

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This edition contains **35 numbered questions**, including the subparts and alternatives supplied in the source.
- (ii) Original question numbering is retained. Answer the alternatives according to the OR labels and instructions within each question.
- (iii) The available questions follow the original Sections A, B, C, D, E.

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

$c = 3 \times 10^8 \text{ m/s}$	Mass of electron (m_e) = $9.1 \times 10^{-31} \text{ kg}$
$h = 6.63 \times 10^{-34} \text{ Js}$	Mass of neutron = $1.675 \times 10^{-27} \text{ kg}$
$e = 1.6 \times 10^{-19} \text{ C}$	Mass of proton = $1.673 \times 10^{-27} \text{ kg}$
$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$	Avogadro's number = $6.023 \times 10^{23} \text{ per gm mole}$
$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$	Boltzmann constant = $1.38 \times 10^{-23} \text{ JK}^{-1}$
$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	

Section A

1. The magnitude of the electric field due to a point charge object at a distance of 4.0 m is 9 N/C. From the same charged object the electric field of magnitude, 16 N/C will be at a distance of

- (A) 1 m (B) 2 m
(C) 3 m (D) 6 m

2. A point P lies at a distance x from the mid point of an electric dipole on its axis. The electric potential at point P is proportional to

- (A) $\frac{1}{x^2}$ (B) $\frac{1}{x^3}$
(C) $\frac{1}{x^{3/2}}$ (D) $\frac{1}{x^{5/2}}$

3. A current of 0.8 A flows in a conductor of $40\ \Omega$ for 1 minute. The heat produced in the conductor will be

- (A) 1445 J (B) 1536 J
(C) 1569 J (D) 1640 J

4. A cell of emf E is connected across an external resistance R . When current I is drawn from the cell, the potential difference across the electrodes of the cell drops to V . The internal resistance ' r ' of the cell is

- (A) $\left(\frac{E - V}{V}\right) R$ (B) $\left(\frac{E - V}{E}\right) R$
(C) $\frac{E - V}{I}$ (D) $\left(\frac{E - V}{I}\right) r$

5. Beams of electrons and protons move parallel to each other in the same direction. They

- (A) attract each other. (B) repel each other.
(C) neither attract nor repel. (D) force of attraction or repulsion depends upon speed of beams.

6. A long straight wire of radius ' a ' carries a steady current ' I '. The current is uniformly distributed across its area of cross-section. The ratio of magnitude of magnetic field B_1 at $\frac{a}{2}$ and B_2 at distance $2a$ is

- (A) $\frac{1}{2}$ (B) 1
(C) 2 (D) 4

7. $\vec{E}$ and $\vec{B}$ represent the electric and the magnetic field of an electromagnetic wave respectively. The direction of propagation of the wave is along

- (A) $\vec{B}$ (B) $\vec{E}$
(C) $\vec{E} \times \vec{B}$ (D) $\vec{B} \times \vec{E}$

8. A ray of monochromatic light propagating in air, is incident on the surface of water. Which of the following will be the same for the reflected and refracted rays?

- (A) Energy carried (B) Speed
(C) Frequency (D) Wavelength

9. A beam of light travels from air into a medium. Its speed and wavelength in the medium are $1.5 \times 10^8\text{ m s}^{-1}$ and 230 nm respectively. The wavelength of light in air will be

- (A) 230 nm (B) 345 nm
(C) 460 nm (D) 690 nm

10. Which one of the following metals does not exhibit emission of electrons from its surface when irradiated by visible light?

