ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

CLASSROOM CONTACT PROGRAMME

(Academic Session : 2023 - 2024)

Sample Paper

PAPER

PHYSICS

Time 3 hrs **Max. Marks : 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 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 two case study based questions of four marks each and **Section-E** contains three long answer questions of five marks each.
4. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION–A

1. The value of electric potential at a distance r from a point charge will be : **[1]**

(A) proportional to r (B) inversely proportional to r

(C) proportional to r^2 (D) inversely proportional to r^2

2. When the separation between two charges is increased, the electric potential energy of the system of charges : **[1]**

(A) will decrease (B) will increase

(C) may increase or decrease (D) will remain same

3. In young's double slit experiment, if the wavelength of light is doubled then fringe-width will be : **[1]**

(A) equal (B) double (C) half (D) one fourth

4. The ratio of the atomic numbers of two atoms is 1 : 27. Ratio of their nuclear radii is : **[1]**

(A) 1 : 3 (B) 1 : 1 (C) 1 : 9 (D) 1 : $2\sqrt{3}$

5. The relationship between geometrical length (L_g) and magnetic length (L_m) is : **[1]**

(A) $L_m = \frac{6}{5} L_g$ (B) $L_m = L_g$ (C) $L_m = 2L_g$ (D) $L_m = \frac{5}{6} L_g$

6. A circular coil of radius R carries a current I. The magnetic field at its centre is B. At what distance from the centre, on the axis of the coil, the magnetic field will be B/8 : **[1]**

(A) $\sqrt{2}R$ (B) 2R (C) $\sqrt{3}R$ (D) 3R

7. The susceptibility of diamagnetic substance is : **[1]**

(A) Negative (B) Zero

(C) Infinity (D) Depends on magnetic field

8. Two point charges of + 10μC and – 10 μC are placed at a distance 40 cm in air. Potential energy of the system will be :– **[1]**

(A) 2.25 J (B) 2.35 J (C) –2.25 J (D) –2.35 J

9. An alternating current in a circuit is represented by I = 50Cos100πt . The frequency of alternating current is : **[1]**

(A) 100 Hz (B) 50 Hz (C) 25 Hz (D) 200 Hz

10. Which of the following rays is not deflected by magnetic field ? **[1]**

(A) Alpha rays (B) Beta rays (C) Gamma rays (D) Positive rays

11. In A.C. circuit, the current and voltage are given by i = 5 cos ωt, and V = 200 sin ωt respectively. Power loss in the circuit is : **[1]**

(A) 20 W (B) 40 W (C) 1000 W (D) Zero

12. The minimum angular momentum of an electron in hydrogen atom will be : **[1]**

(A) $\frac{h}{\pi}$ J s (B) $\frac{h}{2\pi}$ J s (C) h π J s (D) 2 πh J s

ASSERTION-REASON BASED QUESTIONS

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true and R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

13. **Assertion :** At saturation, photo electric current is maximum.

Reason : At saturation, all the electrons emitted from cathode are able to reach at anode. **[1]**

(A) a (B) b (C) c (D) d

14. **Assertion :**Conductivity of a semiconductor increases on doping. **[1]**

Reason : Doping raises the temperature of semiconductor.

(A) a (B) b (C) c (D) d

15. **Assertion :** When bodies are charged through friction, there is a transfer of electric charge from one body to another, but no creation or destruction of charge.

Reason : This follows from conservation of electric charges. **[1]**

(A) a (B) b (C) c (D) d

16. **Assertion :** No interference pattern is detected when two coherent sources are infinitely close to each other.

Reason : The fringe width is inversely proportional to the distance between the two slits. **[1]**

(A) a (B) b (C) c (D) d

SECTION – B

17. A potential barrier of 0.50 V exists across a p-n junction. If the depletion region is 5.0×10^{-7} m wide, what is the intensity of the electric field in this region ? **[2]**

18. What is photo electric effect? Write two factors on which the photo electric current depends. **[2]**

19. Two thin convex lenses of focal length 15 cm and 30 cm are placed in contact. What will be the power of combination ? **[2]**

20. A battery of electromotive force 12V and internal resistance 2Ω is connected to a resistor. If the current of 0.5A is flowing through the circuit then calculate the resistance of resistor. If the circuit is closed then what will be terminal voltage of the cell ? **[2]**

21. Two slits are 1 mm apart and the screen is placed 1 m away. What is the fringe width when blue-green light of wavelength 500 nm is used? **[2]**

OR

Focal length of a convex lens in air is 25 cm. If it is immersed in water, then calculate the focal length of the lens. $\left(n_w = \frac{4}{3}, n_g = \frac{3}{2} \right)$.

