Udaya Public School, Ayodhya
Second Pre-Board Examination 2023-24
Class XII Subject: Physics (042)

Time: 3 Hours MM: 70

General Instructions:

1. There are 33 questions in all. All questions are compulsory

2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

3. Section A contains sixteen questions, twelve MCQ and four Assertion-Reasoning based questions of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.

4. There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.

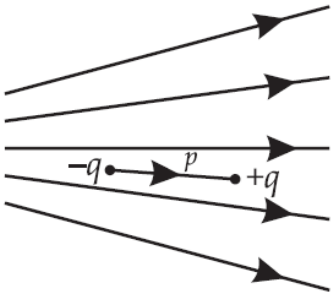
SECTION – A

Questions 1 to 16 carry 1 mark each.

1. Two parallel large thin metal sheets have equal surface densities 26.4 x 10-12 C/m2 of opposite signs. The electric field between these sheets is
(a) 1.5 N/C (b) 15 x 10^{-16} N/C (c) 3 x 10^{-10} N/C (d) 3 N/C

2. In a Young's double-slit experiment the fringe width is found to be 0.4 mm. If the whole apparatus is dipped in water of refractive index 4/3, without disturbing the arrangement, the new fringe width will be
(a) 0.30 mm (b) 0.40 mm (c) 0.53 mm (d) 0.2 mm

3. Figure here shows electric field lines in which an electric dipole p is placed as shown. Which of the following statements is correct?

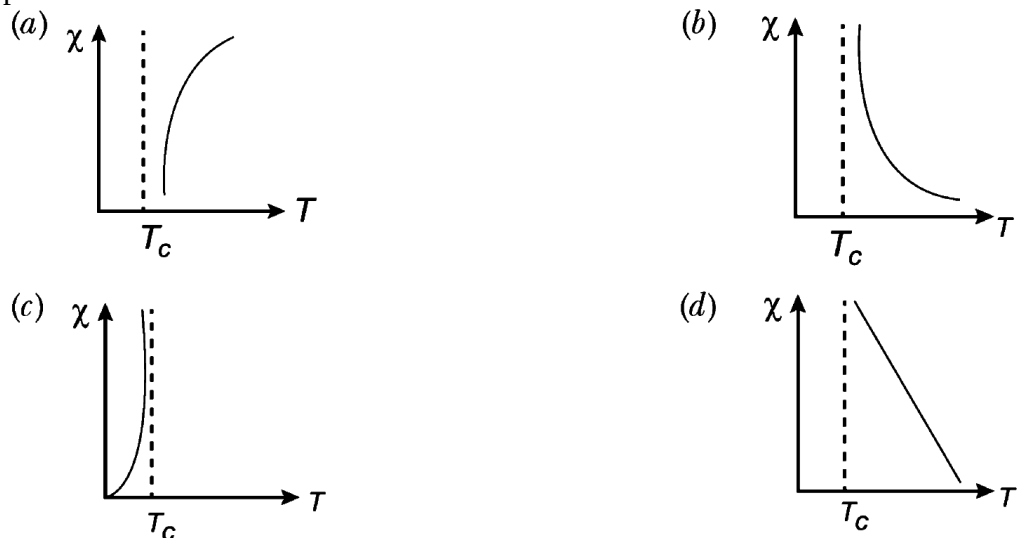


(a) The dipole will not experience any force.
(b) The dipole will experience a force towards right.
(c) The dipole will experience a force towards left.
(d) The dipole will experience a force upwards.

4. The electromagnetic radiations used for water purification and eye surgery is:
(a) Infrared (b) Microwave (c) X-rays (d) None of these

5. The output of a step-down transformer is measured to be 24 V when connected to a 12 W light bulb. The value of the peak current is 1
(a) $\frac{1}{\sqrt{2}A}$ (b) $\sqrt{2}A$ (c) 2A (d) $2\sqrt{2}$ A

6. The variation of magnetic susceptibility with the temperature of a ferromagnetic material can be plotted as



7. A charged particle oscillates about its mean equilibrium position with a frequency of 10^9 Hz. The electromagnetic waves produced.
(a) will have frequency of 10^9 Hz.
(b) will have frequency of 2 x 10^9 Hz.
(c) will have a wavelength of 0.2 m.
(d) fall in the region of micro-waves.

