12th STD

Reg. No.

PUBLIC EXAMINATION - MARCH - 2025

PART - III

TIME ALLOWED : 3.00 Hours] **PHYSICS** (with answers) **[MAXIMUM MARKS : 70**

Instructions : (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.

(2) Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

PART - I

Note : (i) Answer **all** the questions. **(15 × 1 = 15)**

(ii) Choose the most appropriate answer from the given **four** alternatives and write the option code and the corresponding answer.

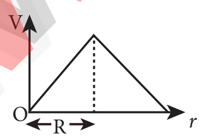
1. Calculate the distance upto which ray optics is a good approximation for light of wavelength 500 nm falls on an aperture of width 0.5 mm.
   (a) 20 cm (b) 25 m
   (c) 25 cm (d) 30 cm

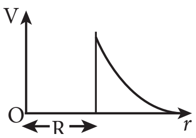
2. The transverse nature of light is shown in :
   (a) scattering (b) interference
   (c) polarisation (d) diffraction

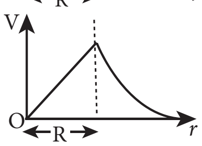
3. If a material having intensity of magnetisation 500 Am^{-1} is placed in a magnetising field of 1000 Am^{-1}, then the susceptibility of the material is :
   (a) 0.2 (b) 0.8 (c) 0.7 (d) 0.5

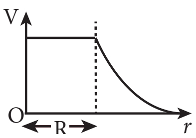
4. In a transformer, the number of turns in the primary and the secondary are 410 and 1230 respectively. If the current in primary is 6A, then that in the secondary coil is :
   (a) 12A (b) 2 A
   (c) 1 A (d) 18 A

5. A thin conducting spherical shell of radius R has a charge Q which is uniformly distributed on its surface. The correct plot for electrostatic potential due to this spherical shell is :

(a) 

(b) 

(c) 

(d) 

6. In Photoelectric emission, a radiation whose frequency is 4 times threshold frequency of a certain metal is incident on the metal. Then, the maximum possible velocity of the emitted electron will be :
   (a) $2\sqrt{\frac{hv_0}{m}}$ (b) $\sqrt{\frac{hv_0}{m}}$
   (c) $\sqrt{\frac{hv_0}{2m}}$ (d) $\sqrt{\frac{6hv_0}{m}}$

7. "Ski wax" is an application of nano product in the field of :
   (a) Sports (b) Medicine
   (c) Automotive industry (d) Textile

8. An electric dipole is placed at an alignment angle of 30° with an electric field of 2×10^5 NC^{-1}. It experiences a torque equal to 8 Nm. The charge on the dipole if the dipole length is 1 cm is :
   (a) 5 mC (b) 4 mC
   (c) 7 mC (d) 8 mC

9. For light incident from air on a slab of refractive index 2, the maximum possible angle of refraction is :
   (a) 60º (b) 30º (c) 90º (d) 45º

10. First diffraction minimum due to a single slit of width 1.0×10^{-5} cm is at 30º. Then wavelength of light used is:
    (a) 600 Å (b) 400 Å
    (c) 700 Å (d) 500 Å

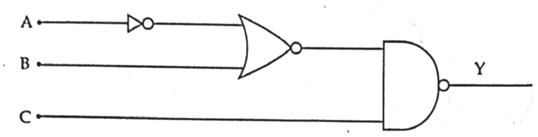
11. To obtain sustained oscillation in an oscillator,
    (a) Feedback factor must be unity
    (b) Phase shift must be 0 or 2π
    (c) Feedback should be positive
    (d) All the above

12. The dimension of $\frac{1}{\mu_0\varepsilon_0}$ is :
    (a) $[L^{-1}T]$ (b) $[LT^{-1}]$
    (c) $[L^{-2}T^2]$ (d) $[L^2T^{-2}]$

