

Class 12 Physics: Previous Year Questions, Chapter-wise

962 CBSE board exam questions, 2022–2026 · 14 chapters · sorted by question type

Each question shows its exam year and marks. A question repeated across paper sets appears once. Questions that need a figure from the original paper are left out. Questions only, no answers. Chapter headings link to free notes and MCQs for that chapter on studynos.co.in.

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1 Electric Charges and Fields

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (24)

Q1. CBSE 2026 · 1 mark A conducting wire connects two charged metallic spheres A and B of radii r_1 and r_2 respectively. The distance between the spheres is very large compared to their radii. The ratio of electric fields, (E_A/E_B) at the surfaces of spheres A and B will be

- (a) r_1/r_2 (b) r_2/r_1 (c) r_1^2/r_2^2 (d) r_2^2/r_1^2

Q2. CBSE 2026 · 1 mark Three point charges $2q$, $-2q$ and q are kept at the vertices of an equilateral triangle of side l . The potential energy of the system is

- (a) zero (b) $-2q^2/(\pi\epsilon_0 l)$ (c) $q^2/(2\pi\epsilon_0 l)$ (d) $-q^2/(\pi\epsilon_0 l)$

Q3. CBSE 2026 · 1 mark Three point charges $+q$, $-2q$ and $+q$ are placed along x-axis at points $x = -1$ m, $x = 0$ m and $x = 2$ m respectively. The potential energy of the system is

- (a) $-q^2/(\pi\epsilon_0)$ (b) $-2q^2/(3\pi\epsilon_0)$ (c) $q^2/(4\pi\epsilon_0)$ (d) $-5q^2/(4\pi\epsilon_0)$

Q4. CBSE 2026 · 1 mark A point charge of $5 \mu\text{C}$ is located at (1 cm, 1 cm) in x-y plane. A second charge of $6 \mu\text{C}$ is brought from infinity to point $(-3 \text{ cm}, 4 \text{ cm})$. The work done in the process is

- (a) 0.54 J (b) 5.4 J (c) -0.54 J (d) 10.8 J

Q5. CBSE 2026 · 1 mark How many protons are needed to make 1 nC charge?

- (a) 1.60×10^{28} (b) 1.60×10^{10} (c) 3.1×10^9
(d) 6.25×10^9

Q6. CBSE 2026 · 1 mark A particle of mass m and charge q starts from rest and moves in an electric field $\vec{E} = E_0 \hat{i}$. After travelling a distance x in the field along x-axis, the kinetic energy of the particle will be:

- (a) $q E_0 x^2$ (b) $q E_0 x$ (c) $q^2 E_0 x$ (d) $q^2 E_0^2 x$

Q7. CBSE 2026 · 1 mark An electric dipole $\vec{P} = 2qa \hat{i}$ is placed in x-y plane, centred at the origin. Let E_1 and E_2 be the magnitudes of electric field at a point distant r ($\gg a$) from its centre, along its axis and on its equatorial plane, respectively. Then the value of E_1/E_2 is:

- (a) $1/4$ (b) $1/2$ (c) 2 (d) 4

Q8. CBSE 2026 · 1 mark An electric dipole with dipole moment $\vec{P} = (2.54 \times 10^{-28} \text{ C.m}) (2.00\hat{i} + 3.00\hat{j})$ is placed in an electric field $\vec{E} = (1000 \text{ N/C}) \hat{i}$. An external agent turns the dipole until its electric dipole moment is $\vec{P} = (2.54 \times 10^{-28} \text{ C.m}) (-3.00\hat{i} + 2.00\hat{j})$. The work done by the agent is:

- (a) $2.54 \times 10^{-25} \text{ J}$ (b) $1.27 \times 10^{-24} \text{ J}$ (c) $1.02 \times 10^{-23} \text{ J}$
(d) $2.29 \times 10^{-26} \text{ J}$

Q9. CBSE 2026 · 1 mark Two small identical metallic balls having charges q and $-2q$ are kept far at a separation r . They are brought in contact and then separated at distance $r/2$. Compared to the initial force F , they will now:

- (a) attract with a force $F/2$ (b) repel with a force $F/2$
(c) repel with a force F (d) attract with a force F

Q10. CBSE 2026 · 1 mark Two point charges $-Q$ and Q are located at points $(d, 0)$ and $(0, d)$ respectively, in x-y plane. The electric field $\vec{E}$ at the origin will be:

- (a) $(1/4\pi\epsilon_0) \times (\sqrt{2}Q/d^2) (\hat{i} - \hat{j})$ (b) $(1/4\pi\epsilon_0) \times (\sqrt{2}Q/d^2) (-\hat{i} - \hat{j})$
(c) $(1/4\pi\epsilon_0) \times (Q/d^2) (\hat{i} - \hat{j})$ (d) $(1/4\pi\epsilon_0) \times (Q/d^2) (-\hat{i} - \hat{j})$

Q11. CBSE 2025 · 1 mark A body acquires charge $8.0 \times 10^{-12} \text{ C}$. The mass of the body:

- (a) increases by $4.5 \times 10^{-7} \text{ kg}$ (b) decreases by $1.0 \times 10^{-6} \text{ kg}$
(c) decreases by $4.55 \times 10^{-23} \text{ kg}$
(d) increases by $9.1 \times 10^{-23} \text{ kg}$

Q12. CBSE 2025 · 1 mark An electric dipole of dipole moment $1.0 \times 10^{-12} \text{ C.m}$ lies along x-axis. An electric field of magnitude $2.0 \times 10^4 \text{ NC}^{-1}$ is switched on at an instant in the region. The unit vector along the electric field is $(\sqrt{3}/2) \hat{i} + (1/2) \hat{j}$. The magnitude of the torque acting on the dipole at that instant is:

- (a) $0.5 \times 10^{-6} \text{ Nm}$ (b) $1.0 \times 10^{-8} \text{ Nm}$ (c) $2.0 \times 10^{-8} \text{ Nm}$
(d) $4.0 \times 10^{-8} \text{ Nm}$

Q13. CBSE 2025 · 1 mark The electric field at a point in a region is given by $\vec{E} = \alpha \vec{r}/r^3$, where α is a constant and r is the distance of the point from the origin. The magnitude of potential of the point is:

- (a) α/r (b) $\alpha r^2/2$ (c) $\alpha/(2r^2)$ (d) $-\alpha/r$



Q14. CBSE 2025 · 1 mark Four point charges Q each, are held at the four corners of a square of side l . The amount of work done in bringing a charge Q from infinity to the centre of the square will be:

- (a) $Q^2/(\pi \epsilon_0 l)$ (b) $\sqrt{2} Q^2/(\pi \epsilon_0 l)$ (c) $Q^2/(2\pi \epsilon_0 l)$ (d) Zero

Q15. CBSE 2025 · 1 mark Two horizontal plates, separated by 1 cm, are arranged one above the other. A particle of mass 5 mg and charge 2 nC is released in air between the plates. The potential difference that should be applied to the plates so that the particle remains suspended between them, is:

- (a) 250 V (b) 200 V (c) 100 V (d) 50 V

Q16. CBSE 2025 · 1 mark The electric field (E) and electric potential (V) at a point inside a charged hollow metallic sphere are respectively:

- (a) $E = 0, V = 0$ (b) $E = 0, V = V_0$ (a constant)
(c) $E \neq 0, V \neq 0$ (d) $E = E_0$ (a constant), $V = 0$

Q17. CBSE 2024 · 1 mark A thin plastic rod is bent into a circular ring of radius R . It is uniformly charged with charge density λ . The magnitude of the electric field at its centre is:

- (a) $\lambda/(2\epsilon_0 R)$ (b) Zero (c) $\lambda/(4\pi\epsilon_0 R)$ (d) $\lambda/(4\epsilon_0 R)$

Q18. CBSE 2024 · 1 mark A charged sphere of radius r has surface charge density σ . The electric field on its surface is E . If the radius of the sphere is doubled, keeping charge density the same, the ratio of the electric field on the old sphere to that on the new sphere will be:

- (a) 1 (b) 1/2 (c) 1/4 (d) 4

Q19. CBSE 2024 · 1 mark Two charged particles P and Q , having the same charge but different masses m_P and m_Q , start from rest and travel equal distances in a uniform electric field E in time t_P and t_Q respectively. Neglecting the effect of gravity, the ratio (t_P/t_Q) is:

- (a) $\sqrt{m_P/m_Q}$ (b) $\sqrt{m_Q/m_P}$ (c) m_P/m_Q (d) m_Q/m_P

Q20. CBSE 2023 · 1 mark A point charge situated at a distance ' r ' from a short electric dipole on its axis, experiences a force F . If the distance of the charge is ' $2r$ ', the force on the charge will be:

- (a) $F/16$ (b) $F/8$ (c) $F/4$ (d) $F/2$

Q21. CBSE 2023 · 1 mark Which one of the following is not a scalar quantity ?

- (a) Electric field (b) Voltage (c) Resistivity (d) Power

Q22. CBSE 2023 · 1 mark An infinitely long uniformly charged wire produces an electric field of $18 \times 10^4 \text{ NC}^{-1}$ at a distance of 1.0 cm. The linear charge density on the wire is:

- (a) $1.12 \times 10^{-14} \text{ Cm}^{-1}$ (b) $3.08 \times 10^{-15} \text{ Cm}^{-1}$
(c) $1.0 \times 10^{-9} \text{ Cm}^{-1}$ (d) $1.0 \times 10^{-7} \text{ Cm}^{-1}$

Q23. CBSE 2023 · 1 mark Two charges q_1 and q_2 are placed at the centres of two spherical conducting shells of radius r_1 and r_2 respectively. The shells are arranged such that their centres are at $[> (r_1 + r_2)]$ distance apart. The force on q_2 due to q_1 is :

- (a) $(1/(4\pi \epsilon_0)) q_1 q_2 / d^2$ (b) $(1/(4\pi \epsilon_0)) q_1 q_2 / (d - r_1)^2$ (c) Zero
(d) $(1/(4\pi \epsilon_0)) q_1 q_2 / [d - (r_1 + r_2)]^2$

Q24. CBSE 2023 · 1 mark A point charge q is kept at a distance r from an infinitely long straight wire with charge density λ . The magnitude of the electrostatic force experienced by charge q is:

- (a) Zero (b) $q\lambda/(2\pi \epsilon_0 r)$ (c) $q\lambda/(4\pi \epsilon_0 r)$ (d) $q\lambda/(\epsilon_0 r)$

VERY SHORT ANSWER (5)

Q25. CBSE 2025 · 2 marks An alpha particle and a deuterium ion are accelerated through the same potential difference. These are then directed towards a target nucleus to make head-on collision. It is observed that their distance of closest approach is the same. Justify it theoretically.

Q26. CBSE 2023 · 2 marks (a) Obtain an expression for electrostatic potential energy of a system of three charges q , $2q$ and $-3q$ placed at the vertices of an equilateral triangle of side a .

Q27. CBSE 2023 · 2 marks Answer the following giving reasons: (a) Why does a moving charged particle at every point?

Q28. CBSE 2023 · 2 marks Use Gauss law to derive the expression for electric field due to a uniformly charged infinite plane thin sheet.

Q29. CBSE 2023 · 2 marks Using Gauss's law derive an expression for the electric field due to an infinitely long straight uniformly charged wire.

SHORT ANSWER (12)

Q30. CBSE 2026 · 3 marks Using Gauss's law, deduce an expression for electric field at a point due to a uniformly charged infinite plane thin sheet.

Q31. CBSE 2026 · 3 marks Using Gauss's law, deduce an expression for electric field at a point due to a uniformly charged infinite plane thin sheet. (b) Two large thin plane sheets, each having surface charge density σ , are held close and parallel to each other in air. What is the net electric field at a point (i) inside and (ii) outside, the sheets?

Q32. CBSE 2026 · 3 marks (a) An electric field $E = E_0 \hat{i}$ exists in a region of space. Draw three equipotential surfaces in the region. (b) Two point charges $-q$ and $+q$ are located at points $(-a, 0, 0)$ and $(a, 0, 0)$ respectively. Find the electrostatic potential at point $(x, 0, 0)$ where $x \gg a$.

Q33. CBSE 2026 · 3 marks (i) Draw electric field lines and equipotential surfaces for a system of two equal and opposite point charges separated by some distance. (ii) Why electric field E at a point on an equipotential surface must be perpendicular to the surface at that point?

Q34. CBSE 2026 · 3 marks (a) Draw electric field lines and equipotential surfaces for a system of two equal positive charges separated by some distance.

Q35. CBSE 2026 · 3 marks Two point charges $q_1 = 2.5 \times 10^{-7} \text{ C}$ and $q_2 = -2.5 \times 10^{-7} \text{ C}$ are located at points $(0, 0, -15 \text{ cm})$ and $(0, 0, 15 \text{ cm})$ respectively. Find: (a) the electric dipole moment of the system, and (b) the magnitude and direction of electric field at the origin $(0, 0, 0)$.

Q36. CBSE 2025 · 3 marks Two small solid metal balls A and B of radii R and $2R$ having charge densities 2σ and 3σ respectively are kept far apart. Find the charge densities on A and B after they are connected by a conducting wire.



Q37. CBSE 2025 · 3 marks Two point charges of $-5 \mu\text{C}$ and $2 \mu\text{C}$ are located in free space at $(-4 \text{ cm}, 0)$ and $(6 \text{ cm}, 0)$ respectively. (a) Calculate the amount of work done to separate the two charges at infinite distance. (b) If this system of charges was initially kept in an electric field $E = A/r^2$, where $A = 8 \times 10^4 \text{ N C}^{-1} \text{ m}^2$, calculate the electrostatic potential energy of the system.

Q38. CBSE 2025 · 3 marks An electric field $\mathbf{E}$ given by: $\mathbf{E} = 100 \hat{i} \text{ N/C}$ for $x > 0$ and $\mathbf{E} = -100 \hat{i} \text{ N/C}$ for $x < 0$ exists in a region. A right circular cylinder of length 10 cm and radius 2 cm , is placed in the region such that its axis coincides with x -axis and its two faces are at $x = -5 \text{ cm}$ and $x = 5 \text{ cm}$. Calculate: (a) the net outward flux through the cylinder, and (b) the net charge inside the cylinder.

Q39. CBSE 2024 · 3 marks Three point charges Q_1 , Q_2 and Q_3 are located in $x - y$ plane at points $(-d, 0)$, $(0, 0)$ and $(d, 0)$ respectively. Q_1 and Q_3 are identical and Q_2 is positive. What will be the nature and value of Q_1 so that the potential energy of the system is zero?

Q40. CBSE 2023 · 3 marks Three point charges Q_1 ($-15 \mu\text{C}$), Q_2 ($10 \mu\text{C}$) and Q_3 ($16 \mu\text{C}$) are located at $(0 \text{ cm}, 0 \text{ cm})$, $(0 \text{ cm}, 3 \text{ cm})$ and $(4 \text{ cm}, 3 \text{ cm})$ respectively. Calculate the electrostatic potential energy of this system of charges.

Q41. CBSE 2022 · 3 marks In Geiger-Marsden experiment, calculate the distance of closest approach for an alpha particle with energy $2.56 \times 10^{-12} \text{ J}$. Consider that the particle approaches gold nucleus ($Z = 79$) in head-on position.

LONG ANSWER (17)

Q42. CBSE 2026 · 5 marks An electric dipole consists of two point charges q and $-q$ separated by a distance $2a$. Derive an expression for the electric field $\mathbf{E}$ due to this dipole at a point distant r from the centre of the dipole on the equatorial plane. Write the expression for the electric field at a far off point, i.e. $r \gg a$. A dipole is placed in x - y plane such that charges q and $-q$ are located at $x = a$ and $x = b$ respectively. There exists an electric field $\mathbf{E} = 2\hat{i} \text{ N/C}$ in the region. Calculate the force $\mathbf{F}$ and torque $\boldsymbol{\tau}$ experienced by the dipole.

Q43. CBSE 2026 · 5 marks An electric dipole consists of two point charges q and $-q$ separated by a distance $2a$. Derive an expression for the electric field $\mathbf{E}$ due to this dipole at a point distant r from the centre of the dipole on the equatorial plane. Write the expression for the electric field at a far off point, i.e. $r \gg a$.

Q44. CBSE 2026 · 5 marks (a) An electric dipole consists of two point charges q and $-q$ separated by a distance $2a$. Derive an expression for the electric field $\mathbf{E}$ due to this dipole at a point distant r from the centre of the dipole on the equatorial plane. Write the expression for the electric field at a far off point, i.e. $r \gg a$. (b) A dipole is placed in x - y plane such that charges q and $-q$ are located at $x = a$ and $x = b$ respectively. There exists an electric field $\mathbf{E} = 2\hat{i} \text{ N/C}$ in the region. Calculate the force $\mathbf{F}$ and torque $\boldsymbol{\tau}$ experienced by the dipole.

Q45. CBSE 2026 · 5 marks (a) Deduce the relation between the electric field ($\mathbf{E}$) at a point due to a charge Q and (i) the force $\mathbf{F}$ on a charge q placed at that point. (ii) the potential at that point due to charge Q . (b) Three point charges, q each, are placed at the three vertices of an equilateral triangle of side ' a '. Obtain an expression for the net force on one charge due to the other two charges.

Q46. CBSE 2026 · 5 marks (a) (i) Explain the following statements giving reason: (I) An equipotential surface through a point is normal to the electric field at that point. (II) When a dielectric is placed in an external electric field, the electric field inside the dielectric is less than that outside it. (III) The potential difference between the plates of a charged parallel plate capacitor decreases when its plates are brought closer. (ii) Obtain an expression for the work done to dissociate the system of three charges q , $-4q$ and $2q$ placed at the vertices A , B and C respectively of an equilateral triangle of side ' a '.

Q47. CBSE 2025 · 5 marks (a) (i) Two point charges $+q$ and $-q$ are held at $(a, 0)$ and $(-a, 0)$ in x - y plane. Obtain an expression for the net electric field due to the charges at a point $(0, y)$. Hence, find electric field at a far off point ($y \gg a$). (ii) Three point charges of -2 nC , -1 nC , and $+5 \text{ nC}$ are kept at the vertices A , B and C of an equilateral triangle of side 0.2 m . Find the total amount of work done in shifting the charges from A to A_1 , B to B_1 and C to C_1 . Here A_1 , B_1 and C_1 are the midpoints of sides AB , BC and CA , respectively.

Q48. CBSE 2025 · 5 marks Two point charges q_1 ($= 16 \mu\text{C}$) and q_2 ($= 1 \mu\text{C}$) are placed at points $\mathbf{r}_1 = (3 \text{ m}) \hat{i}$ and $\mathbf{r}_2 = (4 \text{ m}) \hat{j}$. Find the net electric field $\mathbf{E}$ at point $\mathbf{r} = (3 \text{ m}) \hat{i} + (4 \text{ m}) \hat{j}$.

Q49. CBSE 2025 · 5 marks (i) The electric field in a region is given by $\mathbf{E} = 40x \hat{i} \text{ N/C}$. Find the amount of work done in taking a unit positive charge from a point $(0, 3\text{m})$ to the point $(5\text{m}, 0)$. (ii) A charge Q is distributed over two concentric hollow spheres of radii r and R ($> r$) such that their surface charge densities are equal. Find: (I) the electric field, and (II) the potential at their common centre.

Q50. CBSE 2025 · 5 marks (i) An electric dipole of dipole moment p consists of point charges q and $-q$, separated by $2a$. Derive an expression for electric potential in terms of its dipole moment at a point at a distance x ($> a$) from its centre and lying (I) along its axis, and (II) along its bisector line. (ii) An electric dipole of dipole moment $\mathbf{p} = (0.8\hat{i} + 0.6\hat{j}) \times 10^{-29} \text{ Cm}$ is placed in an electric field $\mathbf{E} = 1.0 \times 10^7 \hat{k} \text{ V/m}$. Calculate the magnitude of the torque acting on it and the angle it makes with the x -axis, at this instant.

Q51. CBSE 2025 · 5 marks (i) Two point charges $5 \mu\text{C}$ and $-1 \mu\text{C}$ are placed at points $(-3 \text{ cm}, 0, 0)$ and $(3 \text{ cm}, 0, 0)$ respectively. An external electric field $\mathbf{E} = (A/r^2) \hat{r}$ where $A = 3 \times 10^5 \text{ Vm}$ is switched on in the region. Calculate the change in electrostatic energy of the system due to the electric field. (ii) A system of two conductors is placed in air and they have net charge of $+80 \mu\text{C}$ and $-80 \mu\text{C}$ which causes a potential difference of 16 V between them. (1) Find the capacitance of the system. (2) If the air between the capacitor is replaced by a dielectric medium of dielectric constant 3, what will be the potential difference between the two conductors? (3) If the charges on two conductors are changed to $+160 \mu\text{C}$ and $-160 \mu\text{C}$, will the capacitance of the system change? Give reason for your answer.



Q52. CBSE 2024 · 5 marks (a) (i) Derive an expression for potential energy of an electric dipole $\mathbf{p}$ in an external uniform electric field $\mathbf{E}$. When is the potential energy of the dipole (1) maximum, and (2) minimum? (ii) An electric dipole consists of point charges -1.0 pC and $+1.0$ pC located at $(0, 0)$ and $(3 \text{ mm}, 4 \text{ mm})$ respectively in $x - y$ plane. An electric field $\mathbf{E} = (1000 \text{ V/m}) \hat{i}$ is switched on in the region. Find the torque $\boldsymbol{\tau}$ acting on the dipole.

Q53. CBSE 2024 · 5 marks Derive an expression for potential energy of an electric dipole $\mathbf{p}$ in an external uniform electric field $\mathbf{E}$. When is the potential energy of the dipole (1) maximum, and (2) minimum? An electric dipole consists of point charges -1.0 pC and $+1.0$ pC located at $(0, 0)$ and $(3 \text{ mm}, 4 \text{ mm})$ respectively in $x - y$ plane. An electric field $\mathbf{E} = (1000 \text{ V/m}) \hat{i}$ is switched on in the region. Find the torque $\boldsymbol{\tau}$ acting on the dipole.

Q54. CBSE 2024 · 5 marks (a) (i) Obtain an expression for the electric potential due to a small dipole of dipole moment $\mathbf{p}$, at a point $\mathbf{r}$ from its centre, for much larger distances compared to the size of the dipole. (ii) Three point charges q , $2q$ and nq are placed at the vertices of an equilateral triangle. If the potential energy of the system is zero, find the value of n .

Q55. CBSE 2024 · 5 marks (b) (i) A charge $+Q$ is placed on a thin conducting spherical shell of radius R . Using Gauss's law, derive an expression for the electric field at a point lying (i) inside and (ii) outside the shell. (ii) Show that the electric field for same charge density (σ) is twice in case of a conducting plate or surface than in a nonconducting sheet.

Q56. CBSE 2024 · 5 marks (b)(i) A charge $+Q$ is placed on a thin conducting spherical shell of radius R . Using Gauss's law, obtain an expression for the electric field at a point lying (i) inside and (ii) outside the shell. (ii) Show that the electric field for same charge density (σ) is twice in case of a conducting plate or surface than in a nonconducting sheet.

Q57. CBSE 2023 · 5 marks (i) State Coulomb's law in electrostatics and write it in vector form for two charges. (ii) Explain why the Gaussian law is based on the inverse square dependence on distance. (iii) Two charges A (charge q) and B (charge $2q$) are located at points $(0, 0)$ and (a, a) respectively. Let $\hat{i}$ and $\hat{j}$ be the unit vectors along x -axis and y -axis respectively. Find the force exerted by A on B, in terms of $\hat{i}$ and $\hat{j}$.

Q58. CBSE 2023 · 5 marks State Coulomb's law in electrostatics in vector form, for two charges. Explain the inverse-square dependence on distance in Coulomb's law. Two charges A (charge q) and B (charge $2q$) are located at points $(0, 0)$ and (a, a) respectively. Let $\hat{i}$ and $\hat{j}$ be the unit vectors along x -axis and y -axis respectively. Find the force exerted by A on B, in terms of $\hat{i}$ and $\hat{j}$.

CASE-BASED (5)

CASE STUDY · CBSE 2026

When an electric dipole of charges q and dipole moment $\mathbf{p}$ is placed in a uniform electric field $\mathbf{E}$ making an angle θ with the electric field $\mathbf{E}$, then two charges experience equal and opposite forces $+q\mathbf{E}$ and $-q\mathbf{E}$. These equal and opposite forces cancel each other. As the two forces are not collinear so a torque acts on the dipole. Since the net force acting on the dipole is zero,

no work is done in moving the electric dipole in a uniform electric field, but some work will be done in rotating the dipole against the torque acting on it.

Q59. CBSE 2026 · 1 mark Two charges $+q$ and $-q$ are located at points $(a, 0)$ and $(3a, 0)$ on x -axis. The dipole moment of the system has magnitude

- (a) $2qa$ and is along $+x$ -axis (b) $2qa$ and is along $-x$ -axis
(c) qa and is along $+x$ -axis (d) qa and is along $-x$ -axis

CASE STUDY · CBSE 2026

The electric potential (V) and electric field ($\mathbf{E}$) are closely related concepts in electrostatics. The electric field is a vector quantity that represents the force per unit charge at a given point in space, whereas electric potential is a scalar quantity that represents the potential energy per unit charge at a given point in space. Electric field and electric potential are related by the equations $\mathbf{E} = -dV/dr \hat{r}$ and $\mathbf{E} = E\hat{r}$, i.e., electric field is the negative gradient of the electric potential. This means that electric field points in the direction of decreasing potential and its magnitude is the rate of change of potential with distance. The electric field is the force that drives a unit charge to move from higher potential region to lower potential region and electric potential difference between the two points determines the work done in moving a unit charge from one point to the other point. A pair of square conducting plates having sides of length 0.05 m are arranged parallel to each other in x - y plane. They are 0.01 m apart along z -axis and are connected to a 200 V power supply. An electron enters with a speed of $3 \times 10^7 \text{ m/s}$ horizontally and symmetrically in the space between the two plates. Neglect the effect of gravity on the electron.

Q60. CBSE 2026 · 1 mark The electric field $\mathbf{E}$ in the region between the plates is:

- (a) $(2 \times 10^2 \text{ V/m}) \hat{k}$ (b) $-(2 \times 10^2 \text{ V/m}) \hat{k}$
(c) $(2 \times 10^4 \text{ V/m}) \hat{k}$ (d) $-(2 \times 10^4 \text{ V/m}) \hat{k}$

CASE STUDY · CBSE 2023

Electrostatics deals with the study of forces, fields and potentials arising from static charges. Force and electric field, due to a point charge is determined by Coulomb's law. Gauss's law, which is essentially based on Coulomb's law, helps us find the electric field for symmetric charge distributions. A charge/a system of charges like a dipole experience a force/torque in an electric field. Work is required to be done to provide a specific orientation to a dipole with respect to an electric field.

Q61. CBSE 2023 · 1 mark (a) Consider a uniformly charged thin conducting shell of radius R . Plot a graph showing the variation of $|\mathbf{E}|$ with distance r from the centre, for points $0 \leq r \leq 3R$.

CASE STUDY · CBSE 2023

Electrostatics deals with the study of forces, fields and potentials arising from static charges. Force and electric field, due to a point charge is determined using Coulomb's law. Gauss law is useful to find the electric field. A charge/a system



of charges like a dipole experience a force/torque in an electric field. Work is required to be done to provide a specific orientation to a dipole with respect to an electric field.

Q62. CBSE 2023 · 1 mark Consider a uniformly charged thin conducting shell of radius R . Plot a graph showing the variation of $|\mathbf{E}|$ with distance r from the centre, for points $0 \leq r \leq 3R$.

CASE STUDY · CBSE 2023

Electrostatics deals with the study of forces, fields and potentials arising from static charges. Force and electric field, due to a point charge is determined fundamentally by Coulomb's law. Gauss law helps us to find the electric field. A charge/a system of charges like a dipole experience a force/torque in an electric field. Work is required to be done to provide a specific orientation to a dipole with respect to an electric field.

Q63. CBSE 2023 · 1 mark Consider a uniformly charged thin conducting shell of radius R . Plot a graph showing the variation of $|\mathbf{E}|$ with distance r from the centre, for points $0 \leq r \leq 3R$.

2 Electrostatic Potential and Capacitance

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (14)

Q1. CBSE 2026 · 1 mark In a region, the electric potential varies as $V = 10 - 50x$, where V is in volts and x in meters. The electric field in the region is

- (a) 10 N/C along $+x$ (b) 10 N/C along $-x$
(c) 50 N/C along $+x$ (d) 50 N/C along $-x$

Q2. CBSE 2026 · 1 mark In a region electric field is given by $\mathbf{E} = 4x\hat{i}$ N/C. The potential difference between points A ($x = 1$ m) and B ($x = 3$ m), ($V_A - V_B$) is

- (a) -16 V (b) 16 V (c) -8 V (d) 8 V

Q3. CBSE 2026 · 1 mark The electric potential for various points in x - y plane is given by $V = 1.0x^2 - 2.0y^2$, where V is in volts and x, y are in metres. The angle that the electric field at point (2.0 m, 1.0 m) makes with the positive x -axis is

- (a) 45° (b) 90° (c) 135° (d) 315°

Q4. CBSE 2026 · 1 mark Two metal spheres of radii r_1 and r_2 ($> r_1$) having charges q_1 and q_2 respectively kept in air, are brought in contact. Which of the following statements is not correct?

- (a) The total charge of the two spheres is conserved.
(b) Both spheres attain the same potential.
(c) The final potential of the system equals $(1/(4\pi\epsilon_0)) (q_1 + q_2)/(r_1 + r_2)$
(d) The final potential of the system equals $(1/(4\pi\epsilon_0)) (q_1 + q_2)(r_1 + r_2)/(r_1r_2)$

Q5. CBSE 2026 · 1 mark Assertion (A): The work done, in taking a unit charge around a closed loop of an electric circuit involving cells and resistors in the loop, is zero. Reason (R): The potential at a point depends on the location of the point in the loop. After completing one round, the charge comes back to the point of start.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q6. CBSE 2026 · 1 mark Two points R and S are equidistant from two charges $+Q$ and $-2Q$. The work done in moving a charge $-Q$ from point R to S is:

- (a) Zero (b) $-Q/(4\pi\epsilon_0 d)$ (c) $Q/(4\pi\epsilon_0 d)$ (d) $3Q/(4\pi\epsilon_0 d)$

Q7. CBSE 2025 · 1 mark A metal sheet is inserted between the plates of a parallel plate capacitor of capacitance C . If the sheet partly occupies the space between the plates, the capacitance:

- (a) remains C (b) becomes greater than C
(c) becomes less than C (d) becomes zero

Q8. CBSE 2025 · 1 mark The dimensions of $(\mu\epsilon)^{-1}$, where ϵ is permittivity and μ is permeability of a medium, are:

- (a) $[M^0 L^1 T^{-1}]$ (b) $[M^0 L^2 T^{-2}]$ (c) $[M^1 L^2 T^{-2}]$ (d) $[M^1 L^{-1} T^1]$

Q9. CBSE 2024 · 1 mark Ten capacitors, each of capacitance $1\mu F$, are connected in parallel to a source of 100 V. The total energy stored in the system is equal to:

- (a) 10^{-2} J (b) 10^{-3} J (c) 0.5×10^{-3} J (d) 5.0×10^{-2} J

Q10. CBSE 2024 · 1 mark The capacitance of a parallel plate capacitor having a medium of dielectric constant $K = 4$ in between the plates is C . If this medium is removed, then the capacitance of the capacitor becomes:

- (a) $4C$ (b) C (c) $C/4$ (d) $2C$

Q11. CBSE 2024 · 1 mark A proton is taken from point P_1 to point P_2 , both located in an electric field. The potentials at points P_1 and P_2 are -5 V and $+5$ V respectively. Assuming that kinetic energies of the proton at points P_1 and P_2 are zero, the work done on the proton is:

- (a) -1.6×10^{-18} J (b) 1.6×10^{-18} J (c) Zero
(d) 0.8×10^{-18} J

Q12. CBSE 2024 · 1 mark The plates P_1 and P_2 of a $2\mu F$ capacitor are at potentials 25 V and -25 V respectively. The charge on plate P_1 will be:

- (a) 0.02 mC (b) 0.1 mC (c) $0.1\mu C$ (d) $1\mu C$

Q13. CBSE 2023 · 1 mark In the process of charging of a capacitor, the current produced between the plates of the capacitor is:

- (a) $\mu_0 d\phi_E/dt$ (b) $(1/\mu_0) d\phi_E/dt$ (c) $\epsilon_0 d\phi_E/dt$
(d) $(1/\epsilon_0) d\phi_E/dt$



Q14. CBSE 2023 · 1 mark A capacitor is charged by a battery. Between the plates, during process of charging:

- (a) only displacement current exists
- (b) only conduction current exists
- (c) both displacement current and conduction current exist
- (d) no current exists

VERY SHORT ANSWER (6)

Q15. CBSE 2026 · 2 marks An electric dipole consists of two point charges $+1\ \mu\text{C}$ and $-1\ \mu\text{C}$, held 10 cm apart. It is subjected to a uniform electric field of 100 N/C. Calculate the amount of work done in turning the dipole from its position of stable equilibrium to the position of unstable equilibrium, in the field.

Q16. CBSE 2023 · 2 marks What is displacement current? Explain in brief how this current is different from a conduction current.

Q17. CBSE 2023 · 2 marks Explain what is meant by displacement current. In brief, explain how this current is different from a conduction current.

Q18. CBSE 2023 · 2 marks Write two differences between the emf and terminal potential difference of a cell. What is the most important precaution that one should take while drawing current from a cell ?

Q19. CBSE 2023 · 2 marks Obtain an expression for electrostatic potential energy of a system of three charges q , $2q$ and $-3q$ placed at the vertices of an equilateral triangle of side a .

Q20. CBSE 2023 · 2 marks A cell of emf E and internal resistance r is connected to a variable resistance R . Draw plots showing the variation of (a) terminal voltage V with R , and (b) V with current I , in the circuit.

SHORT ANSWER (8)

Q21. CBSE 2026 · 3 marks A parallel plate capacitor of capacitance C has a dielectric slab between its plates. It is charged to a potential difference V by connecting it across a battery. The battery is then disconnected. If the dielectric slab is now withdrawn from the capacitor, how will the following be affected? (a) Capacitance of the capacitor, (b) Energy stored in the capacitor, and (c) The potential difference between the plates of the capacitor. Justify your answer in each case.

Q22. CBSE 2026 · 3 marks A $12.0\ \mu\text{F}$ capacitor is charged to a potential difference of 150 V. The terminals of the charged capacitor are then connected to those of an uncharged $6.0\ \mu\text{F}$ capacitor. Calculate final potential difference across and charge on, each capacitor.

Q23. CBSE 2026 · 3 marks A parallel plate capacitor of capacitance C is charged to V volt by a battery. After sometime the battery is disconnected and the distance between the plates is doubled. A slab of dielectric constant $k = 1.8$ is then introduced to completely fill the space between the plates. How will the following be affected? (a) The capacitance of the capacitor. (b) The electric field between the plates of the capacitor. (c) The energy stored in the capacitor. Justify your answer in each case.

Q24. CBSE 2026 · 3 marks Two parallel plate capacitors X and Y are connected in series to a 6 V battery. They have the same plate area and same plate separation but capacitor X has air between its plates, whereas capacitor Y contains a material of dielectric constant 4. (a) Calculate the capacitances of X and Y , if the equivalent capacitance of the combination of X and Y is $4\ \mu\text{F}$. (b) Calculate the potential difference across the plates of X and Y .

Q25. CBSE 2025 · 3 marks A capacitor of plate area A and plate separation d is charged by a battery to voltage V . The battery is disconnected and plates are slowly pulled apart till the separation becomes $2d$. Find the value of: (a) potential difference between the plates, (b) electric field between the plates, (c) work done in pulling the plates apart.

Q26. CBSE 2025 · 3 marks (a) "There is a limit to the amount of charge that can be stored on a given capacitor." Explain. (b) A capacitor is charged by a battery to a potential difference V . It is disconnected from the battery and connected across another identical uncharged capacitor. Calculate the ratio of total energy stored in the combination to the initial energy stored in the capacitor.

Q27. CBSE 2025 · 3 marks (a) A parallel plate capacitor is charged by an ac source. Show that the sum of conduction current (I_c) and the displacement current (I_d) has the same value at all points of the circuit. (b) In case (a) above, is Kirchhoff's first rule (junction rule) valid at each plate of the capacitor ? Explain.

Q28. CBSE 2024 · 3 marks An air-filled parallel plate capacitor with plate separation 1 mm has a capacitance of 20 pF. It is charged to $4.0\ \mu\text{C}$. Calculate the amount of work done to pull its plates to a separation of 5 mm. Assume the charge on the plates remains the same.

LONG ANSWER (8)

Q29. CBSE 2026 · 5 marks (a) Derive an expression for the capacitance of a parallel plate capacitor of plate area A and plate separation d with air present between the plates. (b) Two air-filled capacitors of capacitances C_1 and C_2 are connected in parallel with a dc battery. After the capacitors are fully charged, a slab of dielectric constant K is inserted between the plates of each capacitor. How will the (i) charge on each capacitor and (ii) energy stored in the capacitor affected after the slab is introduced.

Q30. CBSE 2026 · 5 marks (a) Derive an expression for the capacitance of a parallel plate capacitor of plate area A and plate separation d with air present between the plates.

Q31. CBSE 2026 · 5 marks (a) (ii) Two point charges $-2\ \mu\text{C}$ and $5\ \mu\text{C}$ are placed at $(-30\ \text{cm}, 0)$ and $(30\ \text{cm}, 0)$ respectively in an external electric field $\mathbf{E} = (A/x^2)\hat{i}$, where $A = 9 \times 10^5\ \text{Nm}^2\ \text{C}^{-1}$. Find the electrostatic potential energy of this configuration.



