theta$	

3 Properties of dia, Para, Ferro magnetic materials

Property	Dia	Para	Ferro
Susceptibility	Negative	small Positive	Large positive
Relative permeability	Slightly less than one	Greater than one	Large
Field lines	Repelled	Attracted into the materials	Strongly attracted into the material
$\aleph$ *depends on T*	Independent	Inversely proportional	Inversely proportional
Examples	Bi, Cu, H_2O	Al,pt,Cr	Fe, Ni, Co

4 Magnetic field due to a long current carrying solenoid

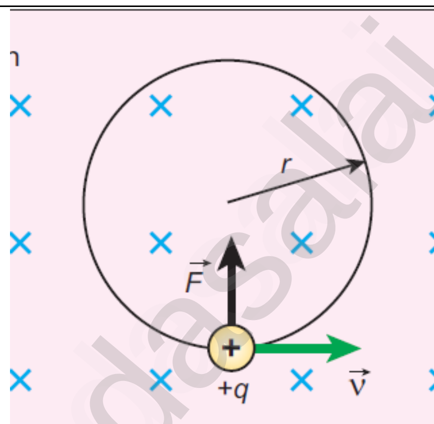
Diagram	 Magnetic field of a solenoid
Net current	NI
Ampere's circuital	$\oint \vec{B}\,.\,\vec{dl} = \int_a^b \vec{B}\,.\,\vec{dl} + \int_b^c \vec{B}\,.\,\vec{dl} + \int_c^d \vec{B}\,.\,\vec{dl} + \int_d^a \vec{B}\,.\,\vec{dl}$

Magnetic field	$\int_a^b \vec{B} \cdot \vec{dl} = BL = \mu_o NI$
	$B = \mu_o \frac{N}{l} I$
	$B = \mu_o n I$

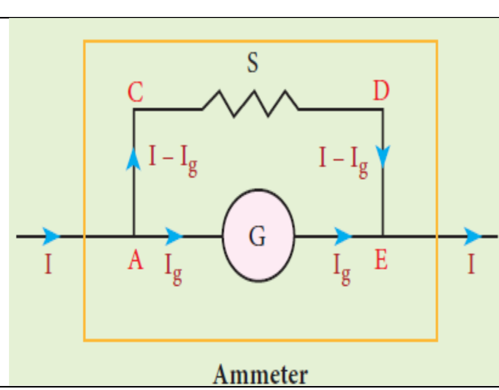
5 What are the special features of Magnetic Lorentz force?

Force	$\vec{F} = q\,(\vec{V}\ X\ \vec{B}) = Bqv\sin\theta$		
	Directly proportional	Magnetic field	$\vec{B}$
		Velocity	$\vec{v}$
		Sine of angle between $\vec{V}$ & $\vec{B}$	Sin θ
		Magnitude of charge	Q

.6 .Motion of a charged particle in a uniform magnetic field

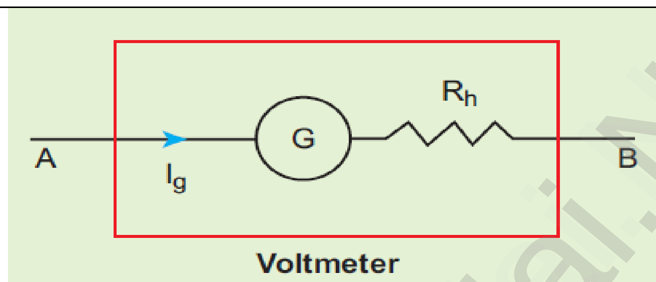
Diagram	
Magnetic Lorentz force	$F = qvB$ — –(1)
Centripetal force provide Lorentz force	$F = \frac{mv^2}{r}$ — –(2)
Radius of the circular path	$r = \frac{mv}{Bq}$
Time period	$T = \frac{2\pi r}{v} = \frac{2\pi m}{Bq}$
Frequency	$f = \frac{Bq}{2\pi m}$

7 Galvanometer into an Ammeter

Conversion	Small resistance in parallel to the galvanometer
Diagram	

$V_{galvanometer} = V_{shunt}$	$I_g R_g = (I - I_g) S$
Shunt resistance	$S = \frac{I_g R_g}{(I - I_g)}$
Current through the galvanometer	$I_g = \left(\frac{S}{S + R_g}\right) I$
Resistance of the ammeter	$R_a = \frac{R_g S}{R_g + S}$
➢ For ideal ammeter, resistance must be equal to zero.	

8 Galvanometer to a Voltmeter

Conversion	Very high resistance in series to the galvanometer
Diagram	
Current through the circuit	$I = I_g = \frac{V}{R_g + R_h}$
High resistance	$R = \frac{V}{I_g} - R_g$
Resistance of the voltmeter	$R_v = R_g + R_h$
An ideal voltmeter should have infinite resistance	

TWO MARKS

1 Coulombs law

Force	Directly proportional	Product of pole strength
	Inversely proportional	Square of the distance

2 Magnetic susceptibility

Ratio of the intensity of magnetization induced in the material due to the magnetizing field

$$\aleph = \frac{\vec{M}}{\vec{H}}$$

- ➢ no unit
- ➢ vector quantity

3 Curie Weiss law

The temperature at which a ferromagnetic material becomes paramagnetic. This temperature is known as curie temperature

$$\aleph = \frac{C}{T - T_c}$$

4 Biot Savat law

Magnetic field at p due to current element	Directly proportional	Strength of current (I)
		Length of the element (dl)
		Sine of angle between $\vec{dl}$ and $\vec{r}$
	Inversely proportional	Square of the distance (r)
Equation	$\vec{dB} = \frac{\mu_0}{4\pi}\frac{i\,\vec{dl}\,x\,\vec{r}}{r^2}$	

5 Difference between Coulombs law and Biot Savat 's law

	Coulombs law	Biot Savat law
Source	Scalar source (charge)	Vector source (current element)
Direction between source and position vector	Parallel	Perpendicular
Angle dependence	No	Angle between $\vec{r}$ and $I\vec{dl}$

6 Ampere's circuital law

The line integral of a magnetic field over a closed loop is μ_o times the net current enclosed by the loop.

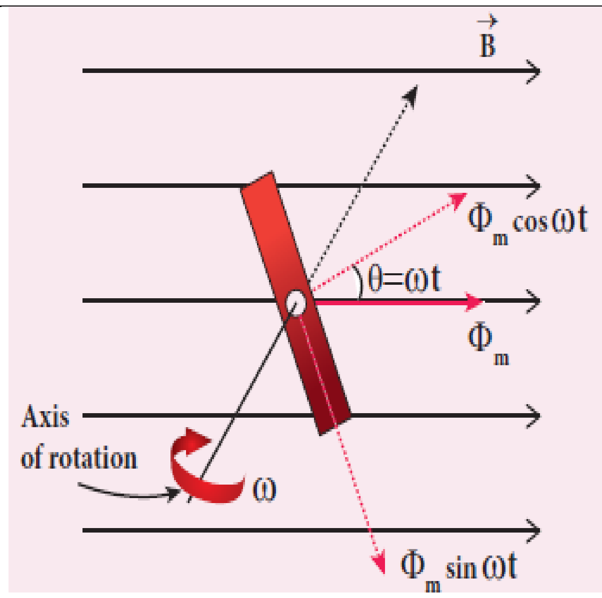
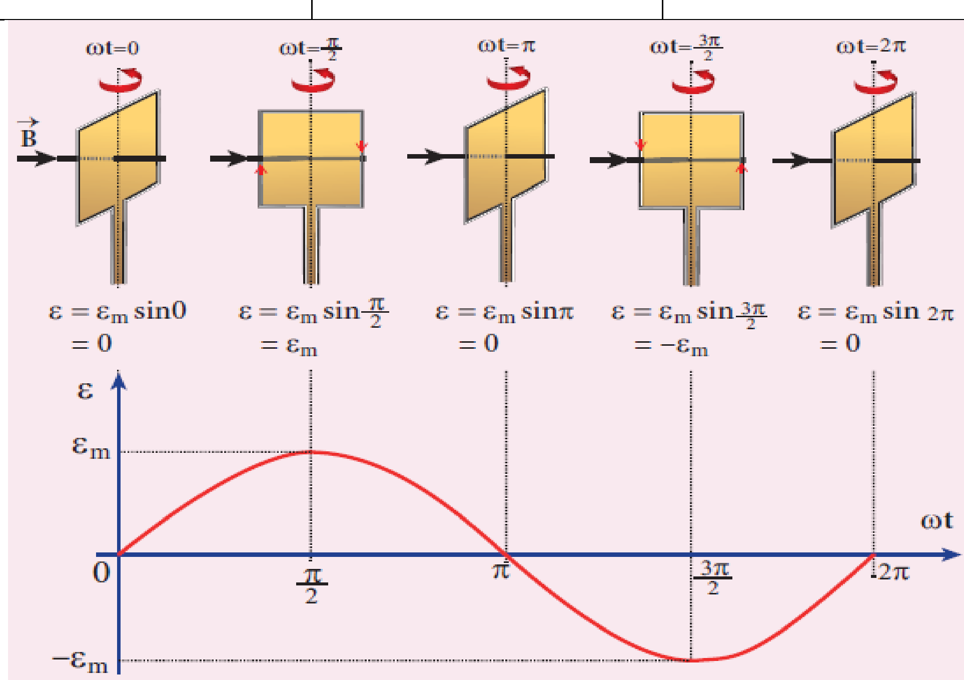
$$\oint \vec{B} \, . \, \vec{dl} = \mu_o \, I_{enclosed}$$