8. Time period of a charged particle undergoing a circular motion in a uniform magnetic field is independent of
(a) speed of the particle (b) mass of the particle
(c) charge of the particle (d) magnetic field

9. Angular width of central maxima of a single slit diffraction pattern is independent of:
(a) slit width (b) frequency of the light used
(c) wavelength of the light used (d) distance between slit and screen

10. A charge moves with velocity *v* in a region where electric field $\vec{E}$ and magnetic field $\vec{B}$ both exist. The force on the particle is
(a) $q(\vec{v}\times\vec{B})$ (b) $q\vec{E}+q(\vec{v}\times\vec{B})$ (c) $q\vec{E}+q(\vec{B}\times\vec{r})$ (d) $q\vec{E}+q(\vec{E}\times\vec{v})$

11. A +q charge is placed in the centre of a cubical box. The total flux coming out of a wall has a value of:
(a) $\frac{q}{6\varepsilon_o}$ (b) $\frac{q}{\varepsilon_o}$ (c) $\frac{6q}{\varepsilon_o}$ (d) $\frac{q}{3\varepsilon_o}$

12. When a voltage measuring device is connected to AC mains, the metre shows the steady input voltage of 220 V. This means:
(a) Input voltage cannot be AC voltage, but a DC voltage.
(b) Maximum input voltage is 220 V.
(c) The metre reads not V but V_2 and is calibrated to read $\sqrt{V^2}$.
(d) The pointer of the meter is stuck by some mechanical defect.

ASSERTION-REASON BASED QUESTIONS

In the following questions, a statement of assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(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) A is false but R is true.

13. **Assertion (A):** If a proton and an electron a replaced in the same uniform electric field, they experience different acceleration.
Reason (R): Electric force on a test charge is independent of its mass.

14. **Assertion (A):** Ferromagnetic substances become paramagnetic beyond Curie temperature.
Reason (R): Domains are destroyed at high temperature.

15. **Assertion (A):** The current in a.c. circuit is said to be wattless if average power consumed in the circuit is zero. It is the component $I_{rms} \sin \phi$ of the a.c.
Reason (R): In an inductive (L) or capacitive (C) circuit as $\phi = \pi/2$ so power factor = 0 and so the current is wattless.

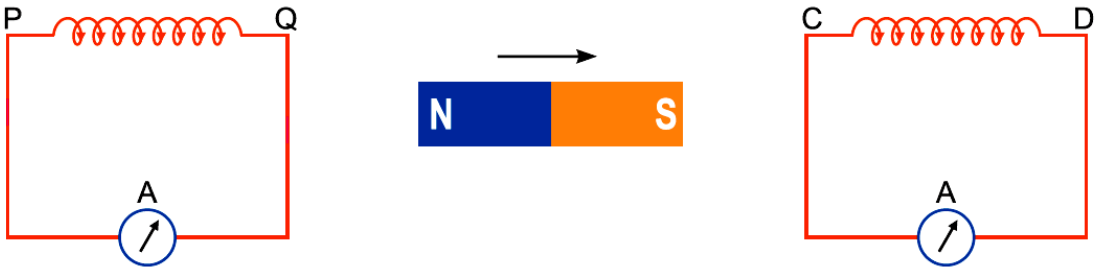
16. **Assertion (A):** In the phenomenon of mutual induction, self induction of each of the coil persists.
Reason (R): Self-induction arises when strength of current in one coil changes. In mutual induction, current is changing in both the individual coils.

SECTION – B

Questions 17 to 21 carry 2 marks each.

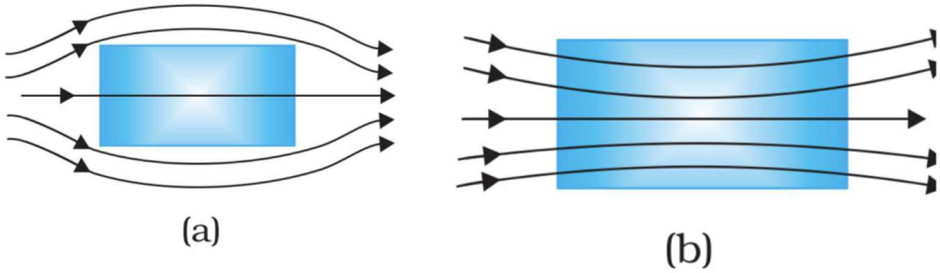
17. Write Einstein's photoelectric equation and point out any two characteristic properties of photons on which this equation is based.

18. A bar magnet is moved in the direction indicated by the arrow between two coils PQ and CD. Predict the directions of induced current in each coil.



OR

A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it.