Q32. CBSE 2026 · 5 marks (a) (i) Explain the following statements giving reason: (I) An equipotential surface through a point is normal to the electric field at that point. (II) When a dielectric is placed in an external electric field, the electric field inside the dielectric is less than that outside it. (III) The potential difference between the plates of a charged parallel plate capacitor decreases when its plates are brought closer. (ii) Obtain an expression for the work done to dissociate the system of three charges q , $-4q$ and $2q$ placed at the vertices A, B and C respectively of an equilateral triangle of side 'a'.

Q33. CBSE 2025 · 5 marks (i) A parallel plate capacitor with plate area A and plate separation d has a capacitance C_0 . A slab of dielectric constant K having area A and thickness (d/4) is inserted in the capacitor, parallel to the plates. Find the new value of its capacitance. (ii) You are provided with a large number of $1\ \mu\text{F}$ identical capacitors and a power supply of 1200 V. The dielectric medium used in each capacitor can withstand up to 200 V only. Find the minimum number of capacitors and their arrangement, required to build a capacitor system of equivalent capacitance of $2\ \mu\text{F}$ for use with this supply.

Q34. CBSE 2025 · 5 marks A parallel plate capacitor with plate area A and plate separation d has a capacitance C_0 . A slab of dielectric constant K having area A and thickness (d/4) is inserted in the capacitor, parallel to the plates. Find the new value of its capacitance. You are provided with a large number of $1\ \mu\text{F}$ identical capacitors and a power supply of 1200 V. The dielectric medium used in each capacitor can withstand up to 200 V only. Find the minimum number of capacitors and their arrangement, required to build a capacitor system of equivalent capacitance of $2\ \mu\text{F}$ for use with this supply.

Q35. CBSE 2024 · 5 marks (a) (i) Derive an expression for potential energy of an electric dipole $\mathbf{p}$ in an external uniform electric field $\mathbf{E}$. When is the potential energy of the dipole (1) maximum, and (2) minimum? (ii) An electric dipole consists of point charges $-1.0\ \text{pC}$ and $+1.0\ \text{pC}$ located at (0, 0) and (3 mm, 4 mm) respectively in $x - y$ plane. An electric field $\mathbf{E} = (1000\ \text{V/m})\hat{i}$ is switched on in the region. Find the torque $\boldsymbol{\tau}$ acting on the dipole.

Q36. CBSE 2024 · 5 marks (a) (i) Obtain the expression for the capacitance of a parallel plate capacitor with a dielectric medium between its plates. (ii) A charge of $6\ \mu\text{C}$ is given to a hollow metallic sphere of radius 0.2 m. Find the potential at (i) the surface and (ii) the centre of the sphere.

CASE-BASED (6)

CASE STUDY · CBSE 2026

When an electric dipole of charges q and dipole moment $\mathbf{p}$ is placed in a uniform electric field $\mathbf{E}$ making an angle θ with the electric field $\mathbf{E}$, then two charges experience equal and opposite forces $+q\mathbf{E}$ and $-q\mathbf{E}$. These equal and opposite forces cancel each other. As the two forces are not collinear so a torque acts on the dipole. Since the net force acting on the dipole is zero, no work is done in moving the electric dipole in a uniform electric field, but some work will be done in rotating the dipole against the torque acting on it.

Q37. CBSE 2026 · 1 mark An electric dipole having dipole moment of $4 \times 10^{-9}\ \text{Cm}$ is placed in a uniform electric field of $5 \times 10^4\ \text{N/C}$. If the angle between the dipole moment and the electric field is 30° then the value of potential energy of the dipole is –

- (a) $3.23 \times 10^{-4}\ \text{J}$ (b) $1.0 \times 10^{-5}\ \text{J}$ (c) $1.73 \times 10^{-4}\ \text{J}$
(d) $5 \times 10^4\ \text{J}$

CASE STUDY · CBSE 2026

Capacitors are manufactured with certain standard capacitances and working voltages. However, these standard values may not be the ones that are actually needed in a particular application. Two or more capacitors can be grouped in series or in parallel to achieve desired capacitance and voltage. When connected in series, the total capacitance decreases while the voltage rating increases, whereas in parallel connections, the total capacitance increases and maintains the same voltage rating. A capacitor stores energy in the electric field between its plates and stored energy is proportional to the square of the voltage and capacitance $U = (1/2)CV^2$, where symbols have their usual meanings.

Q38. CBSE 2026 · 1 mark Two capacitors, one of $3\ \mu\text{F}$ and the other of $6\ \mu\text{F}$, are connected in series in the circuit. The total capacitance of the circuit is:

- (a) $6\ \mu\text{F}$ (b) $3\ \mu\text{F}$ (c) $9\ \mu\text{F}$ (d) $2\ \mu\text{F}$

CASE STUDY · CBSE 2025

A parallel plate capacitor consists of two conducting plates kept generally parallel to each other at a distance. When the capacitor is charged, the charge resides on the inner surfaces of the plates and an electric field is set up between them. Thus, electrostatic energy is stored in the capacitor. Three parallel conducting plates P_1 , P_2 and P_3 are placed parallel and equidistant from each other. The space between P_1 and P_2 and P_2 and P_3 is completely filled with mica sheets of dielectric constant 2. The middle plate P_2 is connected to point A and other plates P_1 and P_3 are connected to point B. Point A is maintained at a positive potential with respect to point B and the potential difference between A and B is V.

Q39. CBSE 2025 · 1 mark The capacitance of the system between A and B will be :

- (a) $\epsilon_0 KL^2/d$ (b) $\epsilon_0 KL^2/2d$ (c) $2\epsilon_0 KL^2/d$ (d) $2\epsilon_0 Kd/L^2$

CASE STUDY · CBSE 2025

A parallel plate capacitor consists of two conducting plates kept generally parallel to each other at a distance d. When the capacitor is charged, the charge resides on the inner surfaces of the plates and an electric field is set up between them. Three parallel conducting plates P_1 , P_2 and P_3 are parallel and equidistant from each other. The space between P_1 and P_2 and P_2 and P_3 is completely filled with mica sheets of dielectric constant 2. Plate P_2 is connected to point A and other plates P_1 and P_3 are connected to point B. Point A is maintained at a



positive potential with respect to point B and the potential difference between A and B is V.

Q40. CBSE 2025 · 1 mark The capacitance of the system between A and B will be :

- (a) $\epsilon_0 KL^2/d$ (b) $\epsilon_0 KL^2/(2d)$ (c) $2\epsilon_0 KL^2/d$ (d) $2\epsilon_0 Kd/L^2$

CASE STUDY · CBSE 2023

Electrostatics deals with the study of forces, fields and potentials arising from static charges. Force and electric field, due to a point charge is determined by Coulomb's law. Gauss's law, which is essentially based on Coulomb's law, helps us find the electric field for symmetric charge distributions. A charge/a system of charges like a dipole experience a force/torque in an electric field. Work is required to be done to provide a specific orientation to a dipole with respect to an electric field.

Q41. CBSE 2023 · 2 marks (c) An electric dipole of dipole moment of $6 \times 10^{-7} \text{ C-m}$ is kept in a uniform electric field of 10^4 N/C such that the dipole moment and the electric field are parallel. Calculate the potential energy of the dipole.

CASE STUDY · CBSE 2023

Electrostatics deals with the study of forces, fields and potentials arising from static charges. Force and electric field, due to a point charge is determined fundamentally by Coulomb's law. Gauss law helps us to find the electric field. A charge/a system of charges like a dipole experience a force/torque in an electric field. Work is required to be done to provide a specific orientation to a dipole with respect to an electric field.

Q42. CBSE 2023 · 2 marks An electric dipole of dipole moment of $6 \times 10^{-7} \text{ C-m}$ is kept in a uniform electric field of 10^4 N/C such that the dipole moment and the electric field are parallel. Calculate the potential energy of the dipole.

3 Current Electricity

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (39)

Q1. CBSE 2026 · 1 mark Two heaters rated as (P_1, V) and (P_2, V) are connected in series across a dc source of $V/2$ volt. The power consumed by the combination will be

- (a) $(P_1 + P_2)$ (b) $(P_1 + P_2)/2$ (c) $P_1 P_2 / (2(P_1 + P_2))$
(d) $P_1 P_2 / (4(P_1 + P_2))$

Q2. CBSE 2026 · 1 mark A copper wire is stretched to increase its length by 1%. Then the change in its resistance is close to

- (a) 1% (b) 4% (c) -4% (d) 2%

Q3. CBSE 2026 · 1 mark A current of 1.5 A is maintained in a copper wire of length 1 m with area of cross-section $1.7 \times 10^{-7} \text{ m}^2$. The magnitude of electric field in the wire is [$\rho_{\text{Cu}} = 1.7 \times 10^{-8} \Omega \text{ m}$]

- (a) 0.15 V/m (b) 0.30 V/m (c) 1.5 V/m (d) 3.0 V/m

Q4. CBSE 2026 · 1 mark A galvanometer of resistance 27 Ω is converted into an ammeter of range (0 – 10 mA) using a resistance of 3 Ω . The galvanometer will show full scale deflection for a current of about

- (a) 10 mA (b) 100 mA (c) 1 mA (d) 3 mA

Q5. CBSE 2026 · 1 mark Assertion (A): Two electric heaters of power P_1 and P_2 ($> P_1$) are joined in series across a dc source of voltage V. The power consumed by the combination will be less than that consumed by P_1 when connected across the same source. Reason (R): The power consumed by a electric device when connected to a dc source of voltage V is proportional to its resistance.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q6. CBSE 2026 · 1 mark Assertion (A): Two electric heaters of power P_1 and P_2 ($> P_1$) are joined in series across a dc source of voltage V. The power consumed by the combination will be less than that consumed by P_1 when connected across the same source. Reason (R): The power consumed by an electric device when connected to a dc source of voltage V is proportional to its resistance.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
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(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q7. CBSE 2026 · 1 mark A lightning strike can transfer 10^{20} electrons from the cloud to the ground in 2 minutes. The average electric current flown from cloud to the ground is –

- (a) 8.0 A (b) $1.96 \times 10^{-2} \text{ A}$ (c) 4.0 A (d) $1.33 \times 10^{-1} \text{ A}$

Q8. CBSE 2026 · 1 mark Assertion (A): In a Wheatstone bridge circuit, if we interchange the position of the cell and the galvanometer, the balance condition $P/Q = R/S$ remains unchanged. Reason (R): $P/Q = R/S \Rightarrow Q/S = P/R$ so balance condition remains same.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.



Q9. CBSE 2026 · 1 mark Assertion (A): The cylindrical soft iron core in a moving coil galvanometer only makes the magnetic field radial and does not affect the strength of the magnetic field. Reason (R): In a moving coil galvanometer, the plane of the coil is always perpendicular to the magnetic field.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q10. CBSE 2026 · 1 mark Two wires of same length and same area of cross-section but made of different material of resistivities ρ_1 and ρ_2 are connected in series. The equivalent resistivity of the combination is:

- (a) $(1/2)(\rho_1 + \rho_2)$ (b) $\rho_1 + \rho_2$ (c) $\sqrt{\rho_1 \rho_2}$ (d) $2(\rho_1 + \rho_2)$

Q11. CBSE 2026 · 1 mark Assertion (A): The work done, in taking a unit charge around a closed loop of an electric circuit involving cells and resistors in the loop, is zero. Reason (R): The potential at a point depends on the location of the point in the loop. After completing one round, the charge comes back to the point of start.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
 (c) Assertion (A) is true, but Reason (R) is false
 (d) Both Assertion (A) and Reason (R) are false

Q12. CBSE 2026 · 1 mark A wire is gradually stretched to make it 100% longer. Its resistance will increase by:

- (a) 100% (b) 200% (c) 300% (d) 400%

Q13. CBSE 2026 · 1 mark Which of the following characteristics of electrons determines the current in the conductor?

- (a) Drift velocity only (b) Thermal velocity only
 (c) Both drift velocity and thermal velocity
 (d) Neither drift nor thermal velocity

Q14. CBSE 2026 · 1 mark The resistivity ρ of a metal increases with rise in temperature because:

- (a) only relaxation time ' τ ' of electrons decreases with temperature.
 (b) only number of electrons per unit volume ' n ' increases appreciably.
 (c) ' τ ' decreases with temperature but ' n ' does not change appreciably.
 (d) ' τ ' decreases with temperature and ' n ' increases.

Q15. CBSE 2026 · 1 mark Which of the following statements is true about mobility of charge carriers in a metal?

- (a) Mobility increases with increase in applied electric field.
 (b) Mobility decreases with increase in temperature.
 (c) Mobility is independent of the mass of the charge carrier.
 (d) Mobility increases with increase in temperature

Q16. CBSE 2026 · 1 mark A galvanometer of resistance G is converted into a voltmeter of range $(0 - V)$ by connecting a resistor of 250Ω with it. If resistor of 250Ω is replaced by another resistor of 900Ω , its range becomes $(0 - 3 V)$. The resistance G of the galvanometer is:

- (a) 150Ω (b) 125Ω (c) 100Ω (d) 75Ω

Q17. CBSE 2025 · 1 mark A current flows through a cylindrical conductor of radius R . The current density at a point in the conductor is $j = \alpha r$ (along its axis), here α is a constant and r is distance from the axis of the conductor. The current flowing through the portion of the conductor from $r = 0$ to $r = R/2$ is proportional to :

- (a) R (b) R^2 (c) R^3 (d) R^4

Q18. CBSE 2025 · 1 mark When the switch of the circuit is turned on, the filament of the bulb glows instantaneously because :

- (a) the electrons coming from the power source move fast through the initially empty filament.
 (b) the filament may be old having low resistance.
 (c) electric field is established instantaneously across the filament which pushes the electrons.
 (d) free electrons in the filament travel with the speed of light.

Q19. CBSE 2025 · 1 mark Three wires A, B and C of the same material have lengths and area of cross-sections as $(2l, A/2)$, (l, A) and $(l/2, 2A)$, respectively. If the resistances of these wires are R_A , R_B and R_C respectively, then:

- (a) $R_A > R_B > R_C$ (b) $R_B > R_C > R_A$ (c) $R_C > R_A > R_B$
 (d) $R_A > R_C > R_B$

Q20. CBSE 2025 · 1 mark A galvanometer can be converted into an ammeter of desired range by connecting a:

- (a) small resistance in series (b) large resistance in series
 (c) small resistance in parallel (d) large resistance in parallel

Q21. CBSE 2025 · 1 mark A wire of resistance R , connected to an ideal battery consumes a power P . If the wire is gradually stretched to double its initial length, and connected across the same battery, the power consumed will be:

- (a) $P/4$ (b) $P/2$ (c) P (d) $2P$

Q22. CBSE 2025 · 1 mark If R_s and R_p are the equivalent resistances of n resistors, each of value R , in series and parallel combinations respectively, then the value of $(R_s - R_p)$ is :

- (a) $((n^2 - 1)/n^2)R$ (b) $((n^2 + 1)/(n^2 - 1))R$ (c) $((n^2 - 1)/n)R$
 (d) $(n^2 + 1)R/n^2$

Q23. CBSE 2025 · 1 mark A steady current I is passed through a conductor at room temperature for time t . It is observed that its temperature rises by 0.5°C . If $2I$ current is passed through the conductor (at room temperature) for the same duration, the rise in its temperature will be approximately:

- (a) 1.0°C (b) 1.5°C (c) 2.0°C (d) 4.0°C



Q24. CBSE 2025 · 1 mark Two wires P and Q are made of the same material. The wire Q has twice the diameter and half the length as that of wire P. If the resistance of wire P is R , the resistance of the wire Q will be

- (a) R (b) $R/2$ (c) $R/8$ (d) $2R$

Q25. CBSE 2024 · 1 mark A galvanometer of resistance $G \Omega$ is converted into an ammeter of range 0 to I A. If the current through the galvanometer is 0.1% of I A, the resistance of the ammeter is:

- (a) $G/999 \Omega$ (b) $G/1000 \Omega$ (c) $G/1001 \Omega$ (d) $G/100.1 \Omega$

Q26. CBSE 2024 · 1 mark A student is asked to connect four cells, each of emf E and internal resistance r , in series. But she/he connects one cell wrongly in series with the other cells. The equivalent emf and the equivalent internal resistance of the combination will be:

- (a) $4E$ and $2r$ (b) $4E$ and $3r$ (c) $3E$ and $4r$ (d) $2E$ and $4r$

Q27. CBSE 2024 · 1 mark In a uniform straight wire, conduction electrons move along $+x$ direction. Let $\mathbf{E}$ and $\mathbf{j}$ be the electric field and current density in the wire, respectively. Then:

- (a) $\mathbf{E}$ and $\mathbf{j}$ both are along $+x$ direction.
 (b) $\mathbf{E}$ and $\mathbf{j}$ both are along $-x$ direction.
 (c) $\mathbf{E}$ is along $+x$ direction, but $\mathbf{j}$ is along $-x$ direction.
 (d) $\mathbf{E}$ is along $-x$ direction, but $\mathbf{j}$ is along $+x$ direction.

Q28. CBSE 2024 · 1 mark Electrons drift with speed v_d in a conductor with potential difference V across its ends. If V is reduced to $(V/2)$, their drift speed will become:

- (a) $v_d/2$ (b) v_d (c) $2 v_d$ (d) $4 v_d$

Q29. CBSE 2023 · 1 mark For a metallic conductor, the correct representation of variation of resistance R with temperature T is:

- (a) (a) (b) (b) (c) (c) (d) (d)

Q30. CBSE 2023 · 1 mark The potential difference across a cell in an open circuit is 8 V. It falls to 4 V when a current of 4 A is drawn from it. The internal resistance of the cell is:

- (a) 4Ω (b) 3Ω (c) 2Ω (d) 1Ω

Q31. CBSE 2023 · 1 mark A steady current flows through a metallic wire whose area of cross-section (A) increases continuously from one end of the wire to the other. The magnitude of drift velocity (v_d) of the free electrons as a:

- (a) (a) (b) (b) (c) (c) (d) (d)

Q32. CBSE 2023 · 1 mark The number of electrons flowing through a conductor per second is 3.3×10^{19} . The current flowing through the conductor is:

- (a) 2.0 A (b) 3.4 A (c) 4.8 A (d) 5.3 A

Q33. CBSE 2023 · 1 mark The current density due to drift of electrons in a conductor is given by (symbols have their usual meanings):

- (a) $n e A v_d$ (b) $n A v_d/e$ (c) $n v_d/(e A)$ (d) $n e v_d$

Q34. CBSE 2023 · 1 mark Assertion (A): The internal resistance of a cell is constant. Reason (R): Ionic concentration of the electrolyte remains same during use of a cell.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
 (c) Assertion (A) is true, but Reason (R) is false
 (d) Assertion (A) is false and Reason (R) is also false

Q35. CBSE 2023 · 1 mark The SI unit of mobility of charge carriers is:

- (a) Ωs^{-1} (b) $m^2 V^{-1} s^{-1}$ (c) $m s^{-1} V^{-1}$ (d) Ωm

Q36. CBSE 2023 · 1 mark The emf and internal resistance of a cell are E and r respectively. It is connected across an external resistance $R = 2r$. The potential drop across the terminals of the cell will be:

- (a) $E/4$ (b) $E/2$ (c) $(2/3)E$ (d) $E/3$

Q37. CBSE 2023 · 1 mark A battery of emf E and internal resistance r is connected to an external circuit. The potential drop within the battery is proportional to:

- (a) current in the circuit (b) total resistance of the circuit
 (c) emf of the battery (d) power dissipated in the circuit

Q38. CBSE 2023 · 1 mark Two wires of equal length and radii r and $2r$ are connected in series. Their resistivities are 2ρ and ρ respectively. For the same current passing through the combination, the potential drop across their ends will be in the ratio of:

- (a) 2:1 (b) 1:2 (c) 4:1 (d) 8:1

Q39. CBSE 2023 · 1 mark Assertion (A) : When three electric bulbs of power 200 W, 100 W and 50 W are connected in series to a source, the power consumed by the 50 W bulb is maximum. Reason (R) : In a series circuit, current is the same through each bulb, but the potential difference across each bulb is different.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Assertion (A) is false and Reason (R) is also false.

VERY SHORT ANSWER (21)

Q40. CBSE 2026 · 2 marks What is the order of magnitude of drift velocity of electrons in a conductor? Deduce the relation between the current flowing through a conductor and drift velocity of electrons in it.

Q41. CBSE 2026 · 2 marks A heating element using nichrome is connected to a 220 V supply. Initially it draws a current of 2.9 A. After some time, the current attains a steady value of 2.5 A. Find the steady temperature of the heating element if the room temperature is 27°C . The temperature coefficient of resistance of nichrome is $1.7 \times 10^{-4} ^\circ\text{C}^{-1}$.

Q42. CBSE 2026 · 2 marks Calculate the temperature at which the resistance of a conductor becomes 20% more than its resistance at 27°C . The value of the temperature coefficient of resistance of the material of conductor is $2.0 \times 10^{-4} ^\circ\text{C}^{-1}$.



Q43. CBSE 2026 · 2 marks (a) Why manganin is used in wire-wound standard resistors? Calculate the temperature at which the resistance of a wire increases by 25% of its resistance at room temperature 27.5°C? The temperature coefficient of resistance of the material of the wire is $0.004\text{ }^{\circ}\text{C}^{-1}$.

Q44. CBSE 2026 · 2 marks A battery of emf 6 V and internal resistance $1\text{ }\Omega$ is connected to a resistor. The current in the circuit is 0.5 A. Calculate (i) the resistance of the resistor and (ii) the terminal voltage of the battery.

Q45. CBSE 2026 · 2 marks (a) An electric iron rated 2.2 kW, 220 V is operated at 110 V supply. Find: (i) its resistance, and (ii) heat produced by it in 10 minutes.

Q46. CBSE 2025 · 2 marks A voltmeter of resistance $1000\text{ }\Omega$ can measure up to 25 V. How will you convert it so that it can read up to 250 V?

Q47. CBSE 2025 · 2 marks The resistance of a wire at 25°C is $10.0\text{ }\Omega$. When heated to 125°C, its resistance becomes $10.5\text{ }\Omega$. Find (i) the temperature coefficient of resistance of the wire, and (ii) the resistance of the wire at 425°C.

Q48. CBSE 2025 · 2 marks A wire of resistance $X\text{ ohm}$ is gradually stretched till its length becomes twice its original length. If its new resistance becomes $40\text{ }\Omega$, find the value of X .

Q49. CBSE 2025 · 2 marks A cell of emf E and internal resistance r is connected to an external variable resistance R . Plot a graph showing the variation of terminal voltage V of the cell as a function of current I , supplied by the cell. Explain how the emf of the cell and its internal resistance can be found from it.

Q50. CBSE 2025 · 2 marks A cell of emf E and internal resistance r is connected across a resistor of variable resistance R . Show graphically the variation of (a) the terminal voltage across the cell, (b) the current supplied by the cell, with R as it is increased from 0 to the maximum value.

Q51. CBSE 2025 · 2 marks Two wires made of the same material have the same length (l) but different cross-sectional areas A_1 and A_2 . They are connected together with a cell of voltage V . Find the ratio of the drift velocities of free electrons in the two wires when they are joined in (i) series, and (ii) parallel.

Q52. CBSE 2025 · 2 marks A battery of emf E and internal resistance r is connected to a rheostat. When a current of 2 A is drawn from the battery, the potential difference across the rheostat is 5 V. The potential difference becomes 4 V when a current of 4 A is drawn from the battery. Calculate the value of E and r .

Q53. CBSE 2024 · 2 marks Find the temperature at which the resistance of a wire made of silver will be twice its resistance at 20°C. Take 20°C as the reference temperature and temperature coefficient of resistance of silver at 20°C = $4.0 \times 10^{-3}\text{ K}^{-1}$.

Q54. CBSE 2024 · 2 marks Two batteries of emfs 6 V and 3 V and internal resistances $0.8\text{ }\Omega$ and $0.2\text{ }\Omega$ respectively are connected in series to an external resistance R . Find the value of R so that the potential difference across the 6 V battery be zero.

Q55. CBSE 2024 · 2 marks A uniform wire of length L and area of cross-section A has resistance R . The wire is uniformly stretched so that its length increases by 25%. Calculate the percentage increase in the resistance of the wire.

Q56. CBSE 2024 · 2 marks Define resistivity of a conductor. How does the resistivity of a conductor depend upon the following: (a) Number density of free electrons in the conductor (n) (b) Their relaxation time (τ)

Q57. CBSE 2024 · 2 marks (a) Drift speed is only a few mm/s for currents in the range of a few amperes for a given conductor. How then is current established almost the instant a circuit is closed? Explain. (b) $V = IR$ Ohm's law is not always true. Explain.

Q58. CBSE 2024 · 2 marks An electric field E is maintained in a wire of length ' l ' and cross-sectional area ' a '. Establish the relationship between current density ' σ ' and electric field E .

Q59. CBSE 2024 · 2 marks (a) What is meant by 'relaxation time' of free electrons in a conductor? Show that the resistance of a conductor can be expressed by $R = ml/(ne^2\tau A)$, where symbols have their usual meanings.

Q60. CBSE 2023 · 2 marks Two identical cells, each of emf E and internal resistance r , are connected with a load resistance R , first in series and then in parallel. Obtain the condition under which the current through R is same in both cases.

SHORT ANSWER (13)

Q61. CBSE 2026 · 3 marks (a) Explain the statement: "Current is a scalar although we represent current with an arrow".

Q62. CBSE 2026 · 3 marks (i) An electric field E is maintained in a conductor of length L and area of cross-section A . Show that the electrons drift with an average velocity $v_d = (-eE/m)\tau$. Here symbols have their usual meanings. (ii) Electrons in metals drift due to force experienced by electrons in the electric field inside the conductor. Thus, the motion of electrons should be accelerated. Then why do the electrons acquire a steady average drift speed?

Q63. CBSE 2026 · 3 marks (a) Establish the relation between drift velocity of electrons (v_d) and electric current (I) in a conductor. (b) How is v_d affected when the length of the conductor is doubled, keeping the voltage applied across the conductor constant?

Q64. CBSE 2026 · 3 marks (a) 'Current is a scalar quantity, although we represent current with an arrow.' Explain. (b) Derive the balance condition of a Wheatstone Bridge.

Q65. CBSE 2025 · 3 marks Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 are connected in parallel. Derive an expression for the emf and internal resistance of the equivalent cell.

Q66. CBSE 2025 · 3 marks Explain the term drift velocity of free electrons in a conductor. A conductor of length l and area of cross-section A is connected across an ideal battery of emf V . Derive the formula for the current density in terms of relaxation time τ .



Q67. CBSE 2025 · 3 marks Three cells A, B and C of emfs 2 V, 3 V and 5 V respectively are connected in parallel to each other. Their internal resistances are $5\ \Omega$, $5\ \Omega$ and $1\ \Omega$ respectively. Calculate the currents flowing through the cells A, B and C.

Q68. CBSE 2025 · 3 marks Two batteries of emf's 3V & 6V and internal resistances $0.2\ \Omega$ & $0.4\ \Omega$ are connected in parallel. This combination is connected to a $4\ \Omega$ resistor. Find : (i) the equivalent emf of the combination (ii) the equivalent internal resistance of the combination (iii) the current drawn from the combination

Q69. CBSE 2024 · 3 marks (a) Define 'current density'. Is it a scalar or a vector? An electric field $\mathbf{E}$ is maintained in a metallic conductor. If n be the number of electrons (mass m , charge $-e$) per unit volume in the conductor and τ its relaxation time, show that the current density $\mathbf{j} = \alpha \mathbf{E}$, where $\alpha = (ne^2/m)\tau$.

Q70. CBSE 2024 · 3 marks A current of 1.6 A flows through a wire when a potential difference of 1.0 V is applied across it. The length and cross-sectional area of the wire are 1.0 m and $1.0 \times 10^{-7}\ \text{m}^2$ respectively. Calculate: (a) Electric field across the wire (b) Current density (c) Average relaxation time (τ) (Number density of free electrons in the wire is $9.0 \times 10^{28}\ \text{m}^{-3}$)

Q71. CBSE 2023 · 3 marks A potential difference V is applied across a conductor of length l and uniform cross-section area A . How will the (i) electric field E , (ii) drift velocity v_d , and (iii) current density j be affected when (a) V is doubled and (b) l is halved (keeping other factors constant) ?

Q72. CBSE 2023 · 3 marks A potential difference V and resistance R can be varied. If the current that flows in the circuit is I , draw a plot showing the variation of power consumed by the resistor as a function of: (a) R , keeping V constant (b) I , keeping R constant (c) V , keeping R constant

Q73. CBSE 2023 · 3 marks Obtain a relation between the current flowing in a conductor and drift velocity of electrons in it. Hence, obtain Ohm's law.

LONG ANSWER (5)

Q74. CBSE 2026 · 5 marks (a) An electric field $\mathbf{E}$ is established across the ends of a cylindrical conductor of length L and area of cross-section A . Discuss how electrons attain an average velocity, independent of time. Hence, obtain a relation between current in the conductor and this 'average velocity' of electrons. (b) (i) This 'average velocity' is found to be few mm s^{-1} for currents in range of a few amperes. How then is current established almost the instant a circuit is closed? (ii) Two copper wires having their radii in the ratio of 3 : 2 are connected in series across a battery. Find the ratio of the drift velocities of the electrons in the wires.

Q75. CBSE 2026 · 5 marks (a) An electric field $\mathbf{E}$ is established across the ends of a cylindrical conductor of length L and area of cross-section A . Discuss how electrons attain an average velocity, independent of time. Hence, obtain a relation between current in the conductor and this 'average velocity' of electrons. (b) (i) This 'average velocity' is found to be few mm/s for currents in range of a few amperes. How then is current established almost the instant a circuit is closed? (ii) Two copper wires having their radii in the ratio of 3 : 2 are connected in series across a battery. Find the ratio of the drift velocities of the electrons in the wires.

Q76. CBSE 2026 · 5 marks (a) An electric field $\mathbf{E}$ is established across the ends of a cylindrical conductor of length L and area of cross-section A . Discuss how electrons attain an average velocity, independent of time. Hence, obtain a relation between current in the conductor and this 'average velocity' of electrons.

Q77. CBSE 2024 · 5 marks (b) (i) What is current sensitivity of a galvanometer? Show how the current sensitivity of a galvanometer may be increased. "Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity." Explain. (ii) A moving coil galvanometer has a resistance $15\ \Omega$ and takes 20 mA to produce full scale deflection. How can this galvanometer be converted into a voltmeter of range 0 to 100 V?

Q78. CBSE 2024 · 5 marks (a) (i) (1) What is meant by current sensitivity of a galvanometer? Mention the factors on which it depends. (2) A galvanometer of resistance G is converted into a voltmeter of range $(0 - V)$ by using a resistance R . Find the resistance, in terms of R and G , required to convert it into a voltmeter of range $(0 - V/2)$. (ii) The magnetic flux through a coil of resistance $5\ \Omega$ increases with time as: $\phi = (2.0\ t^3 + 5.0\ t^2 + 6.0\ t)\ \text{mWb}$. Find the magnitude of induced current through the coil at $t = 2\ \text{s}$.

CASE-BASED (7)

CASE STUDY · CBSE 2026

A galvanometer is used to detect or/and measure small currents in an electrical circuit. It essentially works on the fact that a current-carrying coil experiences a deflecting torque when placed in a magnetic field. This deflection in the coil can be measured and it is related to the current flowing in the coil, the number of turns in the coil, area of the coil and the magnetic field. A hair spring attached to the coil provides a counter torque and helps in measuring the deflection. A galvanometer can be converted to an ammeter or a voltmeter of desired range by using suitable resistances.

Q79. CBSE 2026 · 4 marks The torque on the coil remains constant irrespective of the coil's orientation during rotation due to

- (a) use of soft iron core which increases the magnetic field.
- (b) radial magnetic field
- (c) hair spring which provides the counter torque
- (d) eddy current in the iron core which causes damping.

CASE STUDY · CBSE 2026

Capacitors are manufactured with certain standard capacitances and working voltages. However, these standard values may not be the ones that are actually needed in a particular application. Two or more capacitors can be grouped in series or in parallel to achieve desired capacitance and voltage. When connected in series, the total capacitance decreases while the voltage rating increases, whereas in parallel connections, the total capacitance increases and maintains the same voltage rating. A capacitor stores energy in the electric field between its plates and stored energy is proportional to the square of the voltage and



capacitance $U = (1/2)CV^2$, where symbols have their usual meanings.

Q80. CBSE 2026 · 1 mark The current in the $10\ \Omega$ resistor is:
(a) 0.3 A (b) 0.6 A (c) 0.2 A (d) 0

CASE STUDY · CBSE 2025

A galvanometer is an instrument used to show the direction and strength of the current passing through it. In a galvanometer, a coil placed in a magnetic field experiences a torque and hence gets deflected when a current passes through it. The name is derived from the surname of Italian scientist L. Galvani, who in 1791 discovered that electric current can cause muscle contractions. In equilibrium, the deflecting torque is balanced by the restoring torque of the spring and we have: $NBAI = k\theta$ where N is the total number of turns in the coil, A is the area of cross-section of each turn, B is the radial magnetic field, k is the torsional constant of the spring, θ is the angular deflection of the coil. As the current (I_g) which produces full scale deflection in the galvanometer is very small, the galvanometer cannot as such be used to measure current in electric circuits. A small resistance, called shunt, of a suitable value is connected with the galvanometer to convert it into an ammeter of desired range. By using a higher resistance, a galvanometer can also be converted into a voltmeter.

Q81. CBSE 2025 · 1 mark The value of the current sensitivity of a galvanometer is given by :

- (a) $k/(NBA)$ (b) NBA/k (c) kBA/N (d) kNB/A

Q82. CBSE 2025 · 1 mark (i) A galvanometer is converted into a voltmeter of range $(0 - V)$ by connecting with it, a resistance R_1 . If R_1 is replaced by R_2 , the range becomes $(0 - 2V)$. The resistance of the galvanometer is:

- (a) $(R_2 - 2R_1)$ (b) $(R_2 - R_1)$ (c) $(R_1 + R_2)$ (d) $(R_1 - 2R_2)$

CASE STUDY · CBSE 2025

In a metallic conductor, an electron, moving due to thermal motion, suffers collisions with the heavy fixed ions but after collision, it will emerge out with the same speed but in random directions. If we consider all the electrons, their average velocity will be zero. When an electric field is applied, electrons move with an average velocity, known as drift velocity (v_d). The average time between successive collisions is known as relaxation time (τ). The magnitude of drift velocity per unit electric field is called mobility (μ). An expression for current through the conductor can be obtained in terms of drift velocity, number of electrons per unit volume (n), electronic charge (e), and the cross-sectional area (A) of the conductor.

This expression leads to an expression between current density (J) and the electric field (E). Hence, an expression for resistivity (ρ) of a metal is obtained. This expression helps us to understand increase in resistivity of a metal with increase in its temperature, in terms of change in the relaxation time (τ) and change in the number density of electrons (n).

Q83. CBSE 2025 · 1 mark Consider two cylindrical conductors A and B, made of the same metal connected in series to a battery. The length and the radius of B are twice that of A. If μ_A and μ_B are the mobility of electrons in A and B respectively, then μ_A/μ_B is:

- (a) $1/2$ (b) $1/4$ (c) 2 (d) 1

Q84. CBSE 2025 · 1 mark Consider the contribution of the following two factors I and II in resistivity of a metal: I. Relaxation time of electrons II. Number of electrons per unit volume The resistivity of a metal increases with increase in its temperature because:

- (a) I decreases and II increases.
(b) I increases and II is almost constant.
(c) Both I and II increase.
(d) I decreases and II is almost constant.

CASE STUDY · CBSE 2024

When the terminals of a cell are connected to a conductor of resistance R , an electric current flows through the circuit. The electrolyte of the cell also offers some resistance in the path of the current, like the conductor. This resistance offered by the electrolyte is called internal resistance of the cell (r). It depends upon the nature of the electrolyte, the area of the electrodes immersed in the electrolyte and the temperature. Due to internal resistance, a part of the energy supplied by the cell is wasted in the form of heat. When no current is drawn from the cell, the potential difference between the two electrodes is known as emf of the cell ($\mathcal{E}$). With a current drawn from the cell, the potential difference between the two electrodes is termed as terminal potential difference (V).

Q85. CBSE 2024 · 1 mark (i) Choose the incorrect statement:

- (a) The potential difference (V) between the two terminals of a cell in a closed circuit is always less than its emf ($\mathcal{E}$), during discharge of the cell.
(b) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte.
(c) When current is drawn from the cell then $V = \mathcal{E} - Ir$.
(d) The graph between potential difference between the two terminals of the cell (V) and the current (I) through it is a straight line with a negative slope.



4 Moving Charges and Magnetism

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (43)

Q1. CBSE 2026 · 1 mark A long straight wire of circular cross-section (radius a) carries a steady current I . The current is uniformly distributed across this cross-section. The magnitude of the magnetic field produced at a point at a distance $(a/2)$ from the axis of the wire will be

- (a) Zero (b) $\mu_0 I / 2\pi a$ (c) $\mu_0 I / 4\pi a$ (d) $\mu_0 I / 6\pi a$

Q2. CBSE 2026 · 1 mark A straight conductor lies along x -axis. It carries a current of 10 A along $+x$ direction. The magnetic field $\mathbf{B}$ due to 1 cm segment of this conductor, centred at the origin, at a point $(0, 1 \text{ m}, 0)$ is

- (a) $(1 \text{ nT}) \hat{j}$ (b) $(10 \text{ nT}) \hat{k}$ (c) $-(10 \text{ nT}) \hat{k}$ (d) $-(1 \text{ nT}) \hat{j}$

Q3. CBSE 2026 · 1 mark A straight long wire lying along y -axis, carries a current of 1 A along $-y$ direction. The magnetic field due to the conductor at a point $(50 \text{ cm}, 0, 0)$ will point along.