7 On what a factor does the current sensitivity of a galvanometer depends?

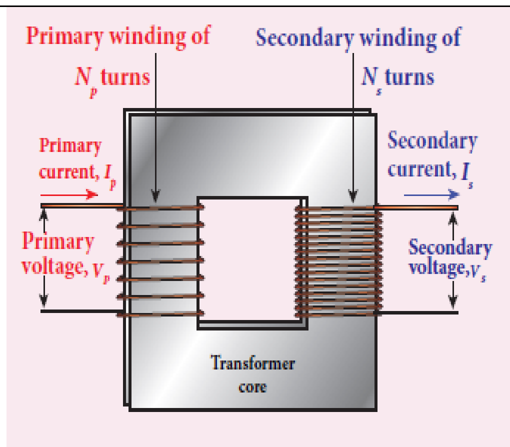
$\frac{\theta}{I} = \frac{NBA}{C}$		
Current sensitivity can be increased	Increasing	No. of turns
		Magnetic field
		Area of the coil
	Decreasing	Couple per unit twist

04. Electromagnetic induction and Alternating current

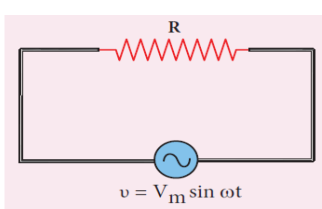
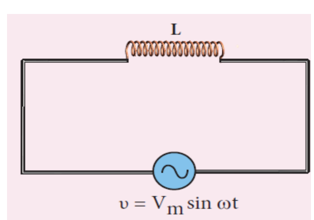
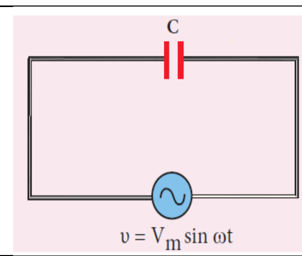
1 Show mathematically that the rotation of a coil in a magnetic field over one rotation induces an alternating emf of one cycle.

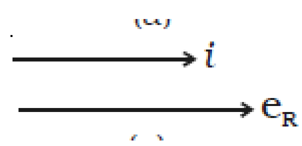
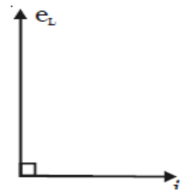
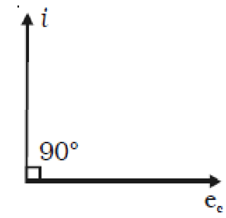
Diagram			
The flux linked	$N\Phi = NBA\cos\omega t$		
Emf induced	$e = -\frac{d\,(N\Phi)}{dt} = -\frac{d(NBA\cos\omega t)}{dt}$ $e = NBA\omega\sin\omega t$		
Maximum emf	$e_m = NBA\omega$		
Emf at any instant	$e = e_m\sin\omega t$		
Tabulation	ωt	Plane	E
	0	Perpendicular	0
	$\frac{\pi}{2}$	Parallel	e_m
	$\frac{2\pi}{2}$	perpendicular	0
	$\frac{3\pi}{2}$	Parallel	$-e_m$
	$\frac{4\pi}{2}$	perpendicular	0
Graph			

2 Explain the construction and working of Transformer

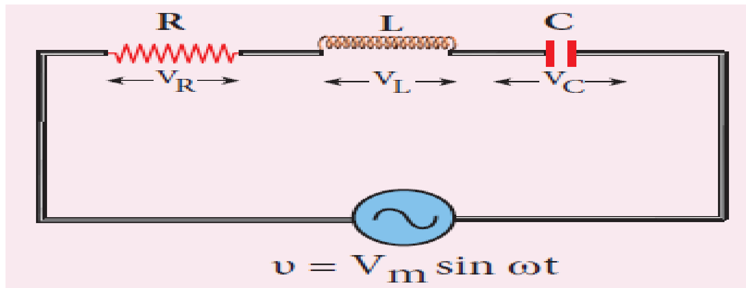
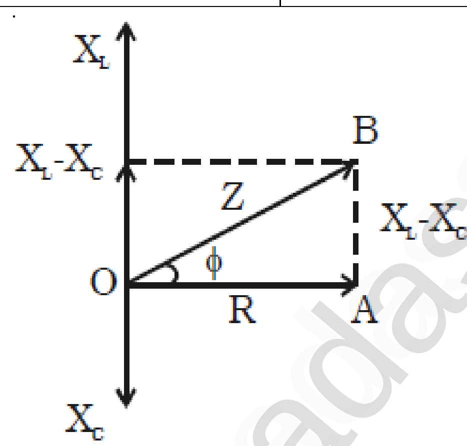
Transformer	Converts electrical power from one circuit to another without changing frequency
	Converts low alternating voltage into high alternating voltage and vice versa
Principle	Mutual Induction
Diagram	
The voltage in the primary coil	$V_p = \epsilon_P = -N_p \frac{d\varphi_B}{dt}$ – –(1)
The emf in the secondary coil	$V_s = \epsilon_s = -N_s \frac{d\varphi_B}{dt}$—(2)
(1) = (2)	$\frac{V_s}{V_P} = \frac{N_s}{N_p} = K$ (*Transformer ratio*)
For Ideal transformer	$V_sI_s = V_pI_p$
	$\frac{V_s}{V_P} = \frac{N_s}{N_p} = \frac{I_p}{I_s} = K$
Efficiency	Ratio of useful output power to the input power $\eta = \frac{\text{Output Power}}{\text{Input Power}}$ X 100 %

3 AC with inductor

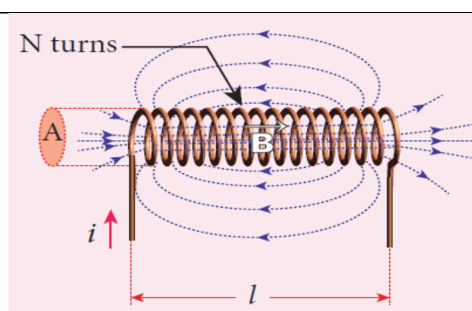
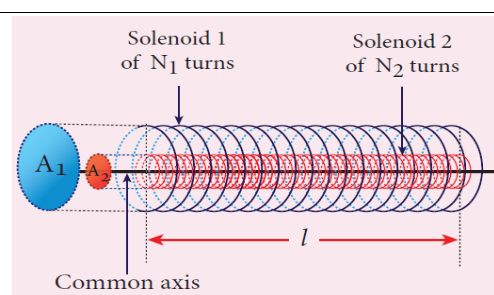
			
Applied V	$v = v_m \sin \omega t$	$v = v_m \sin \omega t$	$v = v_m \sin \omega t$
Developed V	$v_R = iR$	$e = -L\frac{di}{dt}$	$v = \frac{q}{c}$
	$iR = v_m \sin \omega t$	$v_m \sin \omega t = L\frac{di}{dt}$	$q = Cv_m \sin \omega t$
current	$i = i_m \sin \omega t$	$i = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$	$i = i_m \sin\left(\omega t + \frac{\pi}{2}\right)$
Phase difference	In phase	I lags behind e by $\frac{\pi}{2}$	e lags behind I by $\frac{\pi}{2}$

Phase angle			

5 AC circuit containing Resistor, Inductor and capacitor in series

Diagram			
Voltage	across R	$V_R = IR$	In phase with I
	across L	$V_L = IX_L$	Leads I by $\frac{\pi}{2}$
	across C	$V_C = IX_c$	lags behind I by $\frac{\pi}{2}$
Voltage phasor diagram			
Resultant V	$V^2 = V_R^2 + (V_L - V_C)^2$		
Impedance	$Z = \sqrt{(R)^2 + (X_L - X_C)^2}$		
Phase angle	$\tan\Phi = \frac{X_L - X_C}{R}$		

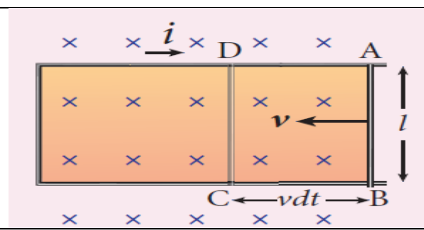
1 Assuming that the length of the solenoid is large when compared to its diameter. Find the equation of inductance.

	self induction	mutual induction
Diagram		
Total flux	$\Phi = N\Phi = \mu_0 n^2 iAl$	$\Phi = N_2\Phi = \mu_0 n_1 n_2 iAl$
From definition	$\Phi = LI$	$\Phi = MI$
In a medium μ_r	$L = \mu_0 \mu_r n^2 Al$	$M = \mu_0 \mu_r n_1 n_2 Al$

2 An inductor of inductance L carries an electric current i. how much energy is stored while establishing the current in it.