- (A) Rubidium (B) Sodium
(C) Cadmium (D) Caesium

11. A hydrogen atom makes a transition from $n = 5$ to $n = 1$ orbit. The wavelength of photon emitted is λ . The wavelength of photon emitted when it makes a transition from $n = 5$ to $n = 2$ orbit is

- | | |
|---------------------------|---------------------------|
| (A) $\frac{3}{2}\lambda$ | (B) $\frac{16}{7}\lambda$ |
| (C) $\frac{24}{7}\lambda$ | (D) $\frac{32}{7}\lambda$ |

12. The curve of binding energy per nucleon as a function of atomic mass number has a sharp peak for helium nucleus. This implies that helium nucleus is

- | | |
|------------------------|---|
| (A) radioactive | (B) unstable |
| (C) easily fissionable | (D) more stable nucleus than its neighbours |

13. In an extrinsic semiconductor, the number density of holes is $4 \times 10^{20} \text{ m}^{-3}$. If the number density of intrinsic carriers is $1.2 \times 10^{15} \text{ m}^{-3}$, the number density of electrons in it is

- | | |
|--------------------------------------|---|
| (A) $1.8 \times 10^9 \text{ m}^{-3}$ | (B) $2.4 \times 10^{10} \text{ m}^{-3}$ |
| (C) $3.6 \times 10^9 \text{ m}^{-3}$ | (D) $3.2 \times 10^{10} \text{ m}^{-3}$ |

14. Pieces of copper and of silicon are initially at room temperature. Both are heated to temperature T . The conductivity of

- | | |
|---|---|
| (A) both increases. | (B) both decreases. |
| (C) copper increases and silicon decreases. | (D) copper decreases and silicon increases. |

15. The formation of depletion region in a p-n junction diode is due to

- | | |
|------------------------------|---|
| (A) movement of dopant atoms | (B) diffusion of both electrons and holes |
| (C) drift of electrons only | (D) drift of holes only |

16. Assertion (A): Diamagnetic substances exhibit magnetism.

Reason (R): Diamagnetic materials do not have permanent magnetic dipole moment.

- | | |
|--|--|
| (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 and Reason (R) is NOT the correct explanation of Assertion (A). |
| (C) Assertion (A) is true and Reason (R) is false. | (D) Assertion (A) is false and Reason (R) is also false. |

17. Assertion (A): Work done in moving a charge around a closed path, in an electric field is always zero.

Reason (R): Electrostatic force is a conservative force.

- | | |
|--|--|
| (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 and Reason (R) is NOT the correct explanation of Assertion (A). |
| (C) Assertion (A) is true and Reason (R) is false. | (D) Assertion (A) is false and Reason (R) is also false. |

18. Assertion (A): In Young's double slit experiment all fringes are of equal width.

Reason (R): The fringe width depends upon wavelength of light (λ) used, distance of screen from plane of slits (D) and slits separation (d).

- | | |
|--|--|
| (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 and Reason (R) is NOT the correct explanation of Assertion (A). |
| (C) Assertion (A) is true and Reason (R) is false. | (D) Assertion (A) is false and Reason (R) is also false. |

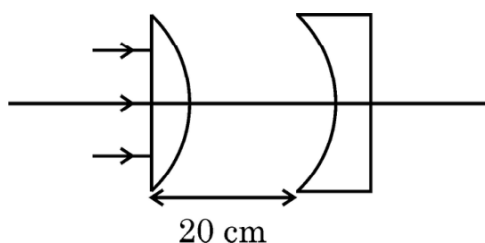
Section B

19. Briefly explain why and how a galvanometer is converted into an ammeter.

20(a). How are infrared waves produced? Why are these waves referred to as heat waves? Give any two uses of infrared waves.

20(b) OR. How are X-rays produced? Give any two uses of these.

21. In the given figure the radius of curvature of curved face in the plano-convex and the plano-concave lens is 15 cm each. The refractive index of the material of the lenses is 1.5. Find the final position of the image formed.



22. What happens to the interference pattern when two coherent sources are

- (a) infinitely close, and
- (b) far apart from each other?

23(a). What is meant by ionisation energy? Write its value for hydrogen atom.

23(b) OR. Define the term, mass defect. How is it related to stability of the nucleus?

24. Draw energy band diagram for an n-type and p-type semiconductor at $T > 0$ K.

25. Answer the following giving reasons:

- (i) A p-n junction diode is damaged by a strong current.
- (ii) Impurities are added in intrinsic semiconductors.