(i)Identify the specimen A and B.
(ii) How is the magnetic susceptibility of specimen A different from that of specimen B?

19. Draw the ray diagram of an astronomical telescope showing image formation in the normal adjustment position. Write the expression for its magnifying power.

20. (a) There are uniform electric and magnetic fields in a region pointing along X-axis. An a-particle is projected along Y-axis with a velocity v. What will be the shape of the trajectory?
(b) An electron is accelerated through a potential difference V. Write the expression for its final speed, if it was initially at rest.

21. Show that the radius of the orbit in hydrogen atom varies as n2, where n is the principal quantum number of the atom.

SECTION – C

Questions 22 to 28 carry 3 marks each.

22. (i) What are the necessary conditions for total internal reflection to occur?
(ii) Draw a labelled diagram of an optical fibre and show how light propagates through the optical fibre using this phenomenon.

23. Explain briefly the reasons why wave theory of light is not able to explain the observed features of photo-electric effect.

24. A charge is distributed uniformly over a ring of radius '*a*'. Obtain an expression for the electric field intensity at a point on the axis of the ring. Hence, show that for points at large distances from the ring, it behaves like a point charge.

OR

(a) Derive the expression for the electric potential due to an electric dipole at a point on its axial line.
(b) Depict the equipotential surface due to electric dipole.

25. An a.c. source generating a voltage $\varepsilon = \varepsilon_0 \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. Plot a graph of ε and I versus ωt to show that the current is ahead of the voltage by π/2.

OR

An ac voltage $V = V_0 \sin \omega t$ is applied across a pure inductor of inductance L. Find an expression for the current i, flowing in the circuit and show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\frac{\pi}{2}$. Also draw graphs of V and i versus ωt for the circuit.

26. (a) Three photo diodes D_1, D_2 and D_3 are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which of them will not be able to detect light of wavelength 600 nm?
(b) Draw the V-I characteristics of P-N junction diode both biasing.

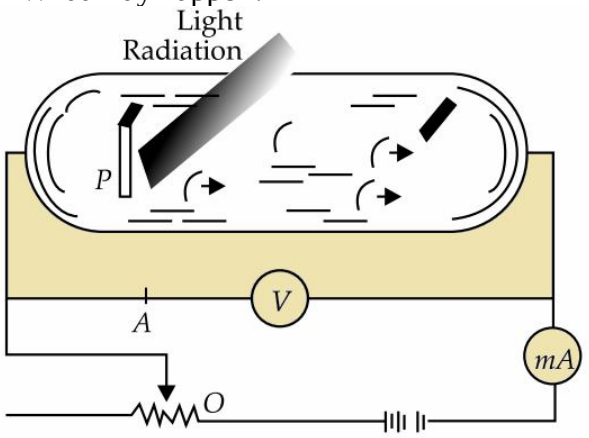
27. Define the terms (i) 'cut-off voltage' and (ii) 'threshold frequency' in relation to the phenomenon of photoelectric effect.
Using Einstein's photoelectric equation show how the cut-off voltage and threshold frequency for a given photosensitive material can be determined with the help of a suitable plot/graph.

28. How are electromagnetic waves produce? What is the source of energy of these waves? Write mathematical expressions for electric and magnetic fields of an electromagnetic wave propagating along the z-axis. Write any two important properties of electromagnetic waves.

SECTION – D

Questions 29 to 31 carry 5 marks each.

29. (a) Consider a beam of electron (each electron with energy E_0) incident on a metal surface kept in an evacuated chamber What may happen?



(b) What should be the wavelength of a photon required to remove a proton from a nucleus which is bound to the nucleus with 1 MeV energy?

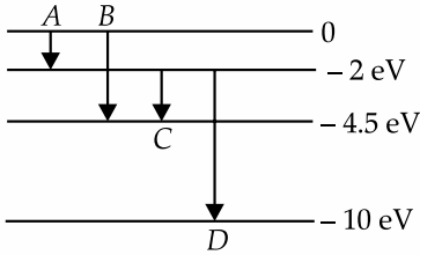
(c) Define intensity of radiation on the basis of photon nature of light. Write its SI unit.

OR

(a) State Bohr's postulate to define stable orbits in hydrogen atom. How does de Broglie's hypothesis explain the stability of these orbits?

(b) A hydrogen atom initially in the ground state absorbs a photon which excites it to the n = 4 level. Estimate the frequency of the photon.

(c) The energy levels of a hypothetical atom are given below. Which of the shown transitions will result in the emission of photon of wavelength 275 nm?



