

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **37 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C, D.
- (iii) Section A - Questions 1 to 20 carry 1 mark each.
- (iv) Section B - Questions 21 to 27 carry 2 marks each.
- (v) Section C - Questions 28 to 34 carry 3 marks each.
- (vi) Section D - Questions 35 to 37 carry 5 marks each.
- (vii) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.
- (viii) Use of calculators is not permitted.

You may use the following values of physical constants wherever necessary:

$$\begin{aligned}c &= 3 \times 10^8 \text{ m/s} \\h &= 6.63 \times 10^{-34} \text{ Js} \\e &= 1.6 \times 10^{-19} \text{ C} \\\mu_0 &= 4\pi \times 10^{-7} \text{ T m A}^{-1} \\\epsilon_0 &= 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \\\frac{1}{4\pi\epsilon_0} &= 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}\end{aligned}$$

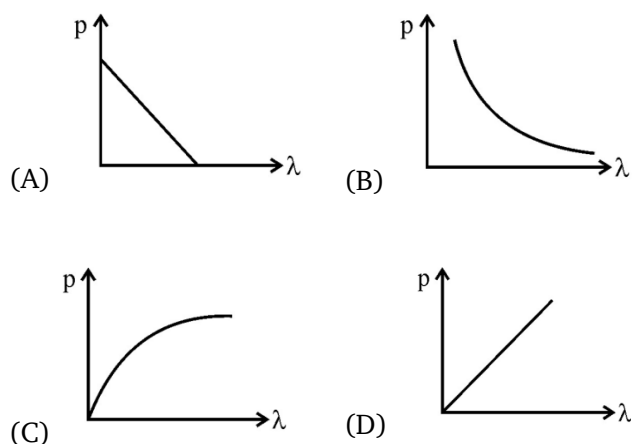
$$\begin{aligned}\text{Mass of electron } (m_e) &= 9.1 \times 10^{-31} \text{ kg} \\\text{Mass of neutron} &= 1.675 \times 10^{-27} \text{ kg} \\\text{Mass of proton} &= 1.673 \times 10^{-27} \text{ kg} \\\text{Avogadro's number} &= 6.023 \times 10^{23} \text{ per gm mole} \\\text{Boltzmann constant} &= 1.38 \times 10^{-23} \text{ JK}^{-1}\end{aligned}$$

Section A

1. The wavelength and intensity of light emitted by a LED depend upon

- | | |
|--|--|
| (A) forward bias and energy gap of the semiconductor | (B) energy gap of the semiconductor and reverse bias |
| (C) energy gap only | (D) forward bias only |

2. The graph showing the correct variation of linear momentum (p) of a charge particle with its de-Broglie wavelength (λ) is —



3. The selectivity of a series LCR a.c. circuit is large, when

- | | |
|-----------------------------------|-----------------------------------|
| (A) L is large and R is large | (B) L is small and R is small |
| (C) L is large and R is small | (D) $L = R$ |

4. Photo diodes are used to detect

- | | |
|-----------------|---------------------|
| (A) radio waves | (B) gamma rays |
| (C) IR rays | (D) optical signals |

5. The relationship between Brewster angle θ and the speed of light v in the denser medium is —

- | | |
|-------------------------|-------------------------|
| (A) $v \tan \theta = c$ | (B) $c \tan \theta = v$ |
| (C) $v \sin \theta = c$ | (D) $c \sin \theta = v$ |

6. A biconvex lens of focal length f is cut into two identical plano-convex lenses. The focal length of each part will be:

- | | |
|----------|-----------|
| (A) f | (B) $f/2$ |
| (C) $2f$ | (D) $4f$ |

7. The phase difference between the current and the voltage in series LCR circuit at resonance is:

- | | |
|-------------|-------------|
| (A) π | (B) $\pi/2$ |
| (C) $\pi/3$ | (D) zero |

8. If photons of frequency ν are incident on the surfaces of metals A & B of threshold frequencies $\nu/2$ and $\nu/3$ respectively, the ratio of the maximum kinetic energy of electrons emitted from A to that from B is

- | | |
|-----------|-----------|
| (A) 2 : 3 | (B) 3 : 4 |
| (C) 1 : 3 | (D) 3 : 2 |

9. The electric flux through a closed Gaussian surface depends upon

- | | |
|--|--|
| (A) Net charge enclosed and permittivity of the medium | (B) Net charge enclosed, permittivity of the medium and the size of the Gaussian surface |
| (C) Net charge enclosed only | (D) Permittivity of the medium only |

10. A charge particle after being accelerated through a potential difference V enters in a uniform magnetic field and moves in a circle of radius r . If V is doubled, the radius of the circle will become

- | | |
|----------|------------------|
| (A) $2r$ | (B) $\sqrt{2}r$ |
| (C) $4r$ | (D) $r/\sqrt{2}$ |

11. A point charge is placed at the centre of a hollow conducting sphere of internal radius r and outer radius $2r$. The ratio of the surface charge density of the inner surface to that of the outer surface will be _____.

