

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.

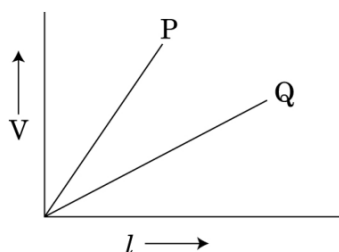
You may use the following values of physical constants wherever necessary:

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

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

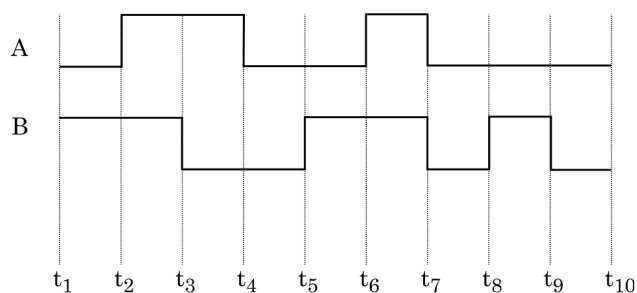
Section A

1. The variation of potential difference V with length l in case of two potentiometer wires P and Q is as shown. Which one of these will you prefer for comparing emfs of two primary cells and why?



2. An a.c. source of voltage $V = V_0 \sin \omega t$ is connected to an ideal inductor. Draw graphs of voltage V and current i versus ωt .

3. Two signals A and B are used as inputs of a NOR gate. Draw the output wave form.



4. Explain why current flows through an ideal capacitor when it is connected to an a.c. source but not when it is connected to a d.c. source in a steady state.

5. Define the term conductivity of a conductor. On what factors does it depend?

Section B

6. Derive an expression for the work done in rotating a dipole from the angle θ_0 to θ_1 in a uniform electric field E .

7. Show mathematically how Bohr's postulate of quantization of orbital angular momentum in hydrogen atom is explained by de-Broglie's hypothesis.

8. State the concept of mobile telephony and explain its working.

OR

8. Use Bohr model of hydrogen atom to calculate the speed of the electron in the first excited state.

9. A hydrogen atom initially in its ground state absorbs a photon and is in the excited state with energy 12.5 eV. Calculate the longest wavelength of the radiation emitted and identify the series to which it belongs. [Take Rydberg constant $R = 1.1 \times 10^7 \text{ m}^{-1}$]

OR

Use Bohr model of hydrogen atom to calculate the speed of the electron in the first excited state.

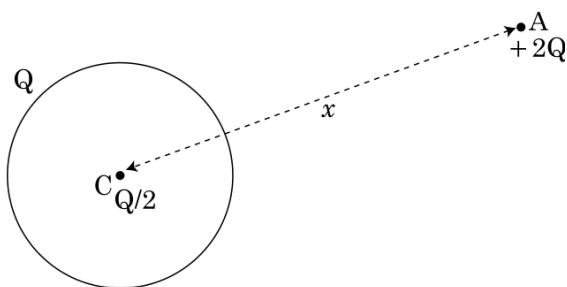
10. (i) How are infrared waves produced? Write their one important use.

(ii) The thin Ozone layer on top of the stratosphere is crucial for human survival. Why?

Section C

11. A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $Q/2$ is placed at the centre C and another charge $+2Q$ is placed outside the shell at A at a distance x from the centre as shown in the figure.

- (i) Find the electric flux through the shell.
- (ii) State the law used.
- (iii) Find the force on the charges at the centre C of the shell and at the point A .



12. How is a galvanometer converted into a voltmeter and an ammeter? Draw the relevant diagrams and find the resistance of the arrangement in each case. Take resistance of galvanometer as G .

- 13. (i) What is total internal reflection? Under what conditions does it occur?
- (ii) Find a relation between critical angle and refractive index.
- (iii) Name one phenomenon which is based on total internal reflection.

14. What is Global Positioning System? Explain its working principle in brief.

15. Half life of ${}_{92}^{238}\text{U}$ against α -decay is 4.5×10^9 years. Calculate the activity of 1 g sample of ${}_{92}^{238}\text{U}$. Given Avogadro's number = 6×10^{26} atoms/kmol.

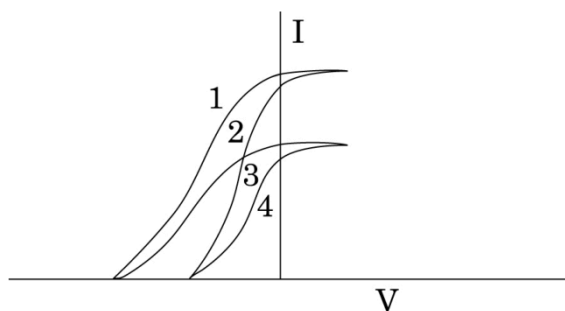
16. Draw a schematic arrangement for winding of primary and secondary coils in a transformer with the two coils on separate limbs of the core. State its underlying principle and find the relation between the primary and secondary voltages in terms of the number of turns of the primary and secondary windings. How are the currents in the primary and secondary coils related to the voltages in the case of an ideal transformer?

17. (a) In Young's double slit experiment, two slits are 1 mm apart and the screen is placed 1 m away from the slits. Calculate the fringe width when light of wavelength 500 nm is used.

(b) What should be the width of each slit in order to obtain 10 maxima of the double slits pattern within the central maximum of the single slit pattern?

18. Explain briefly, with the help of a circuit diagram, the transistor action of npn transistor in CE configuration. Draw the typical shapes of input and output characteristics.