- (a) z -axis (b) $-z$ -axis (c) x -axis (d) $-x$ -axis

Q4. CBSE 2026 · 1 mark A straight conductor lies along x -axis and carries a current of 2 A along $+x$ direction. The magnetic field at a point $(0, 40 \text{ cm}, 0)$ due to 1 cm length of conductor centered at the origin points along

- (a) y -axis (b) $-y$ -axis (c) z -axis (d) $-z$ -axis

Q5. CBSE 2026 · 1 mark A person is standing facing geographic north and a vertical wire in front of him is carrying a current in downward direction. The direction of magnetic field at a point on the right side of wire is

- (a) South (b) East (c) West (d) North

Q6. CBSE 2026 · 1 mark Assertion (A): The cylindrical soft iron core in a moving coil galvanometer only makes the magnetic field radial and does not affect the strength of the magnetic field. Reason (R): In a moving coil galvanometer, the plane of the coil is always perpendicular to the magnetic field.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Both Assertion (A) and Reason (R) are false

Q7. CBSE 2026 · 1 mark A square loop of side L lies in the x - y plane in a magnetic field $\mathbf{B} = B_0(2\hat{i} + 3\hat{j} + 4\hat{k})$, where B_0 is a constant. The magnetic flux through the loop is:

- (a) $\sqrt{29} B_0 L^2$ (b) $4 B_0 L^2$ (c) $3 B_0 L^2$ (d) $2 B_0 L^2$

Q8. CBSE 2026 · 1 mark An electron moves around the nucleus in a circular orbit of radius r and makes n revolutions per second. The value of equivalent current in the orbit is:

- (a) e/n (b) ne (c) ne/r (d) e/nr

Q9. CBSE 2026 · 1 mark Four long straight thin wires are held vertically at the corners A, B, C and D of a square of side ' a ', kept on a table and carry equal current ' I '. The wire at A carries current in upward direction whereas the current in the remaining wires flows in downward direction. The net magnetic field at the centre of the square will have the magnitude:

- (a) $\mu_0 I / (\pi a)$ and directed along OC
(b) $\mu_0 I / (\pi a \sqrt{2})$ and directed along OD
(c) $\mu_0 I \sqrt{2} / (\pi a)$ and directed along OB
(d) $2\mu_0 I / (\pi a)$ and directed along OA

Q10. CBSE 2026 · 1 mark An electron is moving with velocity $v_0 \hat{i}$. If a uniform electric field $\mathbf{E} = E_0 \hat{j}$ is set up in the region, the electron will :

- (a) describe a circular path (b) describe a helical path
(c) describe a parabolic path
(d) continue moving without any deviation

Q11. CBSE 2026 · 1 mark A charged particle of mass m having kinetic energy K passes undeflected through a region with electric field $\mathbf{E}$ and magnetic field $\mathbf{B}$ acting perpendicular to each other. The mass m of the particle will be :

- (a) $KB^2/2E^2$ (b) $2KB^2/E^2$ (c) $2KE^2/B^2$ (d) $KE^2/2B^2$

Q12. CBSE 2025 · 1 mark A long straight wire is held vertically and carries a steady current in upward direction. The shape of magnetic field lines produced by the current-carrying wire are :

- (a) horizontal straight lines directed radially out from the wire.
(b) straight lines parallel to the current-carrying wire.
(c) concentric horizontal circles around the wire.
(d) coaxial helices around the wire.

Q13. CBSE 2025 · 1 mark A particle of mass m and charge q moves along y -axis in a region in which a uniform magnetic field $\mathbf{B}$ is pointing along x -axis. The Lorentz force acting on the charge will point along:

- (a) x -axis (b) y -axis (c) z -axis (d) negative z -axis

Q14. CBSE 2025 · 1 mark A charged particle gains a speed of 10^6 ms^{-1} , when accelerated from rest through a potential difference 10 kV. It enters a region of magnetic field of 0.4 T such that $\mathbf{v} \perp \mathbf{B}$. The radius of circular path described by it is:

- (a) 2.5 cm (b) 5 cm (c) 8 cm (d) 10 cm

Q15. CBSE 2025 · 1 mark A current of $(10/\pi)$ A is maintained in a circular loop of radius 14 cm. The value of dipole moment associated with the loop is:

- (a) 0.019 Am^2 (b) 0.14 Am^2 (c) 0.196 Am^2 (d) 0.615 Am^2

Q16. CBSE 2025 · 1 mark A straight conductor is carrying a current of 2 A in $+x$ direction along it. A uniform magnetic field $\mathbf{B} = (0.6 \hat{j} + 0.8 \hat{k})$ T is switched on, in the region. The force acting on 10 cm length of the conductor is:

- (a) $(0.12 \hat{j} - 0.16 \hat{k})$ N (b) $(-0.16 \hat{j} + 0.12 \hat{k})$ N
(c) $(-0.12 \hat{j} + 0.16 \hat{k})$ N (d) $(0.16 \hat{j} - 0.12 \hat{k})$ N



Q17. CBSE 2025 · 1 mark A proton and an α -particle enter with the same velocity $\mathbf{v}$ in a uniform magnetic field $\mathbf{B}$ such that $\mathbf{v} \perp \mathbf{B}$. The ratio of the radii of their paths is:

- (a) 2 (b) $1/2$ (c) $1/4$ (d) 4

Q18. CBSE 2025 · 1 mark A rectangular coil of area A is kept in a uniform magnetic field $\mathbf{B}$ such that the plane of the coil makes an angle α with $\mathbf{B}$. The magnetic flux linked with the coil is:

- (a) $BA \sin \alpha$ (b) $BA \cos \alpha$ (c) BA (d) zero

Q19. CBSE 2025 · 1 mark Assertion (A): A charged particle is moving with velocity $\mathbf{v}$ in x - y plane, making an angle θ ($0 < \theta < \pi/2$) with x -axis. If a uniform magnetic field $\mathbf{B}$ is applied in the region, along y -axis, the particle will move in a helical path with its axis parallel to x -axis. Reason (R): The direction of the magnetic force acting on a charged particle moving in a magnetic field is along the velocity of the particle.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q20. CBSE 2025 · 1 mark A 1 cm segment of a wire lying along x -axis carries current of 0.5 A along $+x$ direction. A magnetic field $\mathbf{B} = (0.4 \text{ mT})\hat{j} + (0.6 \text{ mT})\hat{k}$ is switched on, in the region. The force acting on the segment is

- (a) $(2\hat{j} + 3\hat{k}) \text{ mN}$ (b) $(-3\hat{j} + 2\hat{k}) \mu\text{N}$ (c) $(6\hat{j} + 4\hat{k}) \text{ mN}$
(d) $(-4\hat{j} + 6\hat{k}) \mu\text{N}$

Q21. CBSE 2025 · 1 mark Assertion (A) : The deflection in a galvanometer is directly proportional to the current passing through it. Reason (R) : The coil of a galvanometer is suspended in a uniform radial magnetic field.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q22. CBSE 2024 · 1 mark A loop carrying a current I clockwise is placed in $x - y$ plane, in a uniform magnetic field directed along z -axis. The tendency of the loop will be to:

- (a) move along x -axis (b) move along y -axis (c) shrink
(d) expand

Q23. CBSE 2024 · 1 mark A 10 cm long wire lies along y -axis. It carries a current of 1.0 A in positive y -direction. A magnetic field $\mathbf{B} = (5 \text{ mT})\hat{j} - (8 \text{ mT})\hat{k}$ exists in the region. The force on the wire is:

- (a) $(0.8 \text{ mN})\hat{i}$ (b) $-(0.8 \text{ mN})\hat{i}$ (c) $(80 \text{ mN})\hat{i}$ (d) $-(80 \text{ mN})\hat{i}$

Q24. CBSE 2024 · 1 mark Assertion (A): Two long parallel wires, freely suspended and connected in series to a battery, move apart. Reason (R): Two wires carrying current in opposite directions repel each other.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Assertion (A) is false and Reason (R) is also false

Q25. CBSE 2024 · 1 mark A piece of wire bent in the form of a circular loop A carries a current I . The wire is then bent into a circular loop B of two turns and carries the same current. The ratio of magnetic fields at the centre of loop A to that of loop B will be:

- (a) $1/16$ (b) 16 (c) 4 (d) $1/4$

Q26. CBSE 2024 · 1 mark Two charged particles, P and Q, each having charge q but of masses m_1 and m_2 , are accelerated through the same potential difference V . They enter a region of magnetic field $\mathbf{B}$ ($\perp \mathbf{v}$) and describe the circular paths of radii a and b respectively. Then (m_1/m_2) is equal to:

- (a) b/a (b) a/b (c) $(b/a)^2$ (d) $(a/b)^2$

Q27. CBSE 2024 · 1 mark A wire of length 4.4 m is bent round in the shape of a circular loop and carries a current of 1.0 A. The magnetic moment of the loop will be:

- (a) 0.7 Am^2 (b) 1.54 Am^2 (c) 2.10 Am^2 (d) 3.5 Am^2

Q28. CBSE 2024 · 1 mark A circular coil of radius 10 cm is placed in a magnetic field $\mathbf{B} = (1.0\hat{i} + 0.5\hat{j}) \text{ mT}$ such that the outward unit vector normal to the surface of the coil is $(0.6\hat{i} + 0.8\hat{j})$. The magnetic flux linked with the coil is:

- (a) $0.314 \mu\text{Wb}$ (b) $3.14 \mu\text{Wb}$ (c) $31.4 \mu\text{Wb}$ (d) $1.256 \mu\text{Wb}$

Q29. CBSE 2024 · 1 mark Assertion (A): An electron and a proton enter with the same momentum $\mathbf{p}$ in a magnetic field $\mathbf{B}$ such that $\mathbf{p} \perp \mathbf{B}$. Then both describe a circular path of the same radius. Reason (R): The radius of the circular path described by the charged particle (charge q , mass m) moving in the magnetic field $\mathbf{B}$ is given by $r = mv/(qB)$.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q30. CBSE 2024 · 1 mark An alpha particle approaches a gold nucleus in Geiger-Marsden experiment with kinetic energy K . It momentarily stops at a distance d from the nucleus and reverses its direction. Then d is proportional to:

- (a) $1/\sqrt{K}$ (b) $\sqrt{K}$ (c) $1/K$ (d) K

Q31. CBSE 2024 · 1 mark A circular loop of wire, carrying current, is placed in the xy -plane with its centre coinciding with the origin. It is subjected to a uniform magnetic field pointing along $+z$ -axis. The loop will :

- (a) move along x -axis (b) move along $-y$ -axis
(c) move along z -axis (d) remain stationary



Q32. CBSE 2024 · 1 mark Assertion (A) : A proton and an electron enter a uniform magnetic field **B** with the same momentum **p** such that **p** is perpendicular to **B**. They describe circular paths of the same radius. Reason (R) : In a magnetic field, orbital radius r is equal to $p/(qB)$.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Assertion (A) is false and Reason (R) is also false.

Q33. CBSE 2024 · 1 mark Two long straight parallel wires, with separation distance a , carry currents in opposite directions. The wires will:

- (a) Repel each other with a force $\mu_0 I^2/(2\pi a^2)$ per unit length
 (b) Attract each other with a force $\mu_0 I^2/(2\pi a^2)$ per unit length
 (c) Attract each other with a force $\mu_0 I^2/(2\pi a)$ per unit length
 (d) Repel each other with a force $\mu_0 I^2/(2\pi a)$ per unit length

Q34. CBSE 2024 · 1 mark A current carrying circular loop of magnetic moment **M** is suspended in a vertical plane in an external magnetic field **B** such that its plane is normal to **B**. The work done in rotating this loop by 45° about an axis perpendicular to **B** is closest to:

- (a) $-0.3 MB$ (b) $0.3 MB$ (c) $-1.7 MB$ (d) $1.7 MB$

Q35. CBSE 2024 · 1 mark A proton and an alpha particle having equal velocities approach a target nucleus. They come momentarily to rest and then reverse their directions. The ratio of the distance of closest approach of the proton to that of the alpha particle will be:

- (a) 2:1 (b) $\sqrt{2}$:1 (c) 4:1 (d) 1:4

Q36. CBSE 2023 · 1 mark A bar magnet is dropped in a hollow metallic cylinder along its vertical axis. The acceleration of the falling magnet will be:

- (a) zero (b) equal to g (c) less than g (d) greater than g

Q37. CBSE 2023 · 1 mark A particle of mass m and charge q moving with a uniform velocity $\mathbf{v} = v_{0x}\hat{i} + v_{0y}\hat{j}$ enters a region with a magnetic field $\mathbf{B} = B_0\hat{j}$. After some time, an electric field $\mathbf{E} = E_0\hat{j}$ is also switched on in the region. The resulting path described by the particle will be :

- (a) a circle in x - z plane (b) a parabola in x - y plane
 (c) a helix with constant pitch
 (d) a helix with increasing pitch

Q38. CBSE 2023 · 1 mark Assertion (A): When radius of a circular loop carrying a steady current is doubled, its magnetic moment becomes four times. Reason (R): The magnetic moment of a circular loop carrying a steady current is proportional to the area of the loop.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
 (c) Assertion (A) is true, but Reason (R) is false
 (d) Assertion (A) is false and Reason (R) is also false

Q39. CBSE 2023 · 1 mark In a moving coil galvanometer, the deflecting torque τ acting on the coil is related to the current I flowing through it as:

- (a) $\tau \propto I^3$ (b) $\tau \propto I^2$ (c) $\tau \propto I$ (d) $\tau \propto \sqrt{I}$

Q40. CBSE 2023 · 1 mark An electron enters a uniform magnetic field with speed v . It describes a semicircular path and comes out of the field. The final speed of the electron is :

- (a) Zero (b) v (c) $v/2$ (d) $2v$

Q41. CBSE 2023 · 1 mark Assertion (A) : A current carrying square loop made of a wire of length L is placed in a magnetic field. It experiences a torque which is greater than the torque on a circular loop made of the same wire carrying the same current in the same magnetic field. Reason (R) : A square loop occupies more area than a circular loop, both made of wire of the same length.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Assertion (A) is false and Reason (R) is also false.

Q42. CBSE 2023 · 1 mark The ratio of the magnitude of magnetic moment to that of angular momentum, of an electron revolving around the nucleus in a hydrogen atom is:

- (a) Zero (b) $9.27 \times 10^{-24} \text{ C/kg}$ (c) $8.8 \times 10^{10} \text{ C/kg}$
 (d) $6.6 \times 10^{-12} \text{ C/kg}$

Q43. CBSE 2023 · 1 mark A particle of mass m and charge $-q$ is moving with a uniform speed v in a circle of radius r , with another charge q at the centre of the circle. The value of r is:

- (a) $(1/(4\pi\epsilon_0 m))(q/v)$ (b) $(1/(4\pi\epsilon_0 m))(q/v)^2$
 (c) $(m/(4\pi\epsilon_0))(q/v)$ (d) $(m/(4\pi\epsilon_0))(q/v)^2$

VERY SHORT ANSWER (8)

Q44. CBSE 2026 · 2 marks A wire of length L is bent round into (i) a square coil having N turns and (ii) a circular coil having N turns. The coil in both cases is free to turn about a vertical axis coinciding with the plane of the coil, in a uniform, horizontal magnetic field and carry the same currents. Find the ratio of the maximum value of the torque acting on the square coil to that on the circular coil.

Q45. CBSE 2025 · 2 marks A circular coil of wire having 200 turns, each of radius 4.0 cm is placed in a horizontal plane. It carries a current of 0.40 A in clockwise direction. Find the magnitude and direction of the magnetic field at the centre of the coil.

Q46. CBSE 2025 · 2 marks A current of 5 A is passing along $+X$ direction through a wire lying along X -axis. Find the magnetic field **B** at a point $\mathbf{r} = (3\hat{i} + 4\hat{j}) \text{ m}$ due to 1 cm element of the wire, centered at origin.

Q47. CBSE 2023 · 2 marks An alpha particle is projected with velocity $\mathbf{v} = (3.0 \times 10^5 \text{ m/s})\hat{i}$ into a region in which magnetic field $\mathbf{B} = [(0.4 \text{ T})\hat{i} + (0.3 \text{ T})\hat{j}]$ exists. Calculate the acceleration of the particle in the region. $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x , y and z axis respectively and charge to mass ratio for alpha particle is $4.8 \times 10^7 \text{ C/kg}$.



Q48. CBSE 2023 · 2 marks A wire of length l is in the form of a circular loop A of one turn. This loop is reshaped into loop B of three turns. Find the ratio of the magnetic fields at the centres of loop A and loop B for the same current through them.

Q49. CBSE 2023 · 2 marks Two wires of equal lengths are shaped in the form of a square loop and a circular loop. Both loops are suspended in a uniform magnetic field. Prove that for the same current, the circular loop will experience larger torque.

Q50. CBSE 2023 · 2 marks A wire of length L is bent round in the form of (i) a square, and then (ii) an equilateral triangle. If current I is passed through each of them, find the ratio of magnetic moment of the square loop to that of the triangle.

Q51. CBSE 2023 · 2 marks A particle of charge q and mass m starts moving with uniform velocity $v_0 \hat{i}$. Specify the direction of magnetic field which should be set up in the region so that the particle moves (a) straight undeviated, and (b) in a circle. Justify your answers.

SHORT ANSWER (18)

Q52. CBSE 2026 · 3 marks Derive an expression for the magnetic field B , due to a circular coil of N turns, each of radius r carrying current I , at a distance ' x ' from the centre along its axis.

Q53. CBSE 2026 · 3 marks (a) A straight vertical wire carries a current of 3 A upward along $+z$ axis. Calculate the magnitude and direction of the magnetic field at a point 15 cm away from the wire on $+x$ -axis. Name the rule used to find the direction of magnetic field. (b) A flexible loop of irregular shape carrying current is placed in an external magnetic field. Why does it change to circular shape ?

Q54. CBSE 2026 · 3 marks (a) A circular coil of 30 turns and radius 8.0 cm carrying a current of 6 A is suspended vertically in a uniform horizontal magnetic field of 1.0 T. The field lines make an angle of 30° with the plane of the coil. Calculate the magnitude of the external torque that must be applied to prevent the coil from turning. What would happen if the circular coil is replaced by a planar coil of irregular shape that encloses the same area, keeping other parameters unchanged?

Q55. CBSE 2026 · 3 marks Write the expression for the magnetic field due to a current element in vector form. Consider a 1 cm segment of a wire, centered at the origin, carrying a current of 10 A in positive x -direction. Calculate the magnetic field B at a point (1 m, 1 m, 0).

Q56. CBSE 2025 · 3 marks (a) A charged particle q moving with a velocity $\mathbf{v}$ is subjected to a uniform magnetic field $\mathbf{B}$ acting perpendicular to $\mathbf{v}$. If a uniform electric field $\mathbf{E}$ is also set up in the region along the direction of $\mathbf{B}$, describe the path followed by the particle and draw its shape. (b) How will the magnetic field inside a long solenoid be affected when: (i) the radius of the turns of the solenoid is increased, (ii) the length of solenoid as well as the total number of its turns are doubled ?

Q57. CBSE 2025 · 3 marks (a) Use Ampere's law to derive the expression for the magnetic field due to a long straight current carrying wire of infinite length. (b) Why is Ampere's law used for the derivation in (a) above and not Biot-Savart's law ? Explain.

Q58. CBSE 2025 · 3 marks Two identical circular coils A and B, each of radius R , carrying currents I and $\sqrt{3}I$ respectively, are placed concentrically in XY and YZ planes respectively. Find the magnitude and direction of the net magnetic field at their common centre.

Q59. CBSE 2025 · 3 marks (i) Write Biot-Savart law in vector form. (ii) Two identical circular coils A and B, each of radius R , carrying currents I and $\sqrt{3}I$ respectively, are placed concentrically in XY and YZ planes respectively. Find the magnitude and direction of the net magnetic field at their common centre.

Q60. CBSE 2025 · 3 marks Using Biot-Savart law, derive expression for the magnetic field (B) due to a circular current carrying loop at a point on its axis and hence at its centre.

Q61. CBSE 2024 · 3 marks A proton with kinetic energy 1.3384×10^{-14} J moving horizontally from north to south, enters a uniform magnetic field B of 2.0 mT directed eastward. Calculate: (a) the speed of the proton (b) the magnitude of acceleration of the proton (c) the radius of the path traced by the proton [Take (q/m) for proton = 1.0×10^8 C/kg]

Q62. CBSE 2024 · 3 marks A circular coil with cross-sectional area 0.2 cm^2 carries a current of 4 A. It is kept in a uniform magnetic field of magnitude 0.5 T normal to the plane of the coil. Calculate: (a) the net force on the coil. (b) the torque on the coil. (c) the average force on each electron in the coil due to the magnetic field. The free electron density in the material of the coil is 10^{28} m^{-3} .

Q63. CBSE 2024 · 3 marks (a) Two long, straight, parallel conductors carry steady currents in opposite directions. Explain the nature of the force of interaction between them. Obtain an expression for the magnitude of the force between the two conductors. Hence define one ampere.

Q64. CBSE 2024 · 3 marks (a) Two long, straight, parallel conductors carry steady currents in opposite directions. Explain the nature of the force of interaction between them. Obtain an expression for the magnitude of the force between the two conductors. Hence define one ampere. OR (b) Obtain an expression for the torque τ acting on a current carrying loop in a uniform magnetic field $\mathbf{B}$. Draw the necessary diagram.

Q65. CBSE 2024 · 3 marks Two long straight parallel conductors carrying currents exert a force on each other. Why ? Derive an expression for the force per unit length between two long straight parallel conductors carrying currents in opposite directions. Explain the nature of the force between these conductors.

Q66. CBSE 2024 · 3 marks A rectangular loop of area A , carrying current I , is placed in a uniform magnetic field $\mathbf{B}$. With the help of a suitable diagram, derive an expression, in vector form, for the torque acting on the loop.

Q67. CBSE 2024 · 3 marks An electron (charge $-e$, mass m) is revolving around a nucleus, in a hydrogen atom, in a circle of radius r . Derive an expression, in vector form, for the magnetic dipole moment, μ_z in terms of its orbital angular momentum $\mathbf{L}$. What is gyromagnetic ratio?



Q68. CBSE 2023 · 3 marks Two circular loops A and B, each of radius 3 m, are placed coaxially at a distance of 4 m. They carry currents of 3 A and 2 A in opposite directions respectively. Find the net magnetic field at the centre of loop A.

Q69. CBSE 2023 · 3 marks Two infinitely long parallel conductors A and B, separated by 2 cm, carry 6 A and 2 A currents in opposite directions respectively. Find: (a) the net magnetic field at a point midway between A and B. (b) the force acting per unit length on B.

LONG ANSWER (8)

Q70. CBSE 2026 · 5 marks (a) (i) A rectangular loop of sides a and b carrying current I is placed in a magnetic field B such that its area vector A makes an angle θ with B . With the help of a suitable diagram, show that the torque τ acting on the loop is given by $\tau = m \times B$, where $m (= IA)$ is the magnetic dipole moment of the loop. (ii) A circular coil of 100 turns and radius $(10/\sqrt{\pi})$ cm carrying current of 5.0 A is suspended vertically in a uniform horizontal magnetic field of 2.0 T. The field makes an angle 30° with the normal to the coil. Calculate: (I) the magnetic dipole moment of the coil, and (II) the magnitude of the counter torque that must be applied to prevent the coil from turning.

Q71. CBSE 2025 · 5 marks (i) With the help of a labelled diagram, explain the principle of working of a moving coil galvanometer. Write the purpose of using (i) radial magnetic field, and (ii) soft iron core, in it. (ii) Explain why increasing current sensitivity may not necessarily increase the voltage sensitivity of a galvanometer.

Q72. CBSE 2025 · 5 marks With the help of a labelled diagram, explain the principle of working of a moving coil galvanometer. Write the purpose of using (i) radial magnetic field, and (ii) soft iron core, in it. Explain why an increase in current sensitivity may not necessarily increase the voltage sensitivity of the galvanometer.

Q73. CBSE 2025 · 5 marks (i) With the help of a labelled diagram, explain the principle of working of a moving coil galvanometer. Write the purpose of using (i) radial magnetic field, and (ii) soft iron core, in it. (ii) Explain why an increase in the current sensitivity may not necessarily increase the voltage sensitivity.

Q74. CBSE 2023 · 5 marks (i) State Biot-Savart law for the magnetic field due to a current-carrying element. Use this law to obtain an expression for the magnetic field at the centre of a circular current loop and show the magnetic field lines indicating the direction of magnetic field. (ii) An electron is revolving around the nucleus in a circular orbit with a speed of 10^7 m s^{-1} . If the radius of the orbit is 10^{-10} m , find the current constituted by the revolving electron in the orbit.

Q75. CBSE 2023 · 5 marks (i) State Biot-Savart law for the magnetic field due to a current-carrying element. Use this law to obtain an expression for the magnetic field at the centre of a circular loop of radius ' a ' carrying current ' I '. Draw the magnetic field lines for a current loop indicating the direction of magnetic field. (ii) An electron is revolving around the nucleus in a circular orbit with a speed of 10^7 m s^{-1} . If the radius of the orbit is 10^{-10} m , find the current constituted by the revolving electron in the orbit.

Q76. CBSE 2023 · 5 marks (a) (i) Write the principle and explain the working of a moving coil galvanometer. A galvanometer as such cannot be used to measure the current in a circuit. Why? (ii) Why is the magnetic field made radial in a moving coil galvanometer? How is it achieved?

Q77. CBSE 2023 · 5 marks Write the principle and explain the working of a moving coil galvanometer. A galvanometer as such cannot be used to measure the current in a circuit. Why? Why is the magnetic field made radial in a moving coil galvanometer? How is it achieved?

CASE-BASED (5)

CASE STUDY · CBSE 2026

A galvanometer is used to detect or/and measure small currents in an electrical circuit. It essentially works on the fact that a current-carrying coil experiences a deflecting torque when placed in a magnetic field. This deflection in the coil can be measured and it is related to the current flowing in the coil, the number of turns in the coil, area of the coil and the magnetic field. A hair spring attached to the coil provides a counter torque and helps in measuring the deflection. A galvanometer can be converted to an ammeter or a voltmeter of desired range by using suitable resistances.

Q78. CBSE 2026 · 4 marks The torque on the coil remains constant irrespective of the coil's orientation during rotation due to

- (a) use of soft iron core which increases the magnetic field.
- (b) radial magnetic field
- (c) hair spring which provides the counter torque
- (d) eddy current in the iron core which causes damping.

Q79. CBSE 2026 · 4 marks A galvanometer is used to detect or/and measure small currents in an electrical circuit. It essentially works on the fact that a current-carrying coil experiences a deflecting torque when placed in a magnetic field. This deflection in the coil can be measured and it is related to the current flowing in the coil, the number of turns in the coil, area of the coil and the magnetic field. A hair spring attached to the coil provides a counter torque and helps in measuring the deflection. A galvanometer can be converted to an ammeter or a voltmeter of desired range by using suitable resistances. (I) The torque on the coil remains constant irrespective of the coil's orientation during rotation due to

- (a) use of soft iron core which increases the magnetic field.
- (b) radial magnetic field
- (c) hair spring which provides the counter torque
- (d) eddy current in the iron core which causes damping.

CASE STUDY · CBSE 2026

A charged particle is moving horizontally with a velocity v . If a uniform magnetic field B directly vertically up is set-up in the



region, the particle moves in a circle of radius R in anti-clockwise direction.

Q80. CBSE 2026 · 1 mark The charged particle exhibiting this motion is

- (a) electron (b) proton (c) alpha-particle (d) neutron

CASE STUDY · CBSE 2026

A charged particle $+q$ in an electric field $E \rightarrow$ experiences a force in the direction of the electric field. As a result, its kinetic energy changes. Similarly, the charged particle also experiences a force when it moves in a magnetic field $B \rightarrow$. But this magnetic force is perpendicular to both velocity $v \rightarrow$ of the charged particle and the magnetic field $B \rightarrow$, so it cannot change the kinetic energy of the charged particle. Consider two charged particles 1 and 2 of masses m and $m/2$ having charges $-q$ and $+2q$ respectively.

They are accelerated from rest through the same potential difference V and acquire kinetic energy K_1 and K_2 . Then they enter in a region of uniform magnetic field $B \rightarrow$ perpendicular to their velocities.

Q81. CBSE 2026 · 1 mark The ratio of their kinetic energies (K_1/K_2) is :

- (a) $1/2$ (b) $1/4$ (c) 4 (d) 1

CASE STUDY · CBSE 2025

A galvanometer is an instrument used to show the direction and strength of the current passing through it. In a galvanometer, a coil placed in a magnetic field experiences a torque and hence gets deflected when a current passes through it. The name is derived from the surname of Italian scientist L. Galvani, who in 1791 discovered that electric current produces magnetic effects. A coil suspended in a magnetic field experiences a torque and hence gets deflected when current passes through it. In equilibrium, the deflecting torque is balanced by the restoring torque of the spring and we have: $NBAI = k\theta$ where N is the total number of turns in the coil, A is the area of cross-section of each turn, B is the radial magnetic field, k is the torsional constant of the spring, and θ is the angular deflection of the coil.

Q82. CBSE 2025 · 1 mark The value of the current sensitivity of a galvanometer is given by :

- (a) k/NBA (b) NBA/k (c) kBA/N (d) kNB/A

5 Magnetism and Matter

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (18)

Q1. CBSE 2026 · 1 mark Assertion (A): All atoms have a net magnetic moment. Reason (R): A current loop does not always behave as a magnetic dipole.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q2. CBSE 2026 · 1 mark Which of the following materials has positive and small value of magnetic susceptibility?

- (a) Cu (b) Al (c) Bi (d) Ni

Q3. CBSE 2026 · 1 mark Which of the following substance has relative magnetic permeability $\mu_r \gg 1$?

- (a) Aluminium (b) Copper (c) Lead (d) Nickel

Q4. CBSE 2026 · 1 mark Which one of the following materials has magnetic susceptibility χ in the range $-1 \leq \chi < 0$?

- (a) Aluminium (b) Copper chloride (c) Copper (d) Nickel

Q5. CBSE 2026 · 1 mark Assertion (A): When a ferromagnetic substance is heated to high temperature it becomes paramagnetic in nature. Reason (R): The disappearance of magnetisation of a ferromagnet is abrupt and not gradual.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q6. CBSE 2026 · 1 mark A coil having 100 closely wound turns and area of cross-section 300 mm^2 carries a current of 5 mA. The magnitude of the magnetic moment associated with the coil is:

- (a) $6 \times 10^{-4} \text{ Am}^2$ (b) $3 \times 10^{-5} \text{ Am}^2$ (c) $1.5 \times 10^{-4} \text{ Am}^2$
(d) $5 \times 10^{-5} \text{ Am}^2$

Q7. CBSE 2025 · 1 mark A bar magnet is initially at right angles to a uniform magnetic field. The magnet is rotated till the torque acting on it becomes one-half of its initial value. The angle through which the bar magnet is rotated is :

- (a) 30° (b) 45° (c) 60° (d) 75°

Q8. CBSE 2025 · 1 mark Which one out of the following materials is not paramagnetic ?

- (a) Aluminium (b) Sodium Chloride (c) Calcium
(d) Copper Chloride

Q9. CBSE 2025 · 1 mark The materials having negative magnetic susceptibility are :

- (a) diamagnetic (b) paramagnetic (c) ferromagnetic
(d) non-magnetic



Q10. CBSE 2025 · 1 mark Which of the following substances has magnetic permeability less than that of free space?

- (a) Sodium (b) Iron (c) Aluminium (d) Copper

Q11. CBSE 2025 · 1 mark A current of $(10/\pi)$ A is maintained in a circular loop of radius 14 cm. The value of dipole moment associated with the loop is:

- (a) 0.019 Am^2 (b) 0.14 Am^2 (c) 0.196 Am^2 (d) 0.615 Am^2

Q12. CBSE 2025 · 1 mark A piece of a diamagnetic material, free to move when placed in a uniform magnetic field:

- (a) moves along the field (b) moves opposite to the field
(c) moves perpendicular to the field
(d) does not move at all

Q13. CBSE 2024 · 1 mark A current carrying circular loop of magnetic moment $\mathbf{M}$ is suspended in a vertical plane in an external magnetic field $\mathbf{B}$ such that its plane is normal to $\mathbf{B}$. The work done in rotating this loop by 45° about an axis perpendicular to $\mathbf{B}$ is closest to:

- (a) -0.3 MB (b) 0.3 MB (c) -1.7 MB (d) 1.7 MB

Q14. CBSE 2024 · 1 mark Which of the following is a diamagnetic substance?

- (a) Gadolinium (b) Sodium (c) Copper chloride
(d) Sodium chloride

Q15. CBSE 2023 · 1 mark A diamagnetic substance is brought near the north or south pole of a bar magnet. It will be:

- (a) repelled by both the poles
(b) attracted by both the poles
(c) repelled by the north pole and attracted by the south pole
(d) attracted by the north pole and repelled by the south pole

Q16. CBSE 2023 · 1 mark Assertion (A): When a bar of copper is placed in an external magnetic field, the field lines get concentrated inside the bar. Reason (R): Copper is a paramagnetic substance.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Assertion (A) is false and Reason (R) is also false

Q17. CBSE 2023 · 1 mark Which one of the following has negative value of susceptibility?

- (a) Nickel (b) Aluminium (c) Lead (d) Iron

Q18. CBSE 2023 · 1 mark Which one of the following has relative magnetic permeability between 0 and 1?

- (a) Aluminium (b) Alnico (c) Water (d) Sodium

VERY SHORT ANSWER (3)

Q19. CBSE 2023 · 2 marks A small magnetised needle P is placed at the origin of x-y plane with its magnetic moment pointing along the y-axis. Another identical magnetised needle Q is placed in two positions, one by one. Case 1 : at (a, 0) with its magnetic moment pointing along x-axis. Case 2 : at (0, a) with its magnetic moment pointing along y-axis. (a) In which case is the potential energy of P and Q minimum? (b) In which case is P and Q not in equilibrium? Justify your answers.

Q20. CBSE 2023 · 2 marks Answer the following giving reasons: (b) If a monopole is present, how would Gauss law in magnetism be modified?

Q21. CBSE 2022 · 2 marks How is an emf generated by a solar cell due to the three basic processes involved? Explain.

SHORT ANSWER (3)

Q22. CBSE 2025 · 3 marks An electron of mass m and charge $-e$ is revolving anticlockwise around the nucleus of an atom. (a) Obtain the expression for the magnetic dipole moment (μ) of the atom. (b) If $\mathbf{L}$ is the angular momentum of electron, show that $\mu = -(e/(2m))\mathbf{L}$.

Q23. CBSE 2025 · 3 marks The magnetic moment (5 J/T) of a bar magnet points along a uniform magnetic field 0.4 T . (a) Calculate (i) the potential energy of the bar magnet, and (ii) the work done in turning the magnet by 180° . (b) In which case is the potential energy of the magnet minimum?

Q24. CBSE 2024 · 3 marks A bar magnet of magnetic moment 2.5 J T^{-1} lies aligned with the direction of a uniform magnetic field of 0.32 T . (a) Find the amount of work done to turn the magnet so as to align its magnetic moment (i) normal to the field direction, and (ii) opposite to the field direction. (b) What is the torque on the magnet in above cases (i) and (ii)?

CASE-BASED (1)

CASE STUDY · CBSE 2025

A galvanometer is an instrument used to show the direction and strength of the current passing through it. In a galvanometer, a coil placed in a magnetic field experiences a torque and hence gets deflected when a current passes through it. The name is derived from the surname of Italian scientist L. Galvani, who in 1791 discovered that electric current can cause muscle contractions. In equilibrium, the deflecting torque is balanced by the restoring torque of the spring and we have: $NBAI = k\theta$ where N is the total number of turns in the coil, A is the area of cross-section of each turn, B is the radial magnetic field, k is the torsional constant of the spring, θ is the angular deflection of the coil. As the current (I_g) which produces full scale deflection in the galvanometer is very small, the galvanometer cannot as such be used to measure current in electric circuits. A small resistance, called shunt, of a suitable value is connected with the galvanometer to convert it into an ammeter of desired range. By using a higher resistance, a galvanometer can also be converted into a voltmeter.



Q25. CBSE 2025 · 1 mark (b) A current of 5 mA flows through a galvanometer. Its coil has 100 turns, each of area of cross-section 18 cm^2 and is suspended in a magnetic field 0.20 T . The deflecting torque acting on the coil will be:

- (a) $3.6 \times 10^{-3} \text{ Nm}$ (b) $1.8 \times 10^{-4} \text{ Nm}$ (c) $2.4 \times 10^{-3} \text{ Nm}$
(d) $1.2 \times 10^{-4} \text{ Nm}$

6 Electromagnetic Induction

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (33)

Q1. CBSE 2026 · 1 mark A magnet held vertically, with its north pole down is dropped along the axis of a closed solenoid placed vertically on a table. If the observer looks down from the top,

- (a) the induced current will flow in the anticlockwise direction.
(b) the induced current will flow in the clockwise direction.
(c) no induced current will flow in the solenoid.
(d) the magnet will fall with a constant velocity.