Section C

26(a). Two charged conducting spheres of radii a and b are connected to each other by a wire. Find the ratio of the electric fields at their surfaces.

26(b) OR. A parallel plate capacitor (A) of capacitance C is charged by a battery to voltage V . The battery is disconnected and an uncharged capacitor (B) of capacitance $2C$ is connected across A. Find the ratio of

- (i) final charges on A and B.
 - (ii) total electrostatic energy stored in A and B finally and that stored in A initially.
-

27. Define current density and relaxation time. Derive an expression for resistivity of a conductor in terms of number density of charge carriers in the conductor and relaxation time.

28. A series CR circuit with $R = 200\ \Omega$ and $C = (50/\pi)\ \mu\text{F}$ is connected across an ac source of peak voltage $\varepsilon_0 = 100\ \text{V}$ and frequency $\nu = 50\ \text{Hz}$. Calculate

- (a) impedance of the circuit (Z),
 - (b) phase angle (φ), and
 - (c) voltage across the resistor.
-

29. Define critical angle for a given pair of media and total internal reflection. Obtain the relation between the critical angle and refractive index of the medium.

30(a). (i) Distinguish between nuclear fission and fusion giving an example of each.

(ii) Explain the release of energy in nuclear fission and fusion on the basis of binding energy per nucleon curve.

30(b) OR. (i) How is the size of a nucleus found experimentally? Write the relation between the radius and mass number of a nucleus.

(ii) Prove that the density of a nucleus is independent of its mass number.

Section D

31(a). (i) Use Gauss' law to obtain an expression for the electric field due to an infinitely long thin straight wire with uniform linear charge density λ .

(ii) An infinitely long positively charged straight wire has a linear charge density λ . An electron is revolving in a circle with a constant speed v such that the wire passes through the centre, and is perpendicular to the plane, of the circle. Find the kinetic energy of the electron in terms of magnitudes of its charge and linear charge density λ on the wire.

(iii) Draw a graph of kinetic energy as a function of linear charge density λ .

31(b) OR. (i) Consider two identical point charges located at points $(0, 0)$ and $(a, 0)$.

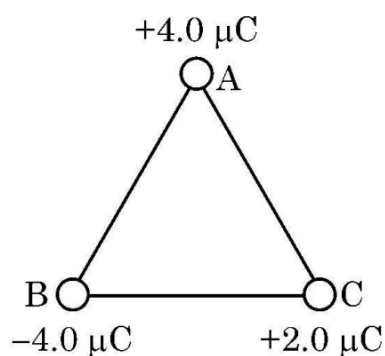
(1) Is there a point on the line joining them at which the electric field is zero?

(2) Is there a point on the line joining them at which the electric potential is zero?

Justify your answers for each case.

(ii) State the significance of negative value of electrostatic potential energy of a system of charges.

Three charges are placed at the corners of an equilateral triangle ABC of side 2.0 m as shown in figure. Calculate the electric potential energy of the system of three charges.



32(a). (i) Define coefficient of self-induction. Obtain an expression for self-inductance of a long solenoid of length l , area of cross-section A having N turns.

(ii) Calculate the self-inductance of a coil using the following data obtained when an AC source of frequency $\left(\frac{200}{\pi}\right)$ Hz and a DC source is applied across the coil.

AC Source: V (V), I (A) = (3.0, 0.5), (6.0, 1.0), (9.0, 1.5).

DC Source: V (V), I (A) = (4.0, 1.0), (6.0, 1.5), (8.0, 2.0).

32(b) OR. (i) With the help of a labelled diagram, describe the principle and working of an ac generator. Hence, obtain an expression for the instantaneous value of the emf generated.

(ii) The coil of an ac generator consists of 100 turns of wire, each of area 0.5 m^2 . The resistance of the wire is 100Ω . The coil is rotating in a magnetic field of 0.8 T perpendicular to its axis of rotation, at a constant angular speed of $60 \text{ radian per second}$. Calculate the maximum emf generated and power dissipated in the coil.