SECTION – C

22. Calculate the wavelength of radiation emitted when electron in a hydrogen atom jumps from n = ∞ to n = 1. **[3]**

OR

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 ?

23. Evaluate the capacitance of a parallel plate capacitor, having plates of area 6 cm^2 placed at a separation of 2 mm. Consider air between plates as a dielectric medium. If the capacitor is connected to 200 V power supply. What will be the charge on each plate ? **[3]**

24. When is H_α line in the emission spectrum of hydrogen atom for balmer series obtained? Calculate the frequency of the photon emitted during this transition. **[3]**

25. Obtain necessary condition for balancing state of wheat stone bridge by using Kirchhoff's law. Draw necessary circuit diagram. **[3]**

26. 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.? **[3]**

27. What is displacement current? Obtain an expression of displacement current for a charged capacitor. Write Ampere-Maxwell's law. **[3]**

28. Describe any two energy losses occurring in transformers. How these can be minimized ? Why electric power is transmitted at high voltage upto large distances ? **[3]**

OR

A rectangular coil has length 'ℓ' and breadth 'b', current I is flowing in it. If it is placed in uniform magnetic field B, then calculate the torque produced on it.

SECTION – D

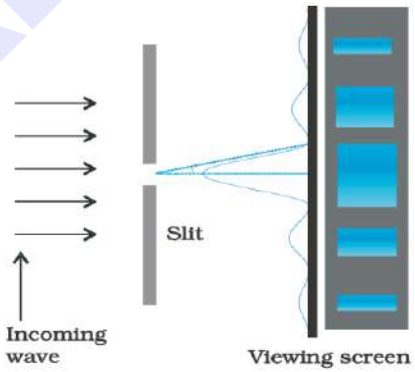
29. **Case Study :**

Diffraction at a Single Slit (Fraunhofer)

When light from a monochromatic source is incident on a single narrow slit, it gets diffracted and a pattern of alternate bright and dark fringes is obtained on screen, called "Diffraction Pattern" of single slit. In diffraction pattern of single slit, it is found that

(I) Central bright fringe is of maximum intensity and the intensity of any secondary bright fringe decreases with increase in its order.

(II) Central bright fringe is twice as wide as any other secondary bright or dark fringe.



(i) A single slit of width 0.1 mm is illuminated by a parallel beam of light of wavelength 6000 Å and diffraction bands are observed on a screen 0.5 m from the slit. What is distance of the third dark band from the central bright band ? **[1]**

(a) 3 mm (b) 1.5 mm (c) 9 mm (d) 4.5 mm

(ii) In Fraunhofer diffraction pattern, slit width is 0.2 mm and screen is at 2 m away from the lens. If wavelength of light used is 5000 Å then the distance between the first minimum on either side the central maximum is : **[1]**

(a) 10^{-1} m (b) 10^{-2} m (c) 2×10^{-2} m (d) 2×10^{-1} m

(iii) Light of wavelength 600 nm is incident normally on a slit of width 0.2 mm. The angular width of central maxima in the diffraction pattern is (measured from minimum to minimum) **[1]**

(a) 6×10^{-3} rad (b) 4×10^{-3} rad (c) 2.4×10^{-3} rad (d) 4.5×10^{-3} rad

(iv) A diffraction pattern is obtained by using a beam of red light. What will happen, if the red light is replaced by the blue light ? **[1]**

(a) bands disappear

(b) bands become broader and farther apart

(c) no change will take place

(d) diffraction bands become narrower and crowded together.