Work done	$dW = -e\,dq$ $dW = -Li\,di$
On integrating	$W = \frac{1}{2}\,L\,i^2$
Work done = Magnetic potential energy	$U = \frac{1}{2}\,L\,i^2$
Energy Density	$u\ \frac{B^2}{2\mu_0}$

3 How will you induce an emf by changing the area enclosed by the coil?

Diagram	
Change in flux	$d\Phi = B.dA = Bl\,(\,vdt\,)$
Emf	$e = \frac{d\Phi}{dt} = Blv$
Magnitude of emf	$e = Blv$
Direction	Clock wise (Flemings' Right Hand Rule)

4 Mention the losses in a transformer.

Losses	Hysteresis loss Eddy current loss Copper loss Flux leakage

6 Power in an AC circuit

Power	➢ rate of consumption of electric energy ➢ product of voltage and current
Alternating voltage	$v = v_m \sin \omega t$
Alternating current	$i = I_m \sin\,(\,\omega t + \Phi\,)$
Instantaneous power	$p = v_m \sin \omega t\, I_m \sin\,(\,\omega t + \Phi\,)$
Average power	$P_{av} = \frac{1}{2}\,V_m I_m \cos \varphi$ $\boxed{P_{av} = V_{RMS} I_{Rms} \cos \emptyset}$
Apparent power	$V_{RMS} I_{Rms}$
Power factor	$\cos \Phi$

7 What are the advantages and disadvantages of AC over DC (2M + 1M)

MARCH 2020

Advantage (2M)	Disadvantages (1M)
➢ Generation of AC is cheap ➢ Transmission loss is low at higher voltages ➢ Can be converted in to DC using rectifiers	➢ can't be used for charging of batteries, electroplating & electric traction ➢ At high voltages, AC is more dangerous

Two Marks

1 Define magnetic flux

Magnetic flux is defined as the no. of magnetic lines of force passing through the area normally.

$$\phi = BA\cos\theta$$

2 State Faradays law of electromagnetic induction

I law	Whenever magnetic flux linked with a closed circuit changes, an emf is induced in the circuit.
II law	The magnitude of induced emf in a closed circuit is equal to the time rate of change of magnetic flux linked with the circuit. $$e = \frac{d\emptyset}{dt}$$

3 State Lenz's law

The induced current will always flow in such a direction that it opposes the change or cause that produces it.

4 State Fleming's Right hand rule

Thumb index and middle finger are stretched mutually perpendicular to each other		
Thumb	Points	Direction of Motion of the conductor
Index		Direction of magnetic field
Middle		Direction of induced current

5 What are the methods of producing emf?

Equation	$e = \frac{d\,(BA\cos\theta)}{dt}$
Emf can be induced by changing	Magnetic Field
	Changing the Area
	Orientation of the coil w.r.t. B

6 Q factor

- It is defined as the ratio of voltage across L or C at resonance to the applied voltage

$$Q = \frac{\text{Voltage across L or C at resonance}}{\text{applied Voltage}}$$

05. ELECTROMAGNETIC WAVES

FIVE MARKS

1. Explain the types of Emission spectr-a

Emission spectra	Light from the self luminous source gives emission spectra Each source has its own characteristics
Types	Continuous Emission Spectra Line Emission spectrum Band Emission spectrum

2. Explain the types of Absorption spectra

Absorption spectra	➢ Light passed through an absorbing substance, then the resulting spectrum is absorption spectrum ➢ Characteristics depends on the absorbing substance
Types	Continuous Absorption Spectra Line Absorption spectrum Band Absorption spectrum

3. Maxwell's equation in integral form

Gauss law	$\oint \vec{E} \cdot \vec{dA} = \frac{Q_{enclosed}}{\varepsilon_0}$
Gauss law in magnetism	$\oint \vec{B} \cdot \vec{dA} = 0$
Faraday law	$\oint \vec{E} \cdot \vec{dl} = -\frac{d\varphi_B}{dt}$
Ampere – Maxwell's law	$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{enclosed} + \mu_0 \varepsilon_0 \frac{d}{dt} \oint \vec{E} \cdot \vec{dA}$

4. Properties of electromagnetic waves

- ➢ Produced by accelerated charges
- ➢ No medium required for propagation
- ➢ Transverse in nature
- ➢ They travel with speed of light in vacuum
- ➢ They are not deflected by E and B
- ➢ Undergo interference, diffraction, polarization
- ➢ They carry energy, momentum and angular momentum

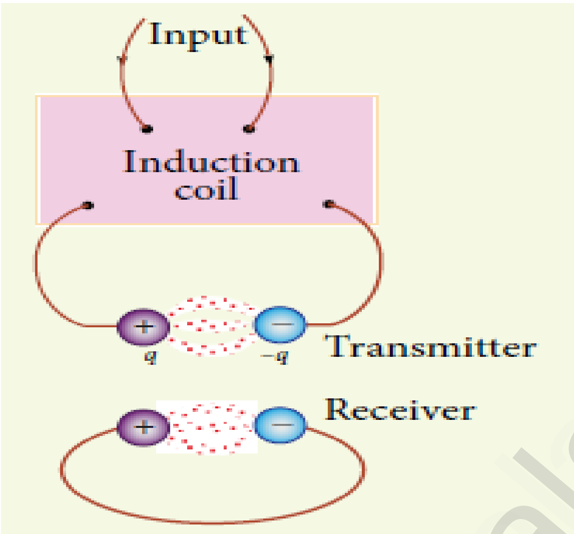
THREE MARKS & TWO MARKS

1. Applications of Electromagnetic waves

Electromagnetic waves	Applications
Micro waves	➢ Radar system for air navigation ➢ Microwave oven ➢ Long distance wireless transmission through satellites
IR radiation	➢ Provides electrical energy to satellites by solar cell ➢ Produce dehydrated fruits ➢ In heat therapy for muscular sprains

	➢ TV remote as a signal carrier ➢ Look through haze fog or mist and for nigh vision in IR photography
UV radiation	➢ Destroying bacteria & sterilizing surgical instruments ➢ To study molecular structure ➢ Burglar alarm, invisible writings and finger prints
X ray (2M) (MARCH 2020)	➢ Structure of inner atomic electron shells ➢ Detecting fractures, diseased organs and healing bones ➢ To check the faults, cracks, flaws and holes in a finished metal product.

2. Hertz experiment

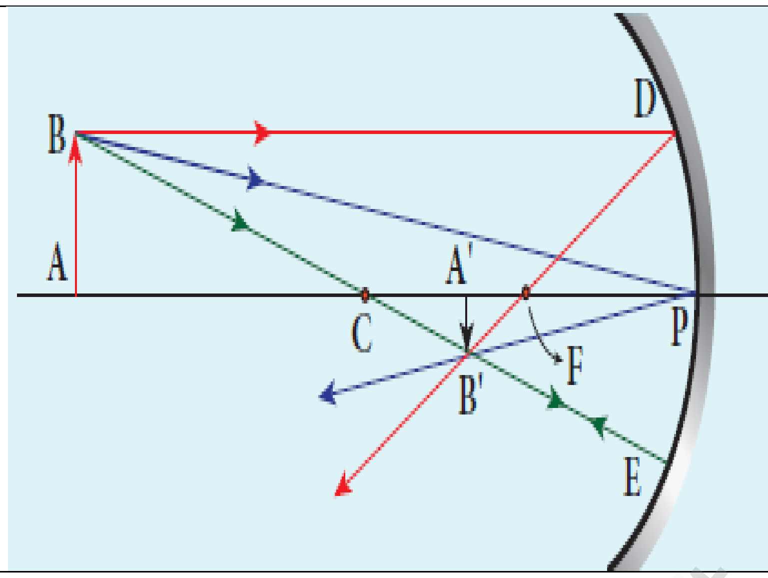
Diagram	
Conclusion	➢ They are transverse waves ➢ They travel with the velocity of light.

3. What is displacement current?

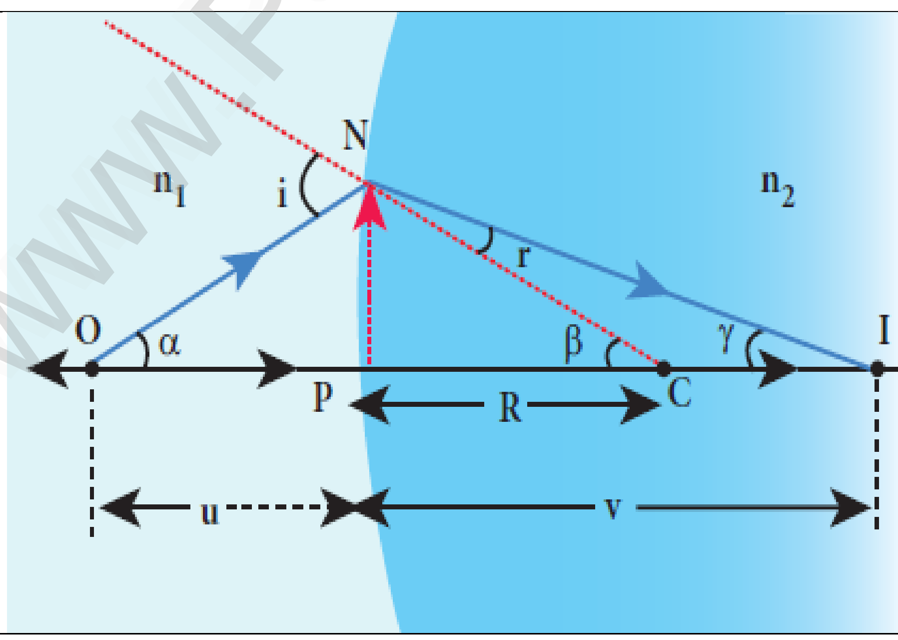
The current comes into play where the electric field and electric flux are changing with time