13. In Joule's heating law, when R and t are constant, if the H is taken along the y-axis and I2 along the x-axis, the graph is :
(a) circle (b) straight line
(c) ellipse (d) parabola

14. A radioactive element has N_0 number of nuclei at t=0. The number of nuclei remaining after half of a half- life (that is, at time $t = \frac{1}{2}T_{\frac{1}{2}}$) is :
(a) $\frac{N_0}{4}$ (b) $\frac{N_0}{2}$ (c) $\frac{N_0}{8}$ (d) $\frac{N_0}{\sqrt{2}}$

15. In the combination of the following gates, write the Boolean equation for output Y in terms of input A, B, C.



(a) $\overline{A}\ B\ \overline{C}$ (b) $A\ \overline{B}\ C$
(c) $\overline{A} + \overline{B} + \overline{C}$ (d) $\overline{A} + B + \overline{C}$

PART - II

Note : Answer **any six** questions. Question No. **24** is **Compulsory.** **(6 × 2 = 12)**

16. A parallel plate capacitor has two square plates of side 5 cm and separated by a distance of 1 mm. Calculate the capacitance of this capacitor.
17. State Lenz's Law.
18. Write the limitations of Cyclotron.
19. What is mass defect? Give its expression.
20. What is optical path?
21. What are the shapes of wavefront for a :
(a) Source at infinite (b) Point source
(c) Line source
22. Draw the circuit diagram for a forward biased p-n junction diode.
23. Define stopping potential.
24. A cell supplies a current of 0.9 A through a 2Ω resistor and a current of 0.3 A through a 7 Ω resistor. Calculate the internal resistance of the cell.

PART - III

Note : Answer **any six** questions. Question No. **33** is **Compulsory.** **(6 × 3 = 18)**

25. State Kirchhoff's current rule and voltage rule.
26. A radiation of wavelength 300nm is incident on calcium surface. Will photoelectrons be observed? Justify your answer. (Work function of calcium = 3.20eV)
27. Give an account of magnetic Lorentz force.
28. What are the advantages and disadvantages of Alternating Current System over Direct Current System?
29. Write down the properties of electromagnetic waves. (Any Six)
30. Obtain the relation between phase difference and path difference.
31. What are the differences between coulomb force and gravitational force?
32. Distinguish between intrinsic and extrinsic semiconductors.
33. Find the (i) Angular momentum (ii) Velocity of the electron revolving in the 5^{th} orbit of hydrogen atom of radius 13.25 Å.

PART - IV

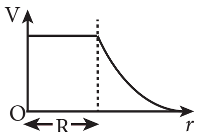
Note: Answer **all** the questions **(5 × 5 = 25)**

34. (a) Obtain the expression for electric field due to an infinitely long charged wire. **(OR)**
(b) State and prove DeMorgan's first and second theorems.
35. (a) How the emf of two cells are compared using potentiometer? **(OR)**
(b) Describe the Fizeau's method to determine the speed of light.
36. (a) Derive the expression for the torque on a current - carrying coil in a magnetic field. **(OR)**
(b) Explain the construction and working of photo emissive cell and give any two applications of photo cell.
37. (a)
(i) How will you induce an emf by changing the area enclosed by a coil?
(ii) A circular metallic disc of area 0.03 m^2 rotates in a uniform magnetic field of 0.4 T. The axis of rotation passes through the centre and perpendicular to its plane and is also parallel to the magnetic field. if the disc completes 20 revolutions in one second and the resistance of the disc is 4 Ω, calculate the induced emf between the axis and the rim. **(OR)**
(b) (i) State Brewster's Law.
(ii) What is the angle at which a glass plate of refractive index 1.65 is to be kept with respect to the horizontal surface so that an unpolarised light travelling horizontal after reflection from the glass plate is found to be plane polarised?
38. (a) Obtain the law of radioactive decay. **(OR)**
(b) What is absorption spectrum? Explain the types of absorption spectrum.