19. The given graph shows the variation of photo-electric current (I) with the applied voltage (V) for two different materials and for two different intensities of the incident radiations. Identify and explain using Einstein's photo electric equation the pair of curves that correspond to (i) different materials but same intensity of incident radiation, (ii) different intensities but same materials.



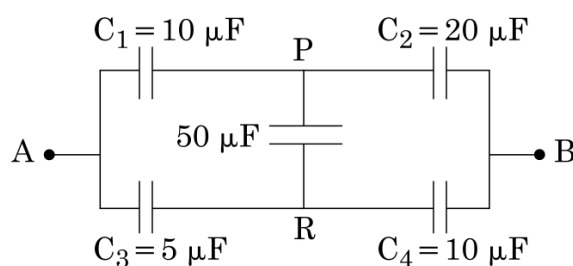
20. (i) Describe the working of photodiode by drawing the circuit diagram.
 (ii) Draw the characteristics of a photodiode for different illumination intensities.
 (iii) Why is photodiode operated in reverse bias even though the reverse bias current is much weaker than the current in forward bias?

21. (a) Draw a schematic diagram of a reflecting telescope.
 (b) State the advantages of reflecting telescope over refracting telescope.

OR

21. (i) Draw a schematic ray diagram of a compound microscope when image is formed at distance of distinct vision.
 (ii) Write the expression for resolving power of a compound microscope. How can the resolving power of a microscope be increased?

22. Calculate the equivalent capacitance between points A and B in the circuit below. If a battery of 10 V is connected across A and B , calculate the charge drawn from the battery by the circuit.



23. Shiv had a high tension tower erected on his farm land. He kept complaining to the authorities to remove it since it occupied a large portion of his land. His uncle, who was a teacher, explained to him the need for erecting these towers for efficient transmission of power. As Shiv got convinced and realized its significance, he stopped complaining.

Based on the above paragraph, answer the following questions:

- (a) Why is it necessary to transport power at high voltages?
 - (b) 'A low power factor implies large power loss'. Explain.
 - (c) Write the two values displayed by Shiv and his Uncle.
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Section E

24. (i) Draw a neat labeled diagram of a cyclotron.

(ii) Show that time period of ions in cyclotron is independent of both the speed of ion and radius of circular path. What is the significance of this property?

(iii) An electron after being accelerated through a potential difference of 100 V enters a uniform magnetic field of 0.004 T perpendicular to its direction of motion. Calculate the radius of the path described by the electron.

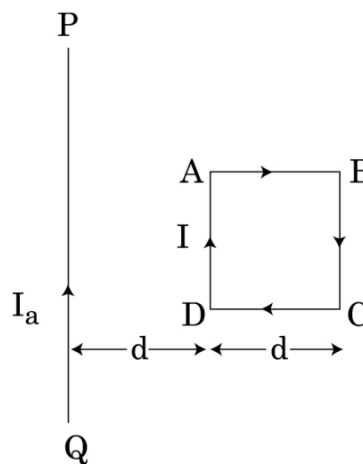
OR

24. (i) Depict magnetic field lines due to two straight, long, parallel conductors carrying steady currents I_1 and I_2 in the same direction.

(ii) Write the expression for the magnetic field produced by one of the conductor over the other. Deduce an expression for the force per unit length.

(iii) Determine the direction of this force.

(iv) In figure given below, wire PQ is fixed while the square loop $ABCD$ is free to move under the influence of currents flowing in them. State with reason, in which direction does the loop begin to move or rotate?



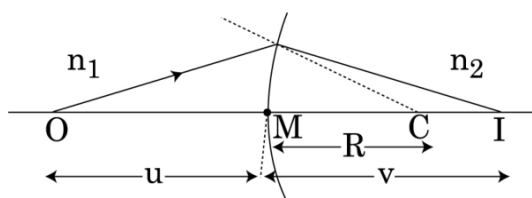
25. (a) Explain why the intensity of light coming out of a polaroid does not change irrespective of the orientation of the pass axis of the polaroid.

(b) State, using a proper diagram, the condition when unpolarized light incident on the boundary between two transparent media produces polarised light. Explain briefly.

Hence show that the angle of incidence i_B is related to the refractive index μ by the relation, $\mu = \tan i_B$.

OR

25. (a) A point object O on the principle axis of a spherical surface of radius of curvature R separating two media of refractive indices n_1 and n_2 forms an image I as shown in the figure.



Prove that $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

(b) Use this expression to derive lens maker's formula. Draw the necessary ray diagram.

(c) A convex lens is placed over a plane mirror. A pin is now positioned so that there is no parallax between the pin and its image formed by this lens-mirror combination. How will you use this observation to find focal length of the lens? Explain briefly.

26. (i) State the principle of working of a meter bridge. Draw the circuit diagram for finding an unknown resistance using a meter bridge. Derive the relevant formula used.

(ii) In a meter bridge with R and S in the gaps, the null point is found at 40 cm from A . If a resistance of 30Ω is connected in parallel with S , the null point occurs at 50 cm from A . Determine the values of R and S .

OR

26. (a) Deduce the expression for the torque acting on a dipole of dipole moment $\vec{P}$ placed in a uniform electric field $\vec{E}$. Depict the direction of the torque. Express it in the vector form.

(b) Show that the potential energy of a dipole making angle θ with the direction of the field is given by $u(\theta) = -\vec{p} \cdot \vec{E}$. Hence find out the amount of work done in rotating it from the position of unstable equilibrium to the stable equilibrium.

- End of Question Paper -