06. Optics

1 Mirror equation

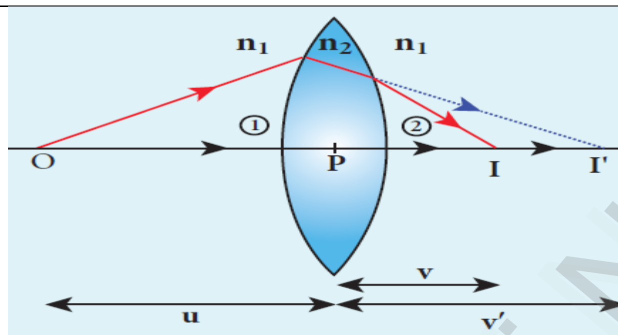
Diagram	
Similar Δ	$\frac{-h'}{h} = \frac{-v}{-u}$ — (1)
	$\frac{-h'}{h} = \frac{-v+f}{-f}$ — (2)
(1) = (2)	$\frac{-v}{-u} = \frac{-v+f}{-f}$
Mirror equation	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ − − − (3)
Magnification	$m = \frac{h'}{h} = -\frac{v}{u}$

2 Derive an equation for refraction at single spherical surface

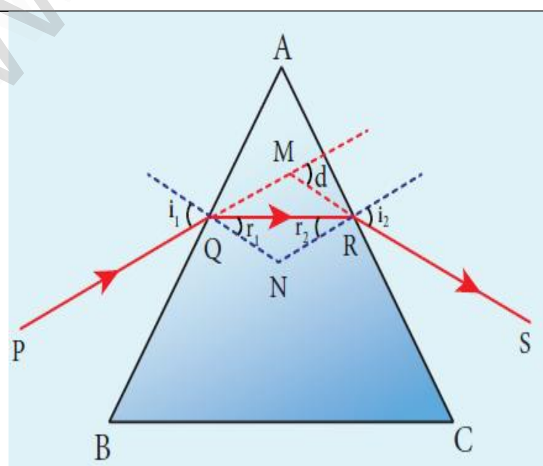
Diagram			
Snells law	$n_1 \sin i = n_2 \sin r$ $n_1 i = n_2 r$ − − − (1)		
	$\tan\alpha = \alpha = \frac{PN}{-u}$	$\tan\beta = \beta = \frac{PN}{R}$	$\tan\gamma = \gamma = \frac{PN}{v}$
ΔNOC	$i = \alpha + \beta$ − − − (2)		
ΔINC	$r = \beta - \gamma$ − − − (3)		

Substituting	$n_1(\alpha+\beta) = n_2(\beta-\gamma)$
	$\frac{n_2}{v} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R}$
	$\frac{n}{v} - \frac{1}{u} = \frac{(n-1)}{R}$

3 Lens makers formula and lens equation

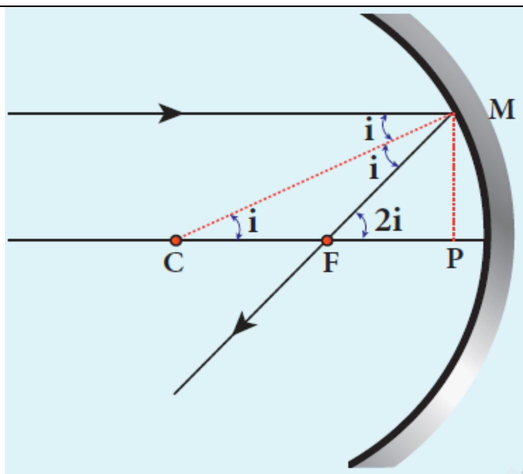
Diagram	
Refracting surface 1	$\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R_1} - - - (1)$
Refracting surface 2	$\frac{n_1}{v} - \frac{n_2}{v_1} = -\frac{(n_2 - n_1)}{R_2} - - - (2)$
	$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\{\frac{1}{R_1} - \frac{1}{R_2}\}$
Lens makers equation	$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\{\frac{1}{R_1} - \frac{1}{R_2}\}$
Lens equation	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

4 Derive an expression for angle of deviation produced by a prism and thus obtain the equation for refractive index of the material of the prism.

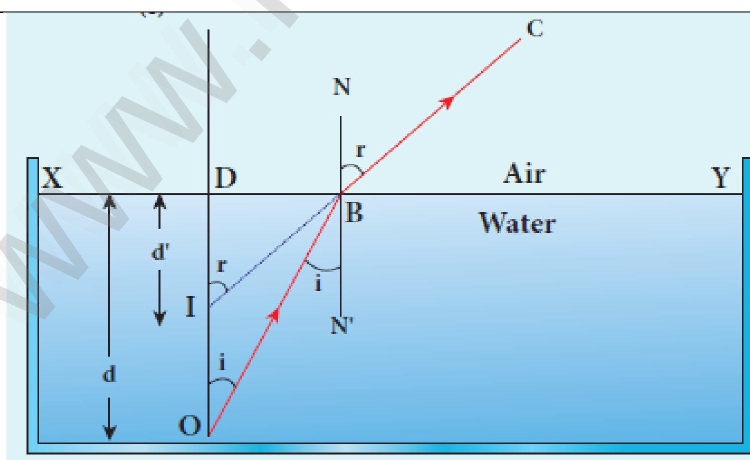
Diagram	
Total deviation	$d = (i_1 + i_2) - (r_1 + r_2) - (1)$
Quadrilateral	$A + QNR = 180^0 - (2)$
ΔQNR	$r_1 + r_2 + QNR = 180^0 - (3)$
From (2) & (3)	$r_1 + r_2 = A \quad - (4)$

(4) in (1)	$i_1 + i_2 = A + d$ — (5)		
Minimum deviation	$i_1 = i_2$	$i = \frac{A+d}{2}$	From (5)
	$r_1 = r_2$	$r = \frac{A}{2}$	From (6)
Refractive index	$n = \frac{\sin i}{\sin r} = \frac{\sin(\frac{A+d}{2})}{\sin(\frac{A}{2})}$		

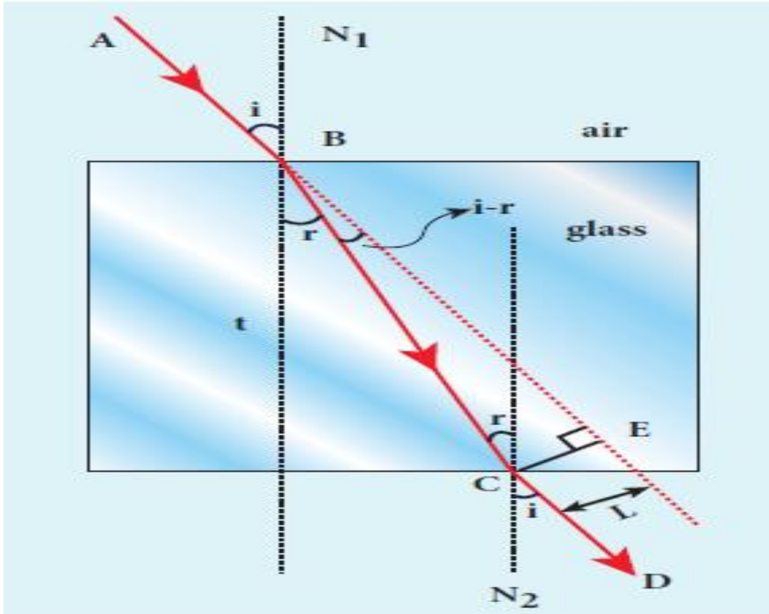
1 Derive a relation between f and R

Diagram		
	$\tan i = i = \frac{PM}{PC}$ — (1)	$\tan 2i = 2i = \frac{PM}{PF}$ — (2)
(1)= (2)	$2\ \frac{PM}{PC} = \frac{PM}{PF}$	
From the figure	$R = 2f$	

2 Apparent depth

Depth	It is observed that the bottom of a tank filled with water appears raised.	
Diagram		
Snell's law	$\sin i = \tan i = \frac{DB}{d}$	$\sin r = \tan r = \frac{DB}{d'}$
	$n_1 \sin i = n_2 \sin r$	
	$n_1 \frac{DB}{d} = n_2 \frac{DB}{d'}$	
	$\frac{n_1}{d} = \frac{n_2}{d'}$	
Apparent depth	$d' = \left(\frac{n_2}{n_1}\right) d$	

221 Lateral displacement in refraction in glass slab

Diagram	
Δ BCE	$BC = \frac{L}{\sin(i-r)} ---(1)$
Δ BCF	$BC = \frac{t}{\cos r} ---(2)$
(2) = (1)	$\frac{L}{\sin(i-r)} = \frac{t}{\cos r}$
Lateral Displacement	$L = t\left(\frac{\sin(i-r)}{\cos r}\right)$

1 State laws of reflection

- The incident ray and normal to the reflecting surface all are co planar
- The angle of incidence = angle of reflection

2 Characteristics of the image formed by a plane mirror

- The image is virtual, erect and laterally inverted
- Size of the image = size of the object
- Distance between image and mirror = distance between object and mirror

3 Critical angle

The angle of incidence in the denser medium for which the refracted ray graces the boundary called critical angle

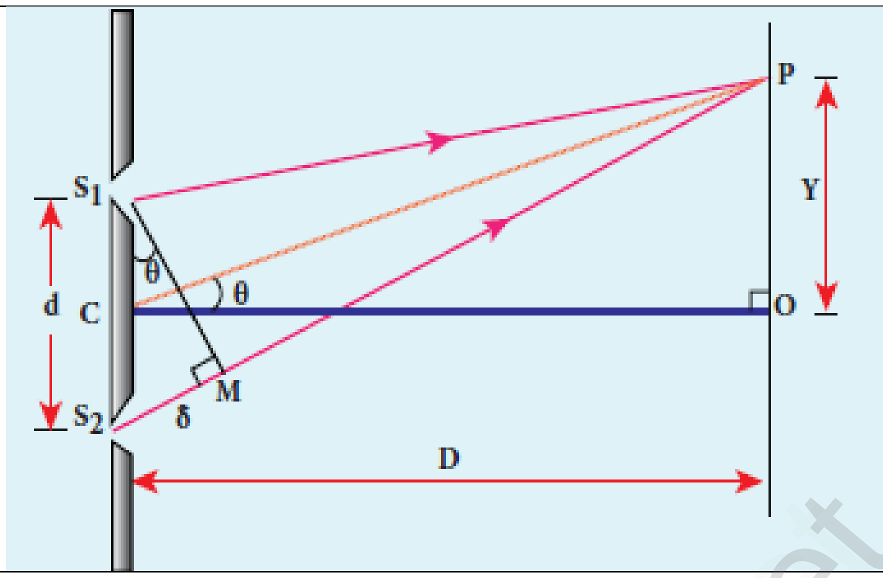
4 State the conditions for total internal reflection

- Light must travel from denser to rarer medium
- Angle of incidence > critical angle.