ANSWERS

PART - I

1. (c) 25 cm
2. (c) polarisation
3. (d) 0.5
4. (b) 2 A
5. (d)



6. (d) $\sqrt{\dfrac{6h\nu_0}{m}}$
7. (a) Sports
8. (d) 8 mC
9. (b) 30°
10. (d) 500 Å
11. (d) All the above
12. (d) $[L^2\ T^{-2}]$
13. (b) straight line
14. (d) $\dfrac{N_0}{\sqrt{2}}$
15. (d) $\overline{A} + B + \overline{C}$

PART - II

16. The capacitance of the capacitor is

$$C = \frac{\epsilon_0\ A}{d} = \frac{8.85\times10^{-12}\times25\times10^{-4}}{1\times10^{-3}}$$

$$= 221.2 \times 10^{-13}\ F$$

$$C = 22.12 \times 10^{-12}\ F = 22.12\ pF$$

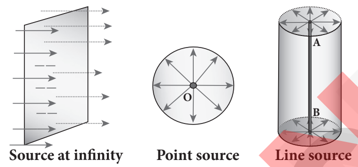
17. Lenz's law states that the direction of the induced current is such that it always opposes the cause responsible for its production.

18. **Limitations of cyclotron :**
(i) the speed of the ion is limited
(ii) electron cannot be accelerated
(iii) uncharged particles cannot be accelerated.

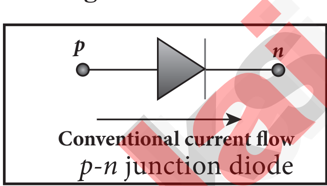
19. The experimental mass of carbon-12 nucleus is less than the total mass of its individual constituents. This difference in mass Δm is called mass defect.
$\Delta m = (Zm_p + Nm_n) - M$

20. Optical path of a medium is defined as the distance d' light travels in vacuum in the same time it travels a distance d in the medium. Optical path d' = nd

21. **(i)** Source is located at infinity gives plane wavefront.
(ii) A point source located at a finite distance gives spherical wavefronts.
(iii) An extended (or) line source at finite distance gives cylindrical wavefronts.



22. **Ciruit diagram**



23. Stopping potential is that value of the negative (retarding) potential given to the collecting electrode A which is just sufficient to stop the most energetic photoelectrons emitted and make the photocurrent zero.

24. **Given :** Cell supplies a current I_1 = 0.9 A through resistor R_1 = 2 Ω. Cell supplies to current I_2 = 0.3 A through resistor R_2 = 7 Ω
To find : Internal resistance of the cell r = ?

Formula : $I_1 = \dfrac{\varepsilon}{R_1 + r}$

$$\varepsilon = I_1 (R_1 + r) \quad ...(1)$$

$$I_2 = \frac{\varepsilon}{R_2 + r}\ ;\ \varepsilon = I_2 (R_2 + r) \quad ...(2)$$

From (1) and (2)

$$I_1 (R_1 + r) = I_2 (R_2 + r)$$

$$r = \frac{I_1R_1 - I_2R_2}{I_2 - I_1} = \frac{(0.9\times2)-(0.3\times7)}{0.3-0.9}$$

$$= \frac{1.8-2.1}{-0.6} = \frac{0.3}{0.6} = \frac{1}{2} = 0.5\ \Omega$$

$$r = 0.5\ \Omega$$

PART - III

25. **Kirchhoff's current rule :**
(i) Kirchhoff's current rule states that the algebraic sum of the currents at any junction of a circuit is zero.
(ii) It is a statement of law of conservation of electric charge.

Kirchhoff's voltage rule :

(i) It states that in a closed circuit, the algebraic sum of the products of the current and resistance of each part of the circuit is equal to the total emf included the circuit.

(ii) It follows from the law of conservation of energy.

