

2022
PHYSICS
(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

All the Questions are compulsory.

The figures in the right margin indicate full marks for the questions.

Question Nos. 1 to 10 are “Very Short Answer” type questions carrying 1 mark each.

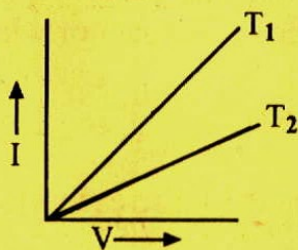
1. What is an equipotential surface ? 1
2. What happens to the capacitance of a capacitor when a dielectric slab is placed between its plates ? 1
3. Why does the resistance of a conductor increase with an increase in temperature? 1
4. If a wire is stretched to double its length, what will be its new resistivity ? 1
5. A Carbon resistor has three strips of red colour and a gold strip. What is the value of the resistor ? 1

P.T.O.

6. Why does a moving coil galvanometer use concave magnetic poles ? 1
7. How are electromagnetic waves produced ? 1
8. State Brewster's law. 1
9. Name the series of hydrogen spectrum lying in ultraviolet and visible region. 1
10. Why does zener diode work in reverse bias ? 1

Question Nos. 11 to 20 are 'Short Answer Type-II' questions carrying 2 marks each.

11. Force of attraction between two point electric charges placed at a distance d in a medium is F . What distance apart should these be kept in the same medium, so that force between them becomes $\frac{F}{3}$? 2
12. V-I graph for a metallic wire at two different temperatures is shown in the figure. Which of these two temperatures is higher and why ? 2



13. State Kirchhoff's laws in electrical network. 2
14. Why does metallic piece become very hot when it is surrounded by a coil carrying high frequency alternating current ? 2

15. Why does microwave oven heats up a food item containing water molecules most efficiently ? 2
16. Write two advantages of total reflecting prisms over a plane mirror. 2
17. Draw a neat labelled circuit diagram of experimental arrangement for study of photoelectric effect. 2
18. Assume that the frequency of the radiation incident on a metal plate is greater than its threshold frequency. If the frequency of the incident radiation is doubled, how will the following change ? 2
- (i) Kinetic energy of electrons
- (ii) Photoelectric current
19. Give two points of difference between alpha and beta particles. 2
20. What is photodiode and solar cell ? 2

Question Nos. 21 to 27 are 'Short Answer Type-I' questions carrying 3 marks each.

21. A circular coil of N turns and radius R carries a current I . It is unwound and rewound to make another square coil of side 'a' keeping number of turns and current same. Calculate the ratio of magnetic moment of the square coil to the circular coil. 3

22. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20A in 0.5s, what is the change of flux linkage with the other coil ? 3
23. Give three ways of reducing energy loss in a transformer. 3
24. What is the focal length of a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm ? Is the system a converging or a diverging lens ? Ignore thickness of the lenses. 3
25. In Young's double slit experiment when a source of light of wavelength 5000 \AA is used the fringe width obtained is 0.6cm. If the distance between slit and screen is reduced to half, calculate the new fringe width. 3
26. Suppose, we think of fission of a ${}^{56}_{26}\text{Fe}$ nucleus into two equal fragments of ${}^{28}_{13}\text{Al}$. Is the fission energetically possible ? Argue by working out Q of the process. 3
Given $m({}^{56}_{26}\text{Fe}) = 55.93494u$ and $m({}^{28}_{13}\text{Al}) = 27.98191u$.
27. Distinguish between conductors, insulators and semiconductors on the basis of energy band. 3

Question Nos. 28 to 30 are 'Long Answer Type' questions carrying 5 marks each.

28. State Gauss's Theorem in electrostatics. Using this theorem, derive an expression for the electric field intensity due to an infinite plane sheet of charge density σ . 1+4=5

OR

Define electric dipole moment. Derive an expression for the electrical potential energy in rotating an electric dipole through an angle θ in a uniform electric field.

1+4=5

29. Derive an expression for the torque on a rectangular current carrying loop suspended in a uniform magnetic field.

5

OR

Derive an expression for potential energy of a magnetic dipole when placed in uniform magnetic field. When does the magnetic dipole possess maximum potential energy inside a magnetic field ?

4+1=5

30. Draw a ray diagram to show the image formation by a concave mirror when the object is kept beyond its focus. Using this diagram, derive the mirror equation.

1+4=5

OR

Draw a ray diagram showing the formation of the image by a point object on the principal axis of a spherical convex surface separating two media of refractive indices n_1 and n_2 when a point source is kept in rarer medium of refractive index n_1 . Derive the relation between object and image distance in terms of refractive indices of the media and radius of curvature of the surface.

1+4=5

Question Nos. 31 to 34 are 'Multiple Choice Type' questions carrying 1 mark each. Choose the correct answer out of the four alternatives and rewrite the correct answer.

31. A substance has critical angle of 45° for yellow light, its refractive index is – 1

(A) $\frac{1}{\sqrt{2}}$

(B) $\sqrt{2}$

(C) 1

(D) 1.5

32. A proton, an electron and an α -particle have same energy. Then their de Broglie wavelengths compare as – 1

(A) $\lambda_\alpha > \lambda_p > \lambda_e$

(B) $\lambda_\alpha < \lambda_p > \lambda_e$

(C) $\lambda_\alpha > \lambda_p < \lambda_e$

(D) $\lambda_\alpha < \lambda_p < \lambda_e$

33. The ground state energy of H-atom is 13.6 eV. The energy needed to ionize H-atom from its second excited state – 1

- (A) 3.4 eV
- (B) 1.51 eV
- (C) 12.1 eV
- (D) 13.6 eV

34. With the increase in temperature, the width of the forbidden gap will – 1

- (A) decrease
- (B) increase
- (C) remain same
- (D) becomes zero