Q2. CBSE 2026 · 1 mark The magnetic flux ϕ (in Wb) linked with a coil is related to time t (in s) as $\phi = 5 At^2 + Bt - 2C$. The SI units of A and B are respectively

- (a) Wb s^{-2} , Wb s^{-1} (b) Wb s^{-1} , Wb (c) Wb s^2 , Wb s
(d) Wb s^{-1} , Wb s^{-2}

Q3. CBSE 2026 · 1 mark Two identical circular loops A and B of metal wire are arranged on a table close to each other. Loop A is connected to a battery and the current in it increases with time. In response, the loop B

- (a) remains stationary (b) is attracted by loop A
(c) is repelled by loop A
(d) rotates about its centre of mass which is fixed

Q4. CBSE 2026 · 1 mark An electric current can be induced in a wire loop if –

- (a) the wire loop is wound around a bar magnet
(b) a bar magnet is placed in contact with the wire loop
(c) a bar magnet is placed near the wire loop
(d) a bar magnet is moved rapidly towards the wire loop

Q5. CBSE 2026 · 1 mark Assertion (A): Displacement current does not have the same physical effect as the conduction current. Reason (R): The concept of displacement current is introduced only to satisfy Kirchhoff's rules.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Both Assertion (A) and Reason (R) are false

Q6. CBSE 2026 · 1 mark A square loop of side 50 cm is placed in a uniform magnetic field of 3.0 T acting perpendicular to the plane of the loop. If the loop is rotated through an angle of 90° in 0.3 s , the value of emf induced in the loop would be:

- (a) 0.25 V (b) 0.50 V (c) 0.75 V (d) 1.0 V

Q7. CBSE 2026 · 1 mark A metallic rod of 1 m length is rotated with a frequency of 40 rev/s , with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius 1 m , about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field of 0.5 T parallel to the axis is present in the region. The value of emf induced between the centre and the metallic ring is close to:

- (a) 20 V (b) 32 V (c) 40 V (d) 63 V

Q8. CBSE 2026 · 1 mark The dimensions of the rate of change of magnetic flux are:

- (a) $[\text{M L T}^{-3} \text{ A}]$ (b) $[\text{M L}^2 \text{ T}^{-3} \text{ A}^{-1}]$ (c) $[\text{M L}^2 \text{ T}^{-2} \text{ A}^{-1}]$
(d) $[\text{M L}^2 \text{ T}^{-3} \text{ A}^{-2}]$

Q9. CBSE 2026 · 1 mark A closely wound long solenoid of self-inductance L is cut into two identical solenoids. The value of self-inductance of each small solenoid will be:

- (a) $L/2$ (b) $2L$ (c) $3L$ (d) $4L$

Q10. CBSE 2026 · 1 mark Two coils are placed closed to each other. The mutual inductance of the pair of coils depends upon the:

- (a) rate at which currents change in the two coils.
(b) relative position and orientation of the coils.
(c) currents in the two coils.
(d) value of voltage induced in one coil due to change in value of current in the other coil.

Q11. CBSE 2026 · 1 mark The magnetic flux through a loop placed in a magnetic field can be changed by changing:

- (a) area of the loop only (b) the value of magnetic field only
(c) orientation of the loop in the magnetic field only
(d) any one or more of the factors given in (A), (B) and (C)

Q12. CBSE 2026 · 1 mark Assertion (A): Induced emf produced in a coil will be more when the magnetic flux linked with the coil is more. Reason (R): Induced emf produced is directly proportional to the magnetic flux.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q13. CBSE 2026 · 1 mark A rectangular loop of size $5 \text{ cm} \times 8 \text{ cm}$ is lying in x - y plane in a uniform magnetic field $\vec{B} = (2.0 \text{ T}) \hat{k}$. The total magnetic flux linked with the loop is:

- (a) 80 Wb (b) 16 Wb (c) $8 \times 10^{-2} \text{ Wb}$ (d) $8 \times 10^{-3} \text{ Wb}$



Q14. CBSE 2026 · 1 mark A square loop of side 0.50 m is placed in a uniform magnetic field of 0.4 T perpendicular to the plane of the loop. The loop is rotated through an angle of 60° in 0.2 s. The value of emf induced in the loop will be:

- (a) 5 V (b) 3.5 V (c) 2.5 V (d) Zero V

Q15. CBSE 2025 · 1 mark When current in a coil changes at a steady rate from 8 A to 6 A in 4 ms, an emf of 1.5 V is induced in it. The value of self-inductance of the coil is :

- (a) 6 mH (b) 12 mH (c) 3 mH (d) 9 mH

Q16. CBSE 2025 · 1 mark The electric field in space between the plates of a parallel plate capacitor (each of area $2.5 \times 10^{-3} \text{ m}^2$) is changing at the rate of $4 \times 10^6 \text{ Vm}^{-1}\text{s}^{-1}$. The displacement current between the plates of the capacitor is :

- (a) $1.8 \times 10^{-5} \text{ A}$ (b) $3.47 \times 10^{-6} \text{ A}$ (c) $8.85 \times 10^{-8} \text{ A}$
(d) $6.32 \times 10^{-4} \text{ A}$

Q17. CBSE 2025 · 1 mark The magnetic flux linked with a closed coil (in Wb) varies with time t (in s) as $\phi = 5t^2 + 4t - 2$. If the resistance of the circuit is 14 Ω , the magnitude of induced current in the coil at $t = 1 \text{ s}$ will be:

- (a) 0.5 A (b) 1.0 A (c) 1.5 A (d) 2.0 A

Q18. CBSE 2025 · 1 mark The magnetic flux linked with a coil changes with time t as $\phi = (8t^2 + 5t + 7)$, where t is in seconds and ϕ is in Wb. The value of emf induced in the coil at $t = 4 \text{ s}$ is:

- (a) 32 V (b) 37 V (c) 64 V (d) 69 V

Q19. CBSE 2025 · 1 mark A metal rod of length 50 cm is held vertically and moved with a velocity of 10 m/s towards east. The horizontal component of the Earth's magnetic field at the place is 0.4 G. The emf induced across the ends of the rod is:

- (a) 0.1 mV (b) 0.2 mV (c) 0.8 mV (d) 1.6 mV

Q20. CBSE 2025 · 1 mark A coil has 100 turns, each of area 0.05 m^2 and total resistance 1.5 Ω . It is inserted at an instant in a magnetic field of 90 mT, with its axis parallel to the field. The charge induced in the coil at that instant is :

- (a) 3.0 mC (b) 0.30 C (c) 0.45 C (d) 1.5 C

Q21. CBSE 2025 · 1 mark You are required to design an air-filled solenoid of inductance 0.016 H having a length 0.81 m and radius 0.02 m. The number of turns in the solenoid should be

- (a) 2592 (b) 2866 (c) 2976 (d) 3140

Q22. CBSE 2025 · 1 mark Assertion (A) : It is difficult to move a magnet into a coil of large number of turns when the circuit of the coil is closed. Reason (R) : The direction of induced current in a coil with its circuit closed, due to motion of a magnet, is such that it opposes the cause.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q23. CBSE 2024 · 1 mark Assertion (A): The mutual inductance between two coils is maximum when the coils are wound on each other. Reason (R): The flux linkage between two coils is maximum when they are wound on each other.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Assertion (A) is false and Reason (R) is also false

Q24. CBSE 2024 · 1 mark A conducting circular loop is placed in a uniform magnetic field $B = 50 \text{ mT}$ with its plane perpendicular to the magnetic field. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1} . At the instant the radius of the loop is 4 cm, the induced emf in the loop is:

- (a) $\pi \mu\text{V}$ (b) $2\pi \mu\text{V}$ (c) $4\pi \mu\text{V}$ (d) $8\pi \mu\text{V}$

Q25. CBSE 2024 · 1 mark Assertion (A): When two coils are wound one over the other, their mutual inductance is maximum. Reason (R): The flux linkage between two coils is maximum when they are wound on each other.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q26. CBSE 2024 · 1 mark A circular coil of radius 10 cm is placed in a magnetic field $\mathbf{B} = (1.0\hat{i} + 0.5\hat{j}) \text{ mT}$ such that the outward unit vector normal to the surface of the coil is $(0.6\hat{i} + 0.8\hat{j})$. The magnetic flux linked with the coil is:

- (a) 0.314 μWb (b) 3.14 μWb (c) 31.4 μWb (d) 1.256 μWb

Q27. CBSE 2024 · 1 mark Assertion (A): Lenz's law is a consequence of energy conservation. Reason (R): There is no power loss in an ideal inductor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q28. CBSE 2024 · 1 mark The emf induced in a coil rotating in a magnetic field does not depend upon the following :

- (a) Area of the coil (b) Resistance of the coil
(c) Number of turns in the coil
(d) Angular speed of rotation of the coil

Q29. CBSE 2024 · 1 mark The current in a coil of 15 mH increases uniformly from zero to 4 A in 0.004 s. The emf induced in the coil will be :

- (a) 22.5 V (b) 17.5 V (c) 15.0 V (d) 12.5 V



Q30. CBSE 2024 · 1 mark Consider a solenoid of length l and area of cross-section A with fixed number of turns. The self-inductance of the solenoid will increase if :

- (a) both l and A are increased
- (b) l is decreased and A is increased
- (c) l is increased and A is decreased
- (d) both l and A are decreased

Q31. CBSE 2024 · 1 mark The mutual inductance of two coils C_1 and C_2 is 20 mH. In coil C_1 , the current changes from 4 A to zero in 0.2 s. If the resistance of coil C_2 is 4 Ω , then the charge that flows through it per second will be:

- (a) 4.0 C (b) 1.5 C (c) 0.05 C (d) 0.1 C

Q32. CBSE 2023 · 1 mark A circular coil of radius 8.0 cm and 40 turns is rotated about its vertical diameter with an angular speed of $25/\pi$ rad s^{-1} in a uniform horizontal magnetic field of magnitude 3.0×10^{-2} T. The maximum emf induced in the coil is:

- (a) 0.12 V (b) 0.15 V (c) 0.19 V (d) 0.22 V

Q33. CBSE 2023 · 1 mark The direction of induced current in the loop abc is :

- (a) along abc if I decreases (b) along acb if I increases
- (c) along abc if I is constant (d) along abc if I increases

VERY SHORT ANSWER (6)

Q34. CBSE 2026 · 2 marks A wire of length L is bent round into (i) a square coil having N turns and (ii) a circular coil having N turns. The coil in both cases is free to turn about a vertical axis coinciding with the plane of the coil, in a uniform, horizontal magnetic field and carry the same currents. Find the ratio of the maximum value of the torque acting on the square coil to that on the circular coil.

Q35. CBSE 2026 · 2 marks A plane circular coil is rotated about its vertical diameter with a constant angular speed ω in a uniform horizontal magnetic field. Initially the plane of the coil is parallel to the magnetic field. Draw plots showing the variation of the following physical quantities as the function of ωt , where t represents time elapsed: (a) Magnetic flux ϕ linked with the coil, and (b) emf induced in the coil.

Q36. CBSE 2026 · 2 marks A square loop of side 10 cm, free to rotate about a vertical axis coinciding with its one arm, is initially held perpendicular to a uniform horizontal magnetic field of 0.2 T. If it is rotated at the uniform speed of 60 rpm, find the emf induced in the loop.

Q37. CBSE 2026 · 2 marks A light copper ring is freely suspended by a light string. A bar magnet is held horizontally with its length along the axis of the ring. The magnet is moved towards the ring with its N pole facing the loop. What will happen to the ring and its position? Explain.

Q38. CBSE 2023 · 2 marks Consider an induced magnetic field due to changing electric field and an induced electric field due to changing magnetic field. Which one is more easily observed? Justify your answer.

Q39. CBSE 2023 · 2 marks (a) What is a displacement current ? How is it different from a conduction current ?

SHORT ANSWER (22)

Q40. CBSE 2026 · 3 marks (i) Define mutual inductance of a pair of coils. Write its SI unit. (ii) A long solenoid of radius R and length L has n turns per unit length. A circular loop of radius $r (< R)$ is placed inside at the centre of the solenoid such that its axis coincides with the axis of the solenoid. Obtain the mutual inductance of the solenoid and the loop.

Q41. CBSE 2026 · 3 marks (i) Define mutual inductance of a pair of coils. Write its SI unit.

Q42. CBSE 2026 · 3 marks (a) Briefly explain how Lenz's law is consistent with the law of conservation of energy. (b) Considering the case of the magnetic field B inside a solenoid of length l , area of cross-section A , prove that magnetic energy per unit volume is $B^2/(2 \mu_0)$.

Q43. CBSE 2026 · 3 marks State Faraday's law of electromagnetic induction. Briefly describe two methods for producing induced emf.

Q44. CBSE 2026 · 3 marks (b) A rectangular loop of sides l and b and resistance ' R ' is kept in a region in which the magnetic field varies as $B = B_0 \sin \omega t$. (i) Derive expression for the emf induced in the loop. (ii) Find the effective value of current that flows in the loop.

Q45. CBSE 2026 · 3 marks Two coils, one of radius 0.5 cm having 10 turns and the other of radius 5 cm having 50 turns are placed coaxially in air such that their centres are coincident. Calculate: (a) the magnetic flux through the smaller coil if the larger coil carries a current of 3 A, and (b) the mutual inductance of the two coils.

Q46. CBSE 2026 · 3 marks A long solenoid of length L and radius r_1 having N_1 turns is surrounded symmetrically by a coil of radius r_2 ($> r_1$) having N_2 turns ($N_2 \ll N_1$) around its mid-point. Derive an expression for the mutual inductance of solenoid and coil. Is $M_{12} = M_{21}$ valid in this case?

Q47. CBSE 2026 · 3 marks Differentiate between conduction current and displacement current. A capacitor is connected across a source providing time-dependent current. Explain how the total current at an instant is the sum of conduction current and displacement current in the circuit at that instant.

Q48. CBSE 2026 · 3 marks What is meant by displacement current? A capacitor is being charged by a battery. Show that Ampere-Maxwell law justifies continuity and constancy of the current flowing in the circuit.

Q49. CBSE 2025 · 3 marks Explain the situations, justifying your answers: (a) Coil 2 is moving towards Coil 1, (b) Coil 2 is moving away from Coil 1, (c) coils stationary.

Q50. CBSE 2025 · 3 marks (a) Differentiate between magnetic flux through an area and magnetic field at a point. (b) A bar magnet is held with its length along the axis of a closed coil. Initially the south pole of the magnet faces the coil. If the magnet is moved towards the coil, explain how a current is induced in the coil and in what direction.



Q51. CBSE 2025 · 3 marks A conducting rod is rotated about one end passing through its end M perpendicular to its length, with a constant angular velocity ω in a uniform magnetic field $\mathbf{B}$ parallel to the axis. Obtain an expression for emf induced between its ends.

Q52. CBSE 2025 · 3 marks A rod of length L is rotated about one of its ends in a plane perpendicular to a uniform magnetic field $\mathbf{B}$, passing through its end M perpendicular to its length, with a constant angular velocity ω in a uniform magnetic field parallel to the axis. Obtain an expression for emf induced between its ends.

Q53. CBSE 2025 · 3 marks (a) A rod of length L is rotated about one end O passing through its end M perpendicular to its length, with a constant angular velocity ω in a uniform magnetic field $\mathbf{B}$ parallel to the axis. Obtain an expression for emf induced between its ends. (b) Derive an expression for the self-inductance of a long solenoid of cross-sectional area A and length l , having n turns per unit length.

Q54. CBSE 2025 · 3 marks Two concentric circular coils of radii r_1 and r_2 ($r_2 \gg r_1$) are placed coaxially with their centres coinciding. If a current I is passed through the outer coil, obtain the expression for mutual inductance of the arrangement. The current in a solenoid decreases steadily from 6 mA to 2 mA in 50 ms. If an average emf of 0.4 V is induced, find the self-inductance of the solenoid.

Q55. CBSE 2025 · 3 marks (a) Show that the energy required to build up the current I in a coil of inductance L is $(1/2) LI^2$. (b) Considering the case of magnetic field produced by air-filled current carrying solenoid, show that the magnetic energy density of a magnetic field B is $B^2/(2\mu_0)$.

Q56. CBSE 2024 · 3 marks A 100-turn coil of radius 1.6 cm and resistance 5.0 Ω is co-axial with a solenoid of 250 turns/cm and radius 1.8 cm. The solenoid current drops from 1.5 A to zero in 25 ms. Calculate the current induced in the coil in this duration. (Take $\pi^2 = 10$)

Q57. CBSE 2024 · 3 marks Prove that induced charge depends on the net change in the magnetic flux and not on the time interval of the flux change.

Q58. CBSE 2023 · 3 marks A long solenoid of radius r consists of n turns per unit length. A current $I = I_0 \sin \omega t$ flows in the solenoid. A coil of N turns is wound tightly around it near its centre. What is: (a) the induced emf in the coil? (b) the mutual inductance between the solenoid and the coil?

Q59. CBSE 2023 · 3 marks What is an expression for the mutual inductance of two long coaxial solenoids, each of length l but having different number of turns N_1 and N_2 and radii r_1 and r_2 ($r_2 > r_1$)?

Q60. CBSE 2023 · 3 marks A rectangular loop of sides 25 cm and 20 cm is lying in x-y plane. It is subjected to a magnetic field $\mathbf{B} = (5t^2 + 2t + 10)\hat{k}$, where B is in Tesla and t is in seconds. If the resistance of the loop is 4 Ω , find the emf induced and the induced current in the loop at $t = 5$ s.

Q61. CBSE 2023 · 3 marks Two coplanar concentric circular loops of radii R and r ($r < R$) are arranged coaxially. Obtain the expression for their mutual inductance.

LONG ANSWER (8)

Q62. CBSE 2026 · 5 marks State Faraday's law of electromagnetic induction. Derive an expression for the self-inductance of an air-filled long solenoid of length l and cross-sectional area A having N turns. A conducting rod of length 50 cm, with one end pivoted, is rotated with angular speed of 60 rpm in a uniform magnetic field of 4.0 mT directed perpendicular to the plane of rotation of rod. Find the emf induced in the rod.

Q63. CBSE 2026 · 5 marks State Faraday's law of electromagnetic induction.

Q64. CBSE 2026 · 5 marks (a) State Faraday's law of electromagnetic induction. (b) Derive an expression for the self-inductance of an air-filled long solenoid of length l and cross-sectional area A having N turns. (c) A conducting rod of length 50 cm, with one end pivoted, is rotated with angular speed of 60 rpm in a uniform magnetic field of 4.0 mT directed perpendicular to the plane of rotation of rod. Find the emf induced in the rod.

Q65. CBSE 2026 · 5 marks (a) Define mutual inductance. Give its units. State two factors on which the mutual inductance between a given pair of coils depends. (b) A 1.0 m long solenoid of radius 2 cm having 2000 turns has a secondary coil of 1000 turns wound closely near its mid-point. Find the mutual inductance between the two coils.

Q66. CBSE 2026 · 5 marks (b) (i) State Lenz's law and explain that it follows the law of conservation of energy.

Q67. CBSE 2025 · 5 marks (a) (i) Define self-inductance of a coil. Derive the expression for the energy required to build up a current I in a coil of self-inductance L .

Q68. CBSE 2025 · 5 marks (i) Define self-inductance of a coil. Derive the expression for the energy required to build up a current I in a coil of self-inductance L . (ii) The currents passing through two inductors of self-inductances 10 mH and 20 mH increase with time at the same rate. Draw graphs showing the variation of: (I) the magnitude of emf induced with the rate of change of current in each inductor. (II) the energy stored in each inductor with the current flowing through it.

Q69. CBSE 2024 · 5 marks (b) (i) A rectangular coil of N turns and area of cross-section A is rotated at a steady angular speed ω in a uniform magnetic field. Obtain an expression for the emf induced in the coil at any instant of time. (ii) Two coplanar and concentric circular loops L_1 and L_2 are placed coaxially with their centres coinciding. The radii of L_1 and L_2 are 1 cm and 100 cm respectively. Calculate the mutual inductance of the loops. (Take $\pi^2 = 10$)

7 Alternating Current

Notes & MCQs →



MULTIPLE CHOICE AND ASSERTION-REASON (27)

Q1. CBSE 2026 · 1 mark In a series LCR circuit, the voltage across the resistor, capacitor and inductor is 10 V each. If the capacitor is short circuited, the voltage across the inductor will be

- (a) 10 V (b) $5\sqrt{2}$ V (c) $5/\sqrt{2}$ V (d) $10\sqrt{2}$ V

Q2. CBSE 2026 · 1 mark A resistor and an inductor of negligible resistance are connected in series to a 20 V ac source. If the voltage across the resistor is 12 V, the voltage across the inductor will be

- (a) 6 V (b) 8 V (c) 10 V (d) 16 V

Q3. CBSE 2026 · 1 mark A series LCR circuit with $R = 3 \Omega$, $X_C = 4 \Omega$, $X_L = 8 \Omega$ is connected to a 220 V, 50 Hz ac source. The power factor for the circuit is

- (a) 0.30 (b) 0.45 (c) 0.50 (d) 0.60

Q4. CBSE 2026 · 1 mark Assertion (A): In a series LCR circuit at resonance, the impedance is equal to ohmic resistance (R) in the circuit. Reason (R): At resonance, the capacitive reactance is not equal to the inductive reactance.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A)
 (c) Assertion (A) is true, but Reason (R) is false
 (d) Both Assertion (A) and Reason (R) are false

Q5. CBSE 2026 · 1 mark An ac voltage is given as $v = 14 \sin(314t)$ V. The average and the effective value of the voltage (in V) over a cycle are respectively:

- (a) 14 and 7 (b) 10 and 14 (c) 0 and 10 (d) 10 and 0

Q6. CBSE 2026 · 1 mark Which of the following statements is not true for electric energy in ac form compared to that in dc form?

- (a) Production of ac is economical.
 (b) ac can be easily and efficiently converted from one voltage to the other.
 (c) ac can be transmitted economically over long distances.
 (d) ac is less dangerous.

Q7. CBSE 2026 · 1 mark The rms and the average value of an ac voltage $V = V_0 \sin \omega t$ volt over a cycle respectively will be:

- (a) $V_0/2$, $V_0/\sqrt{2}$ (b) V_0/π , $V_0/2$ (c) $V_0/\sqrt{2}$, 0 (d) V_0 , $V_0/\sqrt{2}$

Q8. CBSE 2025 · 1 mark An ammeter connected in series in an ac circuit reads 10 A. The maximum value of current at any instant in the circuit is:

- (a) $10\sqrt{2}$ A (b) $10/\sqrt{2}$ A (c) $10/\pi$ A (d) $10/(\sqrt{2}\pi)$ A

Q9. CBSE 2025 · 1 mark Assertion (A) : A series LCR circuit behaves as a pure resistive circuit at resonance. Reason (R) : At resonance, $X_L = X_C$ gives $\omega = 1/\sqrt{LC}$.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q10. CBSE 2025 · 1 mark A transformer is a device used for converting:

- (a) high ac voltage and large ac current to low ac voltage and small ac current
 (b) high ac voltage and small ac current to low ac voltage and small ac current
 (c) low ac voltage and large ac current to high ac voltage and small ac current
 (d) low ac voltage and small ac current to high ac voltage and large ac current

Q11. CBSE 2025 · 1 mark A capacitor of capacitance C has reactance X in an ac circuit. If the capacitance and the frequency of the applied voltage are doubled, the new reactance will become:

- (a) 4X (b) 2X (c) X/2 (d) X/4

Q12. CBSE 2025 · 1 mark An ac source is connected to a resistor and an inductor in series. The voltage across the resistor and inductor are 8 V and 6 V respectively. The voltage of the source is:

- (a) 10 V (b) 12 V (c) 14 V (d) 16 V

Q13. CBSE 2025 · 1 mark A capacitor and an inductor are connected in series across an ac source of voltage of variable frequency. The frequency is increased continuously. The nature of the circuit before and after the resonance will be:

- (a) inductive only (b) capacitive only
 (c) capacitive and inductive respectively
 (d) inductive and capacitive respectively

Q14. CBSE 2025 · 1 mark A voltage $v = v_0 \sin \omega t$ applied to a circuit drives a current $i = i_0 \sin(\omega t + \phi)$ in the circuit. The average power consumed in the circuit over a cycle is

- (a) Zero (b) $i_0 v_0 \cos \phi$ (c) $i_0 v_0/2$ (d) $(i_0 v_0/2) \cos \phi$

Q15. CBSE 2024 · 1 mark The reactance of a capacitor of capacitance C connected to an ac source of frequency ω is 'X'. If the capacitance of the capacitor is doubled and the frequency of the source is tripled, the reactance will become:

- (a) 6X (b) X/6 (c) $3X/2$ (d) $2X/3$

Q16. CBSE 2024 · 1 mark The primary and secondary coils of a transformer have 500 turns and 5000 turns respectively. The primary coil is connected to an ac source of 220 V – 50 Hz. The output across the secondary coil is:

- (a) 220 V – 50 Hz (b) 1100 V – 50 Hz (c) 2200 V – 5 Hz
 (d) 2200 V – 50 Hz

Q17. CBSE 2024 · 1 mark Which of the following quantity/quantities remains same in primary and secondary coils of an ideal transformer? (Current, Voltage, Power, Magnetic flux)

- (a) Current only (b) Voltage only (c) Power only
 (d) Magnetic flux and Power both

Q18. CBSE 2024 · 1 mark A resistor and an ideal inductor are connected in series to a $100\sqrt{2}$ V, 50 Hz ac source. When a voltmeter is connected across the resistor or the inductor, it shows the same reading. The reading of the voltmeter is:

- (a) $100\sqrt{2}$ V (b) 100 V (c) $50\sqrt{2}$ V (d) 50 V



Q19. CBSE 2024 · 1 mark Assertion (A): Lenz's law is a consequence of the law of conservation of energy. Reason (R): There is no power loss in an ideal inductor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is also false.

Q20. CBSE 2024 · 1 mark A series LCR circuit ($L = 2 \text{ mH}$, $C = 0.2 \text{ }\mu\text{F}$ and $R = 30 \text{ }\Omega$) is connected to an ac source of variable frequency. The impedance of this circuit will be minimum at a frequency of:

- (a) $10^5/(4\pi) \text{ Hz}$ (b) $10^5/(2\pi) \text{ Hz}$ (c) $10^4/(4\pi) \text{ Hz}$
- (d) $10^4/(2\pi) \text{ Hz}$

Q21. CBSE 2024 · 1 mark In an ac circuit, the instantaneous values of current (in A) and voltage (in V) are $I = 5 \sin \omega t$ and $E = 200 \cos (\omega t + \pi/3)$ respectively. The phase difference between voltage and current at any instant is :

- (a) $5\pi/6$ (b) $5\pi/4$ (c) $5\pi/2$ (d) $3\pi/2$

Q22. CBSE 2024 · 1 mark Assertion (A): Lenz's law can be stated as a consequence of the law of conservation of energy. Reason (R): There is no power loss in an ideal inductor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is also false.

Q23. CBSE 2024 · 1 mark The average value of the alternating voltage $v = (157 \text{ V}) \sin \omega t$ over its first half-cycle is:

- (a) 157 V (b) $157/\sqrt{2} \text{ V}$ (c) 78.5 V (d) 100 V

Q24. CBSE 2023 · 1 mark An inductor, a capacitor and a resistor are connected in series across an ac source of voltage. If the frequency of the source is decreased gradually, the reactance of :

- (a) both the inductor and the capacitor decreases
- (b) inductor decreases and the capacitor increases
- (c) both the inductor and the capacitor increases
- (d) inductor increases and the capacitor decreases

Q25. CBSE 2023 · 1 mark A voltage signal is described by: $v = V_0$ for $0 \leq t \leq T/2$ and $v = 0$ for $T/2 \leq t \leq T$ for a cycle. Its rms value is :

- (a) $\sqrt{2} V_0$ (b) V_0 (c) $V_0/\sqrt{2}$ (d) $V_0/2$

Q26. CBSE 2023 · 1 mark A voltage signal is described by: $v = V_0$ for $0 \leq t \leq T/2$, $= 0$ for $T/2 \leq t \leq T$ for a cycle. Its rms value is:

- (a) $\sqrt{2} V_0$ (b) V_0 (c) $V_0/\sqrt{2}$ (d) $V_0/2$

Q27. CBSE 2023 · 1 mark An ac voltage $v = v_0 \sin \omega t$ is applied to a series combination of a resistor R and an element X . The instantaneous current in the circuit is $I = I_0 \sin (\omega t + \pi/4)$. Then which of the following is correct ?

- (a) X is a capacitor and $X_C = \sqrt{2} R$
- (b) X is an inductor and $X_L = R$
- (c) X is an inductor and $X_L = \sqrt{2} R$
- (d) X is a capacitor and $X_C = R$

VERY SHORT ANSWER (1)

Q28. CBSE 2023 · 2 marks Define displacement current. Explain in brief how this current is different from a conduction current.

SHORT ANSWER (16)

Q29. CBSE 2026 · 3 marks (a) Discuss the behaviour of an inductor connected to (i) a dc source, and (ii) a high frequency ac source. (b) What is the phase relation between current and voltage in an ideal inductor connected to an ac source? Draw a phasor diagram for the circuit.

Q30. CBSE 2026 · 3 marks A series combination of circuit elements X and Y is connected across an ac source. It is found that the voltage is ahead of current in phase by $\pi/4$ radian. When element Y is replaced by element Z , the current leads the voltage by $\pi/4$ radian. (a) Identify the elements X , Y and Z . (b) What will the phase angle and power factor for the circuit be if X , Y and Z were connected in series across the same ac source? What can you say about the current that flows in the circuit in this case?

Q31. CBSE 2026 · 3 marks What is displacement current (i_d)? Considering the case of charging of a capacitor, show that $i_d = \epsilon_0(d\phi_E/dt)$. What is the value of i_d for a conductor across which a constant voltage is applied?

Q32. CBSE 2026 · 3 marks (a) Differentiate between inductive reactance, capacitive reactance and impedance of an ac circuit. (b) An ideal inductor and an ideal capacitor are connected in series across an ac voltage. Plot a graph showing variation of net reactance of the circuit with frequency of the applied ac voltage.

Q33. CBSE 2026 · 3 marks (a) Can a transformer step up or step down dc power supply? (b) Can a step up transformer work as a step down transformer? (c) Does a step up transformer contradict the principle of conservation of energy? Justify your answer.

Q34. CBSE 2025 · 3 marks Differentiate between half-wave and full-wave rectification. With the help of a circuit diagram, explain the working of a full-wave rectifier.

Q35. CBSE 2025 · 3 marks An ac source of voltage $V = V_0 \sin \omega t$ is connected to a circuit element X . It is observed that the current flowing through X varies as $I = I_0 \sin(\omega t - \pi/2)$. (a) Identify the element X and write the expression for its reactance. (b) Plot a graph to show the variation of reactance of the element with the frequency of the applied voltage. (c) Draw plots showing the variation of voltage and current with time over one cycle of applied ac.



Q36. CBSE 2024 · 3 marks An inductor, a capacitor and a resistor are connected in series with an ac source $v = v_m \sin \omega t$. Derive an expression for the average power dissipated in the circuit. Also obtain the expression for the resonant frequency of the circuit.

Q37. CBSE 2024 · 3 marks Draw the graphs showing the variation of the following with the frequency of ac source in a circuit: (i) Resistance (ii) Capacitive reactance (iii) Inductive reactance. Can the voltage drop across the inductor or the capacitor in a series LCR circuit be greater than the applied voltage of the ac source? Justify your answer.

Q38. CBSE 2024 · 3 marks An ac voltage $v_i = 140 \sin (100 \pi t)$ V is applied to the primary coil having 200 turns, of an ideal transformer and it supplies a power of 5 kW. If the secondary coil has 1000 turns, find : (a) the output voltage, (b) the instantaneous voltage across the secondary coil, and (c) the current in the secondary coil. (Take $\sqrt{2} = 1.4$)

Q39. CBSE 2024 · 3 marks A sinusoidal voltage is applied to an electric circuit containing a circuit element 'X' in which the current leads the voltage by $\pi/2$. (a) Identify the circuit element 'X' in the circuit. (b) Write the formula for its reactance. (c) Show graphically the variation of this reactance with frequency of ac voltage. (d) Explain the behaviour of this element when it is used in (i) an ac circuit, and (ii) a dc circuit.

Q40. CBSE 2024 · 3 marks Distinguish between reactance and impedance of an ac circuit. Show that an ideal inductor in an ac circuit does not dissipate any power.

Q41. CBSE 2023 · 3 marks How does the resistance differ from impedance? With the help of a suitable phasor diagram, obtain an expression for impedance of a series LCR circuit, connected to a source $v = v_m \sin \omega t$.

Q42. CBSE 2023 · 3 marks An ac voltage $v = v_m \sin \omega t$ ($v_m = 310$ V and $f = 50$ Hz) is connected to a pure capacitor of capacitance $15 \mu\text{F}$. Calculate (i) the reactance of the capacitor, and (ii) the amplitude of the current. Write the expression of current through the capacitor as a function of time.

Q43. CBSE 2023 · 3 marks An ac source $v = v_m \sin \omega t$ is connected across an ideal capacitor. Derive the expression for the (i) current flowing in the circuit, and (ii) reactance of the capacitor. Plot a graph of current i versus ωt .

Q44. CBSE 2023 · 3 marks (a) A resistor of 30Ω and a capacitor of $250/\pi \mu\text{F}$ are connected in series to a 200 V, 50 Hz ac source. Calculate (i) the current in the circuit, and (ii) voltage drops across the resistor and the capacitor. (iii) Is the algebraic sum of these voltages more than the source voltage? If yes, solve the paradox.

LONG ANSWER (9)

Q45. CBSE 2026 · 5 marks (a) A series combination of L, C and R is connected to an a.c. source. Using a phasor diagram, derive an expression for the impedance of the circuit and phase difference between V and I. (b) Under what conditions the (i) impedance of the circuit is minimum? (ii) Wattless current flows in the circuit?

Q46. CBSE 2026 · 5 marks (a) A series combination of L, C and R is connected to an a.c. source. Using a phasor diagram, derive an expression for the impedance of the circuit and phase difference between V and I.

Q47. CBSE 2026 · 5 marks (a) (i) A light bulb and an open coil inductor are connected in series across an ac source of variable frequency. How will the glow of the bulb be affected when: (I) an iron bar is inserted inside the coil, and (II) the frequency of the source is decreased? Justify your answers. Assume that in each above case other factors remain unchanged.

Q48. CBSE 2026 · 5 marks (a) (i) A light bulb and an open coil inductor are connected in series across an ac source of variable frequency. How will the glow of the bulb be affected when: (I) an iron bar is inserted inside the coil, and (II) the frequency of the source is decreased? Justify your answers. Assume that in each above case other factors remain unchanged. (ii) An ac voltage $V = 280 \sin (100\pi t)$ volt is connected across a series LCR circuit in which $R = 400 \Omega$, $L = 5/\pi$ H and $C = 50/\pi \mu\text{F}$. Taking $\sqrt{2} = 1.4$, calculate: (I) impedance of the circuit. (II) rms value of current that flows in the circuit. (III) power factor of the circuit.

Q49. CBSE 2026 · 5 marks (a) (i) Define the terms (I) resonant frequency, and (II) power factor of a series LCR circuit. For what value of the power factor will the power dissipated in the circuit be maximum? (ii) An inductor of $5/\pi$ H, a capacitor of $50/\pi \mu\text{F}$ and a resistor of 400Ω are connected in series across an ac voltage $v = 140 \sin (100\pi t)$ V. Calculate: (I) impedance of the circuit, and (II) rms value of current that flows in the circuit. (Take $\sqrt{2} = 1.4$)

Q50. CBSE 2025 · 5 marks (b) (i) Differentiate between peak and rms values of alternating current. How are they related? (ii) A current element X is connected across an ac source of emf $V = V_0 \sin 2\pi vt$. It is found that the voltage leads the current in phase by $\pi/2$ radian. If element X was replaced by element Y, the voltage lags behind the current in phase by $\pi/2$ radian. (I) Identify elements X and Y by drawing phasor diagrams. (II) Obtain the condition of resonance when both elements X and Y are connected in series to the source and obtain expression for resonant frequency. What is the impedance value in this case?

Q51. CBSE 2025 · 5 marks (i) Write the principle of working of an ac generator. Draw its labelled diagram and explain its working. (ii) A resistor of 400Ω , an inductor of $(5/\pi)$ H and a capacitor of $(50/\pi) \mu\text{F}$ are joined in series across an ac source $v = 140 \sin (100\pi t)$ V. Find the rms voltages across these three circuit elements. The algebraic sum of these voltages is more than the rms voltage of source. Explain.

Q52. CBSE 2024 · 5 marks (a) (i) A resistor and a capacitor are connected in series to an ac source $v = v_m \sin \omega t$. Derive an expression for the impedance of the circuit. (ii) When does an inductor act as a conductor in a circuit? Give reason for it. (iii) An electric lamp is designed to operate at 110 V dc and 11 A current. If the lamp is operated on 220 V, 50 Hz ac source with a coil in series, then find the inductance of the coil.



Q53. CBSE 2024 · 5 marks A resistor and a capacitor are connected in series to an ac source $v = v_m \sin \omega t$. Derive an expression for the impedance of the circuit. When does an inductor act as a conductor in a circuit? Give reason for it. An electric lamp is designed to operate at 110 V dc and 11 A current. If the lamp is operated on 220 V, 50 Hz ac source with a coil in series, then find the inductance of the coil.

8 Electromagnetic Waves

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (31)

Q1. CBSE 2026 · 1 mark An electromagnetic wave passes from vacuum into a dielectric medium with relative electrical permittivity (3/2) and relative magnetic permeability (8/3). Then, its

- (a) wavelength is doubled and frequency remains unchanged.
- (b) wavelength is doubled and frequency is halved.
- (c) wavelength is halved and frequency remains unchanged.
- (d) wavelength and frequency both will remain unchanged.