26. $E = \dfrac{hc}{\lambda}$

$\therefore h = 4.136 \times 10^{-15}$, eV ; $C = 3 \times 10^{8}$ m

$\lambda = 300$, nm $= 300 \times 10^{-9}$ m

$$E = \frac{4.136\times10^{-15}\times3\times10^{8}}{300\times10^{-9}}$$

$$E = \frac{1.248\times10^{-6}}{3\times10^{-7}}$$

E = 4.136 eV (or) 4.14 eV.

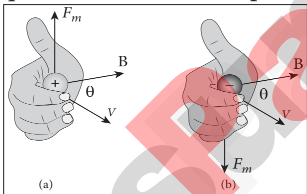
27. **Force on a moving charge in a magnetic field :**

(i) When an electric charge q is moving with velocity $\vec{v}$ in the magnetic field $\vec{B}$, it experiences a force, called magnetic force $\vec{F}_m$.

$\vec{F}_m = q(\vec{v} \times \vec{B})$ ...(1)

In magnitude $F_m = qvB \sin\theta$ ...(2)

The equation (1) and (2) implies.



Direction of the Lorentz force on (a) positive charge (b) negative charge

(ii) $\vec{F}_m$ is directly proportional to the magnetic field $\vec{B}$. $\vec{F}_m$ is directly proportional to the velocity $\vec{v}$ of the moving charge.

(iii) F_m is directly proportional to sine of the angle between the velocity and magnetic field. F_m is directly proportional to the magnitude of the charge q.

(iv) The direction of $\vec{F}_m$ is always perpendicular to $\vec{v}$ and $\vec{B}$. The direction of $\vec{F}_m$ on negative charge is opposite to the direction of F_m on positive charge.

(v) If velocity $\vec{v}$ of the charge q is along magnetic field $\vec{B}$ then $\vec{F}_m$ is zero.

28. **Advantages:**

(i) The generation of AC is cheaper than that of DC. When AC is supplied at higher voltages, the transmission losses are small compared to DC transmission.

(ii) AC can easily be converted into DC with the help of rectifiers.

Disadvantages:

(i) Alternating voltages cannot be used for certain applications such as charging of batteries, electroplating, electric traction etc.

(ii) At high voltages, it is more dangerous to work with AC than DC.

29. **Properties of electromagnetic waves :**

(i) Electromagnetic waves are produced by any accelerated charge.

(ii) Electromagnetic waves do not require any medium for propagation.

(iii) The oscillating electric field vector, oscillating magnetic field vector and propagation vector are mutually perpendicular to each other.

(iv) Electromagnetic waves travel with speed which is equal to the speed of light in vacuum or free space.

(v) Electromagnetic waves are not deflected by electric field or magnetic field.

(vi) Electromagnetic waves can exhibit interference, diffraction and polarization

30. **(i)** In the path of the wave, one wavelength λ corresponds to a phase of 2π.

(ii) A path difference δ corresponds to a phase difference ϕ as given by the equation,

$$\therefore \delta = \frac{\lambda}{2\pi} \times \phi \text{ (or) } \phi = \frac{2\pi}{\lambda} \times \delta$$

31.

	Coulomb	Gravitational
i)	It may be attractive or repulsive.	It is always attractive in nature.
ii)	It depends upon medium	It does not depend upon the medium.
iii)	It is always greater in magnitude because of high value of $K = 9 \times 10^{9}$ Nm^{2} C^{-2}	It is lesser than coulomb force because value of G is 6.67×10^{-11} Nm^{2} kg^{-2}

32.

Intrinsic semiconductor	Extrinsic semiconductor
It is pure form of semiconductor	Small amount of impurity is added.

Intrinsic semiconductor	Extrinsic semiconductor
No doping takes place in instrinsic semiconductor.	Doping takes place.
Number of free electrons in conduction is equal to number of holes in valence band.	Number of free electrons and holes are not equal.
It has bad electrical characteristics.	It has good electrical conductivity.