33(a). (i) State Huygen's principle. With the help of a diagram, show how a plane wave is reflected from a surface. Hence verify the law of reflection.

(ii) A concave mirror of focal length 12 cm forms a three times magnified virtual image of an object. Find the distance of the object from the mirror.

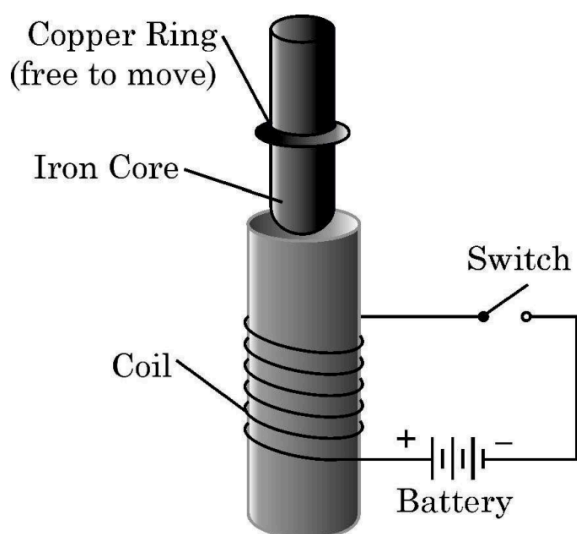
33(b) OR. (i) Draw a labelled ray diagram showing the image formation by a refracting telescope. Define its magnifying power. Write two limitations of a refracting telescope over a reflecting telescope.

(ii) The focal lengths of the objective and the eyepiece of a compound microscope are 1.0 cm and 2.5 cm respectively. Find the tube length of the microscope for obtaining a magnification of 300.

Section E

34(a). Read the following paragraph and answer the questions.

Consider the experimental set up shown in the figure. This jumping ring experiment is an outstanding demonstration of some simple laws of Physics. A conducting non-magnetic ring is placed over the vertical core of a solenoid. When current is passed through the solenoid, the ring is thrown off.

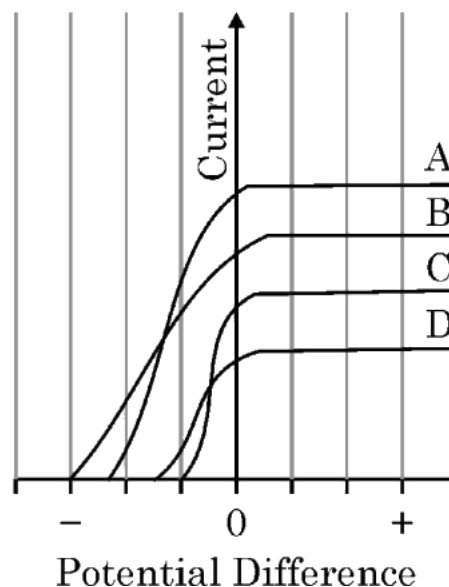


Answer the following questions:

- (i) Explain the reason of jumping of the ring when the switch is closed in the circuit.
- (ii) What will happen if the terminals of the battery are reversed and the switch is closed? Explain.
- (iii) Explain the two laws that help us understand this phenomenon.

34(b) OR. Briefly explain various ways to increase the strength of magnetic field produced by a given solenoid.

35(a). Figure shows the variation of photoelectric current measured in a photo cell circuit as a function of the potential difference between the plates of the photo cell when light beams A, B, C and D of different wavelengths are incident on the photo cell. Examine the given figure and answer the following questions:



- (i) Which light beam has the highest frequency and why?
- (ii) Which light beam has the longest wavelength and why?
- (iii) Which light beam ejects photoelectrons with maximum momentum and why?

35(b) OR. What is the effect on threshold frequency and stopping potential on increasing the frequency of incident beam of light? Justify your answer.

- End of Question Paper -