Q2. CBSE 2026 · 1 mark Electromagnetic waves used in a diagnostic tool in medicine have a wavelength range

- (a) 1 nm to 10^{-3} nm
- (b) 400 nm to 1 nm
- (c) 1 mm to 700 nm
- (d) 0.1 m to 1 mm

Q3. CBSE 2026 · 1 mark Electromagnetic waves used for purification of water are

- (a) X-rays
- (b) Ultraviolet rays
- (c) Infrared rays
- (d) Ultrasonic rays

Q4. CBSE 2026 · 1 mark Welders wear special glass goggles or face masks with glass windows to protect their eyes from

- (a) Infrared rays
- (b) Ultraviolet rays
- (c) X-rays
- (d) Microwaves

Q5. CBSE 2026 · 1 mark An electromagnetic wave is propagating along x-axis. At any instant, the phase difference (in radian) between the electric field (**E**) and the magnetic field (**B**) associated with the wave is

- (a) zero
- (b) $\pi/4$
- (c) $\pi/2$
- (d) π

Q6. CBSE 2026 · 1 mark The expression of magnetic fields associated with four electromagnetic waves are given below: I. $B_1 = (4 \times 10^{-6} \text{ T}) \sin [0.7 \times 10^3 x + 1.4 \times 10^{11} t]$, II. $B_2 = (2 \times 10^{-7} \text{ T}) \sin [0.6 \times 10^3 x + 1.5 \times 10^{11} t]$, III. $B_3 = (3 \times 10^{-5} \text{ T}) \sin [0.5 \times 10^3 x + 1.5 \times 10^{11} t]$, IV. $B_4 = (5 \times 10^{-4} \text{ T}) \sin [0.2 \times 10^4 x + 4.8 \times 10^{11} t]$. Which wave is travelling in free space?

- (a) I
- (b) II
- (c) III
- (d) IV

Q7. CBSE 2026 · 1 mark The electric field and the magnetic field components of an electromagnetic wave travelling in vacuum are represented as $E = m \sin(\alpha z - \beta t)$ and $B = n \sin(\alpha z - \beta t)$ where m , n , α and β are constants characterising the wave. Then

- (a) $m/n = c$, $\beta/\alpha \neq c$
- (b) $n/m = \alpha/\beta = c$
- (c) $\beta/\alpha = c$, $m/n \neq c$
- (d) $m/n = \beta/\alpha = c$

Q8. CBSE 2026 · 1 mark A plane electromagnetic wave travels through a medium and the magnetic field associated with it is given by $B = 5 \times 10^{-8} \sin (3 \times 10^{10} t - 150 x) \text{ T}$ where x is in metres and t is in seconds. The velocity of the wave is :

- (a) $2.0 \times 10^8 \text{ ms}^{-1}$
- (b) $4.5 \times 10^7 \text{ ms}^{-1}$
- (c) $3.5 \times 10^7 \text{ ms}^{-1}$
- (d) $2.5 \times 10^8 \text{ ms}^{-1}$

Q9. CBSE 2026 · 1 mark The ratio of amplitude of electric field to the amplitude of the magnetic field associated with an electromagnetic wave propagating in glass ($n = 1.5$) is:

- (a) $3 \times 10^8 \text{ ms}^{-1}$
- (b) $2 \times 10^8 \text{ ms}^{-1}$
- (c) $3.3 \times 10^{-9} \text{ ms}^{-1}$
- (d) $5 \times 10^{-9} \text{ ms}^{-1}$

Q10. CBSE 2026 · 1 mark The magnetic field in a plane electromagnetic wave travelling in glass ($n = 1.5$) is given by $B_y = (2 \times 10^{-7} \text{ T}) \sin (\alpha x + 1.5 \times 10^{11} t)$ where x is in metres and t is in seconds. The value of α is:

- (a) $0.5 \times 10^3 \text{ m}^{-1}$
- (b) $6.0 \times 10^2 \text{ m}^{-1}$
- (c) $7.5 \times 10^2 \text{ m}^{-1}$
- (d) $1.5 \times 10^3 \text{ m}^{-1}$

Q11. CBSE 2025 · 1 mark The amplitude of electric field in an electromagnetic wave in free space is 1000 Vm^{-1} . The amplitude of the magnetic field in this electromagnetic wave is :

- (a) $3.0 \times 10^{-3} \text{ T}$
- (b) $3.33 \times 10^{-8} \text{ T}$
- (c) $3.0 \times 10^{11} \text{ T}$
- (d) $3.33 \times 10^{-6} \text{ T}$

Q12. CBSE 2025 · 1 mark In an electromagnetic wave travelling in free space, the amplitude of magnetic field is $6.0 \times 10^{-4} \text{ T}$. The amplitude of its electric field is:

- (a) $2 \times 10^4 \text{ Vm}^{-1}$
- (b) $1.5 \times 10^{12} \text{ Vm}^{-1}$
- (c) $1.8 \times 10^5 \text{ Vm}^{-1}$
- (d) $0.3 \times 10^4 \text{ Vm}^{-1}$

Q13. CBSE 2025 · 1 mark Which of the following rays coming from the Sun plays an important role in maintaining the Earth's warmth ?

- (a) Infrared rays
- (b) γ rays
- (c) UV rays
- (d) Visible light rays

Q14. CBSE 2025 · 1 mark The dimensions of $(\mu\epsilon)^{-1}$, where ϵ is permittivity and μ is permeability of a medium, are:

- (a) $[M^0 L^1 T^{-1}]$
- (b) $[M^0 L^2 T^{-2}]$
- (c) $[M^1 L^2 T^{-2}]$
- (d) $[M^1 L^{-1} T^1]$

Q15. CBSE 2025 · 1 mark Which of the following electromagnetic waves has photons of largest momentum?

- (a) X-rays
- (b) AM radio waves
- (c) Microwaves
- (d) TV waves

Q16. CBSE 2025 · 1 mark Which of the following rays coming from the Sun plays an important role in vitamin D synthesis?

- (a) Infrared rays
- (b) Gamma rays
- (c) UV rays
- (d) Visible light rays



Q17. CBSE 2025 · 1 mark Assertion (A): X-rays are produced when slow moving electrons are stopped by a metal target of high atomic number. Reason (R): X-rays consist of low-energy photons.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q18. CBSE 2025 · 1 mark Assertion (A): EM waves do not require a medium for their propagation. Reason (R): EM waves are transverse waves.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q19. CBSE 2024 · 1 mark In the four regions, I, II, III and IV, the electric fields are described as: Region I: $E_x = E_0 \sin(kz - \omega t)$, Region II: $E_x = E_0$, Region III: $E_x = E_0 \sin kz$, Region IV: $E_x = E_0 \cos kz$. The displacement current will exist in the region:

- (a) I (b) IV (c) II (d) III

Q20. CBSE 2024 · 1 mark The electric and magnetic fields of electromagnetic waves are:

- (a) In the same phase and perpendicular to each other.
- (b) In the same phase and not perpendicular to each other.
- (c) Not in the same phase but are perpendicular to each other.
- (d) Neither in the same phase nor perpendicular to each other.

Q21. CBSE 2024 · 1 mark The first scientist who produced and observed electromagnetic waves of wavelengths in the range 25 mm – 5 mm was:

- (a) J.C. Maxwell (b) H.R. Hertz (c) J.C. Bose (d) G. Marconi

Q22. CBSE 2024 · 1 mark Electromagnetic waves with wavelength 10 nm are called:

- (a) Infrared waves (b) Ultraviolet rays (c) Gamma rays (d) X-rays

Q23. CBSE 2024 · 1 mark Welders wear special glass goggles or face masks with glass windows to protect their eyes from radiations produced by welding arcs. These radiations are:

- (a) X-rays (b) Ultraviolet rays (c) Infrared waves (d) Gamma rays

Q24. CBSE 2024 · 1 mark In four regions I, II, III and IV, the magnetic field is given by : I. $B_y = B_0 \sin kz$ II. $B_y = B_0 \cos kz$ III. $B_y = B_0 \sin(kz - \omega t)$ IV. $B_y = B_0 \sin kz + B_0 \cos kz$ The electromagnetic wave will exist in the region :

- (a) IV (b) I (c) III (d) II

Q25. CBSE 2024 · 1 mark Which one of the following has the highest frequency ?

- (a) Infrared rays (b) Gamma rays (c) Radio waves (d) Microwaves

Q26. CBSE 2024 · 1 mark Electromagnetic waves with frequency 1.0×10^{18} Hz are known as :

- (a) Infrared rays (b) Ultraviolet rays (c) X-rays (d) Gamma rays

Q27. CBSE 2024 · 1 mark A plane electromagnetic wave is travelling in air in +x direction. At a particular moment, its electric field **E** is along +y direction. At that moment, the magnetic field **B** is along:

- (a) +z direction and in phase with **E**
- (b) -z direction and in phase with **E**
- (c) +z direction and out of phase with **E**
- (d) -z direction and out of phase with **E**

Q28. CBSE 2023 · 1 mark The electromagnetic radiations used to kill germs in water purifiers are called :

- (a) Infrared waves (b) X-rays (c) Gamma rays (d) Ultraviolet rays

Q29. CBSE 2023 · 1 mark Electromagnetic waves of wavelength of the order of a few meters were first produced and detected in the laboratory by:

- (a) J.C. Maxwell (b) J.C. Bose (c) H.R. Hertz (d) G. Marconi

Q30. CBSE 2023 · 1 mark The electromagnetic waves used in radar systems are :

- (a) Infrared waves (b) Ultraviolet rays (c) Microwaves (d) X-rays

Q31. CBSE 2023 · 1 mark Name the electromagnetic waves also known as 'heat waves'.

- (a) Radio waves (b) Microwaves (c) X-rays (d) Infrared waves

VERY SHORT ANSWER (3)

Q32. CBSE 2026 · 2 marks When monochromatic light is incident on a surface separating two media, the refracted and reflected light both have the same frequency as the incident frequency but the wavelength of refracted light is different. Explain why.

Q33. CBSE 2023 · 2 marks Identify the part of electromagnetic spectrum which is: (a) next to the lowest frequency end of the visible part of electromagnetic spectrum, and (b) produced by bombarding a metal target by high energy electrons. Give one use of each of them.

Q34. CBSE 2023 · 2 marks Write any two characteristics of an electromagnetic wave. Why are microwaves used in radar systems?

SHORT ANSWER (20)

Q35. CBSE 2026 · 3 marks Name the electromagnetic waves which are used for (i) detection of fractures in bones (ii) physiotherapy (iii) radar systems. Also write their wavelength range.



Q36. CBSE 2026 · 3 marks Name the electromagnetic waves which are used (i) as a diagnostic tool in medicine (ii) in remote switches for TV sets (iii) in water purifiers. Also write their wavelength range.

Q37. CBSE 2026 · 3 marks Name the electromagnetic waves which are (i) also known as 'heat waves', (ii) used in LASIK eye surgery, (iii) used to destroy cancer cells. Also write their wavelength range.

Q38. CBSE 2026 · 3 marks (a) A sinusoidal electromagnetic wave of frequency 40 MHz travels in free space in the x-direction. Calculate the wavelength and time period of the wave. (b) At some point and at some instant the electric field in the above electromagnetic wave has its maximum value of 750 N/C and is along the y-axis. Calculate the magnitude and direction of the magnetic field at this position and time.

Q39. CBSE 2026 · 3 marks (a) Depict the variation of electric field ($E \rightarrow$) and magnetic field ($B \rightarrow$) with respect to the direction of propagation of an electromagnetic wave. Write their two important characteristics. (b) Show that $1/\sqrt{\epsilon_0 \mu_0}$ gives the velocity of an electromagnetic wave in free space.

Q40. CBSE 2026 · 3 marks What are infrared waves? Why are these waves referred to as 'heat waves'? Give any two uses of these waves.

Q41. CBSE 2026 · 3 marks What are microwaves? How are they produced? Give any two uses of microwaves.

Q42. CBSE 2026 · 3 marks What are X-rays? How are they produced? Give two uses of X-rays.

Q43. CBSE 2025 · 3 marks (a) State any three characteristics of electromagnetic waves. (b) Briefly explain how and where the displacement current exists during the charging of a capacitor.

Q44. CBSE 2025 · 3 marks Name the electromagnetic wave used (i) in radar, (ii) in eye surgery and (iii) as diagnostic tool in medicine. Write their wavelength range also.

Q45. CBSE 2025 · 3 marks Explain the existence of electromagnetic waves in free space, using the concept of displacement current.

Q46. CBSE 2025 · 3 marks How are electromagnetic waves produced? Write the wavelength range and one use of: (i) Microwaves, and (ii) Ultraviolet waves.

Q47. CBSE 2025 · 3 marks Name the electromagnetic radiations and write their frequency range: (a) Used to take the photograph of the bones (b) Produced by hot bodies (c) Used in television communication systems

Q48. CBSE 2024 · 3 marks (a) The electromagnetic spectrum is generally described by the characteristic size of its sources. Give two examples to justify this statement. (b) (i) Long distance radio broadcasts use short-wave bands. Why? (ii) Optical and radio telescopes are built on the ground, but X-ray astronomy is possible only from satellites orbiting the Earth. Why?

Q49. CBSE 2024 · 3 marks (a) The wavelength of electromagnetic waves is generally associated with the size of objects that scatter them. Give two examples to justify this statement. (b) (i) Long distance radio broadcasts use short-wave bands. Why? (ii) Optical and radio telescopes are built on the ground, but X-ray astronomy is possible only from satellites orbiting the Earth. Why?

Q50. CBSE 2024 · 3 marks The wavelength of an electromagnetic wave is related to the characteristic size of the object it can detect. Give two examples to justify this statement. Long distance radio broadcasts use short-wave bands. Why? Optical and radio telescopes are built on the ground, but X-ray astronomy is possible only from satellites orbiting the Earth. Why?

Q51. CBSE 2024 · 3 marks (a) On what factors does the speed of an electromagnetic wave in a medium depend? (b) How is an electromagnetic wave produced? (c) Sketch a schematic diagram depicting the electric and magnetic fields for an electromagnetic wave propagating along z-axis.

Q52. CBSE 2024 · 3 marks The electric field in an electromagnetic wave in vacuum is given by: $\mathbf{E} = (6.3 \text{ N/C}) [\cos(1.5 \text{ rad/m}) y + (4.5 \times 10^8 \text{ rad/s}) t] \hat{i}$ (a) Find the wavelength and frequency of the wave. (b) What is the amplitude of the magnetic field of the wave? (c) Write an expression for the magnetic field of this wave.

Q53. CBSE 2022 · 3 marks (a) (i) Depict a plane electromagnetic wave propagating along the x-axis. Write the expressions for its oscillating electric and magnetic fields. (ii) Write three characteristics of electromagnetic waves.

Q54. CBSE 2022 · 3 marks Identify electromagnetic waves which: (i) are used in radar system. (ii) affect a photographic plate. (iii) are used in surgery. Write their frequency range.

9 Ray Optics and Optical Instruments

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (21)

Q1. CBSE 2026 · 1 mark A concave lens of focal length 10 cm is cut into two identical plano-concave lenses. The focal length of each lens will be

- (a) 20 cm (b) 30 cm (c) 40 cm (d) 5 cm

Q2. CBSE 2026 · 1 mark A concave lens of focal length 40 cm is coaxially in contact with two convex lenses, each of focal length 20 cm, on each side. The focal length of the combination is

- (a) zero (b) 20/3 cm (c) -20/3 cm (d) 40/3 cm

Q3. CBSE 2026 · 1 mark Light from a small object in air falls on a spherical glass surface ($n = 1.5$) of radius of curvature R . A real image of the object will be formed if the object distance u is related to R as:

- (a) $u < R/2$ (b) $R/2 < u < R$ (c) $R < u < 2R$ (d) $u > 2R$

Q4. CBSE 2026 · 1 mark The process that allows light to travel through a tube which is not straight is –

- (a) reflection of light (b) dispersion of light
(c) scattering of light (d) total internal reflection



Q5. CBSE 2026 · 1 mark A telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. The magnifying power and the length of telescope tube will be respectively:

- (a) 24, 150 cm (b) 42, 138 cm (c) 24, 138 cm
(d) 42, 150 cm

Q6. CBSE 2026 · 1 mark In which of the following, total internal reflection does not occur?

- (a) Twinkling of stars (b) Brilliance of diamonds
(c) Optical fibre (d) Reflecting prism

Q7. CBSE 2026 · 1 mark An equiconvex lens of focal length 15 cm is cut into two equal plano-convex halves. The focal length of each half will be:

- (a) 30 cm (b) 20 cm (c) 15 cm (d) 7.5 cm

Q8. CBSE 2026 · 1 mark A plano-convex lens, made of glass ($n = 1.5$) has a curved surface whose radius is 40 cm. The image formed of an object is of the same size as that of the object. The distance of the object from the lens is:

- (a) 40 cm (b) 80 cm (c) 160 cm (d) 200 cm

Q9. CBSE 2026 · 1 mark Assertion (A): When a convex lens made of glass is immersed in water, its converging power increases. Reason (R): The focal length of a lens depends only on the radii of curvature of its two faces.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Both Assertion (A) and Reason (R) are false

Q10. CBSE 2025 · 1 mark The magnification produced by a spherical mirror is -2.0 . The mirror used and the nature of the image formed will be

- (a) Convex and virtual (b) Concave and real
(c) Concave and virtual (d) Convex and real

Q11. CBSE 2025 · 1 mark A compound microscope has an objective and an eyepiece of focal lengths f_o and f_e , respectively. To obtain a large magnification of a small object, the microscope should have:

- (a) f_o and f_e small, and $f_e > f_o$ (b) f_o and f_e small, and $f_o > f_e$
(c) f_o and f_e large, and $f_e > f_o$ (d) f_o and f_e large, and $f_o > f_e$

Q12. CBSE 2025 · 1 mark A glass slab ($\mu = 1.5$) of thickness 6 cm is placed over a paper. The shift in the letters printed on the paper will be:

- (a) 2 cm (b) 1 cm (c) 4 cm (d) 3 cm

Q13. CBSE 2025 · 1 mark A beam of light of wavelength 720 nm in air enters water (refractive index = $4/3$). Its wavelength in water will be:

- (a) 540 nm (b) 480 nm (c) 420 nm (d) 720 nm

Q14. CBSE 2025 · 1 mark Assertion (A): In a reflecting telescope, the image does not have chromatic aberration. Reason (R): Chromatic aberration occurs only due to refraction of light through an optical medium.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q15. CBSE 2025 · 1 mark Assertion (A): A ray of light is incident normally on the face of a prism. The emergent ray will graze along the opposite face of the prism when the critical angle at glass-air interface is equal to the angle of the prism. Reason (R): The refractive index of a prism depends on angle of the prism.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q16. CBSE 2025 · 1 mark A beaker is filled with water (refractive index $4/3$) up to a height H. A coin is placed at its bottom. The depth of the coin, when viewed along the near normal direction, will be

- (a) $H/4$ (b) $3H/4$ (c) H (d) $4H/3$

Q17. CBSE 2024 · 1 mark Assertion (A): Plane and convex mirrors cannot produce real images under any circumstance. Reason (R): A virtual image cannot serve as an object to produce a real image.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Assertion (A) is false and Reason (R) is also false

Q18. CBSE 2024 · 1 mark Assertion (A): The magnifying power of a compound microscope is negative. Reason (R): The final image formed is erect with respect to the object.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q19. CBSE 2024 · 1 mark Assertion (A) : A convex lens, when immersed in a liquid, disappears. Reason (R) : The refractive indices of material of the lens and the liquid are equal.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.



Q20. CBSE 2023 · 1 mark For a concave mirror of focal length 'f', the minimum distance between the object and its real image is:

- (a) zero (b) f (c) 2f (d) 4f

Q21. CBSE 2023 · 1 mark A plane wavefront is incident on a concave mirror of radius of curvature R. The radius of curvature of the refracted wavefront will be:

- (a) 2R (b) R (c) R/2 (d) R/4

VERY SHORT ANSWER (29)

Q22. CBSE 2026 · 2 marks A ray of light in air is incident at angle $\angle i$ on a face of an equilateral glass prism and is refracted through the prism. As $\angle i$ is varied, it is observed that the ray undergoes minimum deviation, when the $\angle i$ is three-fourth of the angle of the prism. Calculate the speed of light in the prism.

Q23. CBSE 2026 · 2 marks A 5 cm long pencil is placed along the principal axis of a concave mirror of focal length 20 cm such that its nearest end is at a distance of 25 cm from the mirror. Calculate the length of the image of the pencil.

Q24. CBSE 2026 · 2 marks A ray of light is incident at an angle 2A on one of the faces of a glass prism of refracting angle A. After refraction from this face, the ray strikes the opposite face which is silvered. The reflected ray from this face retraces on its path. Trace the ray diagram and find the relation between the refractive index of material of prism and the angle of prism.

Q25. CBSE 2026 · 2 marks A ray of light travelling along the principal axis is incident on a spherical mirror and reflected back along the same path. Explain, why ?

Q26. CBSE 2026 · 2 marks A small object is placed in air in front of a convex glass surface ($n = 1.5$ and radius of curvature 20 cm) at a distance of 50 cm from it. Find the position and nature of the image.

Q27. CBSE 2026 · 2 marks Draw a labelled ray diagram of an astronomical telescope when final image is formed at infinity. Write the expression for its magnifying power.

Q28. CBSE 2026 · 2 marks A small bulb is placed at the bottom of a tank, containing a transparent liquid of refractive index $\sqrt{2}$, to a depth of 1 m. Calculate the area of the surface of the liquid through which light from the bulb emerges.

Q29. CBSE 2026 · 2 marks A concave mirror of radius of curvature 16 cm produces two-times enlarged real image of an object kept in front of it. Find the position of the object.

Q30. CBSE 2026 · 2 marks A convex lens of refractive index 1.5 has a focal length of 20 cm in air. Find its nature and focal length when it is immersed in a transparent liquid of refractive index 1.25.

Q31. CBSE 2026 · 2 marks A tank is filled with a liquid to a height of 12.5 m. The apparent depth of a needle lying at the bottom of the tank is measured to be 9.0 m. Calculate the speed of light in the liquid.

Q32. CBSE 2026 · 2 marks Two thin lenses of focal length f_1 and f_2 are placed in contact with each other coaxially. Prove that the focal length f of the combination is given by $f = f_1 f_2 / (f_1 + f_2)$.

Q33. CBSE 2026 · 2 marks A point source, in air, is placed at a distance of 6 cm in front of a convex spherical surface ($n = 1.5$ and radius of curvature = 24 cm). Find the position and nature of the image formed.

Q34. CBSE 2026 · 2 marks A ray of light MN is incident normally on the face corresponding with side AB of a prism with an isosceles right-angled triangular base ABC. Trace the path of the ray as it passes through the prism when the refractive index of the prism material is (i) $\sqrt{2}$, and (ii) $\sqrt{3}$.

Q35. CBSE 2025 · 2 marks An equiconvex lens is made of glass of refractive index 1.55. If the focal length of the lens is 15.0 cm, calculate the radius of curvature of its surfaces.

Q36. CBSE 2025 · 2 marks Find the focal length of plano-convex lens of refractive index 1.5 and radius of curvature 10 cm when it is immersed in a liquid of refractive index 1.25.

Q37. CBSE 2025 · 2 marks The two surfaces of a biconvex lens have equal radii of curvature. If one of the two surfaces of this lens is made plane, what will be the new focal length of the lens?

Q38. CBSE 2025 · 2 marks A point object is placed in air at a distance $R/3$ in front of a convex surface of radius of curvature R, separating air from a medium of refractive index $n (< 4)$. Find the nature and position of the image formed.

Q39. CBSE 2025 · 2 marks A point source of light in air is kept at a distance of 12 cm in front of a convex spherical surface of glass of refractive index 1.5 and radius of curvature 30 cm. Find the nature and position of the image formed.

Q40. CBSE 2025 · 2 marks A ray of light is incident on face AB of a prism ABC with angle of prism A and emerges out from face AC. The prism is set in the position of minimum deviation with angle of deviation δ . Find (i) the angle of incidence and (ii) the angle of refraction on face AB.

Q41. CBSE 2025 · 2 marks A tank is filled with a liquid of refractive index $\sqrt{2}$, up to a height of 30 cm. A tiny bulb is glowing at the bottom of the tank. Calculate the diameter of an opaque disc floating symmetrically on the liquid surface that can cut off completely the light from the bulb that comes out of the liquid surface.

Q42. CBSE 2025 · 2 marks A convex lens of focal length 10 cm, a concave lens of focal length 15 cm and a third lens of unknown focal length are placed coaxially in contact. If the focal length of the combination is +12 cm, find the nature and focal length of the third lens, if all lenses are thin. Will the answer change if the lenses were thick?

Q43. CBSE 2025 · 2 marks Using the mirror equation and the formula of magnification, deduce that "the virtual image produced by a convex mirror is always diminished in size and is located between the pole and the focus."

Q44. CBSE 2024 · 2 marks (b) A plano-convex lens of focal length 16 cm is made of a material of refractive index 1.4. Calculate the radius of the curved surface of the lens.

Q45. CBSE 2024 · 2 marks An object is placed 30 cm in front of a concave mirror of radius of curvature 40 cm. Find the (i) position of the image formed and (ii) magnification of the image.



Q46. CBSE 2024 · 2 marks A convex lens ($n = 1.52$) has a focal length of 15.0 cm in air. Find its focal length when it is immersed in liquid of refractive index 1.65. What will be the nature of the lens?

Q47. CBSE 2024 · 2 marks The magnifying power of an astronomical telescope is 24. In normal adjustment, distance between its two lenses is 150 cm. Find the focal length of the objective lens.

Q48. CBSE 2024 · 2 marks Explain the following: (a) For a simple microscope, the angular size of the object equals the angular size of the image. Yet it offers magnification. (b) Both plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances?

Q49. CBSE 2023 · 2 marks The radii of curvature of the faces of a double-convex lens are 20 cm and 30 cm. Its power is 25/6 D. What is the refractive index of the glass of the lens?

Q50. CBSE 2023 · 2 marks The refractive indices of two media A and B are 2 and $\sqrt{2}$ respectively. What is the critical angle for their interface?

SHORT ANSWER (14)

Q51. CBSE 2026 · 3 marks Draw the ray diagram to show the image formation by a refracting telescope and write the expression for angular magnification for the telescope in normal adjustment. Give two reasons to explain why a reflecting telescope is preferred over a refracting telescope.

Q52. CBSE 2026 · 3 marks Draw a labelled ray diagram showing the formation of image by a compound microscope when final image is formed at least distance of distinct vision. Derive an expression for its magnifying power for this case.

Q53. CBSE 2026 · 3 marks A ray of light is travelling through a rectangular glass slab (refractive index $3/2$) and is incident on the horizontal glass-air surface at the critical angle for the two media. The slab is then brought in contact with water (refractive index $4/3$) such that a thin horizontal layer of water is formed on the surface of the slab. Find the angle at which the ray will emerge into air from the water-air surface.

Q54. CBSE 2026 · 3 marks A ray of light is incident at angle of 45° on one face of a prism with an equilateral triangular base. If it passes symmetrically through the prism, find the: (a) angle of minimum deviation for the prism, and (b) refractive index of the material of the prism.

Q55. CBSE 2025 · 3 marks Draw a ray diagram showing the image formation when a concave mirror produces a real, inverted and magnified image of an object and hence obtain the mirror formula.

Q56. CBSE 2025 · 3 marks A ray of light is incident at an angle i on a parallel sided glass slab of refractive index μ . Draw a diagram to show its path as it emerges out of the slab. Hence, obtain an expression for the lateral shift of the ray. Under what condition will the shift be minimum?

Q57. CBSE 2025 · 3 marks (a) A concave mirror has radius of curvature 20 cm. Calculate the distance of an object from the mirror so as to form an image of magnification -2 . Also find the location of the image. (b) If the silver coating around the centre of a concave mirror is removed, will the mirror still form the image of an object? Justify your answer.

Q58. CBSE 2022 · 3 marks (a) Draw a labelled ray diagram showing the formation of an image by an astronomical refracting telescope in normal adjustment. Hence, obtain the expression for its magnifying power.

Q59. CBSE 2022 · 3 marks A converging lens made of glass ($\mu = 1.5$) has its spherical faces of radii of curvature 10 cm and 20 cm. Find its focal length (a) in air, and (b) when it is immersed in a liquid of refractive index 1.25.

Q60. CBSE 2022 · 3 marks (b) A small bulb is placed at the bottom of a tank containing water to a depth of 70 cm. Find the area of the surface of water through which light from the bulb can emerge out. Given refractive index of water is $4/3$.

Q61. CBSE 2022 · 3 marks The refractive index of an equilateral triangular prism kept in air is $\sqrt{2}$. Calculate: (a) the angle of minimum deviation. (b) the critical angle for the prism.

Q62. CBSE 2022 · 3 marks An equiconvex lens forms a two times enlarged real image when an object is kept 16 cm from it. The lens is cut into two identical plano-convex lenses. If the object is again kept 16 cm in front of one of these lenses, then find the nature and position of the image formed.

Q63. CBSE 2022 · 3 marks Draw a labelled ray diagram showing the formation of the image at infinity by an astronomical telescope. A telescope consists of an objective of focal length 150 cm and an eyepiece of focal length 6.0 cm. If the final image is formed at infinity, then calculate: (I) the length of the tube in this adjustment, and (II) the magnification produced.

Q64. CBSE 2022 · 3 marks A diver looking up through water ($\mu = 4/3$) sees the outside world contained in a circular region on the water surface. If the diver's eyes are $\sqrt{7}$ m below the surface of water, then calculate the area of the circle.

LONG ANSWER (20)

Q65. CBSE 2026 · 5 marks Using the relation for refraction at a curved spherical surface, derive the expression for lens maker's formula. Three lenses L_1 , L_2 and L_3 , each of focal length 40 cm, are placed coaxially. The distance between L_1 and L_2 and between L_2 and L_3 are 120 cm and 20 cm respectively. An object is kept at a distance of 80 cm to the left of lens L_1 . Find the distance of the final image formed from the object.

Q66. CBSE 2026 · 5 marks Using the relation for refraction at a curved spherical surface, derive the expression for lens maker's formula.

Q67. CBSE 2026 · 5 marks (a) Using the relation for refraction at a curved spherical surface, derive the expression for lens maker's formula. (b) Three lenses L_1 , L_2 and L_3 , each of focal length 40 cm, are placed coaxially. The distance between L_1 and L_2 and between L_2 and L_3 are 120 cm and 20 cm respectively. An object is kept at a distance of 80 cm to the left of lens L_1 . Find the distance of the final image formed from the object.



Q68. CBSE 2026 · 5 marks (a) Draw a labelled ray diagram of a refracting telescope when it forms image of a distant object at infinity. Derive expression for its magnifying power. (b) (i) In a telescope the objective has much larger aperture than the eye piece. Why? (ii) Write two advantages of reflecting telescope over refracting telescope.

Q69. CBSE 2026 · 5 marks (a) Draw a labelled ray diagram of a refracting telescope when it forms image of a distant object at infinity. Derive expression for its magnifying power.

Q70. CBSE 2026 · 5 marks (a) (i) A point object is kept in front of a convex spherical surface of radius of curvature R . Draw the ray diagram to show the formation of image and derive the relation between the object and image distance (u and v) in terms of refractive index n of the medium and R .

Q71. CBSE 2026 · 5 marks (a) (i) A point object is kept in front of a convex spherical surface of radius of curvature R . Draw the ray diagram to show the formation of image and derive the relation between the object and image distance (u and v) in terms of refractive index n of the medium and R . (ii) A convex lens of focal length of 20 cm is used to form the image of an object placed 30 cm away from the lens. Find the position and nature of the image formed.

Q72. CBSE 2026 · 5 marks (b) (i) With the help of a ray diagram, describe the construction and working of a compound microscope. (ii) (I) The real image of an object placed between f and $2f$ from a convex lens can be seen on a screen placed at the image location. If the screen is removed, is the image still there? Explain. (II) Plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances? Explain.

Q73. CBSE 2025 · 5 marks (a) (i) An object is placed 30 cm from a thin convex lens of focal length 10 cm. The lens forms a sharp image on a screen. If a thin concave lens is placed in contact with the convex lens, the sharp image on the screen is formed when the screen is moved by 45 cm from its initial position. Calculate the focal length of the concave lens. (ii) Calculate the angle of minimum deviation of an equilateral prism. The refractive index of the prism is $\sqrt{3}$. Calculate the angle of incidence for this case of minimum deviation also.

Q74. CBSE 2025 · 5 marks (a) (i) Draw a ray diagram of a reflecting telescope (Cassegrain) and explain the formation of image. State two important advantages that a reflecting telescope has over a refracting telescope.

Q75. CBSE 2025 · 5 marks (i) Draw a ray diagram of a reflecting telescope (Cassegrain) and explain the formation of image. State two important advantages that a reflecting telescope has over a refracting telescope. (ii) In a refracting telescope, the focal length of the objective is 50 times the focal length of the eyepiece. When the final image is formed at infinity, the length of the tube is 102 cm. Find the focal lengths of the two lenses.

Q76. CBSE 2025 · 5 marks (i) Draw a ray diagram to show the image formation by a compound microscope. Obtain the expression for the total magnification of the microscope when the final image is formed at infinity. (ii) In a compound microscope, an object is placed at a distance of 1.5 cm from the objective of focal length 1.25 cm. The eyepiece has a focal length of 5 cm. The final image is formed at infinity. Calculate the distance between the objective and the eyepiece.

Q77. CBSE 2025 · 5 marks (i) Explain with the help of a labelled ray diagram the formation of final image by an astronomical telescope at infinity. Write the expression for its magnifying power. (ii) The total magnification produced by a compound microscope is 20. The magnification produced by the eyepiece is 5. When the microscope is focussed on a certain object, the distance between the objective and eyepiece is observed to be 14 cm. Calculate the focal lengths of the objective and the eyepiece. (Given that the least distance of distinct vision = 25 cm)

Q78. CBSE 2025 · 5 marks Explain with the help of a labelled ray diagram the formation of final image by an astronomical telescope at infinity. Write the expression for its magnifying power. The total magnification produced by a compound microscope is 20. The magnification produced by the eyepiece is 5. When the microscope is focussed on a certain object, the distance between the objective and eyepiece is observed to be 14 cm. Calculate the focal lengths of the objective and the eyepiece. (Given that the least distance of distinct vision = 25 cm)

Q79. CBSE 2024 · 5 marks (b) (i) Draw a labelled ray diagram of a compound microscope showing image formation at least distance of distinct vision. Derive an expression for its magnifying power. (ii) A telescope consists of two lenses of focal length 100 cm and 5 cm. Find the magnifying power when the final image is formed at infinity.

Q80. CBSE 2023 · 5 marks (a) (i) Draw a ray diagram showing the formation of a real image of an object placed in front of a concave mirror beyond the centre of curvature. Using this diagram, obtain the mirror formula. (ii) A 1.8 m tall person stands in front of a convex lens of focal length 1 m, at a distance of 5 m. Find the position and height of the image formed.

Q81. CBSE 2023 · 5 marks Draw a ray diagram showing the formation of a real image of an object placed at a distance u from the pole of a concave mirror of focal length f . Obtain the relation for the image distance v in terms of u and f . A 1.8 m tall person stands in front of a convex lens of focal length 1 m, at a distance of 5 m. Find the position and height of the image formed.

Q82. CBSE 2023 · 5 marks (i) Draw a ray diagram showing the formation of a real image of an object placed at $2f$ in front of a concave mirror of focal length f . Hence, obtain a relation between image distance v , object distance u and focal length f in terms of R . (ii) A 1.8 m tall person stands in front of a convex lens of focal length 1 m, at a distance of 5 m. Find the position and height of the image formed.



Q83. CBSE 2023 - 5 marks (a) (i) Draw a ray diagram to show how the final image is formed at infinity in an astronomical refracting telescope. Obtain an expression for its magnifying power. (ii) Two thin lenses L_1 and L_2 , L_1 being a convex lens of focal length 24 cm and L_2 a concave lens of focal length 18 cm are placed coaxially at a separation of 45 cm. A 1 cm tall object is placed in front of the lens L_1 at a distance of 36 cm. Find the location and height of the image formed by the combination.

Q84. CBSE 2023 - 5 marks Draw a ray diagram to show how the final image is formed at infinity in an astronomical refracting telescope. Obtain an expression for its magnifying power. Two thin lenses L_1 and L_2 , L_1 being a convex lens of focal length 24 cm and L_2 a concave lens of focal length 18 cm are placed coaxially at a separation of 45 cm. A 1 cm tall object is placed in front of the lens L_1 at a distance of 36 cm. Find the location and height of the image formed by the combination.

CASE-BASED (8)

CASE STUDY - CBSE 2026

In an experiment with convex lens of focal length f , the screen is fixed at a distance D from the object. A student slowly moves the lens away from the object towards the screen and finds that she is able to form sharp image of the object for two positions of the lens. The distance between these two positions of the lens is d .

Q85. CBSE 2026 - 1 mark The value of d is

- (a) $\sqrt{D(D - 4f)}$ (b) $\sqrt{D(D - 2f)}$ (c) $2\sqrt{Df}$
(d) $\sqrt{D(D - f)}$

Q86. CBSE 2026 - 1 mark In an experiment with convex lens of focal length f , the screen is fixed at a distance D from the object. A student slowly moves the lens away from the object towards the screen and finds that she is able to form sharp image of the object for two positions of the lens. The distance between these two positions of the lens is d . The value of d is

- (a) $\sqrt{D(D - 4f)}$ (b) $\sqrt{D(D - 2f)}$ (c) $2\sqrt{Df}$
(d) $\sqrt{D(D - f)}$

CASE STUDY - CBSE 2026

An astronomical telescope consists of two converging lenses. One of them of large aperture and large focal length is called objective lens and the other one, of smaller focal length and smaller aperture is called the eyepiece. It is used to see distant objects which are not seen clearly with naked eyes. The image formed by the objective lens acts as an object for the eyepiece and the final image produced by the eyepiece is magnified.