33. (i) Angular momentum is given by

$$l = n\hbar = \frac{nh}{2\pi} = \frac{5 \times 6.6 \times 10^{-34}}{2 \times 3.14}$$

$$= 5.25 \times 10^{-34}\ \text{kgm}^2\text{s}^{-1}$$

(ii) Velocity is given by

$$\text{Velocity } v = \frac{l}{mr}$$

$$= \frac{(5.25 \times 10^{-34}\ kgm^2 s^{-1})}{(9.1 \times 10^{-31}\ kg)(13.25 \times 10^{-10}\ m)}$$

$v = 4.4 \times 10^5 \text{ms}^{-1}$

PART - IV

34.(a)

λ - Linear charge density of an infinitily long, uniformly charged wire,

r - distance between wire and point 'P'.

(i) A_1, A_2 two charge elements.

(ii) The resultant 'E' due to A_1 and A_2, act radially outward and is same at all points.

(iii) r & L radius & length of cylindrical Gaussian surface of radius 'r'. The total electric flux.

$$\Phi_E = \oint \vec{E} \cdot d\vec{A}$$

$$\underset{\text{Curved surface}}{\oint \vec{E} \cdot d\vec{A}} + \underset{\text{top surface}}{\oint \vec{E} \cdot d\vec{A}} + \underset{\text{bottom surface}}{\oint \vec{E} \cdot d\vec{A}} \quad ...(1)$$

(iv) For the curved surface, $\vec{E} \parallel \vec{A}$ and $\vec{E} \cdot d\vec{A}$ = E dA. For the top and bottom surfaces,

(v) $\vec{E} \perp r\ \vec{A}$ and $\vec{E} \cdot d\vec{A} = 0$

Applying Gauss law to the cylindrical surface,

$$\phi_E = \underset{\text{Curved surface}}{\int} E \cdot dA = \frac{Q_{encl}}{\varepsilon_0} \quad ...(2)$$

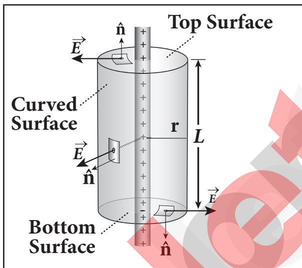
$$Q_{encl} = \lambda L. \quad E \underset{\text{Curved surface}}{\int} dA = \frac{\lambda L}{\varepsilon_0} \quad ...(3)$$

But $\int dA$ = Total area of the curved surface = $2\pi rl$.

$$\therefore E \cdot 2\pi r L = \frac{\lambda L}{\varepsilon_0}$$

$$E = \frac{1}{2\pi\varepsilon_0} \frac{\lambda}{r}$$

(or)



Cylindrical Gaussian surface

In vector form $\vec{E} = \frac{1}{2\pi\varepsilon_0} \frac{\lambda}{r} \hat{r}$ and is true for an infinitely long wire.

(OR)

(b) **De morgan's First theorem :**

Statement : The first theorem states that the complement of the sum of two logical inputs is equal to the product of its complements.

Proof :

(i) The Boolean equation for NOR gate is $Y = \overline{A+B}$

(ii) The Boolean equation for a bubbled AND gate is $Y = \overline{A} . \overline{B}$

(iii) Both cases generate same outputs for same inputs. It can be verified using the following truth table.

A	B	A+ B	$\overline{A+B}$	$\overline{A}$	$\overline{B}$	$\overline{A} . \overline{B}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

From the above truth table, we can conclude $\overline{A+B} = \overline{A} \cdot \overline{B}$

De morgan's second theorem :

Statement : The second theorem states that the complement of the product of two inputs is equal to the sum of its complements.

Proof :

(i) The Boolean equation for NAND gate is $Y = \overline{A . B}$.

(ii) The Boolean equation for bubbled OR gate is $Y = \overline{A} + \overline{B}$.

(iii) A and B are the inputs and Y is the output. The above two equations produces the same output for the same inputs. It can be verified by using the truth table.