07. WAVE OPTICS

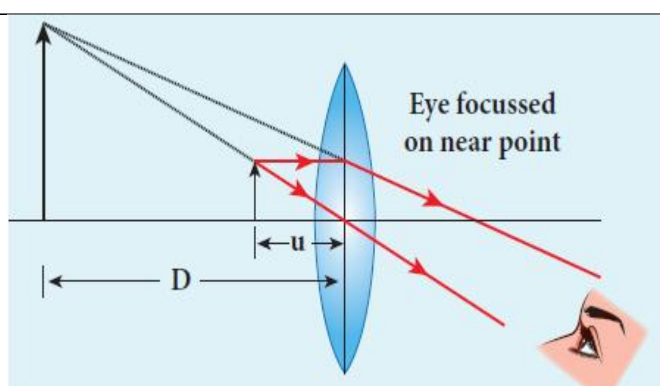
FIVE MARKS

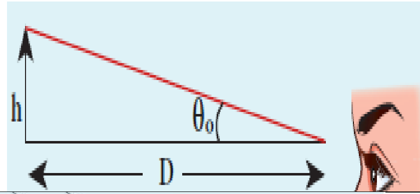
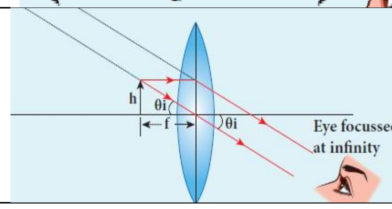
01 Expression for bandwidth

Diagram			
Path difference	$\delta = S_2P - MP = S_2M$		
	$\delta = d\sin\theta$		
	$\delta = \frac{dy}{D}$		
Maxima / Minima		Maxima	Minima
	Interference	Constructive	Destructive
	Distance of nth fringe	$y = n\frac{\lambda D}{d}$	$y = \frac{(2n-1)}{2}\frac{\lambda D}{d}$
Band width	Distance between any two consecutive bright or dark fringes. $\beta = \frac{\lambda D}{d}$		

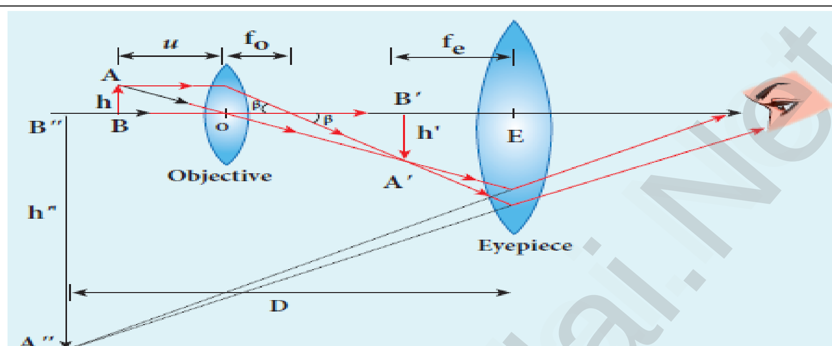
Simple microscope

02

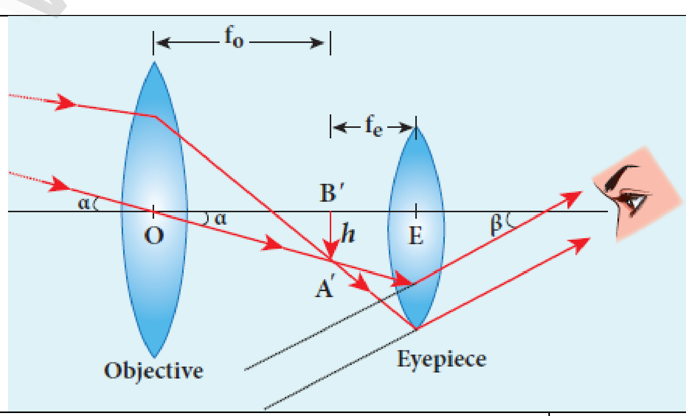
Simple microscope	Single magnifying lens of a short focal length.	
Magnification for near point focusing	Diagram	
	Lens equation	$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
	Magnification	$m = \frac{v}{u} = 1 - \frac{v}{f}$
	$v = -D$	$m = 1 + \frac{D}{f}$

	Unaided eye		$\tan\theta_0 = \frac{h}{D}$
	Aided eye		$\tan\theta_i = \frac{h}{f}$
	Angular magnification	$m = \frac{\theta_i}{\theta_0} = \frac{D}{f}$	

03 Compound microscope

Diagram		
Magnification of Objective	$\tan\beta = \beta = \frac{h}{f_0}$	$\tan\beta = \beta = \frac{h'}{L}$
	$m_0 = \frac{h'}{h} = \frac{L}{f_0}$	
Magnification of eye piece	$m_e = 1 + \frac{D}{f_e}$	
Total magnification	Near point focusing	$\left(\frac{L}{f_0}\right)\left(1 + \frac{D}{f_e}\right)$
	Normal focusing	$\left(\frac{L}{f_0}\right)\left(\frac{D}{f_e}\right)$

04 Astronomical telescope

Use	Get the magnification of distant astronomical objects	
Diagram		
	$\tan\beta = \beta = \frac{h}{f_e}$ — (1)	$\tan\alpha = \alpha = \frac{h}{f_0}$ — (2)
	$\frac{1}{2}$	$m = \frac{f_0}{f_e}$

THREE MARKS

01 Distinguish between Fresnel and Fraunhofer diffraction

	Fresnel	Fraunhofer
Wave front	Spherical or cylindrical	Plane
Source	Finite distance	Infinite distance
Lens	No	Convex
Observe and Analyze	Difficult	Easy

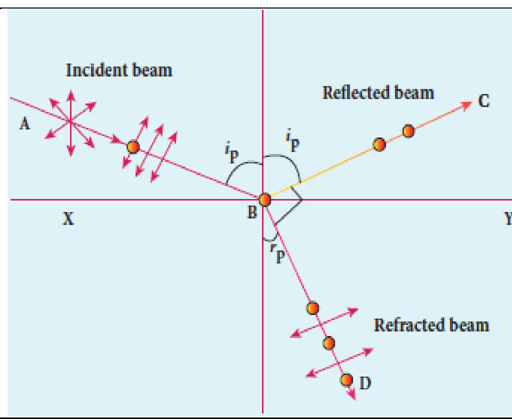
02 Difference between interference and diffraction

	Interference	Diffraction
Definition	Superposition of two waves	Bending of waves around edges
Fringe space	Equal	Un equal
Intensity	Same	Falls rapidly
No. of fringes	More	Less

03 Write down the uses of polarids

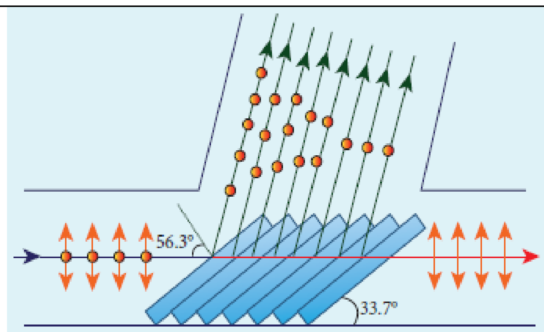
Polarids are used in	Used in goggles and cameras to avoid light glare
	Holography
	Improve color contrasts in old oil painting.
	Optical stress analysis
	Controlling the light intensity in window glases
	Reading and writing CDs.
	LCD

04 State and prove Brewster's law

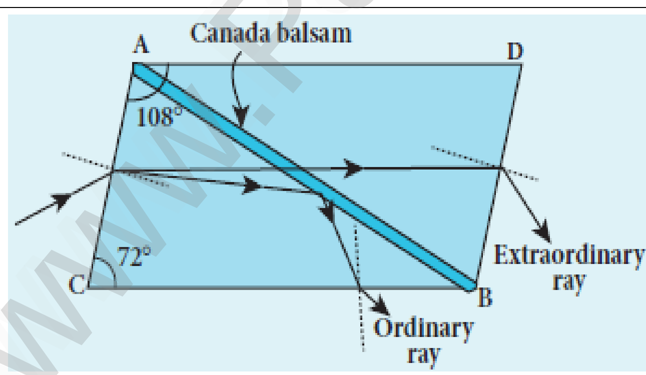
Brewster's law	The tangent of the polarizing angle is equal to the refractive index of the medium
Diagram	

Polarizing angle = incident angle	$r_p = 90^0 - i_P$
Snells law	$n = \frac{\sin i_p}{\sin r_p} = \frac{\sin i_p}{\sin(90^0 - i_P)}$
Brewster's law	$n = \tan i_P$

05 Pile of plates

Principle	Polarization by reflection
Uses	Used as a polarizer and analyzer
Diagram	
Working	Angle of incidence = angle of polarization for glass = 56.3^0 Perpendicular vibrations are reflected Parallel vibrations are transmitted Larger the no. of plates greater the intensity of polarized light.