Q87. CBSE 2026 - 1 mark An astronomical telescope consists of two converging lenses. One of them of large aperture and large focal length is called objective lens and the other one, of smaller focal length and smaller aperture is called the eyepiece. It is used to see distant objects which are not seen clearly with naked eyes. The image formed by the objective lens acts as an object for the eyepiece and the final image produced by the eyepiece is magnified. The images formed by the objective lens and the eyepiece are respectively:

- (a) virtual, real (b) real, virtual (c) virtual, virtual
(d) real, real

Q88. CBSE 2026 - 1 mark An astronomical telescope consists of two converging lenses. One of them of large aperture and large focal length is called objective lens and the other one, of smaller focal length and smaller aperture is called the eyepiece. It is used to see distant objects which are not seen clearly with naked eyes. The image formed by the objective lens acts as an object for the eyepiece and the final image produced by the eyepiece is magnified. (i) The images formed by the objective lens and the eyepiece are respectively:

- (a) virtual, real (b) real, virtual (c) virtual, virtual
(d) real, real

Q89. CBSE 2026 - 1 mark The images formed by the objective lens and the eyepiece are respectively:

- (a) virtual, real (b) real, virtual (c) virtual, virtual
(d) real, real

CASE STUDY - CBSE 2025

When light travels from an optically denser medium to an optically rarer medium, at the interface it is partly reflected back into the same medium and partly refracted to the second medium. The angle of incidence corresponding to an angle of refraction 90° is called the critical angle (i_c) for the given pair of media. This angle is related to the refractive index of medium 1 with respect to medium 2. Refraction of light through a prism involves refraction at two plane interfaces. A relation for the refractive index of the material of the prism can be obtained in terms of the refracting angle of the prism and the angle of minimum deviation. For a thin prism, this relation reduces to a simple equation. Laws of refraction are also valid for refraction of light at a spherical interface. When an object is placed in front of a spherical surface separating two media, its image is formed. A relation between object and image distance, in terms of refractive indices of two media and the radius of curvature of the spherical surface can be obtained.

Q90. CBSE 2025 - 1 mark An object is placed in front of a convex spherical glass surface ($n = 1.5$ and radius of curvature R) at a distance of $4R$ from it. As the object is moved slowly close to the surface, the image formed is:

- (a) always real (b) always virtual
(c) first real and then virtual (d) first virtual and then real

CASE STUDY - CBSE 2024



A lens is a transparent medium bounded by two surfaces, with one or both surfaces being spherical. The focal length of a lens is determined by the radii of curvature of its two surfaces and the refractive index of its medium with respect to that of the surrounding medium. The power of a lens is reciprocal of its focal length. If a number of lenses are kept in contact, the power of the combination is the algebraic sum of the powers of the individual lenses.

Q91. CBSE 2024 · 1 mark (i) A double-convex lens, with each face having same radius of curvature R , is made of glass of refractive index n . Its power is:

- (a) $2(n - 1)/R$ (b) $(2n - 1)/R$ (c) $(n - 1)/(2R)$
(d) $(2n - 1)/(2R)$

CASE STUDY · CBSE 2023

The lens makers formula is useful to design lenses of desired focal lengths using surfaces of suitable radii of curvature. The focal length also depends on the refractive index of the material of the lens and the surrounding medium. The refractive index depends on the wavelength of the light used. The power of a lens is related to its focal length.

Q92. CBSE 2023 · 1 mark (a) How will the power of a lens be affected with an increase of wavelength of light ?

10 Wave Optics

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (22)

Q1. CBSE 2026 · 1 mark The shape of the interference fringes in Young's double-slit experiment, when the distance between the slit and the screen is very large as compared to the slit-separation, is nearly

- (a) straight (b) parabolic (c) circular (d) hyperbolic

Q2. CBSE 2026 · 1 mark Four independent waves are expressed as (i) $y_1 = A_1 \sin \omega t$ (ii) $y_2 = A_2 \sin 2\omega t$ (iii) $y_3 = A_3 \cos \omega t$ (iv) $y_4 = A_4 \sin (\omega t + \pi/3)$. The interference between two of these waves is possible in

- (a) (i) and (iii) only (b) (iii) and (iv) only
(c) (i), (iii) and (iv) only (d) All of them

Q3. CBSE 2026 · 1 mark The angular width of interference fringes in Young's double-slit experiment depends on

- (a) distance between the slits and the screen only
(b) wavelength of light used only
(c) both wavelength of light used and the slits separation
(d) slits separation only

Q4. CBSE 2026 · 1 mark The phenomenon of interference is shown by

- (a) longitudinal mechanical wave only
(b) transverse mechanical wave only
(c) electromagnetic waves only (d) all these waves

Q5. CBSE 2026 · 1 mark Assertion (A): Light added to light can produce darkness. Reason (R): When two coherent light waves interfere, there is darkness at position of destructive interference.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q6. CBSE 2026 · 1 mark Assertion (A): When a ray of light enters from air into glass, frequency of light remains the same. Reason (R): The speed and wavelength of light both changes in glass.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Both Assertion (A) and Reason (R) are false

Q7. CBSE 2026 · 1 mark The phase difference between the two superimposing waves that give rise to a bright spot in a Young's double-slit experiment is (n is an integer):

- (a) $2n\pi$ (b) $2n\pi + \pi/4$ (c) $2n\pi + \pi/2$ (d) $2n\pi + \pi$

Q8. CBSE 2026 · 1 mark A ray of monochromatic light travelling in air is incident on a glass slab and is partly reflected and partly refracted. Both the reflected and refracted lights will have:

- (a) same wavelength (b) same frequency
(c) same intensity (d) same speed

Q9. CBSE 2026 · 1 mark A ray of yellow light undergoes total internal reflection when it is incident at the interface of two media. This ray is successively replaced by the ray of blue, green and red lights. Which of the following statements is true if the angle of incidence is same in all cases?

- (a) Total internal reflection occurs for blue light only.
(b) Total internal reflection occurs for red light only.
(c) Total internal reflection occurs for both green and blue lights.
(d) None of them will undergo total internal reflection.

Q10. CBSE 2026 · 1 mark Assertion (A): When a convex lens made of glass is immersed in water, its converging power increases. Reason (R): The focal length of a lens depends only on the radii of curvature of its two faces.

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false (d) Both A and R are false



Q11. CBSE 2026 · 1 mark Assertion (A): In Young's double-slit experiment, the fringe width for dark and bright fringes is the same. Reason (R): Fringe width is given by $\beta = \lambda D/d$, where symbols have their usual meanings.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q12. CBSE 2025 · 1 mark Assertion (A) : In double slit experiment if one slit is closed, diffraction pattern due to the other slit will appear on the screen. Reason (R) : For interference, at least two waves are required.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q13. CBSE 2025 · 1 mark Two coherent light waves, each having amplitude a , superpose to produce an interference pattern on a screen. The intensity of light as seen on the screen varies between:

- (a) 0 and $2a^2$ (b) 0 and $4a^2$ (c) a^2 and $2a^2$ (d) $2a^2$ and $4a^2$

Q14. CBSE 2025 · 1 mark Two coherent waves, each of intensity I_0 , produce interference pattern on a screen. The average intensity of light on the screen is:

- (a) zero (b) I_0 (c) $2I_0$ (d) $4I_0$

Q15. CBSE 2025 · 1 mark Assertion (A): In a reflecting telescope, the image does not have chromatic aberration. Reason (R): Chromatic aberration occurs only due to refraction of light through an optical medium.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q16. CBSE 2024 · 1 mark Assertion (A): A convex lens, when immersed in a liquid, disappears. Reason (R): The refractive indices of material of the lens and the liquid are equal.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
- (c) Assertion (A) is true, but Reason (R) is false
- (d) Assertion (A) is false and Reason (R) is also false

Q17. CBSE 2023 · 1 mark Assertion (A): The phase difference between any two points on a wavefront is zero. Reason (R): All points on a wavefront are at the same distance from the source and thus oscillate in the same phase.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
- (c) Assertion (A) is true, but Reason (R) is false
- (d) Assertion (A) is false and Reason (R) is also false

Q18. CBSE 2023 · 1 mark Which of the following pairs of media has the least value of critical angle?

- (a) Glass to air (b) Glass to water (c) Diamond to water (d) Diamond to air

Q19. CBSE 2023 · 1 mark In the wave picture of light, the intensity I of light is related to the amplitude A of the wave as :

- (a) $I \propto A$ (b) $I \propto \sqrt{A}$ (c) $I \propto A^2$ (d) $I \propto 1/A^2$

Q20. CBSE 2023 · 1 mark In a single-slit diffraction experiment, the width of the slit is halved. The width of the central maximum, in the diffraction pattern, will become :

- (a) half (b) twice (c) four times (d) one-fourth

Q21. CBSE 2023 · 1 mark In a Young's double-slit experiment, the fringe width is found to be β . If the entire apparatus is immersed in a liquid of refractive index μ , the new fringe width will be :

- (a) β (b) $\mu\beta$ (c) β/μ (d) β/μ^2

Q22. CBSE 2023 · 1 mark In Young's double-slit experiment, the fringe width is found to be β . If the entire apparatus is immersed in a liquid of refractive index η , the new fringe width will be:

- (a) β (b) $\eta\beta$ (c) β/η (d) β/η^2

VERY SHORT ANSWER (29)

Q23. CBSE 2026 · 2 marks A beam of light consisting of two wavelengths 400 nm and 600 nm is used to illuminate a single slit of width 1 mm. Find the least distance of the point from the central maximum where the dark fringes due to both wavelengths coincide on the screen placed 1.5 m from the slit.

Q24. CBSE 2026 · 2 marks In a Young's double-slit experiment, a beam of light consisting of two wavelengths 500 nm and 600 nm is used. The interference fringes are observed at a screen placed 1.8 m away from the plane of slits (slit separation 0.3 mm). Calculate the least distance from the central maximum where the bright fringes due to both the wavelengths coincide.

Q25. CBSE 2026 · 2 marks A ray of light is incident on the face of a triangular prism of refracting angle 60° and it just suffers total internal reflection at the other face. Find the angle of incidence for the ray if the refractive index of the material of the prism is $\sqrt{2}$.

Q26. CBSE 2026 · 2 marks Explain why diffraction of sound is more common in daily experience than that of light.

Q27. CBSE 2026 · 2 marks In Young's double slit experiment, the central maximum is bright in the interference pattern obtained on a screen. What will happen when: (a) light waves emitted out of slits S_1 and S_2 have an initial phase difference of π radian? (b) one of the slits is closed? Justify your answers.



Q28. CBSE 2026 · 2 marks (a) State Huygens principle. How did Huygens justify the absence of the backwave on a spherical wavefront?

Q29. CBSE 2026 · 2 marks In a Young's double-slit experiment, two waves each of intensity I superpose each other and produce an interference pattern. Prove that the resultant intensities at maxima and minima are $4I$ and zero respectively.

Q30. CBSE 2025 · 2 marks Find the angle of diffraction (in degrees) for first secondary maximum of the pattern due to diffraction at a single slit. The width of the slit and wavelength of light used are 0.55 mm and 550 nm , respectively.

Q31. CBSE 2025 · 2 marks In a double slit experiment, the two slits are 1.5 mm apart. The slits are illuminated by a mixture of lights of wavelengths of 600 nm and 400 nm and the interference pattern is observed on a screen 1.5 m away from the slits. Find the minimum distance of the point from the central maximum at which bright fringes of the interference patterns of the two wavelengths coincide.

Q32. CBSE 2025 · 2 marks In double slit experiment with green light, an interference pattern is formed on the screen. As a consequence, the fringe width of the pattern changes by 0.09 mm . If the slits separation used is 2 mm , calculate the wavelength of light used in the experiment.

Q33. CBSE 2025 · 2 marks In a double slit interference set-up, the intensity of the central maximum is I_0 . Calculate the intensity at a point where the path difference between two interfering waves is $\lambda/3$.

Q34. CBSE 2025 · 2 marks In Young's double slit experiment, at which the interfering waves of intensity I_0 each, have a path difference of (i) $\lambda/3$, and (ii) $\lambda/2$.

Q35. CBSE 2025 · 2 marks (a) In Young's double slit experiment, at which the interfering waves of intensity I_0 each, have a path difference of (i) $\lambda/3$, and (ii) $\lambda/2$. (b) A point source of light in air is kept at a distance of 12 cm in front of a convex spherical surface of glass of refractive index 1.5 and radius of curvature 30 cm . Find the nature and position of the image formed.

Q36. CBSE 2025 · 2 marks Write two differences in the patterns of double-slit interference experiment and single-slit diffraction experiment. Light waves from two pinholes illuminated by two sodium lamps do not produce interference patterns. Explain why.

Q37. CBSE 2025 · 2 marks The ratio of the intensities at maxima to minima in Young's double-slit experiment is $25 : 9$. Calculate the ratio of intensities of the interfering waves.

Q38. CBSE 2025 · 2 marks In double-slit experiment, the intensity at the central maximum in the interference pattern on the screen is I_0 . Find the intensity at a point on the screen where the path difference between the interfering waves is $\lambda/6$.

Q39. CBSE 2025 · 2 marks In a diffraction experiment, the slit is illuminated by light of wavelength 600 nm . The first minimum of the pattern falls at $\theta = 30^\circ$. Calculate the width of the slit.

Q40. CBSE 2024 · 2 marks (a) Monochromatic light of frequency $5.0 \times 10^{14}\text{ Hz}$ passes from air into a medium of refractive index 1.5 . Find the wavelength of the light (i) reflected, and (ii) refracted at the interface of the two media.

Q41. CBSE 2024 · 2 marks (a) Waves from two coherent sources of light superpose at a point. If the phase difference between the two waves is ϕ , obtain an expression for the resultant intensity at that point. OR (b) What happens to the fringe width in Young's double-slit experiment when (i) the source slit is moved closer to the plane of the slits, and (ii) the separation between the two slits is increased? Justify your answers.

Q42. CBSE 2024 · 2 marks (a) Two waves, each of amplitude ' a ' and frequency ' ω ' emanating from two coherent sources of light superpose at a point. If the phase difference between the two waves is ϕ , obtain an expression for the resultant intensity at that point.

Q43. CBSE 2024 · 2 marks Write two points of difference between interference and diffraction of light.

Q44. CBSE 2024 · 2 marks What is a sustained or stable interference pattern? What are the conditions for obtaining such an interference pattern?

Q45. CBSE 2023 · 2 marks Using Huygens' principle, draw a ray diagram showing propagation of a plane wave refracting at a plane surface separating two media.

Q46. CBSE 2023 · 2 marks Two coherent monochromatic light beams of intensities I and $4I$ superpose each other. Find the ratio of maximum and minimum intensities in the resulting beam.

Q47. CBSE 2023 · 2 marks Draw a diagram of a plane wave refracting at a plane surface separating two media using Huygens principle. Verify also Snell's law of refraction.

Q48. CBSE 2023 · 2 marks Write Huygens' principle. How did Huygens explain the absence of the backward wave?

Q49. CBSE 2023 · 2 marks The refractive indices of two media A and B are 2 and $\sqrt{2}$ respectively. What is the critical angle for their interface ?

Q50. CBSE 2023 · 2 marks State Huygens' principle. How did Huygens explain the absence of the backwave ?

Q51. CBSE 2023 · 2 marks State Huygens' principle. How did Huygens explain the absence of the backward wave?

SHORT ANSWER (18)

Q52. CBSE 2026 · 3 marks State the two conditions under which total internal reflection occurs.

Q53. CBSE 2026 · 3 marks What are coherent sources of light ? Why are coherent sources of light required to produce interference of light ? Give an example of interference of light in daily life.

Q54. CBSE 2026 · 3 marks Define the term 'critical angle'. A small bulb is placed at the bottom of a tank containing a liquid of refractive index μ at a depth H . It is observed that the light emerges from a circular area of radius r of the surface. Obtain the expression for r in terms of H and μ .



Q55. CBSE 2025 · 3 marks A double slit set-up was initially placed in a tank filled with water and the interference pattern was obtained using a laser light. When water is replaced by a transparent liquid of refractive index $n > n_{\text{water}}$, what will be the effect on the following ? (a) Speed, frequency and wavelength of the light of laser beam. (b) The fringe width, shape of interference fringes and shift in the position of central maximum.

Q56. CBSE 2025 · 3 marks (a) Write the conditions under which two light waves originating from two coherent sources can interfere each other (i) constructively, and (ii) destructively, in terms of wavelength. Can these be applied for two lights originating from two sodium lamps? Give reason. (b) In a double slit experiment an interference pattern is observed on a screen. If the green light is replaced by red monochromatic light of the same intensity, how will the fringe width of interference pattern be affected? Justify your answer.

Q57. CBSE 2025 · 3 marks Two slits separated by 1.0 mm and the screen is 1.0 m away from the slits. A beam of light consisting of two wavelengths 500 nm and 600 nm is used to obtain interference fringes. Calculate: (a) the distance between the first maxima for the two wavelengths. (b) the least distance from the central maximum, where the bright fringes due to both the wavelengths coincide.

Q58. CBSE 2025 · 3 marks Using Huygens' principle, explain the concept of a wavefront from a reflecting surface. Hence, prove the laws of reflection.

Q59. CBSE 2025 · 3 marks (a) "You cannot see a person standing on the other side of a boundary wall but can hear him." Explain with reason. (b) Light of wavelength 750 nm is incident normally on a slit of width 1.5 mm. Diffraction pattern is obtained on a screen 1.0 m away from the slit. Find the distance of the nearest point from the central maxima at which the intensity is zero.

Q60. CBSE 2023 · 3 marks (a) (i) In diffraction due to a single slit, the phase difference between light waves reaching a point on the screen is 5π . Explain whether a bright or a dark fringe will be formed at the point. (ii) What should the width (a) of each slit be to obtain eight maxima of two double-slit patterns (slit separation d) within the central maximum of the single slit pattern ? (iii) Draw the plot of intensity distribution in a diffraction pattern due to a single slit.

Q61. CBSE 2023 · 3 marks In diffraction due to a single slit, the phase difference between light waves reaching a point on the screen is 5π . Explain whether a bright or a dark fringe will be formed at the point. What should the width (a) of each slit be to obtain eight maxima of two double-slit patterns (slit separation d) within the central maximum of the single slit pattern? Draw the plot of intensity distribution in a diffraction pattern due to a single slit.

Q62. CBSE 2022 · 3 marks (a) State the conditions for total internal reflection to take place. (b) A coin suspended by a thread in the liquid is gradually lowered till it touches the bottom. The apparent depth is determined corresponding to different positions of the coin. (i) Plot a graph showing variation of the apparent depth with the real depth of the coin. (ii) What is the physical significance of the slope of the graph?

Q63. CBSE 2022 · 3 marks (b) A plane wavefront of light of wavelength ' λ ' is incident normally on a narrow slit of width 'a' and a diffraction pattern is observed on a screen at a distance 'D' from the slit. (i) Depict the intensity distribution in the pattern observed. (ii) Obtain the expression for the first maximum from the central maximum.

Q64. CBSE 2022 · 3 marks (a) Is the speed of light in glass independent of the colour of light? Give reason.

Q65. CBSE 2022 · 3 marks (b) Light of wavelength λ is incident normally on a single slit. (i) Depict the intensity distribution in the pattern observed. (ii) Obtain the expression for the first maximum from the central maximum.

Q66. CBSE 2022 · 3 marks Briefly explain how bright and dark fringes are formed on the screen in Young's double slit experiment. Write the expression for fringe width.

Q67. CBSE 2022 · 3 marks A plane wavefront is propagating from a rarer into a denser medium. Use Huygens principle to show the refracted wavefront and verify Snell's law.

Q68. CBSE 2022 · 3 marks When the two sources S_1 and S_2 are far apart, the observation of interference pattern is not possible in Young's double slit experiment. Explain. Mention the conditions for the two sources to be coherent. If the source of wavelength λ is replaced by another source of wavelength 1.5λ , with the interference pattern still observable?

Q69. CBSE 2022 · 3 marks Briefly explain how bright and dark fringes are formed on a screen due to the diffraction at a single slit. Hence, explain why the intensity at the bright fringes decreases sharply as their order (n) increases.

LONG ANSWER (19)

Q70. CBSE 2026 · 5 marks (a) What are coherent sources? Why they are necessary for observing stable interference pattern? Draw a graph showing the variation of intensity of light with the position on the screen in Young's double-slit experiment. (b) Find the intensity of light at a point on the screen when two interfering waves of the same intensity (I_0) have a path difference of (i) $\lambda/4$ and (ii) $\lambda/3$.

Q71. CBSE 2026 · 5 marks (a) What are coherent sources? Why they are necessary for observing stable interference pattern? Draw a graph showing the variation of intensity of light with the position on the screen in Young's double-slit experiment.

Q72. CBSE 2026 · 5 marks (a) In a single slit diffraction pattern, how is the angular width of central maximum affected when (i) slit width is increased (ii) the distance between the slit and the screen is increased. (iii) light of smaller wavelength is used. Justify your answer. (b) A slit of width d is illuminated by light of wavelength 700 nm. Find the value of d for which the first minimum falls at an angle of 30° .



Q73. CBSE 2026 · 5 marks (b) (ii) A beam of coherent light of wavelength 550 nm is incident normal to the plane of a pair of two slits S_1 and S_2 each of width 1.2×10^{-6} m separated by 1.1 mm. Dark and bright fringes are observed on a screen 2.2 m away from the plane of the slits. Calculate: (I) fringe width. (II) distance of the second dark fringe from the central maximum. (III) what will happen when the entire apparatus is immersed in water.

Q74. CBSE 2026 · 5 marks (b) (i) What is the difference between a ray and a wavefront? (ii) A plane wave is incident on a reflecting surface. Using Huygens principle, show how it is reflected from the surface. Hence, verify the law of reflection. (iii) Depict refraction of a plane wave by a convex lens.

Q75. CBSE 2026 · 5 marks (a) (i) A parallel beam of monochromatic light falls normally on a single slit of width 'a' and a diffraction pattern is observed on a screen placed at distance D from the slits. Explain: (I) the formation of maxima and minima in the diffraction pattern, and (II) why the maxima go on becoming weaker and weaker with its increasing number (n). (ii) Write any two points of difference between interference pattern due to double-slit and diffraction pattern due to single-slit.

Q76. CBSE 2025 · 5 marks (b) (i) A physics teacher wants to demonstrate interference with the help of double slit experiment using a laser beam of 633 nm wavelength. Since the hall is large enough, interference pattern is formed on the wall 5.0 m from the slits. For clear and comfortable view by all the students they want the fringe width 5 mm. (I) Find the slit separation for obtaining the desired interference pattern. (II) How far will the first minimum be from the central maximum? (ii) A parallel beam of light of wavelength 650 nm passes through a slit of width 0.6 mm. The diffraction pattern is obtained on a screen kept 60 cm away from the slit. Find the distance between first order minima on both sides of the central maximum.

Q77. CBSE 2025 · 5 marks (i) Explain the concept of wavefront, propagating in air, at a plane interface between two media. (ii) Use mirror formula to deduce that a convex mirror always produces a virtual image of an object kept in front of it.

Q78. CBSE 2025 · 5 marks (b) (i) Derive the conditions for constructive and destructive interference in light in terms of path difference considering wavefront, propagating in air, at a plane interface between two media. (ii) Use mirror formula to deduce that a convex mirror always produces a virtual image of an object kept in front of it.

Q79. CBSE 2025 · 5 marks (i) Two coherent light waves, each of intensity I_0 superpose each other and produce interference pattern on a screen. Obtain the expression for the resultant intensity at a point where the phase difference between the waves is ϕ . Write its maximum and minimum possible values. (ii) In a single slit diffraction experiment, the aperture of the slit is 3 mm and the separation between the slit and the screen is 1.5 m. A monochromatic light of wavelength 600 nm is normally incident on the slit. Calculate the distance of (I) first order minimum, and (II) second order maximum, from the centre of the screen.

Q80. CBSE 2025 · 5 marks (i) (1) What are coherent sources? Why are they necessary for observing a sustained interference pattern? (2) Lights from two independent sources are not coherent. Explain. (ii) Two slits 0.1 mm apart are arranged 1.20 m from a screen. Light of wavelength 600 nm from a distant source is incident on the slits. (1) How far apart will adjacent bright interference fringes be on the screen? (2) Find the angular width (in degree) of the first bright fringe.

Q81. CBSE 2024 · 5 marks (a) (i) A ray of light passes through a triangular prism. Show graphically, how the angle of deviation varies with the angle of incidence? Hence define the angle of minimum deviation. (ii) A ray of light is incident normally on a refracting face of a prism of prism angle A and suffers a deviation of angle δ . Prove that the refractive index n of the material of the prism is given by $n = \sin(A + \delta)/\sin A$. (iii) The refractive index of the material of a prism is $\sqrt{2}$. If the refracting angle of the prism is 60° , find the (1) Angle of minimum deviation, and (2) Angle of incidence.

Q82. CBSE 2024 · 5 marks A ray of light passes through a triangular prism. Show graphically, how the angle of deviation varies with the angle of incidence? Hence define the angle of minimum deviation. A ray of light is incident normally on a refracting face of a prism of prism angle A and suffers a deviation of angle δ . Prove that the refractive index n of the material of the prism is given by $n = \sin(A + \delta)/\sin A$. The refractive index of the material of a prism is $\sqrt{2}$. If the refracting angle of the prism is 60° , find the (1) Angle of minimum deviation, and (2) Angle of incidence.

Q83. CBSE 2024 · 5 marks (a) (i) Give any two differences between the interference pattern obtained in Young's double-slit experiment and a diffraction pattern due to a single slit. (ii) Draw an intensity distribution graph in case of a double-slit interference pattern. (iii) In Young's double-slit experiment using monochromatic light of wavelength λ , the intensity of light at a point on the screen, where path difference is λ , is K units. Find the intensity of light at a point on the screen where the path difference is $\lambda/6$.

Q84. CBSE 2024 · 5 marks (b) (i) The displacement of two light waves, frequency ω , emanating from two coherent sources of light, are given by $y_1 = a \cos \omega t$ and $y_2 = a \cos(\omega t + \phi)$. ϕ is the phase difference between the two waves. These light waves superpose at a point. Obtain the expression for the resultant intensity at that point. (ii) In Young's double slit experiment, if the waves emanating from two slits reaching a point on a screen have path differences (i) $\lambda/6$ and (ii) $\lambda/12$, find the ratio of intensities at these two points.

Q85. CBSE 2024 · 5 marks (b) (i) The displacement of two light waves, frequency ω , emanating from two coherent sources of light, are given by $y_1 = a \cos \omega t$ and $y_2 = a \cos(\omega t + \phi)$. ϕ is the phase difference between the two waves. These light waves superpose at a point. Obtain the expression for the resultant intensity at that point. (ii) In the Young's double slit experiment, find the ratio of intensities at two points on a screen when waves emanating from two slits reaching these points have path differences (i) $\lambda/6$ and (ii) $\lambda/12$.



Q86. CBSE 2024 · 5 marks (b)(i) The displacement of two light waves, frequency ω , emanating from two coherent sources of light, are given by $y_1 = a \cos \omega t$ and $y_2 = a \cos (\omega t + \phi)$. ϕ is the phase difference between the two waves. These light waves superpose at a point. Obtain the expression for the resultant intensity at that point. (ii) In Young's double slit experiment, find the ratio of intensities at two points on a screen when waves emanating from two slits reaching these points have path differences (i) $\lambda/6$ and (ii) $\lambda/12$.

Q87. CBSE 2023 · 5 marks (i) (1) Write two points of difference between an interference pattern and a diffraction pattern. (2) Name any two factors on which the fringe width in a double-slit experiment depends. (ii) In Young's double-slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate: (1) the angular separation in radians between the central maximum and the adjacent maximum. (2) the distance between these two maxima on a screen 50 cm from the slits.

Q88. CBSE 2023 · 5 marks (i) (1) Write two points of difference between an interference pattern and a diffraction pattern. (2) Name any two factors on which the fringe width in a double-slit experiment depends. (ii) In a double-slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate: (1) the angular separation in radians between the central maximum and the adjacent maximum. (2) the distance between these two maxima on a screen 50 cm from the slits.

CASE-BASED (9)

CASE STUDY · CBSE 2026

In a Young's double-slit experiment, the two slits behave as coherent sources. When coherent light waves superpose over each other they create an interference pattern of successive bright and dark regions due to constructive and destructive interference. Two slits 2 mm apart are illuminated by a source of monochromatic light and the interference pattern is observed on a screen 5.0 m away from the slits.

Q89. CBSE 2026 · 1 mark What property of light does this interference experiment demonstrate?

- (a) Wave nature of light (b) Particle nature of light
(c) Transverse nature of light
(d) Both wave nature and transverse nature of light

CASE STUDY · CBSE 2024

When a ray of light propagates from a denser medium to a rarer medium, it bends away from the normal. When the incident angle is increased, the refracted ray deviates more from the normal. For a particular angle of incidence in the denser medium, the refracted ray just grazes the interface of the two surfaces. This angle of incidence is called the critical angle for the pair of media involved.

Q90. CBSE 2024 · 1 mark (i) For a ray incident at the critical angle, the angle of reflection is :

- (a) 0° (b) $< 90^\circ$ (c) $> 90^\circ$ (d) 90°

CASE STUDY · CBSE 2024

Diffraction and interference are closely related phenomena that occur together. Diffraction is the phenomenon of bending of light around the edges of the obstacle, while interference is the combination of waves that results in a new wave pattern. In order to get interference, there must be at least two waves that are diffracting. So while diffraction can occur without interference, interference cannot occur without diffraction. Two slits of width 2 m each in an opaque material are separated by a distance of 6 m. Monochromatic light of wavelength 450 nm is incident normally on the slits. One finds a combined interference and diffraction pattern on the screen.

Q91. CBSE 2024 · 1 mark The number of peaks of the interference fringes formed within the central peak of the envelope of the diffraction pattern will be :

- (a) 2 (b) 3 (c) 4 (d) 6

CASE STUDY · CBSE 2023

Strontium titanate is a rare oxide mineral found in Siberia. It is used as a substitute for diamond because its refractive index and critical angle are 2.41 and 24.5° , respectively, which are approximately equal to the refractive index and critical angle of diamond. It has all the properties of diamond. Even an expert jeweller is unable to differentiate between diamond and strontium titanate. A ray of light is incident normally on one face of an equilateral triangular prism ABC made of strontium titanate.

Q92. CBSE 2023 · 4 marks Trace the path of the ray showing its passage through the prism.

CASE STUDY · CBSE 2023

Strontium titanate is a rare oxide a natural mineral found in Siberia. It is used as a substitute for diamond because its refractive index and critical angle are 2.41 and 24.5° , respectively, which are approximately equal to the refractive index and critical angle of diamond. It has all the properties of diamond. Even an expert jeweller is unable to differentiate between diamond and strontium titanate. A ray of light is incident normally on one face of an equilateral triangular prism ABC made of strontium titanate.

Q93. CBSE 2023 · 4 marks (a) Trace the path of the ray showing its passage through the prism.

CASE STUDY · CBSE 2023

Diffraction of light is bending of light around the corners of an object whose size is comparable with the wavelength of light. Diffraction actually defines the limits of ray optics. This limit for optical instruments is set by the wavelength of light. An experimental arrangement is set up to observe the diffraction pattern due to a single slit.



Q94. CBSE 2023 · 4 marks (a) How will the width of central maximum be affected if the wavelength of light is increased ?

CASE STUDY · CBSE 2022

The British physicist Thomas Young explained the interference of light using the principle of superposition of waves. He observed the interference pattern on the screen, in his experimental set-up called double slit experiment. The two slits S_1 and S_2 were illuminated by light from a slit S . The interference pattern consists of dark and bright bands of light. Such bands are called fringes. The distance between two consecutive bright and dark fringes is called fringe width.

Q95. CBSE 2022 · 1 mark If the screen is moved closer to the plane of slits S_1 and S_2 , then the fringe width:

- (a) will decrease, but the intensity of bright fringe remains the same.
- (b) will increase, but the intensity of bright fringe decreases.
- (c) will decrease, but the intensity of bright fringe increases.
- (d) and the intensity both remain the same.

CASE STUDY · CBSE 2022

The British physicist Thomas Young explained the interference of light using the principle of superposition of waves. He observed the interference pattern on the screen, in his experimental setup called the double slit experiment. The two slits S_1 and S_2 were illuminated by light from a slit S . The interference pattern consists of dark and bright bands of light.

Such bands are called fringes. The distance between two consecutive bright and dark fringes is called fringe width.

Q96. CBSE 2022 · 1 mark (a) If the screen is moved closer to the plane of slits S_1 and S_2 , then the fringe width:

- (a) will decrease, but the intensity of bright fringe remains the same.
- (b) will increase, but the intensity of bright fringe decreases.
- (c) will decrease, but the intensity of bright fringe increases.
- (d) and the intensity both remain the same.

CASE STUDY · CBSE 2022

The British physicist Thomas Young explained the interference of light using the principle of superposition of waves. He observed the interference pattern on the screen, in his experimental set-double slit experiment. The two slits S_1 and S_2 were illuminated by light from a slit S . The interference pattern consists of dark and bright bands of light. Such bands are called fringes. The distance between two consecutive bright and dark fringes is called fringe width.

Q97. CBSE 2022 · 1 mark If the screen is moved closer to the plane of slits S_1 and S_2 , then the fringe width:

- (a) will decrease, but the intensity of bright fringe remains the same.
- (b) will increase, but the intensity of bright fringe decreases.
- (c) will decrease, but the intensity of bright fringe increases.
- (d) and the intensity both remain the same.

11 Dual Nature of Radiation and Matter

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (54)

Q1. CBSE 2026 · 1 mark Assertion (A): If accelerated electrons are passed through a narrow slit, a diffraction pattern is observed. Reason (R): Electrons behave as both particles and waves.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q2. CBSE 2026 · 1 mark The maximum kinetic energy of the electrons emitted from a photosensitive surface depends on

- (a) work function of the surface ϕ_0 only.
- (b) frequency of the incident radiation ν only.
- (c) intensity of the incident radiation I only.
- (d) Both ϕ_0 and ν .

Q3. CBSE 2026 · 1 mark Assertion (A): On increasing the intensity of incident light of frequency $\nu (> \nu_0)$ on a photosensitive surface, the photocurrent increases. Reason (R): The stopping potential for a photosensitive surface increases with increase of frequency $\nu (> \nu_0)$ of incident light.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is also false.

Q4. CBSE 2026 · 1 mark A photosensitive surface is illuminated by radiations of wavelength λ_1 , $\lambda_2 (> \lambda_1)$ and λ_3 one by one and photoemission is observed in each case. λ_1 , λ_2 lies in UV range and λ_3 in visible range. If V_1 , V_2 and V_3 are stopping potential in these cases respectively, then

- (a) $V_1 = V_2 = V_3$ (b) $V_2 > V_1 > V_3$ (c) $V_1 > V_2 > V_3$
- (d) $V_3 > V_1 > V_2$



Q5. CBSE 2026 · 1 mark The equivalent mass of a photon of wavelength 100 nm is

- (a) 2.21×10^{-35} kg (b) 6.63×10^{-33} kg (c) 1.11×10^{-35} kg
(d) 3.31×10^{-33} kg

Q6. CBSE 2026 · 1 mark A beam of blue light is incident on a metal surface with a work function of $\phi_0 = hc/(550 \text{ nm})$ and photoelectrons are ejected from the surface. If the blue light is replaced by red light of same intensity, then

- (a) emitted electrons will be more energetic
(b) emitted electrons will be less energetic
(c) no electrons are emitted
(d) less number of electrons are emitted

Q7. CBSE 2026 · 1 mark An electron and a proton are accelerated through the same potential difference. Let λ_e and λ_p be the de Broglie wavelength associated with electron and proton respectively. Then λ_e/λ_p is

- (a) m_e/m_p (b) m_p/m_e (c) $\sqrt{(m_e/m_p)}$ (d) $\sqrt{(m_p/m_e)}$

Q8. CBSE 2026 · 1 mark Assertion (A): Photoelectric effect demonstrates particle nature of light. Reason (R): The number of photoelectrons emitted from a surface depends upon the intensity of radiation.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Both Assertion (A) and Reason (R) are false

Q9. CBSE 2026 · 1 mark Radiation of wavelength 200 nm is incident on a photosensitive surface of work function 4.2 eV. The kinetic energy of fastest photoelectrons emitted from this surface will be close to:

- (a) 3.5 eV (b) 3.0 eV (c) 2.5 eV (d) 2.0 eV

Q10. CBSE 2026 · 1 mark A proton and an alpha particle have equal momentum. The ratio of their kinetic energies (E_p/E_α) and de Broglie wavelengths associated with them (λ_p/λ_α) respectively are:

- (a) 2, 1 (b) 1, 2 (c) 4, 1 (d) 1, 4

Q11. CBSE 2026 · 1 mark Assertion (A): Photoelectric current depends upon the intensity of the incident radiation. Reason (R): Stopping potential is independent of the intensity of the incident radiation.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q12. CBSE 2026 · 1 mark The velocity of the photoelectrons emitted from a surface depends upon the:

- (a) Wavelength of incident radiation only
(b) Intensity of incident radiation only
(c) Work function of the surface only
(d) Both wavelength of the incident radiation and work function of the surface

Q13. CBSE 2026 · 1 mark The ratio of the de Broglie wavelengths associated with the electron revolving in the first and third orbits in hydrogen atom is:

- (a) 2 (b) 1/2 (c) 3 (d) 1/3

Q14. CBSE 2026 · 1 mark While studying photoelectric emission from a given surface, the wavelength of the incident radiation is changed from 600 nm to 400 nm, keeping the intensity of radiation the same. Then:

- (a) cut-off potential will decrease
(b) cut-off potential will increase
(c) saturation current will decrease
(d) saturation current will increase

Q15. CBSE 2026 · 1 mark Radiation of wavelength 331 nm irradiates the following metals: Na (work function 1.92 eV), K (work function 2.15 eV), Ca (work function 3.20 eV), Mo (work function 4.17 eV). Which of the following statements is correct?