A	B	A.B	$\overline{A . B}$	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$
0	0	0	1	1	1	1

0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

(iv) From the above truth table we can conclude $\overline{A \cdot B} = \overline{A} + \overline{B}$.

35. (a)

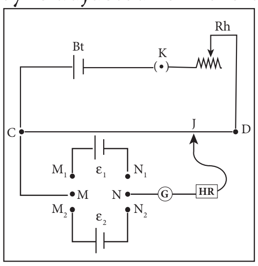
(i) Potentiometer wire CD is connected to a battery Bt and a key K in series. This is the primary circuit.

(ii) The end C of the wire is connected to the terminal M of a DPDT switch.

(iii) The terminal N is connected to a jockey through a galvanometer G and a high resistance HR.

(iv) Cell 1 is connected between M_1 and N_1. Cell 2 is connected between M_2 and N_2.

(v) The jockey is adjusted for zero deflection.



Comparison of emf of two cells

(vi) The DPDT switch is pressed towards (ε_1).

(vii) The potential difference across balancing length l_1 is Irl_1.

$$\varepsilon_1 = Irl_1 \quad \text{...(1)}$$

$$\varepsilon_2 = Irl_2 \quad \text{...(2)}$$

By dividing equation (1) by (2)

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} \quad \text{...(3)}$$

(OR)

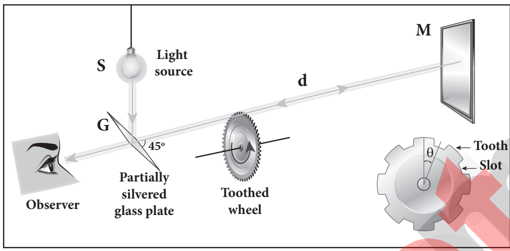
(b) **Apparatus :**

(i) The light from the source S was first allowed to fall on a partially silvered glass plate G kept at an angle of 45° to the incident light.

(ii) The light then was allowed to pass through a rotating toothed-wheel with N teeth and N cuts of equal widths.

(iii) The light passing through one cut in the wheel will get reflected by a mirror M kept at a long distance *d*, about 8 km.

(iv) The toothed wheel was not rotating, the light reflected by partially silvered glass plate.



Speed of light by Fizeau's method

Working :

(i) The angular speed of rotation of the toothed wheel was increased from zero to a value ω.

(ii) This is ensured by the disappearance of light while looking through the partially silvered glass plate.

Expression for speed of light :

$$v = \frac{2d}{t} \quad \text{...(1)}$$

$2d \Rightarrow$ distance travelled by light

$$t \Rightarrow \text{time taken} \quad \omega = \frac{\theta}{t} \quad \text{...(2)}$$

$$\theta = \frac{\text{total angle of the circle in radian}}{\text{number of teeth + number of cuts}}$$

$$\theta = \frac{2\pi}{2N} = \frac{\pi}{N}$$

Substituting for θ in the equation (2),

$$\omega = \frac{\pi / N}{t} = \frac{\pi}{Nt}$$

Rewriting the above equation for t,

$$t = \frac{\pi}{N\omega} \quad \text{...(3)}$$

Substituting *t* from equation (3) in equation (1),

$$v = \frac{2d}{\pi / N\omega}$$

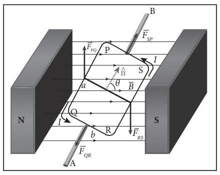
After rearranging $v = \dfrac{2dN\omega}{\pi}$

The speed of light in air was determined as,

$V = 2.99792 \times 10^8\ ms^{-1}$

36. (a)

Consider a rectangular loop PQRS carrying current I is placed in a uniform magnetic field $\vec{B}$. Let a and b be the length and breadth of rectangular loop respectively. The unit vector $\hat{n}$ normal to the plane of the loop makes an angle θ with the magnetic field.