OR

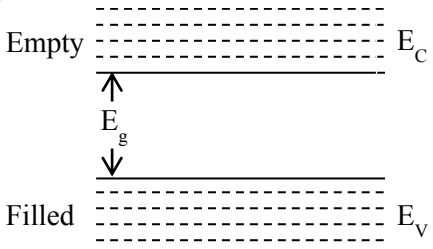
To observe diffraction, the size of the obstacle :

(a) should be $\lambda/2$, where λ is the wavelength. (b) should be much larger than the wavelength.

(c) has no relation to wavelength. (d) should be of the order of wavelength.

30. Energy Band Gap:

From Bohr's atomic model, we know that the electrons have well defined energy levels in an isolated atom. But due to interatomic interactions in a crystal, the electrons of the outer shells are forced to have energies different from those in isolated atoms. Each energy level splits into a number of energy levels forming a continuous band. The gap between top of valence band and bottom of the conduction band in which no allowed energy levels for electrons can exist is called energy gap.



(i) In an insulator energy band gap is :- **[1]**

(a) $E_g = 0$ (b) $E_g < 3eV$ (c) $E_g > 3eV$ (d) None of these

(ii) In a semiconductor, separation between conduction and valance band is of the order of - **[1]**

(a) 0 eV (b) 1 eV (c) 10 eV (d) 50 eV

(iii) Based on the band theory of conductors, insulators and semiconductors, the forbidden gap is smallest in **[1]**

(a) conductors (b) insulators (c) semiconductors (d) All of these

(iv) Conductivity of semiconductors –

(a) Increases with increase in temperature.

(b) Decreases with increase in temperature.

(c) Does not depend on temperature.

(d) First increases then decreases with increase in temperature.

OR

At absolute zero, Si acts as which of the following?

(a) Insulator (b) Metal (c) Non-metal (d) Superconductor

SECTION – E

31. **(a)** Plot a graph to show variation of the angle of deviation as a function of angle of incidence for light passing through a prism.

(b) The refractive index of the material of a concave lens is n_1. It is immersed in a medium of refractive index n_2. A parallel beam of light is incident on the lens. Trace the path of emergent rays when (a) $n_2 = n_1$ (b) $n_2 > n_1$ (c) $n_2 < n_1$

(c) Name the principle on which optical fibre works. Mention its two applications. **[5]**

OR

(a) Define a wavefront. Using Huygen's principle, verify the laws of reflection at a plane surface.

(b) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band ? Explain.

(c) An astronomical telescope having a magnifying power of 8 consists of two thin lenses 45 cm apart. Find the focal length of the lenses. **[5]**

32. **(a)** Define electric flux. Apply Gauss law to obtain an expression for the electric field intensity at a point due to an infinitely long uniformly charged straight wire. Draw the necessary diagram.

(b) An electron is moving around an infinite linear charge in circular path of diameter 0.30 m. If linear charge density is 10^{-6} C/m, then calculate the speed of an electron. ($m_e = 9.0 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$C) **[5]**

OR

(a) Write the definition of electric potential. Calculate the electric potential due to a point charge Q at a distance 'r' from it. Draw a graph between electric potential V and distance r for a point charge Q.

(b) Two point charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what point on the line joining these charges the electric potential will be zero ? **[5]**

33. (a) In an ac generator, a rectangular coil of N turns and cross-section A is rotated in uniform magnetic field (B) with a uniform angular speed ω, then find the instantaneous value of the induced emf in it. Draw the necessary diagram. **[3]**

(b) Write the statement of Lenz's law of electromagnetic induction.

A 2m horizontal long straight conducting wire extending from east to west direction is falling with a speed of 5 m/s perpendicular to the horizontal component of the earth's magnetic field 0.3×10^{-4} tesla. Calculate the value of instantaneous emf induced across the ends of wire. **[2]**

OR

(a) Write one merit and one de-merit of alternating current in comparison of direct current.

Obtain expression for following in a pure inductive alternating current circuit- **[1]**

(i) Instantaneous value of current

(ii) Reactance of circuit

(iii) Peak value of current

Draw curve for power in pure inductive circuit. **[3]**

(b) A bar magnet N-S is moved in the direction indicated by an arrow between two coils AB and CD as shown in the figure. In which coil the direction of current will look like anti-clockwise if viewed from left side? **[1]**