- (a) Only Na and K show photoelectric emission
(b) Only Mo will not show photoelectric emission
(c) All of the given metals show photoelectric emission
(d) None of them show photoelectric emission

Q16. CBSE 2026 · 1 mark The kinetic energy of a charged particle is increased to four times of its initial value. The de Broglie wavelength associated with the particle will:

- (a) increase by 100% of its initial value
(b) increase by 50% of its initial value
(c) decrease by 25% of its initial value
(d) decrease by 50% of its initial value

Q17. CBSE 2026 · 1 mark In an experiment on photoelectric emission, the intensity of incident radiation is halved keeping its frequency constant. As a result:

- (a) cut-off potential will increase
(b) maximum kinetic energy of photoelectrons will remain the same
(c) photocurrent will increase
(d) cut-off potential will decrease

Q18. CBSE 2026 · 1 mark Photons of frequency ν are incident on the surfaces of two metals A and B of threshold frequencies $\nu/2$ and $\nu/3$. The ratio of maximum kinetic energy of electrons emitted from metal A to that from metal B is:

- (a) 1/3 (b) 3/4 (c) 2/3 (d) 3/2

Q19. CBSE 2026 · 1 mark Light of which of the following colours will have the maximum energy in a photon associated with it?

- (a) Red light (b) Yellow light (c) Green light (d) Blue light



Q20. CBSE 2026 · 1 mark Assertion (A): Photoelectric effect is a spontaneous phenomenon. Reason (R): According to the wave picture of radiation, an electron would take hours/days to absorb sufficient energy to overcome the work function and come out from a metal surface.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q21. CBSE 2026 · 1 mark The momentum of a photon associated with a microwave of wavelength 4.00 cm is :

- (a) $1.66 \times 10^{-32} \text{ kg ms}^{-1}$ (b) $1.83 \times 10^{-34} \text{ kg ms}^{-1}$
- (c) $2.05 \times 10^{-34} \text{ kg ms}^{-1}$ (d) $1.66 \times 10^{-34} \text{ kg ms}^{-1}$

Q22. CBSE 2026 · 1 mark A 500 nm photon is incident normally on a perfectly reflecting surface and is reflected. The value of momentum transferred to the surface is:

- (a) $3.87 \times 10^{-43} \text{ kg ms}^{-1}$ (b) $2.5 \times 10^{-30} \text{ kg ms}^{-1}$
- (c) $2.65 \times 10^{-27} \text{ kg ms}^{-1}$ (d) $1.33 \times 10^{-27} \text{ kg ms}^{-1}$

Q23. CBSE 2025 · 1 mark Choose the correct statement :

- (a) Photons of light show diffraction whereas electrons do not show diffraction.
- (b) Electrons have momentum whereas photons do not have momentum.
- (c) Photons of light and electrons both exhibit dual nature.
- (d) All electromagnetic radiations do not have photons.

Q24. CBSE 2025 · 1 mark A beam of red light and a beam of blue light have equal intensities. Which of the following statements is true ?

- (a) The blue beam has more number of photons than the red beam.
- (b) The red beam has more number of photons than the blue beam.
- (c) Wavelength of red light is lesser than wavelength of blue light.
- (d) The blue light beam has lesser energy per photon than that in the red light beam.

Q25. CBSE 2025 · 1 mark Assertion (A) : For monochromatic incident radiation, the emitted photoelectrons from a given metal have speed ranging from zero to a certain maximum value. Reason (R) : Each metal has a definite work function.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q26. CBSE 2025 · 1 mark The kinetic energy of an alpha particle is four times the kinetic energy of a proton. The ratio (λ_α/λ_p) of de Broglie wavelengths associated with them will be:

- (a) 1/16 (b) 1/8 (c) 1/4 (d) 1/2

Q27. CBSE 2025 · 1 mark The work function of a material is 2.21 eV. Which of the following cannot produce photoelectrons from it?

- (a) Red light (b) Blue light (c) Violet light (d) Green light

Q28. CBSE 2025 · 1 mark The momentum (in kg m/s) of a photon of frequency $6.0 \times 10^{14} \text{ Hz}$ is:

- (a) 6.63×10^{-25} (b) 1.326×10^{-27} (c) 2.652×10^{-26}
- (d) 3.978×10^{-24}

Q29. CBSE 2025 · 1 mark Assertion (A): X-rays are produced when slow moving electrons are stopped by a metal target of high atomic number. Reason (R): X-rays consist of low-energy photons.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q30. CBSE 2025 · 1 mark The de Broglie wavelength associated with an electron moving with energy 5 eV is:

- (a) 0.75 nm (b) 1.2 nm (c) 2.4 nm (d) 0.55 nm

Q31. CBSE 2025 · 1 mark The wavelength of a photon is equal to the wavelength associated with an electron. Both will have the same value of:

- (a) energy (b) angular momentum (c) velocity
- (d) linear momentum

Q32. CBSE 2025 · 1 mark The frequency of a photon of energy 1.326 eV is:

- (a) $1.18 \times 10^{14} \text{ Hz}$ (b) $3.20 \times 10^{14} \text{ Hz}$ (c) $4.20 \times 10^{15} \text{ Hz}$
- (d) $4.80 \times 10^{15} \text{ Hz}$

Q33. CBSE 2025 · 1 mark Assertion (A): The minimum negative potential applied to the anode in a photoelectric experiment at which photoelectric current becomes zero, is called cut-off voltage. Reason (R): The threshold frequency for a metal is the minimum frequency of incident radiation below which emission of photoelectrons does not take place.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q34. CBSE 2025 · 1 mark The stopping potential V_0 measured in a photoelectric experiment for a metal surface is plotted against frequency ν of the incident radiation. Let m be the slope of the straight line so obtained. Then the value of charge of an electron is given by (h is the Planck's constant.)

- (a) mh (b) m/h (c) h/m (d) $1/(mh)$

Q35. CBSE 2025 · 1 mark Let λ_e , λ_p and λ_d be the wavelengths associated with an electron, a proton and a deuteron, all moving with the same speed. Then the correct relation between them is

- (a) $\lambda_d > \lambda_p > \lambda_e$ (b) $\lambda_e > \lambda_p > \lambda_d$ (c) $\lambda_p > \lambda_e > \lambda_d$
- (d) $\lambda_e = \lambda_p = \lambda_d$



Q36. CBSE 2024 · 1 mark Two beams, A and B whose photon energies are 3.3 eV and 11.3 eV respectively, illuminate a metallic surface (work function 2.3 eV) successively. The ratio of maximum speed of electrons emitted due to beam A to that due to beam B is:

- (a) 3 (b) 9 (c) $1/3$ (d) $1/9$

Q37. CBSE 2024 · 1 mark The waves associated with a moving electron and a moving proton have the same wavelength λ . It implies that they have the same:

- (a) momentum (b) angular momentum (c) speed
(d) energy

Q38. CBSE 2024 · 1 mark Assertion (A): In photoelectric effect, the kinetic energy of the emitted photoelectrons increases with increase in the intensity of the incident light. Reason (R): Photoelectric current depends on the wavelength of the incident light.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Assertion (A) is false and Reason (R) is also false

Q39. CBSE 2024 · 1 mark The work function for a photosensitive surface is 3.315 eV. The cut-off wavelength for photoemission of electrons from this surface is:

- (a) 150 nm (b) 200 nm (c) 375 nm (d) 500 nm

Q40. CBSE 2024 · 1 mark Assertion (A): Photoelectric current increases with an increase in intensity of incident radiation, for a given frequency of incident radiation and the accelerating potential. Reason (R): Increase in the intensity of incident radiation results in an increase in the number of photoelectrons emitted per second and hence an increase in the photocurrent.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q41. CBSE 2024 · 1 mark A photosensitive surface has a work function of 2.00 eV. The maximum kinetic energy of electrons ejected from this surface by radiation of wavelength 300 nm is:

- (a) 0.54 eV (b) 1.07 eV (c) 1.61 eV (d) 2.14 eV

Q42. CBSE 2024 · 1 mark The momentum (in SI units) associated with a photon of energy 1.5 eV is :

- (a) 4×10^{-27} (b) 8×10^{-28} (c) 2×10^{-30} (d) 6×10^{-29}

Q43. CBSE 2024 · 1 mark A proton and an alpha particle having equal velocities approach a target nucleus. They come momentarily to rest and then reverse their directions. The ratio of the distance of closest approach of the proton to that of the alpha particle will be :

- (a) $1/2$ (b) 2 (c) $1/4$ (d) 4

Q44. CBSE 2024 · 1 mark Assertion (A) : Photoelectric effect demonstrates the particle nature of light. Reason (R) : Photoelectric current is proportional to frequency of incident radiation.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q45. CBSE 2024 · 1 mark The wavelength of matter wave associated with an electron of kinetic energy K is λ . If the kinetic energy of the electron is doubled, the associated wavelength becomes:

- (a) 2λ (b) $\lambda/\sqrt{2}$ (c) $\lambda/2$ (d) $\lambda/2\sqrt{2}$

Q46. CBSE 2023 · 1 mark Assertion (A): Photoelectric effect demonstrates the particle nature of light. Reason (R): Photoelectric current is proportional to intensity of incident radiation for frequencies more than the threshold frequency.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is false
(d) Assertion (A) is false and Reason (R) is also false

Q47. CBSE 2023 · 1 mark In an experiment, photons of energy 7.5 eV are incident on a metal surface. Electrons emitted from the metal surface are stopped by an electrode at a potential of -4.5 V w.r.t. the metal. The work function of the metal is:

- (a) 3.0 eV (b) 4.5 eV (c) 7.5 eV (d) 12.0 eV

Q48. CBSE 2023 · 1 mark A graph is plotted between the stopping potential (on y-axis) and the frequency of incident radiation (on x-axis) for a metal. The product of the slope of the straight line obtained and the magnitude of charge on an electron is equal to :

- (a) h (b) h/c (c) $2h/c$ (d) $h/(2c)$

Q49. CBSE 2023 · 1 mark Light of frequency 6.4×10^{14} Hz is incident on a metal of work function 2.14 eV. The maximum kinetic energy of the emitted electrons is about:

- (a) 0.25 eV (b) 0.51 eV (c) 1.02 eV (d) 0.10 eV

Q50. CBSE 2023 · 1 mark In an experiment on photoelectric effect, the intensity of incident radiation is increased, keeping the frequency ν the same. The number of photoelectrons emitted will:

- (a) increase (b) decrease (c) remain same
(d) depend on frequency

Q51. CBSE 2023 · 1 mark Photons of energy 3.2 eV are incident on a photosensitive surface. If the stopping potential for the emitted electrons is 1.5 V, the work function for the surface is :

- (a) 1.5 eV (b) 1.7 eV (c) 3.2 eV (d) 4.7 eV

Q52. CBSE 2023 · 1 mark A proton and an alpha particle have the same kinetic energy. The ratio of de Broglie wavelengths associated with the proton to that with the alpha particle is :

- (a) 1 (b) 2 (c) $2\sqrt{2}$ (d) $1/2$



Q53. CBSE 2023 · 1 mark Photons of energy 4.3 eV are incident on a photosensitive surface of work function 2.3 eV. The stopping potential for photoelectrons is:

- (a) 2.0 eV (b) 2.3 eV (c) 4.3 eV (d) 6.6 eV

Q54. CBSE 2023 · 1 mark A light of frequency ν is incident on a metal surface whose work function is W_0 . The kinetic energy of emitted electron is K . If the frequency of the incident light is doubled then the kinetic energy of emitted electron will be:

- (a) $2K$ (b) more than $2K$ (c) between K and $2K$
(d) less than K

VERY SHORT ANSWER (15)

Q55. CBSE 2026 · 2 marks In a photoelectric experiment, the emitter plate is irradiated with radiation of 200 nm. The photocurrent becomes zero when the collector plate potential is -0.80 V. Calculate the work function (in eV) of the emitter.

Q56. CBSE 2026 · 2 marks Find the ratio (λ_a/λ_p) of de Broglie wavelength λ_a associated with an alpha particle to de Broglie wavelength λ_p associated with a proton if both are moving with the (a) same velocity (b) same kinetic energy.

Q57. CBSE 2026 · 2 marks In an electron microscope, accelerated electrons have wavelength of 0.011 nm. Calculate the voltage through which electrons were accelerated to attain this wavelength. (Take $e = 1.6 \times 10^{-19}$ C, $m_e = 9 \times 10^{-31}$ kg, $h = 6.6 \times 10^{-34}$ J.s)

Q58. CBSE 2026 · 2 marks Find ratio (λ_a/λ_p) of the de Broglie wavelength λ_a and λ_p associated respectively with an alpha particle and a proton, (i) if they are moving with the same kinetic energy. (ii) just after they are accelerated through the same potential difference.

Q59. CBSE 2026 · 2 marks What is meant by threshold frequency (ν_0) for photoelectric emission? Does it depend on the intensity of light? How does photoelectric current vary with the intensities of radiation of frequency $\nu(>\nu_0)$?

Q60. CBSE 2026 · 2 marks A particle of mass M at rest splits up into two particles of masses m_1 and m_2 having non-zero velocities. Calculate the ratio of the de Broglie wavelengths associated with the two particles.

Q61. CBSE 2026 · 2 marks Calculate the de Broglie wavelength of a neutron having kinetic energy of 150 eV.

Q62. CBSE 2026 · 2 marks Light of frequency 5.0×10^{14} Hz is incident on a metal surface. If the maximum speed of photoelectrons emitted is 6.63×10^5 ms $^{-1}$, calculate the threshold frequency for the surface.

Q63. CBSE 2025 · 2 marks The threshold frequency for a given metal is 3.6×10^{14} Hz. If monochromatic radiations of frequency 6.8×10^{14} Hz are incident on this metal, find the cut-off potential for the photoelectrons.

Q64. CBSE 2025 · 2 marks A laser beam of frequency 3.0×10^{14} Hz produces average power of 9 mW. Find (i) the energy of photon of the beam, and (ii) the number of photons emitted per second on an average by the source.

Q65. CBSE 2025 · 2 marks A laser beam of wavelength 500 nm and power 5 mW strikes normally on a perfectly reflecting surface of area 1 mm ^{2} of a body. It rebounds back from the surface. Find the force exerted by the laser beam on the body.

Q66. CBSE 2025 · 2 marks Define the 'distance of closest approach'. An α -particle of kinetic energy K is bombarded on a thin gold foil. Derive an expression for the 'distance of closest approach'.

Q67. CBSE 2024 · 2 marks Consider a neutron (mass m) of kinetic energy E and a photon of the same energy. Let λ_n and λ_p be the de Broglie wavelength of neutron and the wavelength of photon respectively. Obtain an expression for λ_n/λ_p .

Q68. CBSE 2024 · 2 marks Light of wavelength 500 nm is incident on caesium metal (work function 2.14 eV) and photoemission of electrons occurs. Calculate the (i) kinetic energy (in eV) of the fastest electrons and (ii) stopping potential for this situation. (Take $hc = 1240$ eV.nm)

Q69. CBSE 2024 · 2 marks Light of wavelength 600 nm is incident on potassium (work function 2.3 eV). Will photoemission of electrons occur? What is the longest wavelength that will cause photoemission of electrons? (Take $hc = 1240$ eV. nm)

SHORT ANSWER (21)

Q70. CBSE 2026 · 3 marks (a) A particle of charge q and mass m is accelerated through a potential difference V . Deduce an expression for the de Broglie wavelength associated with the particle.

Q71. CBSE 2026 · 3 marks (a) Explain how the dual aspect of matter is evident in the de Broglie relation. (b) Radiation of wavelength λ is incident on a photosensitive surface. Find the de Broglie wavelength of electrons emitted from the surface. Assume that the work function of the surface is negligible.

Q72. CBSE 2026 · 3 marks Photoemission of electrons occurs from a metal ($\phi_0 = 1.96$ eV) when light of frequency 6.4×10^{14} Hz is incident on it. Calculate: (a) Energy of a photon in the incident light, (b) The maximum kinetic energy of the emitted electrons, and (c) The stopping potential.

Q73. CBSE 2026 · 3 marks What are de Broglie waves? Show that the wavelength of the electromagnetic radiation is equal to the de Broglie wavelength of its quantum (photon).

Q74. CBSE 2025 · 3 marks Explain the following observations using Einstein's photoelectric equation: (a) Photoelectric emission does not occur from a surface when the frequency of the light incident on it is less than a certain minimum value. (b) It is the frequency, and not the intensity of the incident light which affects the maximum kinetic energy of the photoelectrons. (c) The cut-off voltage (V_0) versus frequency (ν) of the incident light curve is a straight line with a slope h/e .

Q75. CBSE 2025 · 3 marks (a) Photoelectric emission does not occur from a surface when the frequency of the light incident on it is less than a certain minimum value. (b) It is the frequency, and not the intensity of the incident light which affects the maximum kinetic energy of the photoelectrons. (c) The cut-off voltage (V_0) versus frequency (ν) of the incident light curve is a straight line with a slope h/e .



Q76. CBSE 2025 · 3 marks The work function of a metal is 2.4 eV. A stopping potential of 0.6 V is required to reduce the photocurrent to zero, in a photoelectric experiment. Calculate the wavelength of light used.

Q77. CBSE 2025 · 3 marks Explain the phenomenon of photoelectric effect. Four metals with their work functions are listed below: K = 2.3 eV, Na = 2.75 eV, Mo = 4.17 eV and Ni = 5.15 eV. The radiation of wavelength 330 nm from a laser source placed 1 m away, falls on these metals. Which of these metals will not show photoelectric emission? What will happen if the laser source is brought closer to a distance of 50 cm?

Q78. CBSE 2025 · 3 marks Answer the following giving reasons: (a) The maximum kinetic energy of the photoelectrons is independent of the intensity of incident radiation. (b) Photoelectric current increases with the increase in the intensity of the incident radiation. (c) The stopping potential V_0 varies linearly with the frequency ν of the incident radiation for a given photosensitive surface.

Q79. CBSE 2025 · 3 marks Answer the following giving reason : (a) All the photo electrons do not eject with the same kinetic energy when monochromatic light is incident on a metal surface. (b) The saturation current in case (a) is different for different intensity. (c) If one goes on increasing the wavelength of light incident on a metal surface, keeping its intensity constant, emission of photo electrons stop at a certain wavelength for this metal.

Q80. CBSE 2024 · 3 marks (a) Briefly explain de Broglie hypothesis for wave nature of matter. (b) Find the ratio of de Broglie wavelength associated with a proton and an alpha particle when both are (i) accelerated from rest through the same potential difference, and (ii) moving with the same kinetic energy.

Q81. CBSE 2023 · 3 marks Explain briefly how Einstein's photoelectric equation explains the ejection of electrons from a metal surface. Plot the variation of photocurrent with: (a) collector plate potential for different intensity of incident radiation, and (b) intensity of incident radiation.

Q82. CBSE 2023 · 3 marks A particle is associated with a de Broglie wave of wavelength 1.2 nm. The kinetic energy of the particle is made four times. Calculate the new value of the wavelength of the wave.

Q83. CBSE 2023 · 3 marks Calculate the wavelength of de Broglie waves associated with a proton having (500/1.673) eV energy. How will the wavelength be affected for an alpha particle having the same energy ?

Q84. CBSE 2023 · 3 marks A particle of mass m and charge q is accelerated through a potential difference V . Plot a graph of de Broglie wavelength λ associated with it as a function of V . Calculate the energy acquired by and de Broglie wavelength associated with, an electron accelerated through a potential difference of 400 V.

Q85. CBSE 2022 · 3 marks Find the ratio of the de Broglie wavelengths associated with an alpha particle and a proton, if both (a) have the same speeds, (b) have the same kinetic energy, (c) are accelerated through the same potential difference.

Q86. CBSE 2022 · 2 marks (b) Photoelectric emission occurs when a surface is irradiated with the radiation of frequency (i) ν_1 , and (ii) ν_2 . The maximum kinetic energy of the electrons emitted in the two cases are K and $2K$ respectively. Obtain the expression for the threshold frequency for the surface.

Q87. CBSE 2022 · 2 marks What are matter waves? A proton and an alpha particle are accelerated through the same potential difference. Find the ratio of the de Broglie wavelength associated with the proton to that with the alpha particle.

Q88. CBSE 2022 · 3 marks Use Einstein photoelectric equation to depict the variation of the maximum kinetic energy (E_k) of electrons emitted, with the frequency (ν) of the incident radiation.

Q89. CBSE 2022 · 3 marks The wavelength of the waves associated with a particle having kinetic energy E is λ . How and by what factor should its kinetic energy be changed so that the wavelength becomes $(\lambda/2)$? Also, find the ratio of the final to the initial velocity of the particle.

Q90. CBSE 2022 · 3 marks A proton is accelerated through a potential difference V . After acceleration, the de Broglie wavelength associated with it is λ . If the proton is replaced by an alpha particle, then find the de Broglie wavelength associated with it if it were accelerated through the same potential difference V . What will be the momentum of the alpha particle?

12 Atoms

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (26)

Q1. CBSE 2026 · 1 mark Assertion (A): In Bohr model of hydrogen atom, the energy levels are discrete and quantised. Reason (R): In a hydrogen atom, the electrostatic force on the electron provides the necessary centripetal force to it to revolve around the nucleus.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q2. CBSE 2026 · 1 mark The ratio of the potential energy to the kinetic energy of an electron in n^{th} orbit of Bohr model of hydrogen atom is

- (a) $-1/2$ (b) $1/2$ (c) 2 (d) -2

Q3. CBSE 2026 · 1 mark In Bohr model of hydrogen atom, for large values of n , the distance between the consecutive orbits is proportional to

- (a) $\sqrt{n}$ (b) n (c) n^2 (d) n^3



Q4. CBSE 2026 · 1 mark In Bohr model of hydrogen atom, the electron makes a transition from $n = 5$ to $n = 1$ state. As a result, a photon of wavelength λ is emitted in the process. The wavelength of the photon emitted when an electron makes a transition from energy level $n = 5$ to $n = 2$ will be

- (a) $8\lambda/7$ (b) $24\lambda/7$ (c) $16\lambda/7$ (d) $32\lambda/7$

Q5. CBSE 2026 · 1 mark In Bohr model of hydrogen atom, the value of potential energy of an electron in n^{th} orbit varies with 'n' as

- (a) $1/n^2$ (b) $1/n$ (c) n (d) n^2

Q6. CBSE 2026 · 1 mark In Bohr model of hydrogen atom, an electron makes a transition from $n = 4$ state to $n = 1$ state and a photon of frequency ν is emitted. The frequency of photon emitted when an electron makes a transition from $n = 4$ state to $n = 2$ state in the same model is

- (a) $\nu/3$ (b) $\nu/4$ (c) $\nu/5$ (d) $\nu/6$

Q7. CBSE 2026 · 1 mark In Bohr model of hydrogen atom, an electron is moving in an orbit, with total energy -3.4 eV. Its angular momentum will be

- (a) 1.05×10^{-34} J s (b) 6.63×10^{-34} J s (c) 3.31×10^{-34} J s
(d) 2.1×10^{-34} J s

Q8. CBSE 2026 · 1 mark According to Bohr model of hydrogen atom, the time period of an electron in its n^{th} orbit is proportional to

- (a) n (b) n^2 (c) n^3 (d) n^4

Q9. CBSE 2026 · 1 mark Suppose there is an atom that contains five energy levels. How many transitions are possible in which photons are emitted ?

- (a) 4 (b) 5 (c) 10 (d) 15

Q10. CBSE 2026 · 1 mark In Bohr's model of hydrogen atom, the potential energy of the electron in the ground state is –

- (a) -27.2 eV (b) 27.2 eV (c) -13.6 eV (d) 13.6 eV

Q11. CBSE 2026 · 1 mark Paschen series in spectrum of hydrogen atom lies in:

- (a) infrared region (b) ultraviolet region (c) visible region
(d) partly in ultraviolet region and partly in visible region

Q12. CBSE 2026 · 1 mark The energy of an electron in an orbit in hydrogen atom is -3.4 eV. Its angular momentum in the orbit will be:

- (a) $3h/(2\pi)$ (b) $2h/\pi$ (c) h/π (d) $h/(2\pi)$

Q13. CBSE 2026 · 1 mark The energy of an electron revolving in the n^{th} orbit in Bohr model of hydrogen atom is proportional to :

- (a) n^2 (b) n (c) $1/n$ (d) $1/n^2$

Q14. CBSE 2025 · 1 mark Assertion (A) : The Balmer series in hydrogen atom spectrum is formed when the electron jumps from higher energy state to the ground state. Reason (R) : In Bohr's model of hydrogen atom, the electron can jump between successive orbits only.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q15. CBSE 2025 · 1 mark Out of the four options given, in which transition will the emitted photon have the maximum wavelength?

- (a) $n = 4$ to $n = 3$ (b) $n = 3$ to $n = 2$ (c) $n = 2$ to $n = 1$
(d) $n = 3$ to $n = 1$

Q16. CBSE 2025 · 1 mark The minimum energy required to free the electron from the ground state of the hydrogen atom is:

- (a) 3.4 eV (b) less than 3.4 eV (c) 13.6 eV
(d) between 13.6 eV and 3.4 eV

Q17. CBSE 2025 · 1 mark Assertion (A) : The potential energy of an electron revolving in any stationary orbit in a hydrogen atom is positive. Reason (R) : The total energy of a charged particle is always positive.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

Q18. CBSE 2024 · 1 mark The transition of electron that gives rise to the formation of the second spectral line of the Balmer series in the spectrum of hydrogen atom corresponds to:

- (a) $n_f = 2$ and $n_i = 3$ (b) $n_f = 3$ and $n_i = 4$
(c) $n_f = 2$ and $n_i = 4$ (d) $n_f = 2$ and $n_i = \infty$

Q19. CBSE 2024 · 1 mark Energy levels A, B and C of an atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$. Let λ_1 , λ_2 and λ_3 be the wavelengths of radiation corresponding to the transitions C to B, B to A and C to A, respectively. The correct relation between λ_1 , λ_2 and λ_3 is:

- (a) $\lambda_1^2 + \lambda_2^2 = \lambda_3^2$ (b) $1/\lambda_1 + 1/\lambda_2 = 1/\lambda_3$ (c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$
(d) $\lambda_1 + \lambda_2 = \lambda_3$

Q20. CBSE 2024 · 1 mark An alpha particle approaches a gold nucleus in Geiger-Marsden experiment with kinetic energy K. It momentarily stops at a distance d from the nucleus and reverses its direction. Then d is proportional to:

- (a) $1/K$ (b) K (c) $1/\sqrt{K}$ (d) $\sqrt{K}$

Q21. CBSE 2024 · 1 mark An electron makes a transition from $n = 2$ level to $n = 1$ level in the Bohr model of a hydrogen atom. Its period of revolution :

- (a) increases by 87.5% (b) decreases by 87.5%
(c) increases by 43.75% (d) decreases by 43.75%



Q22. CBSE 2024 · 1 mark A proton and an alpha particle having equal velocities approach a target nucleus. They come momentarily to rest and then reverse their directions. The ratio of the distance of closest approach of the proton to that of the alpha particle will be :

- (a) 2 (b) 1/2 (c) 4 (d) 1/4

Q23. CBSE 2023 · 1 mark The radius of the n^{th} orbit in Bohr model of hydrogen atom is proportional to:

- (a) $1/n^2$ (b) $1/n$ (c) n^2 (d) n

Q24. CBSE 2023 · 1 mark Hydrogen atom initially in the ground state, absorbs a photon which excites it to $n = 5$ level. The wavelength of the photon is:

- (a) 975 nm (b) 740 nm (c) 523 nm (d) 95 nm

Q25. CBSE 2023 · 1 mark The ratio of maximum frequency and minimum frequency of light emitted in Balmer series of hydrogen spectrum, in Bohr's model is :

- (a) 11/9 (b) 9/5 (c) 11/7 (d) 16/7

Q26. CBSE 2023 · 1 mark The potential energy of an electron in the second excited state in hydrogen atom is :

- (a) -3.4 eV (b) -3.02 eV (c) -1.51 eV (d) -6.8 eV

VERY SHORT ANSWER (8)

Q27. CBSE 2025 · 2 marks Find the ratio of minimum to maximum wavelength of radiations emitted when electron jumps from higher energy state into ground state of hydrogen atom.

Q28. CBSE 2025 · 2 marks For a hydrogen atom, find the change in the radius of its orbit when an electron makes a transition from $n = 3$ state to $n = 2$ state.

Q29. CBSE 2025 · 2 marks Prove that, in Bohr model of hydrogen atom, the time period of revolution of an electron in n^{th} orbit is proportional to n^3 .

Q30. CBSE 2024 · 2 marks In Bohr model of hydrogen atom, find the ratio of period of revolution of the electron in the orbit $n = 2$ to that in the orbit $n = 1$.

Q31. CBSE 2023 · 2 marks The ground state energy of hydrogen atom is -13.6 eV. What is the potential energy and kinetic energy of an electron in the third excited state?

Q32. CBSE 2023 · 2 marks The ground state energy of hydrogen atom is -13.6 eV in Bohr model. An electron makes a transition from an energy level of -1.51 eV to that of -3.4 eV. Calculate the wavelength of the spectral line emitted.

Q33. CBSE 2022 · 2 marks (a) (i) Define impact parameter and distance of closest approach of an α -particle in Geiger-Marsden scattering experiment. (ii) What will be the value of the impact parameter for scattering angle (I) $\theta = 0^\circ$ and (II) $\theta = 180^\circ$?

Q34. CBSE 2022 · 2 marks (a) (i) In Geiger-Marsden scattering experiment, define the impact parameter for an alpha particle. (ii) What will be the value of the impact parameter for scattering angle (I) $\theta = 0^\circ$ and (II) $\theta = 180^\circ$?

SHORT ANSWER (24)

Q35. CBSE 2026 · 3 marks (a) State Bohr's second postulate and mention its significance. (b) Prove that, in Bohr model of hydrogen atom as principal quantum number n becomes large, the energy levels get closer and closer.

Q36. CBSE 2026 · 3 marks Calculate the de Broglie wavelength associated with an electron revolving in the second excited state of hydrogen atom. The ground state energy of the hydrogen atom is -13.6 eV. Take $m_e = 9 \times 10^{-31}$ kg, $h = 6.6 \times 10^{-34}$ J.s.

Q37. CBSE 2026 · 3 marks The total energy of an electron in an orbit in Bohr model of hydrogen atom is -3.4 eV. Calculate: (i) the angular momentum of the electron, in this orbit and (ii) the potential energy of the electron, in this orbit.

Q38. CBSE 2026 · 3 marks In Bohr model of hydrogen atom, calculate: (a) the radius of the innermost electron orbit, and (b) the speed of electron in this orbit.

Q39. CBSE 2026 · 3 marks (b) (i) Draw the number of scattered particles versus the scattering angle graph for scattering of alpha particles by a thin foil. Write two important conclusions that can be drawn from this plot. (ii) If Bohr's quantization postulate (angular momentum $= nh/(2\pi)$) is a basic law of nature, it should be equally valid for the case of planetary motion also. Why, then, do we never speak of quantization of orbits of planets around the Sun? Explain.

Q40. CBSE 2025 · 3 marks How is the necessary force provided to an electron to keep it moving in a circular orbit according to Bohr model of hydrogen atom? Derive an expression for the total energy of an electron moving in an orbit of radius r in hydrogen atom. Give the significance of negative sign in this expression.

Q41. CBSE 2025 · 3 marks Describe briefly Geiger-Marsden scattering experiment. Depict the graph showing the variation of number of scattered particles detected with the scattering angle. How did this graph lead to the discovery of the nucleus?

Q42. CBSE 2025 · 3 marks In Bohr model of hydrogen atom, an electron is revolving in second orbit. Find the value of: (i) angular momentum of electron, (ii) radius of the orbit, and (iii) kinetic energy of electron. Take radius of first orbit of hydrogen atom as $0.5 \text{ \AA}$.

Q43. CBSE 2025 · 3 marks Using Bohr's postulates of the theory of the hydrogen atom, prove that, for an electron revolving in the n^{th} orbit, (a) the radius of the orbit is proportional to n^2 , and (b) the total energy of the atom is proportional to $(1/n^2)$.

Q44. CBSE 2025 · 3 marks State Bohr's postulates for the hydrogen atom. Using them prove that, for an electron revolving in the n^{th} orbit, (a) the radius of the orbit is proportional to n^2 , and (b) the total energy of the atom is proportional to $1/n^2$.

Q45. CBSE 2025 · 3 marks Write Bohr's postulates for the hydrogen atom. Using them prove that, for an electron revolving in the n^{th} orbit, (a) the radius of the orbit is proportional to n^2 , and (b) the total energy of the atom is proportional to $(1/n^2)$.

Q46. CBSE 2024 · 3 marks Write the drawbacks of Rutherford's atomic model. How did Bohr remove them? Show that different orbits in Bohr's atom are not equally spaced.



Q47. CBSE 2024 · 3 marks State the three postulates of Bohr's theory of hydrogen atom. A hydrogen atom de-excites from level n to level $(n - 1)$. Show that, for large values of n , the frequency of emitted radiation $\nu \propto 1/n^3$, where the constant of proportionality has dimensions of frequency. This result exactly agrees with that obtained from classical physics.

Q48. CBSE 2024 · 3 marks Using Bohr's postulates, derive the expression for the radius of the n^{th} orbit of an electron in a hydrogen atom. Also find the numerical value of a_0 .

Q49. CBSE 2024 · 3 marks State Bohr's first and second postulates. Use them to derive an expression for the radius of the n^{th} orbit in a hydrogen atom.

Q50. CBSE 2024 · 3 marks Using Bohr theory. Draw the energy level diagram of hydrogen atom showing its various spectral series.

Q51. CBSE 2024 · 3 marks State Bohr's second postulate for his theory of hydrogen atom. Prove that a hydrogen atom radius is directly proportional to n^2 , where n is the principal quantum number.

Q52. CBSE 2023 · 3 marks Draw the energy level diagram for hydrogen atom. Mark the transitions corresponding to the series lying in the ultraviolet region, visible region and infrared region.

Q53. CBSE 2023 · 3 marks Briefly explain Geiger-Marsden experiment. Show the variation of the number of particles scattered (N) with scattering angle (θ) in this experiment. What is the main conclusion that can be inferred from this plot?

Q54. CBSE 2023 · 3 marks An electron cannot revolve around the nucleus in a hydrogen atom at an arbitrary distance. Explain.

Q55. CBSE 2022 · 3 marks The energy of a hydrogen atom in the first excited state is -3.4 eV. Find: (a) the radius of this orbit. (Take Bohr radius = $0.53 \text{ \AA}$) (b) the angular momentum of the electron in the orbit. (c) the kinetic and potential energy of the electron in the orbit.

Q56. CBSE 2022 · 2 marks Define the terms : 'impact parameter' and 'distance of closest approach' for an α -particle in Geiger-Marsden scattering experiment.

Q57. CBSE 2022 · 3 marks An electron is in the third excited state in a hydrogen atom. It undergoes transitions to the lower energy states. (a) What is the maximum number of spectral lines that can be emitted? (b) Calculate the minimum wavelength of the spectral lines emitted.

Q58. CBSE 2022 · 2 marks Name the spectral series for a hydrogen atom which lies in the visible region. Find the ratio of the maximum to the minimum wavelengths of this series.

CASE-BASED (1)

CASE STUDY · CBSE 2025

A hydrogen atom consists of an electron revolving in a circular orbit of radius r with certain velocity v around a proton located at the nucleus of the atom. The electrostatic force of attraction between the revolving electron and the proton provides the requisite centripetal force to keep it in certain stable orbits. The angular momentum of the electron in these orbits is some integral multiple of $h/(2\pi)$. Further, when an electron makes a transition from one orbit of higher energy to that of lower energy, a photon is emitted having energy equal to the difference between energies of the initial and final states. Assuming the mass and charge of an electron as m and e respectively.

Q59. CBSE 2025 · 1 mark The expression for the speed of electron v in terms of radius of the orbit (r) and physical constant ($K = 1/(4\pi\epsilon_0)$) is :

- (a) $Ke^2/(mr)$ (b) $Ke^2/(mr^2)$ (c) $\sqrt{Ke^2/(mr)}$
(d) $\sqrt{(Ke^2/(mr^2))}$

13 Nuclei

Notes & MCQs →

MULTIPLE CHOICE AND ASSERTION-REASON (24)

Q1. CBSE 2026 · 1 mark The 'distance of closest approach' of an alpha-particle is ' d ' when it moves with a velocity v head-on towards the target nucleus. If the velocity of alpha particle is halved, the new 'distance of closest approach' will be –
(a) $d/2$ (b) $2d$ (c) $d/4$ (d) $4d$

Q2. CBSE 2026 · 1 mark Assertion (A): The mass of a nucleus is less than the sum of the masses of the constituent nucleons. Reason (R): Energy is absorbed when the nucleons are bound together to form a nucleus.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Both Assertion (A) and Reason (R) are false.