Rectangular coil placed in a magnetic field

(i) The current-carrying arm PQ is FPQ = IaBsin $\left(\frac{\pi}{2}\right)$ = IaB.

(ii) The magnitude of the force on the arm QR is FQR = IbBsin $\left(\frac{\pi}{2}-\theta\right)$ = IbB cos θ and its direction.

(iii) The magnitude of the force on the arm RS is FRS = IaBsin $\left(\frac{\pi}{2}\right)$ = IaB and its direction is downwards.

(iv) The magnitude of the force acting on the arm SP is FSP = IbBsin $\left(\frac{\pi}{2}+\theta\right)$ = IbB cos θ and its direction.

(v) But the forces FPQ and FRS. The magnitude of torque acting on the arm PQ about AB is

$\tau_{PQ} = \left(\frac{b}{2}\sin\theta\right)$ IaB.

The magnitude of the torque acting on the arm RS about AB is

$\tau_{RS} = \left(\frac{b}{2}\sin\theta\right)$ IaB.

(vi) The total torque acting on the entire loop about an axis AB is given by

$\tau \quad = \left(\frac{b}{2}\sin\theta\right)F_{PQ} + \left(\frac{b}{2}\sin\theta\right)$

FRS = Ia(bsinθ)B

τ = IABsinθ along the direction AB

In vector form $\vec{\tau} = (I\hat{A})\times\hat{B}$

(vii) The above equation can also be written in terms of magnetic dipole moment

$\vec{\tau} = \vec{P}_m \times \vec{B}$ where $\vec{P}_m = I\vec{A}$

(viii) The torque is given by τ = NIAB sin θ

Special cases :

(i) When θ = 90° ; τ_{max} = IAB

(ii) When θ = 0°/180° = 0

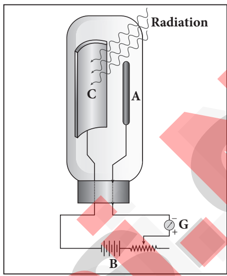
(OR)

(b) **Construction:**

(i) It consists of an evacuated glass or quartz bulb in which two metallic electrodes – that is, a cathode and an anode are fixed.

(ii) The cathode C is semi-cylindrical in shape and is coated with a photo sensitive material. The anode A is a thin rod or wire kept along the axis of the semi-cylindrical cathode.

(iii) A potential difference is applied between the anode and the cathode through a galvanometer G.



Construction of photo cell

Working :

(i) When cathode is irradiated with suitable radiation, electrons are emitted from it.

(ii) These electrons are attracted by anode and hence a current is produced which is measured by the galvanometer. For a given cathode, the magnitude of the current depends on

i) the intensity to incident radiation and
ii) the potential difference between anode and cathode.

Applications of photo cells:

(i) Photo cells have many applications, especially as switches and sensors. Automatic lights that turn on when it gets dark use photocells, and street lights that switch on and switch off according to whether it is night or day use photocells.

(ii) Photo cells are used for reproduction of sound in motion pictures and are used as timers to measure the speeds of athletes during a race.

37. (a)

(i) Consider a conducting rod of length *l* moving with a velocity v towards left. The whole arrangement is uniform magnetic field $\vec{B}$ whose magnetic lines are perpendicularly directed into the plane of the paper.

As the rod moves from AB to DC in a time *dt*, the area enclosed by the loop changes and hence the magnetic flux through the loop decreases.

The change in magnetic flux in time *dt* is

$d\Phi_B$ = B × change in area (dA)

= B × Area ABCD

Since area ABCD = *l* (*vdt*)

$d\Phi_B = Blvdt$ (or) $\frac{d\Phi_B}{dt} = Blv$

The magnitude of the induced emf is

$$\varepsilon = \frac{d\Phi_B}{dt} \Rightarrow \varepsilon = Blv$$

This emf is called motional emf. The direction of induced current is found to be clockwise from Fleming's right hand rule.