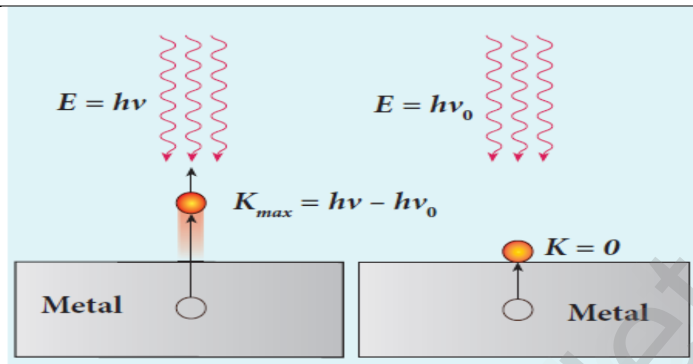
06 Nicol prism

Principle	Double refraction
Diagram	
Construction	Calcite crystal with length = 3 X breadth Cut into two halves Face angle are 72^0 and 108^0 joined by Canada balsam
Working	Monochromatic light incident on the face AC Double refraction take places Ordinary ray is total internally reflected Extra ordinary ray which is plane polarized is transmitted

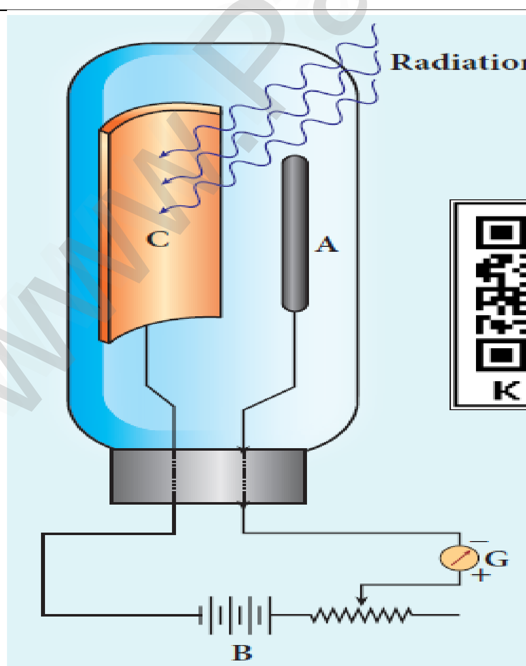
08. DUAL NATURE OF RADIATION & MATTER

FIVE MARKS

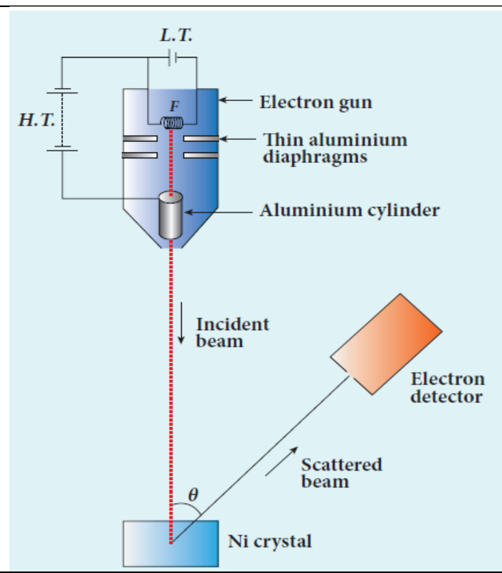
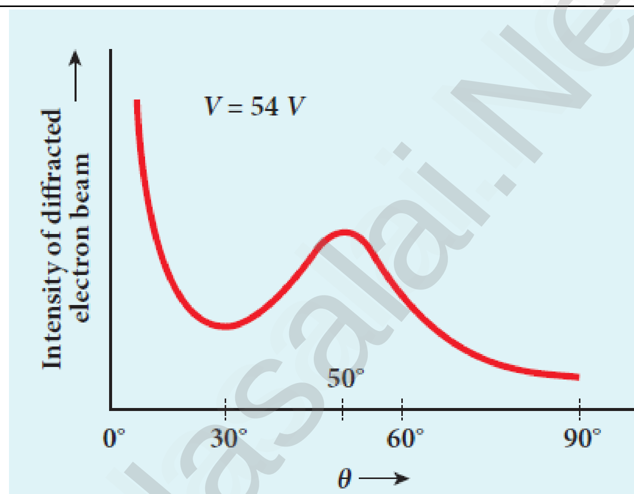
01 Obtain Einstein's photoelectric equation with necessary explanation.

Einstein applied quantum theory. Incident energy = Work function + Kinetic energy	
By conservation of energy	$h\upsilon = \phi_0 + \frac{1}{2}mv^2$ – (1)
Diagram	
Work function	$\phi_0 = h\upsilon_0$
Einstein's equation	$h\upsilon = h\upsilon_0 + \frac{1}{2}mv^2$
No internal collisions,	$h\upsilon = h\upsilon_0 + \frac{1}{2}mv_{max}^2$

02 Give the construction and working of photo emissive cell.

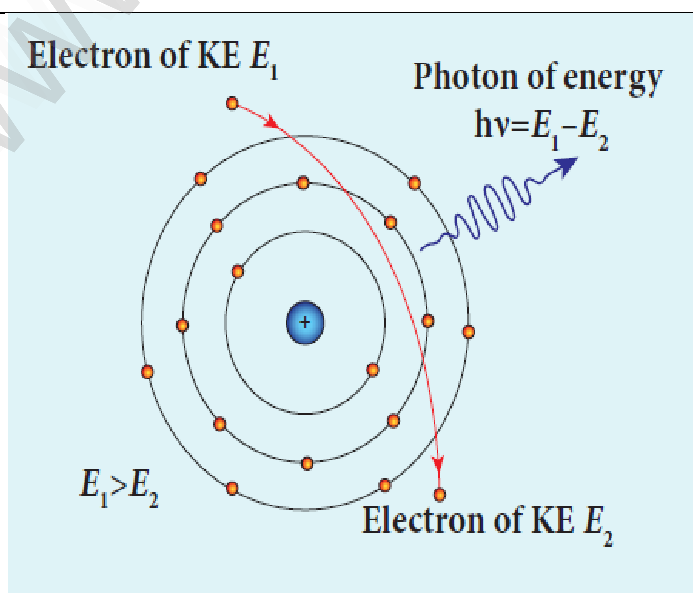
Photo cell	Light energy ➔ electrical energy
Principle	Photo electric effect
Diagram	
Working	Electrons are emitted when cathode is illuminated Electrons are attracted by anode, hence current is produced. Current is measured by galvanometer

03 Describe briefly Davisson – Germer experiment which demonstrated the wave nature of electrons

Diagram		
Working	Electrons are scattered in all directions by Ni crystal. Received by the electron detector. It measures the intensity of scattered electron beam.	
Graph		
Wave length	Experimentally	$\lambda = 1.65\text{Å}$
	De Broglie eqn	$\lambda = 1.67\text{Å}$

THREE MARKS

01 Continuous X ray spectra

Diagram	
Initial kinetic energy	$eV = \frac{hc}{\lambda_o}$
Cut off wave length	$\lambda_0 = \frac{12400}{V}$ Å

02 Laws of photoelectric emission

Given frequency	No. of photo electron	Proportional	Intensity of light
	Saturation current		
Maximum kinetic energy		Independent	
		Proportional	Frequency of light

03 Characteristics of photons

The energy of the photon $E = h\nu$

Energy depends on frequency

Photons travel with velocity of light

They are electrically neutral

They are not deflected by $\vec{E}$ and $\vec{B}$

04 What are the applications of photo cell?

Photo cells are used as	Switches and sensors
	Automatic on and off of street light
	Reproduction of sound in videos
	as timers to measure the speed of athletes
	To measure intensity and exposure time of radiation.

05 De Broglie wavelength for matter waves

The momentum of the photon	$p = \frac{h\upsilon}{C} = \frac{h}{\lambda}$
We know that	$c = \nu\lambda$
debroglie wavelength	$\lambda = \frac{h}{p} = \frac{h}{mv}$

06 Derive an expression for de Broglie wavelength of electrons.

Kinetic energy acquired by the electron	$\frac{1}{2}mv^2 = eV$	1M
Speed of the electron	$v = \sqrt{\frac{2eV}{m}}$	1M
Debroglie wavelength	$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$	1M
Substituting the known values	$\lambda = \frac{12.27}{\sqrt{V}}\text{Å}$	
eV = K = Kinetic energy	$\lambda = \frac{h}{\sqrt{2mK}}$	

TWO MARKS

01 Why electron is preferred over X ray in microscope

X ray cannot be deflected by electric and magnetic field and cannot be focused by electrostatic and magnetic lenses

Electron bean can be deflected by electric and magnetic field and can be focused.

