

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **26 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C, D, E.
- (iii) Section A - Questions 1 to 5 carry 1 mark each.
- (iv) Section B - Questions 6 to 10 carry 2 marks each.
- (v) Section C - Questions 11 to 22 carry 3 marks each.
- (vi) Section D - Question 23 carries 4 marks.
- (vii) Section E - Questions 24 to 26 carry 5 marks each.
- (viii) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.

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

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

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

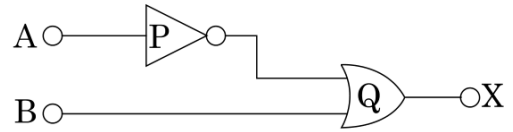
Section A

1. Two wires one of copper and other of manganin have same resistance and equal length. Which wire is thicker and why?

2. The power factor of an a.c. circuit is 0.5. What is the phase difference between voltage and current in the circuit?

3. In which situation is there a displacement current but no conduction current?

4. Name the logic gates marked P and Q in the given logic circuit.



5. Define the term 'relaxation time' in a conductor.

Section B

6. What is electrostatic shielding? How is this property used in actual practice? Is the potential in the cavity of a charged conductor zero?

7. State two properties of electromagnetic waves. How can we show that em waves carry momentum?

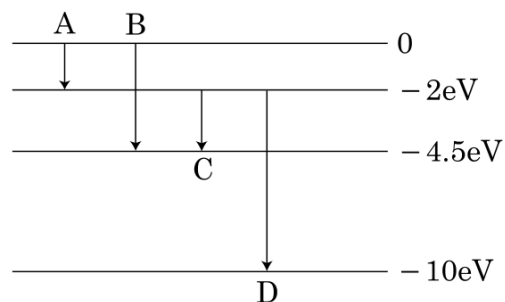
8. Write briefly the underlying principle used in Davison-Germer experiment to verify wave nature of electrons experimentally. What is the de-Broglie wavelength of an electron with kinetic energy (K.E.) 120 eV?

9. Write the function of a (i) transducer and (ii) repeater in a communication system.

10. In the ground state of hydrogen atom, its Bohr radius is given as 5.3×10^{-11} m. The atom is excited such that the radius becomes 21.2×10^{-11} m. Find (i) the value of the principal quantum number and (ii) the total energy of the atom in this excited state.

OR

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



(Energy levels: 0, -2 eV, -4.5 eV, -10 eV, with transitions labelled A, B, C, D as shown in the figure.)

Section C

11. Derive an expression for the electric field intensity at a point on the equatorial line of an electric dipole of dipole moment $\vec{P}$ and length $2a$. What is the direction of this field?

12. (a) A parallel plate capacitor (C_1) having charge Q is connected, to an identical uncharged capacitor C_2 in series. What would be the charge accumulated on the capacitor C_2 ?

(b) Three identical capacitors each of capacitance $3 \mu\text{F}$ are connected, in turn, in series and in parallel combination to the common source of V volt. Find out the ratio of the energies stored in two configurations.

13. (a) Define the term 'intensity of radiation' in photon picture.

(b) Plot a graph showing the variation of photo current vs collector potential for three different intensities $I_1 > I_2 > I_3$, two of which (I_1 and I_2) have the same frequency ν and the third has frequency $\nu_1 > \nu$.

(c) Explain the nature of the curves on the basis of Einstein's equation.

14. (i) Explain briefly the process of emission of light by a Light Emitting Diode (LED).

(ii) Which semiconductors are preferred to make LEDs and why?

(iii) Give two advantages of using LEDs over conventional incandescent lamps.

15. A capacitor of unknown capacitance, a resistor of 100Ω and an inductor of self inductance $L = (4/\pi^2)$ henry are connected in series to an ac source of 200 V and 50 Hz. Calculate the value of the capacitance and impedance of the circuit when the current is in phase with the voltage. Calculate the power dissipated in the circuit.

16. (i) For a glass prism ($\mu = \sqrt{3}$) the angle of minimum deviation is equal to the angle of the prism. Calculate the angle of the prism.

(ii) Draw ray diagram when incident ray falls normally on one of the two equal sides of a right angled isosceles prism having refractive index $\mu = \sqrt{3}$.

OR

16. Draw ray diagram when incident ray falls normally on one of the two equal faces of a right angled isosceles prism having refractive index $\mu = \sqrt{3}$.

17. Plot a graph showing the variation of binding energy per nucleon as a function of mass number. Which property of nuclear force explains the approximate constancy of binding energy in the range $30 < A < 170$? How does one explain the release of energy in both the processes of nuclear fission and fusion from the graph?

18. Draw a circuit diagram of a common emitter amplifier using n-p-n transistor. Derive an expression for the current gain β_{ac} .

19. (i) Name the phenomenon on which the working of an optical fibre is based.

(ii) What are the necessary conditions for this phenomenon to occur?

(iii) Draw a labelled diagram of an optical fibre and show how light propagates through the optical fibre using this phenomenon.

20. Mention any three applications of the internet. Explain one of these in detail.

21. Two harmonic waves of monochromatic light $y_1 = a \cos \omega t$ and $y_2 = a \cos(\omega t + \phi)$ are superimposed on each other. Show that maximum intensity in interference pattern is four times the intensity due to each slit. Hence write the conditions for constructive and destructive interference in terms of the phase angle ϕ .

22. (i) Mention two properties of soft iron due to which it is preferred for making an electromagnet.