(ii) **Solution:** $A = 0.03\ m^2$; $B = 0.4$ T; $f = 20$ rps; $R = 4\Omega$

Area swept out by the disc in unit time

= Area of the disc × frequency

$$\frac{dA}{dt} = 0.03 \times 20 = 0.6\ m^2s^{-1}$$

The magnitude of the induced emf,

$$\varepsilon = \frac{d\phi_B}{dt} = \frac{d(BA)}{dt} = B\frac{dA}{dt}$$

$$\varepsilon = \frac{0.4 \times 0.6}{1} = 0.24\ V$$

$$\text{Induced current, } i = \frac{\varepsilon}{R} = \frac{0.24}{4} = 0.06\ A.$$

(OR)

(b) **(i)** The law states that the tangent of the polarising angle for a transparent medium is equal to its refractive index. $\tan i_p = n$.

(ii) Solution : $n = 1.65$; Brewster's law, $\tan i_p = n$

$\tan i_p = 1.65$; $i_p = \tan^{-1} 1.65$; $i_p = 58.8$

The inclination with the horizontal surface is, $(90^o - 58.8^o) = 31.2^o$.

38. (a)

(i) At any instant t, the number of decays per unit time, called rate of decay $\left(\frac{dN}{dt}\right)$ is proportional to the number of nuclei (N) at the same instant.

$$-\frac{dN}{dt} \propto N$$

The negative sign in the equation implies that N is decreasing with time.

$$\frac{dN}{dt} = -\lambda N \qquad ...(1)$$

(ii) Here proportionality constant λ is called decay constant which is different for different radioactive sample. By rewriting the equation (1), we get $dN = -\lambda N dt$ ...(2)

(iii) Here dN represents the number of nuclei decaying in the time interval dt.

(iv) Let us assume that at time t = 0 s, the number of nuclei present in the radioactive sample be N_0.

$$\frac{dN}{N} = -\lambda dt \qquad ...(3)$$

$$\int_{N_0}^{N} \frac{dN}{N} = -\int_0^t \lambda dt$$

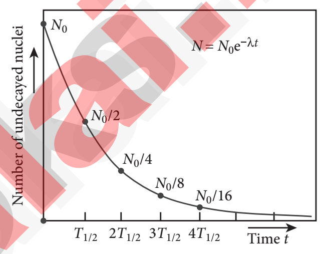
$$[\ln N]_{N_0}^{N} = -\lambda t$$

$$\ln\left[\frac{N}{N_0}\right] = -\lambda t$$

Taking exponentials on both sides, we get $N = N_0 e^{-\lambda t}$ ...(4)

[Note : $e^{\ln x} = e^y \Rightarrow x = e^y$]

(v) Equation (4) is called the law of radioactive decay. N_0 denotes the number of nuclei at initial time $t = 0$.



Law of radioactive decay

(vi) N denotes the number of undecayed nuclei present at any time t. Note that the number of atoms is decreasing exponentially over the time. This implies that the time taken for all the radioactive nuclei to decay will be infinite.

(OR)

(b) When light is allowed to pass through an absorbing substance then the spectrum obtained is known as absorption spectrum. It is the characteristic of absorbing substance.

(a) Continuous absorption spectrum : When we pass white light through a blue glass plate, it absorbs all the colours except blue and gives continuous absorption spectrum.

(b) Line absorption spectrum :

(i) When light from the incandescent lamp is passed through cold gas, the spectrum is thus obtained through the dispersion.

(ii) Light from the carbon arc is made to pass through sodium vapour, a continuous spectrum of carbon arc with two dark lines in the yellow region are obtained.

(c) Band absorption spectrum :

(i) When the white light is passed through the iodine vapour, dark bands on continuous bright background is obtained.

(ii) White light is passed through diluted solution of blood or chlorophyll or through certain solutions of organic and inorganic compounds.

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