02 What is a photo cell? Mention the different types of photocells.

converts light energy into electrical energy.	Photo emissive cell Photo voltaic cell Photo conductive cell

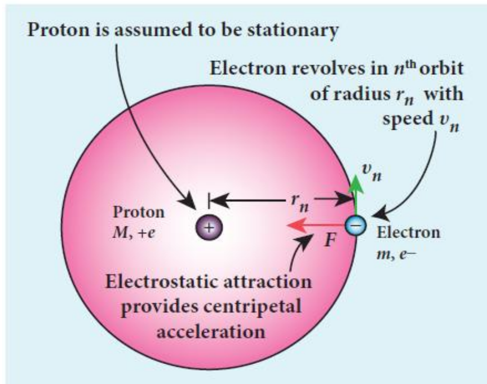
03 Work function

The minimum energy needed for an electron to escape from the metal surface Unit : eV

09. ATOMIC & NUCLEAR PHYSICS

FIVE MARKS

01 Radius of nth orbit of an electron

Diagram	
Equating Force	$\frac{1}{4\pi\epsilon_0}\frac{Ze^2}{r_n^2} = \frac{Mv^2}{r_n}$
	$\frac{4\pi\epsilon_0\,(mvr)^2}{Zme^2}$
Bohrs condition	$mv_nr_n = \frac{nh}{2\pi}$
Substituting	$r_n = \frac{n^2h^2\varepsilon_o}{\pi mZe^2}$
	$r_n \propto n^2$ (radius is proportional to square of the principal quantum no)
Bohr radius	$r_n = 0.53$ Å

02 Energy of an electron in the n^{th} orbit

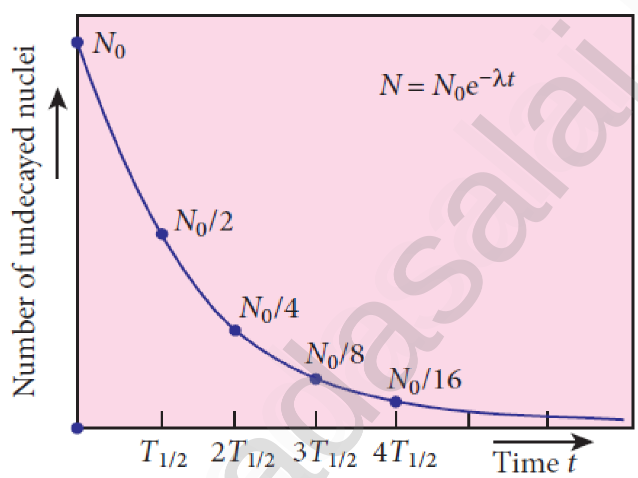
Total energy	sum of the potential energy and kinetic energy $T = K + U$
Potential Energy	$U = -\frac{1}{4\pi\epsilon_0}\frac{Ze^2}{r}$
Kinetic Energy	$K = \frac{1}{8\pi\epsilon_0}\frac{Ze^2}{r}$
Total energy	$E_n = -\frac{13.6}{n^2}\ eV$

03 Spectral series of an hydrogen atom

Series	n	m	Equation	Region
Lyman	1	2,3,4,5,6	$\frac{1}{\lambda} = R\left[\frac{1}{1} - \frac{1}{m^2}\right]$	UV
Balmer	2	3,4,5,6,7	$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{m^2}\right]$	Visible
Paschen	3	4,5,6,7,8	$\frac{1}{\lambda} = R\left[\frac{1}{9} - \frac{1}{m^2}\right]$	IR

Brackett	4	5,6,7,8,9	$\frac{1}{\lambda} = R\left[\frac{1}{16} - \frac{1}{m^2}\right]$	IR
P Fund	5	6,7,8,9	$\frac{1}{\lambda} = R\left[\frac{1}{25} - \frac{1}{m^2}\right]$	IR

04 State law of radioactive decay

Law	Rate of disintegration is directly proportional to the number of atoms present at that instant	
From law	$\frac{dN}{dt} = -\lambda N$	-ve sign denotes atom decreases
Rewriting	$\int_{N_0}^{N} \frac{dN}{N} = -\int_0^t \lambda dt$	
On integrating	$\ln\left(\frac{N}{N_0}\right) = -\lambda t$	
Taking exponentials	$N = N_0\, e^{-\lambda t}$	
Graph		

THREE MARKS

01 What are the properties of cathode rays?

Possess energy and momentum

Can be deflected by both E & B

They affect photographic plates

They produces fluorescence

Ionize the gas through which they pass

02 Half life

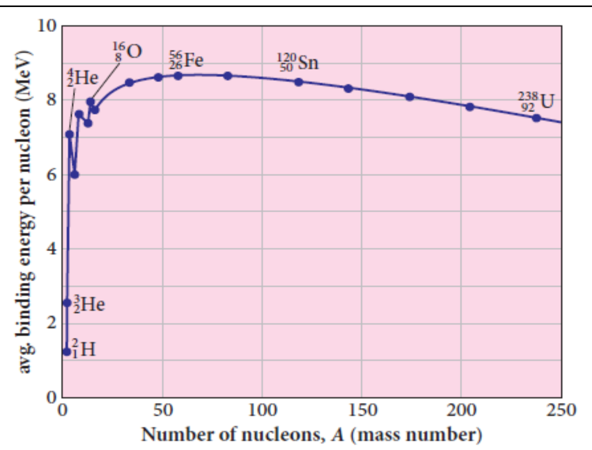
Half life time	time required to become half of the initial
From definition	$\frac{N_0}{2} = N_0\, e^{-\lambda T_{\frac{1}{2}}}$
Reciprocating	$e^{\lambda T_{\frac{1}{2}}} = 2$
Taking log on both sides	$T_{\frac{1}{2}} = \frac{\ln 2}{\lambda} = \frac{0.6931}{\lambda}$

03 Classifications of nuclei

	Element	Atomic No	Mass No	Neutron No	Example
Isotopes	Same	Same	Different	Different	$_1H^1$ $_1H^2$
Isobars	Different	Different	same	Different	$_{16}Si^{40}$ $_{17}Cl^{40}$
Isotones	Different	Different	Different	Same	$_5B^{12}$ $_6C^{13}$

04 Explanation for Binding energy curve

MARCH 2020 (3M)

Graph	
A < 40	$\overline{\text{BE}}$ Increases with A
A = 56	$\overline{\text{BE}} = 8.8\ MeV$ reaches the maximum at A = 56
A= 40 to 120	Average $\overline{\text{BE}} = 8.5\ MeV$ More stable & non radioactive
A > 120	Average $\overline{\text{BE}}$ reduces slowly $\overline{\text{BE}} = 7.6\ MeV$ for uranium Unstable & radioactive

TWO MARKS

01 Properties of Nuclear Force

Strongest force of nature

Very short range force

strong attractive force

Nuclear force is same for (n-n), (p-p), (p-n)

02 Define one amu

One atomic mass unit is defined as the $\frac{1}{12}$th of the mass of the isotope of carbon $_6C^{12}$.

$$1u = 1.660 \times 10^{-27}\ Kg$$

03 Properties of Nuclear Force

Strongest force of nature

Very short range force

It is an strong attractive force

Nuclear force is same for (n-n), (p-p), (p-n)

It doesn't act on electrons hence chemical properties of the atoms remain unaltered.

04 What are the properties of neutrino? (2M)

It has Zero charge

It has an antiparticle called anti neutrino

experiments shows that they have tiny mass

they interacts weakly with matter

05 One curie

One curie is defined as the no. of decays per second in 1g of radium which is equal to 3.7 $X10^{10}$ decays/s

$$\boxed{\text{1 curie} = 3.7 \text{ x } 10^{10} \text{ decays per second}}$$

06 What are the properties of neutrons?

They are stable inside the nucleus

Outside the nucleus it decays with a half life of 13 mins.

They are neutral in charge

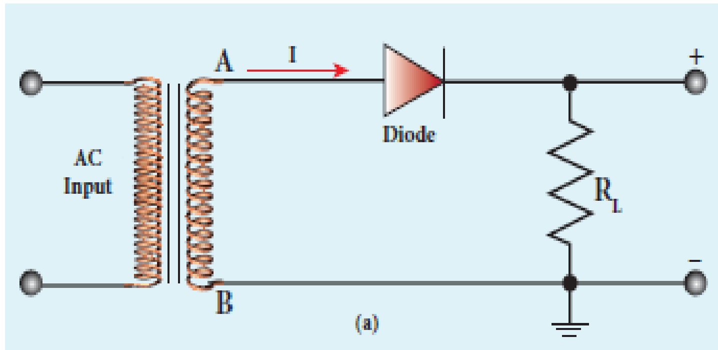
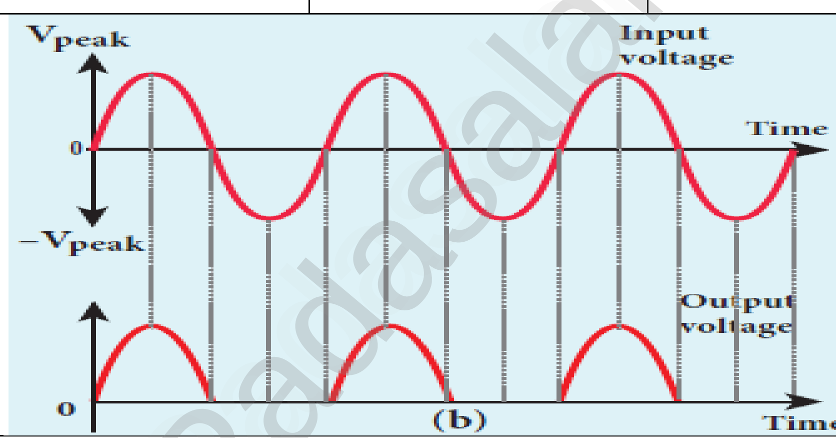
Penetrating power is high