(ii) State Gauss's law in magnetism. How is it different from Gauss's law in electrostatics and why?

OR

Derive an expression for the axial magnetic field of a finite solenoid of length $2l$ and radius r carrying current I . Under what condition does the field become equivalent to that produced by a bar magnet?

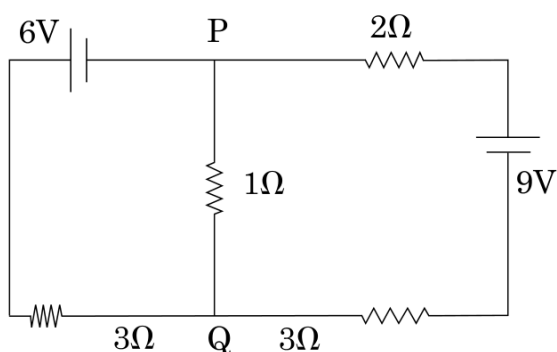
23. During a thunderstorm the 'live' wire of the transmission line fell down on the ground. A group of boys passing through noticed it and some of them wanted to place the wire by the side. As they were approaching the wire and trying to lift it, Hari noticed it and immediately pushed them away to prevent them from touching the wire. Two of them got hurt in the process. Hari took them to a doctor to get medical aid.

Based on the above paragraph, answer the following:

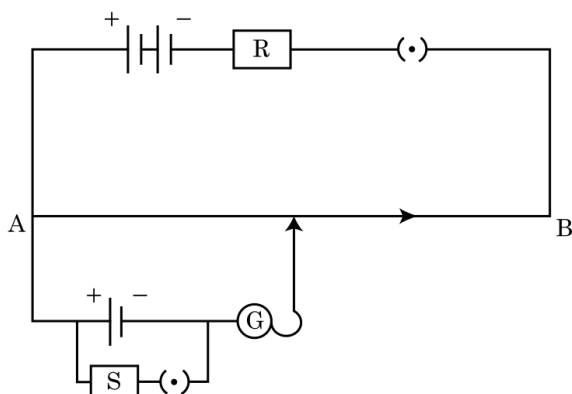
- (a) Write two values which Hari displayed during the incident.
 - (b) Why is it that a bird can sit over a suspended 'live' wire without any harm whereas touching it on the ground can give a fatal shock?
 - (c) The electric power from a power plant is set up to a very high voltage before transmitting it to distant consumers. Write the reason for it.
-

Section E

24. (i) Find the magnitude and direction of current in $1\ \Omega$ resistor in the given circuit.



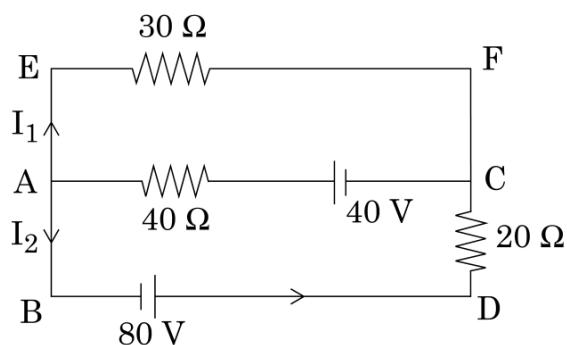
- (ii) Two students X and Y perform an experiment on potentiometer separately using the circuit diagram shown below.



Keeping other things unchanged (a) X increases the value of resistance R , (b) Y decreases the value of resistance S in the set up. How will these changes affect the position of null point in each case and why?

OR

24. (a) Use Kirchhoff's rules, calculate the current in the arm AC of the given circuit.



- (b) On what principle does the meter bridge work? Why are the metal strips used in the bridge?

25. (i) Express Biot-Savart law in the vector form.

- (ii) Use it to obtain the expression for the magnetic field at an axial point, distance d from the centre of a circular coil of radius R carrying current I .

- (iii) Also, find the ratio of the magnitudes of the magnetic field of this coil at the centre and at an axial point for which $x = R\sqrt{3}$.

OR

25. (a) Consider a beam of charged particles moving with varying speeds. Show how crossed electric and magnetic fields can be used to select charged particles of a particular velocity?

(b) Name another device/machine which uses crossed electric and magnetic fields. What does this machine do and what are the functions of magnetic and electric fields in this machine? Where do these fields exist in this machine? Write about their natures.

26. When a parallel beam of monochromatic source of light of wavelength λ is incident on a single slit of width a , show how the diffraction pattern is formed at the screen by the interference of the wavelets from the slit.

Show that, besides the central maximum at $\theta = 0$, secondary maxima are observed at $\theta =$

$$\left(n + \frac{1}{2}\right) \frac{\lambda}{a} \text{ and the minima at } \theta = \frac{n\lambda}{a}.$$

Why do secondary maxima get weaker in intensity with increasing n ? Explain.

OR

26. (i) Draw a ray diagram showing the geometry of formation of image of a point object situated on the principal axis and on the convex side of a spherical surface of radius of curvature R . Taking the rays as incident from a rarer medium of refractive index n_1 to a denser medium of refractive index n_2 , derive the relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$, where symbols have their usual meaning.

(ii) Explain briefly how the focal length of a convex lens changes with increase in wavelength of incident light.

(iii) What happens to the focal length of convex lens when it is immersed in water? Refractive index of the material of lens is greater than that of water.

- End of Question Paper -