12. The _____, a property of materials C, Si and Ge depends upon the energy gap between their conduction and valence bands.

13. The ability of a junction diode to _____ an alternating voltage, is based on the fact that it allows current to pass only when it is forward biased.

14. The physical quantity having SI unit $\text{NC}^{-1} \text{m}$ is _____.

15. A copper wire of non-uniform area of cross-section is connected to a d.c. battery. The physical quantity which remains constant along the wire is _____.

16. Write the conditions on path difference under which (i) constructive (ii) destructive interference occur in Young's double slit experiment.

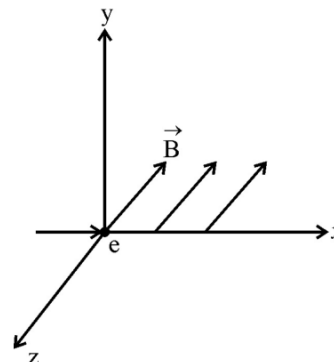
17. Plot a graph showing variation of induced e.m.f. with the rate of change of current flowing through a coil.

OR

A series combination of an inductor (L), capacitor (C) and a resistor (R) is connected across an ac source of emf of peak value E_0 and angular frequency (ω). Plot a graph to show variation of impedance of the circuit with angular frequency (ω).

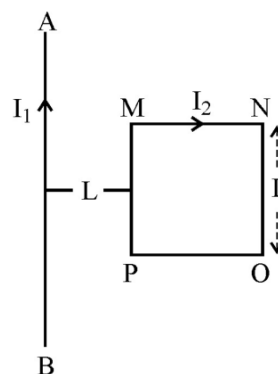
18. Depict the fields diagram of an electromagnetic wave propagating along positive X -axis with its electric field along Y -axis.

19. An electron moves along $+x$ direction. It enters into a region of uniform magnetic field B directed along $-z$ direction as shown in fig. Draw the shape of trajectory followed by the electron after entering the field.



OR

A square shaped current carrying loop $MNOP$ is placed near a straight long current carrying wire AB as shown in the fig. The wire and the loop lie in the same plane. If the loop experiences a net force F towards the wire, find the magnitude of the force on the side NO of the loop.



20. Define the term 'current sensitivity' of a moving coil galvanometer.

Section B

21. (a) Define one Becquerel.

(b) A radioactive substance disintegrates into two types of daughter nuclei, one type with disintegration constant λ_1 and the other type with disintegration constant λ_2 . Determine the half-life of the radioactive substance.

22. In a single slit diffraction experiment, the width of the slit is increased. How will the (i) size and (ii) intensity of central bright band be affected? Justify your answer.

23. In case of photo electric effect experiment, explain the following facts, giving reasons.

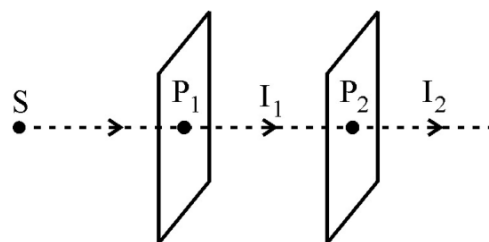
(a) The wave theory of light could not explain the existence of the threshold frequency.

(b) The photo electric current increases with increase of intensity of incident light.

24. Gamma rays and radio waves travel with the same velocity in free space. Distinguish between them in terms of their origin and the main application.

25. Use Bohr's model of hydrogen atom to obtain the relationship between the angular momentum and the magnetic moment of the revolving electron.

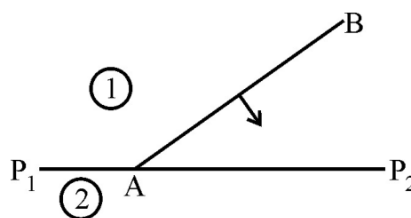
26. Light from a sodium lamp (S) passes through two polaroid sheets P_1 and P_2 as shown in fig. What will be the effect on the intensity of the light transmitted (i) by P_1 and (ii) by P_2 on rotating polaroid P_2 about the direction of propagation of light? Justify your answer in both cases.



OR

Define the term 'wave front of light'. A plane wave front AB propagating from denser medium (1) into a rarer medium (2) is incident on the surface P_1P_2 separating the two media as shown in fig.

Using Huygen's principle, draw the secondary wavelets and obtain the refracted wave front in the diagram.



27. Derive the expression for the torque acting on an electric dipole, when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field, in which it attains a stable equilibrium.

OR

Obtain the expression for the energy stored in a capacitor connected across a dc battery. Hence define energy density of the capacitor.

Section C

28. (a) Two point charges q_1 and q_2 are kept at a distance of r_{12} in air. Deduce the expression for the electrostatic potential energy of this system.

(b) If an external electric field ($\vec{E}$) is applied on the system, write the expression for the total energy of this system.