07 Classify the neutrons based on their kinetic energy

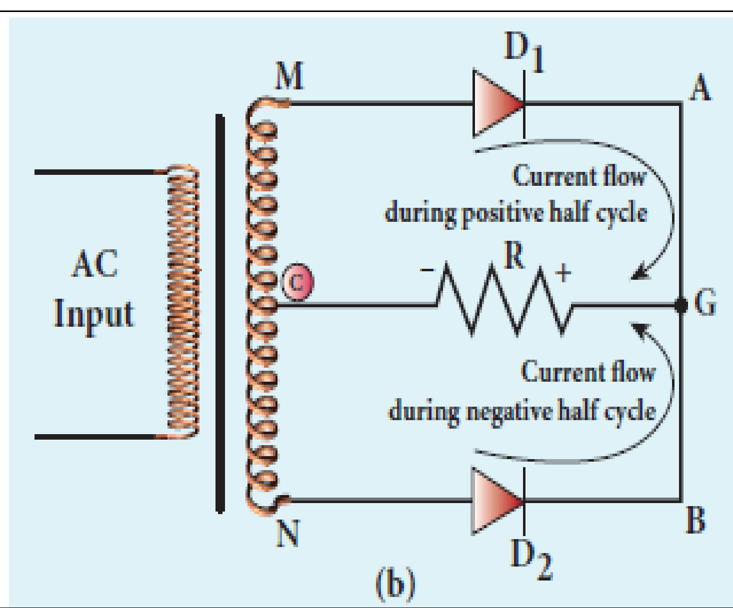
Name	Kinetic energy
Slow neutron	0 to 1000eV
Fast neutron	0.5MeV to 10MeV
Thermal neutron	0.025eV in thermal equilibrium

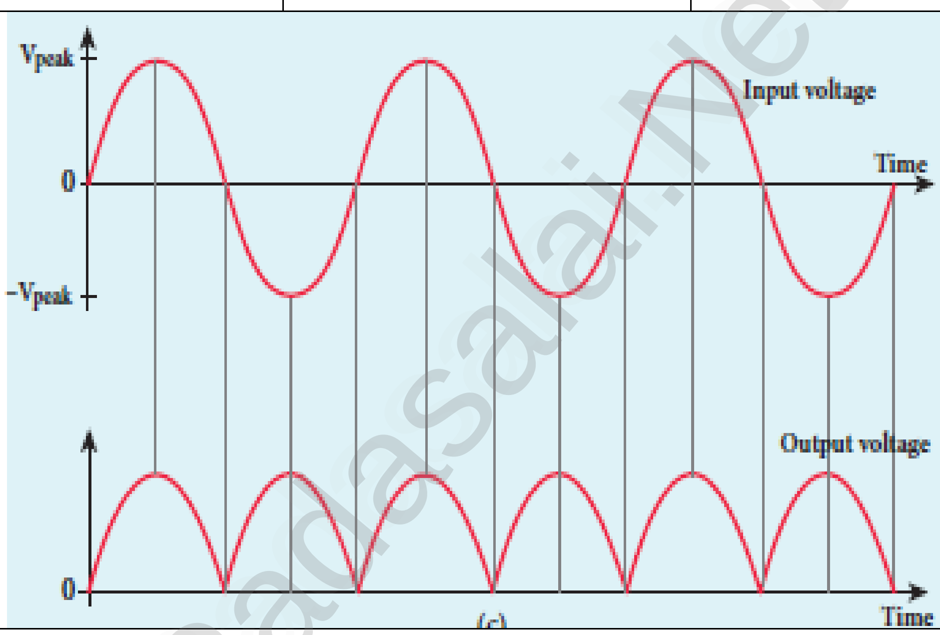
10. SEMICONDUCTOR DEVICES

01 Explain the working of half wave rectifier with a circuit diagram and a graph

Definition	The circuit which rectifies one half of the input ac signal		
Circuit diagram			
Working		+ve half cycle	-ve half cycle
	Terminal A	Positive	Negative
	Terminal B	Negative	Positive
	Diode D	Forward Bias	Reverse Bias
	Current	Conducts	doesn't conduct
	Output voltage	Obtained	Not obtained
Wave Form			
Output Nature	Unidirectional & Pulsating output		
Efficiency	$\eta = \frac{\text{output dc power}}{\text{input ac power}} = 40.6\ \%$		

02 Explain the working of full wave rectifier with a circuit diagram and a graph

Definition	It rectifies both half cycle of the input signal
Circuit diagram	

		+ve half cycle	-ve half cycle
Working	Terminal M	Positive	Negative
	Terminal N	Negative	Positive
	Terminal G	Zero	Zero
	Diode (D_1)	Forward bias and +conducts	Reverse Bias and doesn't conduct
	Diode (D_2)	Reverse Bias and doesn't conduct	Forward bias and conducts
	Output voltage	Obtained	Obtained
	Current direction	MD_1AGC	ND_2BGC
	Voltage direction	G ➔ C	G ➔ C
Wave Form			
Output nature	Voltage drop in same direction Still pulsating output		
Efficiency	81.2%		

03 State and prove Demorgan theorem

First Theorem The complement of the sum is equal to product of its complements $\overline{A+B} = \overline{A}.\overline{B}$					Second Theorem The complement of the product is equal to sum of its complements $\overline{AB} = \overline{A} + \overline{B}$				
A	B	A+B	$\overline{A+B}$	AB	$\overline{AB}$	$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$	$\overline{A}.\overline{B}$
0	0	0	1	0	1	1	1	1	1
0	1	1	0	0	1	1	0	1	0
1	0	1	0	0	1	0	1	1	0
1	1	1	0	1	0	0	0	0	0

THREE MARKS

01 Write down the applications of satellite communication

Weather satellite	Monitoring the weather and climate Predict rain, storms, cyclones
Communication satellite	Transmission of TV, Radio and internet signal
Navigations satellite	To locate ships, aircrafts

02 What is fiber optic communication? Mention its principle & write its application

F. O. C	The method of transmitting information from one place to another in terms of light pulses through an optical fiber
Principle	Total internal reflection
Applications	International, inter – city communication, data – links, plant and traffic control and defense application

03 What are merits and Demerits of Fiber optic communication?

Merits	Demerits
cables are very thin and less weight	More fragile
Much larger bandwidth.	Expensive technology
No electrical interference	
Cheaper	

04 What is RADAR? Write its applications

RADAR	Radio Detection and Ranging	
Applications	Military	For locating and detecting the targets
	Navigation	air search & missile guidance system
	Meteorological	Measure precipitation rate and wind speed
	Emergency	Locate and rescue people

05 Write down the applications of mobile communication

Voice calls and high speed data connectivity
Transmission of news
To control various devices
Enable smart classroom, online availability of notes & monitoring students activities

06 hat are the applications of internet communication

Search engine	Web based service tool to search for information
Communication	Connects millions of people by email, social networking and instant messaging

E commerce	Buying and selling of goods and services Transfer of funds on electronic networks

07 What are the applications of LED ?

Applications	Indicator lamp on scientific and laboratory equipments Seven Segment Display Traffic signal, emergency vehicle lighting Remote control of TV and AC

08 Write down the uses of Photodiode.

Applications	Alarm system Count items in conveyor belt Photo conductors CD players and smoke detectors Computer tomography

09 Mention the applications of solar cell

Application	Used in calculators, watches, toys, portable power supplies Used in satellite and space applications Solar panels are used to generate electricity.

10 Barkhausen conditions for sustained oscillations

The loop phase shift must be 0^0 or $n2\pi$ (where n = 1,2,3.....)

Loop gain $|A\beta| = 1$

11 What are the applications of oscillators ?

To generate periodic sinusoidal and non sinusoidal waveforms

To generate RF carriers

To generate audio tones

To generate clock signal in digital circuits

As a sweep circuits in TV set and CRO

12 What are the advantages of IC?

Cost

Size

Reliability

Performance

Speed

Easy replacement

13 What are the advantages and limitations of AM?

Advantages	Disadvantages
Easy transmission and reception	Noise level is high
Lesser Bandwidth	Low efficiency
Low cost	Small operating range

14 What are the advantages and limitations of FM

Advantages	Disadvantages
Large decrease in noise	Requires wider channel
Large operating range	Complex and costly Transmitters and receivers
Efficiency is very high	Less coverage area
Bandwidth covers entire audible range	

15 What are the methods of propagation of electromagnetic waves?

Ground Wave propagation

Space wave propagation

Sky wave propagation

16 What is skip distance?

The shortest distance between the transmitter and the point of reception of the sky wave along the surface

17 What is skip zone?

There is zone (Area) where there is no reception of electromagnetic waves neither ground nor sky called skip zone or skip area

18 What are the advantages of using microwaves in space wave propagation?

Larger bandwidth

High data rates

Better directivity

Small antenna size

Low power consumption

19 What are intrinsic semiconductors?

- A semiconductor is in pure form without impurity.
- The no. of electrons in the conduction = The no. of holes in the valence band
- E.g. : Pure Si, Pure Ge

20 What is doping?(MARCH 2020 (2M))

The process of adding of small amount of impurity to the pure semiconductor is called doping.

21 What is rectification?

The process of converting alternating current into a direct current is called rectification