Q3. CBSE 2026 · 1 mark The distance-of-closest-approach for an alpha particle is ' d ' when it moves head-on with speed v towards a target nucleus. If the alpha particle is replaced by a proton moving with the same speed, the new distance-of-closest-approach will be
(a) $2d$ (b) d (c) $d/2$ (d) $d/\sqrt{2}$

Q4. CBSE 2026 · 1 mark Which of the following particles do not exist in ${}_{92}\text{U}^{238}$ nucleus?
(a) 92 protons (b) 92 electrons (c) 146 neutrons
(d) 238 nucleons

Q5. CBSE 2026 · 1 mark The main source for energy generation in the stars is –
(a) fusion of lighter nuclei (b) fission of heavy nuclei
(c) chemical reaction (d) fusion of heavy nuclei

Q6. CBSE 2026 · 1 mark If r_1 and r_2 are the radii of atomic nuclei of mass numbers 64 and 27 respectively, then the value of (r_1/r_2) is:
(a) 1 (b) $4/3$ (c) $3/4$ (d) $27/64$



Q7. CBSE 2026 · 1 mark Assertion (A): Nuclear forces are always attractive. Reason (R): The nuclear force between protons and neutrons in a nucleus is a weak force.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q8. CBSE 2026 · 1 mark Nuclides with the same number of neutrons are called:

- (a) Isobars (b) Isotones (c) Isotopes (d) Isomers

Q9. CBSE 2026 · 1 mark The radius of a nucleus of mass number 125 is

- (a) 6.0 fm (b) 30 fm (c) 72 fm (d) 150 fm

Q10. CBSE 2026 · 1 mark Assertion (A): Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion. Reason (R): For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei, it decreases with increasing Z .

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q11. CBSE 2026 · 1 mark Consider the nuclear reaction $X \rightarrow Y + Z$. Let M_x , M_y and M_z be the masses of the three nuclei X , Y and Z respectively. Then which of the following relations hold true?

- (a) $(M_x - M_z) < M_y$ (b) $(M_x - M_y) < M_z$ (c) $M_x > (M_y + M_z)$
 (d) $M_x < (M_y + M_z)$

Q12. CBSE 2025 · 1 mark Assertion (A): During formation of a nucleus, the mass defect produced is the source of the binding energy of the nucleus. Reason (R): For all nuclei, the value of binding energy per nucleon increases with mass number.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q13. CBSE 2025 · 1 mark Assertion (A): The presence of only few alpha particles at angle of scattering greater than 90° led Rutherford to the discovery of nucleus. Reason (R): The size of nucleus is approximately 10^{-5} times the size of an atom and therefore only few alpha particles are rebounded.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q14. CBSE 2025 · 1 mark Assertion (A): Rutherford's observation of the presence of only few alpha particles at angle of scattering greater than 90° led him to the discovery of nucleus. Reason (R): The size of nucleus is approximately 10^{-5} times the size of an atom and therefore only few alpha particles are rebounded.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q15. CBSE 2025 · 1 mark Inside a nucleus, the nuclear forces between proton and proton, proton and neutron, neutron and neutron are F_{pp} , F_{pn} and F_{nn} respectively. Then:

- (a) $F_{pp} > F_{pn} > F_{nn}$ (b) $F_{pn} > F_{nn} > F_{pp}$ (c) $F_{nn} > F_{pp} > F_{pn}$
 (d) $F_{pp} = F_{pn} = F_{nn}$

Q16. CBSE 2025 · 1 mark Assertion (A): The binding energy per nucleon is practically constant for mass number in the range ($30 < A < 170$). Reason (R): Nuclear forces between the nucleons for mass numbers in the range ($30 < A < 170$) are not short-range.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Both Assertion (A) and Reason (R) are false.

Q17. CBSE 2025 · 1 mark Isotones are the nuclides having:

- (a) same mass numbers (b) same atomic numbers
 (c) same neutron number, but different atomic number
 (d) different neutron number, and different mass number

Q18. CBSE 2023 · 1 mark The mass density of a nucleus of mass number A is:

- (a) proportional to $A^{1/3}$ (b) proportional to $A^{2/3}$
 (c) proportional to A^3 (d) independent of A

Q19. CBSE 2023 · 1 mark Two nuclei have their mass numbers in the ratio of 8 : 1. The ratio of their nuclear densities is:

- (a) 8 : 1 (b) 4 : 1 (c) 2 : 1 (d) 1 : 1

Q20. CBSE 2023 · 1 mark Assertion (A): The nucleus ${}^7_3\text{X}$ is more stable than the nucleus ${}^4_3\text{Y}$. Reason (R): ${}^7_3\text{X}$ contains more number of protons.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
 (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
 (c) Assertion (A) is true, but Reason (R) is false.
 (d) Assertion (A) is false and Reason (R) is also false.



Q21. CBSE 2023 · 1 mark Which of the following statements is not true for nuclear forces ?

- (a) They are stronger than Coulomb forces.
- (b) They have about the same magnitude for different pairs of nucleons.
- (c) They are always attractive.
- (d) They saturate as the separation between two nucleons increases.

Q22. CBSE 2023 · 1 mark The difference in mass of ${}^7\text{X}$ nucleus and total mass of its constituent nucleons is 21.00 u. The binding energy per nucleon for this nucleus is equal to the energy equivalent of :

- (a) 3 u (b) 3.5 u (c) 7 u (d) 21 u

Q23. CBSE 2023 · 1 mark The difference in mass of a ${}^7\text{X}$ nucleus and total mass of its constituent nucleons is 21.00 u. The binding energy per nucleon for this nucleus is equal to the energy equivalent of:

- (a) 3 u (b) 3.5 u (c) 7 u (d) 21 u

Q24. CBSE 2023 · 1 mark The difference in mass of a nucleus ${}^7\text{X}$ and total mass of its constituent nucleons is 21.00 u. The binding energy per nucleon for this nucleus is equal to the energy equivalent of:

- (a) 3 u (b) 3.5 u (c) 7 u (d) 21 u

VERY SHORT ANSWER (16)

Q25. CBSE 2026 · 2 marks Draw the plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions that can be drawn from this plot.

Q26. CBSE 2026 · 2 marks Draw a graph showing variation of binding energy per nucleon as a function of mass number A. The binding energy per nucleon for heavy nuclei ($A > 170$) decreases with increase in mass number. Explain its significance.

Q27. CBSE 2026 · 2 marks Suppose a nucleus with mass number $A = 240$ and $B.E./A = 7.6$ MeV, breaks into two nuclei, each of mass number $A = 120$ with $B.E./A = 8.5$ MeV. Calculate the energy released in the process.

Q28. CBSE 2026 · 2 marks Explain the terms mass defect and binding energy. How are they related?

Q29. CBSE 2026 · 2 marks Prove that the density of nuclear matter is same for all nuclei.

Q30. CBSE 2026 · 2 marks Differentiate between nuclear fission and nuclear fusion, giving one example for each.

Q31. CBSE 2025 · 2 marks Calculate the mass of an α -particle in atomic mass unit (u). Given, Mass of a normal helium atom = 4.002603 u, Mass of carbon atom = 1.9926×10^{-26} kg

Q32. CBSE 2025 · 2 marks When a neutron collides with ${}_{92}^{235}\text{U}$, the nucleus gives ${}_{54}^{140}\text{Xe}$ and ${}_{38}^{94}\text{Sr}$ as fission products and two neutrons are ejected. Calculate the mass defect and the energy released (in MeV) in the process. Given: $m({}_{92}^{235}\text{U}) = 235.04393$ u, $m({}_{54}^{140}\text{Xe}) = 139.92164$ u, $m({}_{38}^{94}\text{Sr}) = 93.91536$ u, $m({}_0^1\text{n}) = 1.00866$ u, $1 \text{ u} = 931 \text{ MeV}/c^2$

Q33. CBSE 2025 · 2 marks (a) Why is the mass of a nucleus always less than the sum of the masses of its constituents, i.e. free neutrons and free protons? (b) How is Coulomb repulsion between protons in a nucleus overcome? Explain.

Q34. CBSE 2025 · 2 marks Define the term, 'distance of closest approach'. A proton of 3.95 MeV energy approaches a target nucleus $Z = 79$ in head-on position. Calculate its distance of closest approach.

Q35. CBSE 2025 · 2 marks Briefly explain how energy is produced in stars, giving two examples of the nuclear reactions involved.

Q36. CBSE 2025 · 2 marks Calculate the binding energy per nucleon (in MeV) of a helium nucleus (${}^4_2\text{He}$). Given: $m({}^4_2\text{He}) = 4.002603$ u, $m_n = 1.008665$ u, $m_H = 1.007825$ u, $1 \text{ u} = 931.5 \text{ MeV}/c^2$

Q37. CBSE 2024 · 2 marks The carbon isotope ${}^{12}_6\text{C}$ has a nuclear mass of 12.000000 u. Calculate the binding energy of its nucleus. Given $m_p = 1.007825$ u; $m_n = 1.008665$ u.

Q38. CBSE 2023 · 2 marks Draw a graph showing the variation of binding energy per nucleon as a function of mass number A. The binding energy per nucleon for heavy nuclei ($A > 170$) decreases with the increase in mass number. Explain.

Q39. CBSE 2023 · 2 marks Draw the graph showing the variation of binding energy per nucleon with mass number A of nuclei ($2 < A < 170$). Use this graph to explain the release of energy in nuclear fission.

Q40. CBSE 2023 · 2 marks Show that the density of a nucleus is independent of its mass number. Why are lighter nuclei more stable than heavier nuclei?

SHORT ANSWER (27)

Q41. CBSE 2026 · 3 marks (a) Consider the following nuclides: ${}^{12}_6\text{C}$, ${}^{198}_{80}\text{Hg}$, ${}^{14}_6\text{C}$, ${}^{197}_{79}\text{Au}$. Group them into isotopes and isotones. (b) How does the size of a nucleus depend on its mass number A? Hence prove that the density of nucleus is a constant, independent of A, for all nuclei.

Q42. CBSE 2026 · 3 marks (a) Consider the following nuclides: ${}^{12}_6\text{C}$, ${}^{198}_{80}\text{Hg}$, ${}^{14}_6\text{C}$, ${}^{197}_{79}\text{Au}$. Group them into isotopes and isotones.

Q43. CBSE 2026 · 3 marks Differentiate between nuclear fission and nuclear fusion. Give one example for each with nuclear reaction.

Q44. CBSE 2026 · 3 marks Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation (r). Using this plot, show that the nuclear force is (i) attractive for $r > r_0$, and (ii) repulsive for $r < r_0$.

Q45. CBSE 2026 · 3 marks A deuterium nucleus and an alpha particle approach a target nucleus separately in head-on position. Find the ratio of their distance of closest approach to the nucleus, when both have: (a) the same velocity, and (b) the same momentum.

Q46. CBSE 2026 · 3 marks In the nuclear reaction: ${}_1^2\text{H} + {}_1^2\text{H} \rightarrow {}_2^A\text{X} + {}_0^1\text{n}$ (a) Find the value of A. (b) Calculate the amount of energy released in the reaction. Given: $m({}_1^2\text{H}) = 2.014102$ u, $m({}_2^A\text{X}) = 3.016049$ u, $m({}_0^1\text{n}) = 1.008665$ u, $1 \text{ u} = 931.5 \text{ MeV}/c^2$



Q47. CBSE 2026 · 3 marks (a) Distinguish between isotopes and isobars, giving one example for each. (b) Derive the relation between atomic mass unit (u) and electron volt (eV).

Q48. CBSE 2026 · 3 marks (a) (i) Write any two features of nuclear forces. (ii) If both the number of protons and the neutrons are conserved in each nuclear reaction, in what way is mass converted into energy (or vice versa) in a nuclear reaction? Explain.

Q49. CBSE 2025 · 3 marks Consider the so-called Deuteron-Tritium reaction (also known as D-T fusion or Tritium reaction). In a thermonuclear fusion reactor, the following nuclear reaction occurs: ${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n} + Q$. Find the amount of energy released in the reaction. Given: mass of deuterium = 2.014102 u, mass of tritium = 3.016049 u, mass of helium = 4.002603 u, mass of neutron = 1.008665 u, 1 u = 931 MeV/c²

Q50. CBSE 2025 · 3 marks Find the Q value of the following nuclear reaction: ${}^{12}_6\text{C} + {}^{12}_6\text{C} \rightarrow {}^{20}_{10}\text{Ne} + {}^4_2\text{He}$ Is this reaction exothermic or endothermic? Given: $m({}^{12}_6\text{C}) = 12.000000$ u, $m({}^{20}_{10}\text{Ne}) = 19.992439$ u, $m({}^4_2\text{He}) = 4.002603$ u, 1 u = 931 MeV/c²

Q51. CBSE 2025 · 3 marks (a) Define 'Mass defect' and 'Binding energy' of a nucleus. Describe 'Fission process' on the basis of binding energy per nucleon. (b) A deuteron contains a proton and a neutron and has a mass of 2.013553 u. Calculate the mass defect for it in u and its energy equivalence in MeV. ($m_p = 1.007277$ u, $m_n = 1.008665$ u, 1 u = 931.5 MeV/c²)

Q52. CBSE 2024 · 3 marks (a) State any two properties of a nucleus. (b) Why is the density of a nucleus much more than that of an atom? (c) Show that the density of the nuclear matter is the same for all nuclei.

Q53. CBSE 2024 · 3 marks (a) Write two characteristic properties of nuclear force. (b) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions that can be drawn from the plot.

Q54. CBSE 2024 · 3 marks State any two properties of a nucleus. Why is the density of a nucleus much more than that of an atom? Show that the density of the nuclear matter is the same for all nuclei.

Q55. CBSE 2024 · 3 marks (a) Plot a graph depicting potential energy of a pair of nucleons in a nucleus as a function of their separation. (b) Identify the regions where the nuclear force is (i) attractive, and (ii) repulsive. Justify your answer.

Q56. CBSE 2024 · 3 marks (a) Briefly discuss three characteristics of the forces between nucleons. (b) Which out of ${}^8_4\text{X}$ and ${}^5_3\text{Y}$ nuclei is more stable and why?

Q57. CBSE 2024 · 3 marks Draw a schematic arrangement of Geiger-Marsden experiment. Briefly explain the conclusions drawn from the observations about the structure of the atom. In this context, write the definition of the distance of closest approach.

Q58. CBSE 2024 · 3 marks (a) Define atomic mass unit (u). (b) Calculate the energy required to separate a deuteron into its constituent parts (a proton and a neutron). Given: $m(\text{D}) = 2.014102$ u, $m_H = 1.007825$ u, $m_n = 1.008665$ u

Q59. CBSE 2023 · 3 marks (a) (i) Prove that the nuclear density is same for all nuclei. (ii) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Draw two inferences from this plot.

Q60. CBSE 2023 · 3 marks Prove that the nuclear density is same for all nuclei. Draw a plot of potential energy of a pair of nucleons as a function of their separation. Draw two inferences from this plot.

Q61. CBSE 2023 · 3 marks Distinguish between the impact parameter in alpha particle scattering experiment. Identify, situations when impact parameter is (i) minimum, and (ii) very large.

Q62. CBSE 2023 · 3 marks Draw a plot showing the variation of potential energy of two nucleons as a function of distance between them. Identify the regions in which the force between the nucleons is (i) attractive, and (ii) repulsive. Justify your answers.

Q63. CBSE 2022 · 3 marks (a) Depict the variation of the potential energy of a pair of nucleons with the separation between them. (b) Imagine the fission of a ${}^{56}_{26}\text{Fe}$ into two equal fragments of ${}^{28}_{13}\text{Al}$ nucleus. Is the fission energetically possible? Justify your answer by working out Q value of the process. Given: $m({}^{56}_{26}\text{Fe}) = 55.93494$ u, $m({}^{28}_{13}\text{Al}) = 27.98191$ u.

Q64. CBSE 2022 · 3 marks Differentiate between nuclear fission and nuclear fusion.

Q65. CBSE 2022 · 3 marks In Geiger-Marsden experiment, calculate the distance of closest approach for an alpha particle with energy 2.56×10^{-12} J. Consider that the particle approaches gold nucleus ($Z = 79$) in head-on position.

Q66. CBSE 2022 · 3 marks Differentiate between nuclear fission and nuclear fusion. Deuterium undergoes fusion as per the reaction: ${}^2_1\text{H} + {}^2_1\text{H} \rightarrow {}^3_2\text{He} + {}^1_0\text{n} + 3.27$ MeV. Find the duration for which an electric bulb of 500 W can be kept glowing by the fusion of 100 g of deuterium.

Q67. CBSE 2022 · 3 marks In Geiger-Marsden experiment, calculate the distance of closest approach for an alpha particle with energy 2.56×10^{-12} J. Consider that the particle approaches gold nucleus ($Z = 79$) in head-on position. If the above experiment is repeated with a proton of the same energy, then what will be the value of the distance of closest approach?

14 Semiconductor Electronics

Notes & MCQs →



MULTIPLE CHOICE AND ASSERTION-REASON (30)

Q1. CBSE 2026 · 1 mark In an unbiased p-n junction, at equilibrium, which of the following statements is true ?

- (a) Diffusion current is zero but drift current exists.
- (b) Diffusion current exists but drift current is zero.
- (c) Diffusion and drift currents are equal and opposite.
- (d) Both the diffusion and drift currents exist but are unequal.

Q2. CBSE 2026 · 1 mark Assertion (A): On forward biasing a p-n junction diode, the height of the barrier potential increases. Reason (R): In forward biasing of a p-n junction diode, the direction of the applied voltage is in the same direction as the built-in potential.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is also false.

Q3. CBSE 2026 · 1 mark A n-type semiconductor is obtained by doping silicon with

- (a) Boron (b) Arsenic (c) Indium (d) Aluminium

Q4. CBSE 2026 · 1 mark When a forward biasing is applied across a junction diode, it –

- (a) raises the potential barrier height
- (b) decreases the depletion layer width
- (c) increases the resistance of the p-n junction
- (d) reduces the majority carrier current to zero

Q5. CBSE 2026 · 1 mark When the forward bias voltage in a semiconductor diode is changed from 0.8 V to 1.0 V, the forward current changes by 2.0 mA. The forward bias resistance of the diode will be:

- (a) 200 Ω (b) 175 Ω (c) 100 Ω (d) 125 Ω

Q6. CBSE 2026 · 1 mark The process named 'minority carrier injection' in a p-n junction diode occurs during:

- (a) forward biasing (b) reverse biasing
- (c) no biasing at low temperature
- (d) no biasing at high temperature

Q7. CBSE 2026 · 1 mark In a reversed-biased p-n junction diode, the applied voltage mostly drops across:

- (a) p-region only (b) n-region only (c) depletion region
- (d) the diode

Q8. CBSE 2026 · 1 mark Assertion (A): The conductivity of an n-type semiconductor is higher than that of a p-type semiconductor at a given temperature. Reason (R): The electrons being in the conduction band in n-type semiconductor are more mobile than the holes in the valence band in p-type semiconductor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
- (c) Assertion (A) is true, but Reason (R) is false
- (d) Both Assertion (A) and Reason (R) are false

Q9. CBSE 2026 · 1 mark A good diode checked by a multimeter should indicate:

- (a) high resistance in reverse bias and a low resistance in forward bias
- (b) high resistance in both forward bias and reverse bias
- (c) low resistance in both reverse bias and forward bias
- (d) high resistance in forward bias and low resistance in reverse bias

Q10. CBSE 2025 · 1 mark Which of the following is an electrical conductor at room temperature ?

- (a) Sn (b) Mica (c) Si (d) C

Q11. CBSE 2025 · 1 mark Assertion (A) : n-type semiconductor is not negatively charged. Reason (R) : Neutral pentavalent impurity atom doped in intrinsic semiconductor (neutral) donates its fifth unpaired electron to the crystal lattice and becomes a positive donor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q12. CBSE 2025 · 1 mark Assertion (A): The impurities in p-type Si are not pentavalent atoms. Reason (R): The hole density in valance band in p-type semiconductor is almost equal to the acceptor density.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.

Q13. CBSE 2025 · 1 mark Assertion (A): A hole is an apparent free particle with effective positive electronic charge. Reason (R): A hole is not necessarily a vacancy left behind by an electron in the valence band.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Both Assertion (A) and Reason (R) are false.



Q14. CBSE 2025 · 1 mark Germanium crystal is doped at room temperature with a minute quantity of boron. The charge carriers in the doped semiconductors will be:

- (a) electrons only (b) holes only
- (c) holes and few electrons (d) electrons and few holes

Q15. CBSE 2025 · 1 mark A p-n junction diode is forward biased. As a result,

- (a) both the potential barrier height and the width of depletion layer decrease.
- (b) both the potential barrier height and the width of depletion layer increase.
- (c) the potential barrier height decreases and the width of depletion layer increases.
- (d) the potential barrier height increases and the width of depletion layer decreases.

Q16. CBSE 2025 · 1 mark When a p-n junction diode is forward biased

- (a) the barrier height and the depletion layer width both increase.
- (b) the barrier height increases and the depletion layer width decreases.
- (c) the barrier height and the depletion layer width both decrease.
- (d) the barrier height decreases and the depletion layer width increases.

Q17. CBSE 2025 · 1 mark Assertion (A) : We cannot form a p-n junction diode by taking a slab of a p-type semiconductor and physically joining it to another slab of a n-type semiconductor. Reason (R) : In a p-type semiconductor $\eta_e \gg \eta_h$ while in a n-type semiconductor $\eta_h \gg \eta_e$.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is also false.

Q18. CBSE 2024 · 1 mark Ge is doped with As. Due to doping:

- (a) the structure of Ge lattice is distorted
- (b) the number of conduction electrons increases
- (c) the number of holes increases
- (d) the number of conduction electrons decreases

Q19. CBSE 2024 · 1 mark An n-type semiconducting Si is obtained by doping intrinsic Si with:

- (a) Al (b) B (c) P (d) In

Q20. CBSE 2024 · 1 mark When a p-n junction diode is subjected to reverse biasing:

- (a) the barrier height decreases and the depletion region widens.
- (b) the barrier height increases and the depletion region widens.
- (c) the barrier height decreases and the depletion region shrinks.
- (d) the barrier height increases and the depletion region shrinks.

Q21. CBSE 2024 · 1 mark Si is doped with a pentavalent element. The energy required to set the additional electron free is about :

- (a) 0.01 eV (b) 0.05 eV (c) 0.72 eV (d) 1.1 eV

Q22. CBSE 2024 · 1 mark Assertion (A) : In a semiconductor, the electrons in the conduction band have lesser energy than those in the valence band. Reason (R) : Donor energy level is just above the valence band in a semiconductor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false and Reason (R) is also false.

Q23. CBSE 2023 · 1 mark An ac source of voltage is connected in series with a p-n junction diode and a load resistor. The correct option for output voltage across load resistance will be:

- (a) (a) (b) (b) (c) (c) (d) (d)

Q24. CBSE 2023 · 1 mark When an intrinsic semiconductor is doped with a small amount of trivalent impurity, then:

- (a) its resistance increases
- (b) it becomes a p-type semiconductor
- (c) there will be more free electrons than holes in the semiconductor
- (d) dopant atoms become donor atoms

Q25. CBSE 2023 · 1 mark In the energy-band diagram of n-type Si, the gap between the bottom of the conduction band E_C and the donor energy level E_D is of the order of:

- (a) 10 eV (b) 1 eV (c) 0.1 eV (d) 0.01 eV

Q26. CBSE 2023 · 1 mark If a p-n junction diode is reverse biased,

- (a) the potential barrier is lowered.
- (b) the potential barrier remains unaffected.
- (c) the potential barrier is raised.
- (d) the current is mainly due to majority carriers.

Q27. CBSE 2023 · 1 mark At a certain temperature in an intrinsic semiconductor, the electrons and holes concentration is $1.5 \times 10^{16} \text{ m}^{-3}$. When it is doped with a trivalent dopant, hole concentration increases to $4.5 \times 10^{22} \text{ m}^{-3}$. In the doped semiconductor, the concentration of electrons (n_e) will be:

- (a) $3 \times 10^6 \text{ m}^{-3}$ (b) $5 \times 10^7 \text{ m}^{-3}$ (c) $5 \times 10^9 \text{ m}^{-3}$
- (d) $6.75 \times 10^{38} \text{ m}^{-3}$



Q28. CBSE 2023 · 1 mark At 0 K, the resistivity of an intrinsic semiconductor is:

- (a) same as that at 0°C (b) same as that at 300 K (c) zero
(d) infinite

Q29. CBSE 2023 · 1 mark For the forward biasing of a p-n junction diode, which of the following statements is not correct?

- (a) The potential barrier decreases
(b) Minority carrier injection occurs
(c) Width of depletion layer increases
(d) Forward current is due to the diffusion of both holes and electrons

Q30. CBSE 2023 · 1 mark Assertion (A): In n-type semiconductors, the number density of electrons is greater than the number density of holes but the crystal maintains an overall charge neutrality. Reason (R): The charge of electrons donated by donor atoms is just equal and opposite to that of the ionised donor.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is also false.

VERY SHORT ANSWER (26)

Q31. CBSE 2026 · 2 marks Write two points of difference between intrinsic and extrinsic semiconductors.

Q32. CBSE 2026 · 2 marks Differentiate between n-type and p-type semiconductors.

Q33. CBSE 2026 · 2 marks How are charge carriers created in an intrinsic semiconductor? Explain.

Q34. CBSE 2026 · 2 marks Explain, with the help of suitable diagram, the two important processes that occur during the formation of a p-n junction.

Q35. CBSE 2026 · 2 marks Write any two points of difference between intrinsic and extrinsic semiconductors.

Q36. CBSE 2026 · 2 marks The hole concentration in an intrinsic semiconductor is $5 \times 10^8 \text{ m}^{-3}$. When it is doped with certain impurity, the electron concentration becomes $4 \times 10^{12} \text{ m}^{-3}$. Find the new value of the hole concentration. Also identify the type of new semiconductor formed after doping.

Q37. CBSE 2026 · 2 marks Suppose a pure Si crystal has 5×10^{28} atoms per m^3 . It is doped with 5×10^{22} atoms per m^3 of Arsenic. Calculate the majority and minority carrier concentration in the doped silicon. (Given: $n_i = 1.5 \times 10^{16} \text{ m}^{-3}$)

Q38. CBSE 2025 · 2 marks In an intrinsic semiconductor, the hole concentration is $5 \times 10^8 \text{ m}^{-3}$. On doping with impurity atoms, the hole concentration becomes $8 \times 10^{12} \text{ m}^{-3}$. (a) Identify (i) the type of dopant and (ii) the extrinsic semiconductor so formed. (b) Calculate the electron concentration in the extrinsic semiconductor.

Q39. CBSE 2025 · 2 marks In an intrinsic semiconductor, carrier's concentration is $5 \times 10^8 \text{ m}^{-3}$. On doping with impurity atoms, the hole concentration becomes $8 \times 10^{12} \text{ m}^{-3}$. (a) Identify (i) the type of dopant and (ii) the extrinsic semiconductor so formed. (b) Calculate the electron concentration in the extrinsic semiconductor.

Q40. CBSE 2025 · 2 marks An intrinsic semiconductor has electron concentration of $5 \times 10^8 \text{ m}^{-3}$. On doping with impurity atoms, the hole concentration becomes $8 \times 10^{12} \text{ m}^{-3}$. (a) Identify (i) the type of dopant and (ii) the extrinsic semiconductor so formed. (b) Calculate the electron concentration in the extrinsic semiconductor.

Q41. CBSE 2025 · 2 marks In an n-type semiconductor electron-hole combination is a continuous process at room temperature. Yet the electron concentration is always greater than the hole concentration in it. Explain.

Q42. CBSE 2025 · 2 marks Draw energy band diagrams of n-type and p-type semiconductors at temperature $T > 0 \text{ K}$. Show the donor/acceptor energy levels with the order of difference of their energies from the bands.

Q43. CBSE 2025 · 2 marks A p-type Si semiconductor is made by doping an average of one dopant atom per 5×10^7 silicon atoms. If the number density of silicon atoms in the specimen is $5 \times 10^{28} \text{ atoms m}^{-3}$, find the number of holes created per cubic centimetre in the specimen due to doping. Also give one example of such dopants.

Q44. CBSE 2024 · 2 marks Plot a graph showing the variation of current with voltage for the material GaAs. On the graph, mark the region where: (a) resistance is negative, and (b) Ohm's law is obeyed.

Q45. CBSE 2024 · 2 marks How does the conductivity of an intrinsic semiconductor vary with temperature? Explain. Show the variation in a plot.

Q46. CBSE 2024 · 2 marks Differentiate between 'diffusion current' and 'drift current'. Explain their role in the formation of p-n junction.

Q47. CBSE 2024 · 2 marks How does the energy gap of an intrinsic semiconductor effectively change when doped with a (a) trivalent impurity, and (b) pentavalent impurity? Justify your answer in each case.

Q48. CBSE 2024 · 2 marks Suppose a pure Si crystal has 5×10^{28} atoms m^{-3} . It is doped by 1 ppm concentration of boron. Calculate the concentration of holes and electrons, given that $n_i = 1.5 \times 10^{16} \text{ m}^{-3}$. Is the doped crystal n-type or p-type?

Q49. CBSE 2023 · 2 marks Differentiate between intrinsic and extrinsic semiconductors.

Q50. CBSE 2023 · 2 marks Briefly explain how the diffusion and drift currents contribute to the formation of potential barrier in a p-n junction diode.

Q51. CBSE 2023 · 2 marks Explain the roles of diffusion current and drift current in the formation of the depletion layer in a p-n junction diode.



Q52. CBSE 2023 · 2 marks Explain the property of a p-n junction which makes it suitable for rectifying alternating voltages. Differentiate between a half-wave and a full-wave rectifier.

Q53. CBSE 2023 · 2 marks How is the width of depletion layer of a p-n junction diode affected when it is (i) forward biased, and (ii) reverse biased? Justify your answers.

Q54. CBSE 2023 · 2 marks Draw a circuit diagram of a p-n junction diode in (a) forward biasing, and (b) reverse biasing. Draw the V – I characteristics for each case.

Q55. CBSE 2023 · 2 marks Briefly describe the multi-step process involved in the generation of energy in the Sun.

Q56. CBSE 2022 · 2 marks Explain the formation of depletion region in a p-n junction.

SHORT ANSWER (22)

Q57. CBSE 2026 · 3 marks Briefly explain the two important processes that occur during the formation of a p-n junction.

Q58. CBSE 2026 · 3 marks A semiconductor has equal electron and hole concentration of $3 \times 10^8 \text{ m}^{-3}$. On doping with a certain impurity, the hole concentration increases to $6 \times 10^{10} \text{ m}^{-3}$. (a) What type of semiconductor is obtained on doping? (b) Calculate the new electron concentration of the semiconductor. (c) How does the energy gap of semiconductor change with doping? Draw the energy band diagram for it.

Q59. CBSE 2026 · 3 marks (a) Draw the V-I characteristics of silicon diode. (b) Explain the following terms: (i) minority carrier injection in forward bias (ii) breakdown voltage in reverse bias

Q60. CBSE 2026 · 3 marks (a) Explain the working of a junction diode as a half-wave rectifier. (b) The efficiency of a half-wave rectifier is 40%. What happens to the remaining 60% power ?

Q61. CBSE 2026 · 3 marks With the help of circuit diagrams, briefly explain the forward biasing and the reverse biasing of a p-n junction diode.

Q62. CBSE 2026 · 3 marks With the help of a circuit diagram, explain the working of a full wave rectifier. Depict the input and output waveforms.

Q63. CBSE 2026 · 3 marks Draw a circuit diagram of a full-wave rectifier using p-n junction diodes. Explain its working and show the input-output waveforms.

Q64. CBSE 2025 · 3 marks (a) What are majority and minority charge carriers of p-type and n-type semiconductors ? (b) Explain briefly the formation of diffusion current and drift current in a p-n junction diode.

Q65. CBSE 2025 · 3 marks (a) Draw the energy-band diagrams for conductors, semiconductors and insulators at $T = 0 \text{ K}$. How is an electron-hole pair formed in a semiconductor at room temperature? (b) Carbon and silicon both, are members of IV group of periodic table and have the same lattice structure. Carbon is an insulator whereas silicon is a semiconductor. Explain.

Q66. CBSE 2025 · 3 marks Explain the formation of depletion layer in a p-n junction region of a diode, with the help of a suitable diagram. Which feature of junction diode makes it suitable for its use as a rectifier?

Q67. CBSE 2025 · 3 marks Explain the formation of depletion layer in the p-n junction region of a diode, with the help of a suitable diagram. Which feature of junction diode makes it suitable for its use as a rectifier?

Q68. CBSE 2025 · 3 marks (a) Draw circuit arrangement for studying V-I characteristics of a p-n junction diode. (b) Show the shape of the characteristics of a diode. (c) Mention two information that you can get from these characteristics.

Q69. CBSE 2024 · 3 marks With the help of a circuit diagram, explain the working of a p-n junction diode as a full wave rectifier. Draw its input and output waveforms.

Q70. CBSE 2024 · 3 marks (a) Draw the circuit diagrams for obtaining the V-I characteristics of a p-n junction diode. Explain briefly the salient features of the V-I characteristics in (i) forward biasing, and (ii) reverse biasing.

Q71. CBSE 2022 · 3 marks With the help of a circuit diagram, explain the working of a p-n junction diode as a full-wave rectifier. Also draw its input and output waveforms.

Q72. CBSE 2022 · 2 marks Briefly explain the working of a light emitting diode. Mention its two uses.

Q73. CBSE 2022 · 2 marks What is meant by energy band gap in a solid? Draw the energy band diagrams for a conductor, an insulator and a semiconductor.

Q74. CBSE 2022 · 2 marks Name the device which converts electrical energy into light energy. Write three advantages of the device.

Q75. CBSE 2022 · 3 marks Answer the following, giving reason: (a) The resistance of a p-n junction is low when it is forward biased and is high when it is reversed biased.

Q76. CBSE 2022 · 2 marks Name the device which converts an ac input signal into a dc output signal. Write the principle of working of the device.

Q77. CBSE 2022 · 3 marks Answer the following, giving reason: (a) The resistance of a p-n junction is low when it is forward biased and is high when it is reversed biased. (b) Doping of intrinsic semiconductors is a necessity for making electronic devices. (c) Photodiodes are operated in reverse bias.

Q78. CBSE 2022 · 2 marks Define barrier potential. Why does the thickness of the depletion layer in a p-n junction diode vary with increase in reverse bias?

LONG ANSWER (2)

Q79. CBSE 2023 · 5 marks (a) (i) A germanium crystal is doped with antimony. With the help of energy-band diagram, explain how the conductivity of the doped crystal is affected. (ii) Briefly explain the two processes involved in the formation of a p-n junction. (iii) What will the effect of (1) forward biasing, and (2) reverse biasing be on the width of depletion layer in a p-n junction diode ?



Q80. CBSE 2023 · 5 marks A germanium crystal is doped with antimony. With the help of energy-band diagram, explain how the conductivity of the doped crystal is affected. Briefly explain the two processes involved in the formation of a p-n junction. What will the effect of (1) forward biasing, and (2) reverse biasing be on the width of depletion layer in a p-n junction diode?

CASE-BASED (4)**CASE STUDY · CBSE 2026**

A p-type or n-type semiconductor can be converted into a p-n junction by doping it with suitable impurity. The motion of majority charge carriers causes diffusion current across the junction while the barrier electric field causes motion of minority carriers for drift current. In case of unbiased diode, the diffusion and drift currents are equal. This equilibrium is disturbed by the biasing batteries. Diodes, therefore, allow currents in one direction. This property of diode is used in making rectifiers.

Q81. CBSE 2026 · 1 mark Silicon is doped with which of the following to obtain p-type semiconductor?

- (a) Phosphorus (b) Arsenic (c) Boron (d) Antimony

CASE STUDY · CBSE 2025

Extrinsic semiconductors are made by doping pure or intrinsic semiconductors with suitable impurity. There are two type of dopants used in doping, Si or Ge, and using them p-type and n-type semiconductors can be obtained. A p-n junction is the basic building block of many semiconductor devices. Two important processes occur during the formation of a p-n junction: diffusion and drift. When such a junction reaches equilibrium, depletion layers and space charge form. This is responsible for a junction potential barrier. The width of a depletion layer and the height of potential barrier changes

when a junction is forward-biased or reverse-biased. A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for application of an external voltage. Using diodes, alternating voltages can be rectified.

Q82. CBSE 2025 · 1 mark Which of the following is a donor impurity atom for Ge?

- (a) Boron (b) Antimony (c) Aluminium (d) Indium

Q83. CBSE 2025 · 1 mark (i) (a) In reverse-biased p-n junction:

- (a) the drift current is of the order of few mA.
(b) the applied voltage mostly drops across the depletion region.
(c) the depletion region width decreases.
(d) the current increases with increase in applied voltage.

CASE STUDY · CBSE 2024

Junction Diode as a Rectifier: The process of conversion of an ac voltage into a dc voltage is called rectification and the device which performs this conversion is called a rectifier. The characteristics of a p-n junction diode reveal that when a p-n junction diode is forward biased, it offers a low resistance and when it is reverse biased, it offers a high resistance. Hence, a p-n junction diode conducts only when it is forward biased. This property of a p-n junction diode makes it suitable for its use as a rectifier. Thus, when an ac voltage is applied across a p-n junction, it conducts only during those alternate half cycles for which it is forward biased. A rectifier which rectifies only half cycle of an ac voltage is called a half-wave rectifier and one that rectifies both the half cycles is known as a full-wave rectifier.

Q84. CBSE 2024 · 1 mark (i) The root mean square value of an alternating voltage applied to a full-wave rectifier is $V_0/\sqrt{2}$. Then the root mean square value of the rectified output voltage is:

- (a) $V_0/\sqrt{2}$ (b) $V_0^2/\sqrt{2}$ (c) $2V_0/\sqrt{2}$ (d) $V_0/(2\sqrt{2})$