29. What is a solar cell ? Draw its V - I characteristics. Explain the three processes involved in its working.

OR

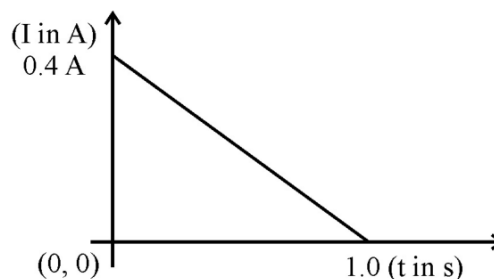
Draw the circuit diagram of a full wave rectifier. Explain its working showing its input and output waveforms.

30. (a) Define internal resistance of a cell.

(b) A cell of emf E and internal resistance r is connected across a variable resistor R . Plot the shape of graphs showing variation of terminal voltage V with (i) R and (ii) circuit current I .

31. Calculate the de-Broglie wavelength associated with the electron revolving in the first excited state of hydrogen atom. The ground state energy of the hydrogen atom is -13.6 eV.

32. When a conducting loop of resistance $10\ \Omega$ and area 10 cm^2 is removed from an external magnetic field acting normally, the variation of induced current in the loop with time is shown in the figure.



Find the

- (i) total charge passed through the loop.
- (ii) change in magnetic flux through the loop.
- (iii) magnitude of the magnetic field applied.

33. Draw the curve showing the variation of binding energy per nucleon with the mass number of nuclei. Using it explain the fusion of nuclei lying on ascending part and fission of nuclei lying on descending part of this curve.

34. An optical instrument uses a lens of 100 D for the objective lens and 50 D for its eye piece. When the tube length is kept at 20 cm , the final image is formed at infinity.

- (a) Identify the optical instrument.
- (b) Calculate the magnification produced by the instrument.

Section D

35. (a) Write two important characteristics of equipotential surfaces.

(b) A thin circular ring of radius r is charged uniformly so that its linear charge density becomes λ . Derive an expression for the electric field at a point P at a distance x from it along the axis of the ring. Hence, prove that at large distances ($x \gg r$), the ring behaves as a point charge.

OR

(a) State Gauss's law on electrostatics and derive an expression for the electric field due to a long straight thin uniformly charged wire (linear charge density λ) at a point lying at a distance r from the wire.

(b) The magnitude of electric field (in NC^{-1}) in a region varies with the distance r (in m) as

$$E = 10r + 5$$

By how much does the electric potential increase in moving from point at $r = 1$ m to a point at $r = 10$ m.

36. (a) Define the term 'focal length of a mirror'. With the help of a ray diagram, obtain the relation between its focal length and radius of curvature.

(b) Calculate the angle of emergence (e) of the ray of light incident normally on the face AC of a glass prism ABC of refractive index $\sqrt{3}$. How will the angle of emergence change qualitatively, if the ray of light emerges from the prism into a liquid of refractive index 1.3 instead of air?

OR

(a) Define the term 'resolving power of a telescope'. How will the resolving power be effected with the increase in

(i) Wavelength of light used.

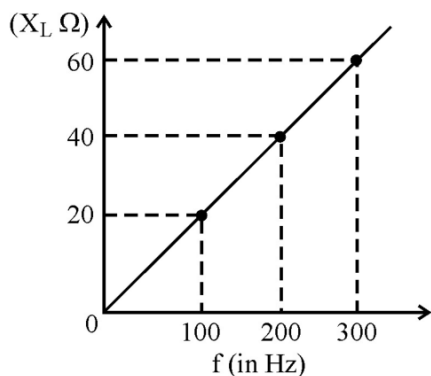
(ii) Diameter of the objective lens.

Justify your answers.

(b) A screen is placed 80 cm from an object. The image of the object on the screen is formed by a convex lens placed between them at two different locations separated by a distance 20 cm. Determine the focal length of the lens.

37. (a) Show that an ideal inductor does not dissipate power in an ac circuit.

(b) The variation of inductive reactance (X_L) of an inductor with the frequency (f) of the ac source of 100 V and variable frequency is shown in the fig.



(i) Calculate the self-inductance of the inductor.

(ii) When this inductor is used in series with a capacitor of unknown value and a resistor of $10\ \Omega$ at 300 s^{-1} , maximum power dissipation occurs in the circuit. Calculate the capacitance of the capacitor.

OR

(a) A conductor of length l is rotated about one of its ends at a constant angular speed ω in a plane perpendicular to a uniform magnetic field B . Plot graphs to show variations of the emf induced across the ends of the conductor with (i) angular speed ω and (ii) length of the conductor l .

(b) Two concentric circular loops of radius 1 cm and 20 cm are placed coaxially.

(i) Find mutual inductance of the arrangement.

(ii) If the current passed through the outer loop is changed at a rate of 5 A/ms , find the emf induced in the inner loop. Assume the magnetic field on the inner loop to be uniform.

- End of Question Paper -