30. A capacitor is charged to potential V_1. The power supply is then disconnected and the capacitor is then connected in parallel to another capacitor (uncharged).

(a) Derive the expression for the common potential of the combination of capacitors.

(b) Show that the total energy of combination is less than the sum of the energy stored in them before they were connected.

OR

State Gauss theorem in electrostatics. Apply this theorem to obtain the expression for the electric field at a point due to an infinitely long, thin, uniformly charged straight wire of linear charge density λ C/m.

31. (a) Define a wave front.

(b) Draw the diagram to show the shape of plane wave front as they pass through (i) a thin prism and (ii) a thin convex lens. State the nature of refracted wave front.

(c) Verify Snell's law of refraction using Huygens's principle.

OR

(a) State two main considerations taken into account while choosing the objective of astronomical telescope.

(b) Draw a ray diagram of reflecting type telescope. State its magnifying power.

(c) State the advantages of reflecting type telescope over the refracting type.

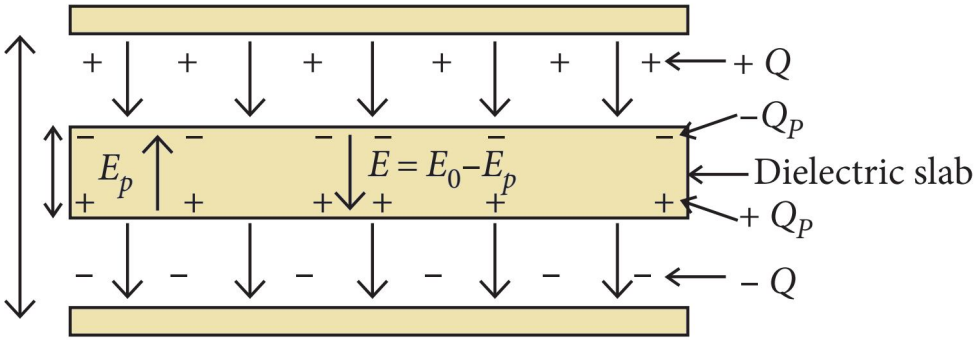
SECTION – E(Case Study Based Questions)

Questions 32 to 33 carry 4 marks each.

32. Case-Study 1:

Read the following paragraph and answer the questions.

A dielectric slab is a substance which does not allow the flow of charges through it but permits them to exert electrostatic forces on one another. When a dielectric slab is placed between the plates, the field E_0 polarises the dielectric. This induces charge $-Q_p$ on the upper surface and $+Q_p$ on the lower surface of the dielectric. These induced charges set up a field E_p inside the dielectric in the opposite direction of $\overrightarrow{E_0}$ as shown.



(i) In a parallel plate capacitor, the capacitance increases from 4μF to 80μF, on introducing a dielectric medium between the plates. What is the dielectric constant of the medium? (1)

(ii) A parallel plate capacitor with air between the plates has a capacitance of 8 pF. The separation between the plates is now reduced half and the space between them is filled with a medium of dielectric constant 5. Calculate the value of capacitance of the capacitor in second case. (2)

OR

(ii) A parallel plate capacitor of capacitance 1 pF has separation between the plates is d. When the distance of separation becomes 2d and wax of dielectric constant x is inserted in it the capacitance becomes 2 pF. What is the value of x? (2)

(iii) A parallel plate capacitor having area A and separated by distance d is filled by copper plate of thickness b. Write the expression of the new capacity. (1)

33. Case-Study 2:

Read the following paragraph and answer the questions

The relation between self-inductance and mutual inductance of two coils is M = $\sqrt{L_1 L_2}$. However, the above equation assumes zero flux leakage and 100% magnetic coupling between the two coils. In reality there is always some loss due to leakage and position, so the magnetic coupling between the two coils can never reach or exceed 100%. The fraction of magnetic flux produced by the current in one coil that links with the other coil is called the coefficient of coupling between the two coils. It is denoted by (k). k = 1, when the flux produced by one coil, completely links with the other coil and is called magnetically tightly coupled. k = 0, when the flux produced by one coil, does not link at all with the other coil and thus the coils are said to be magnetically isolated.

(i) Under which condition the relation between self-inductance and mutual inductance of two coils M = $\sqrt{L_1 L_2}$ is valid? (1)

(ii) What is coefficient of coupling? (1)

(iii) When two coils are said to be magnetically isolated? (2)

OR

When two coils are said to be magnetically tightly coupled? (2)