

2023

PHYSICS**(Theory)****Full Marks : 70****Pass Marks : 21****Time : Three hours*****All questions are compulsory.******The figures in the right margin indicate full marks for the questions.******You may use the following values of physical constants wherever necessary :***

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 \text{ C}^{-2}$$

$$h = 6.6 \times 10^{-34} \text{ Js}$$

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

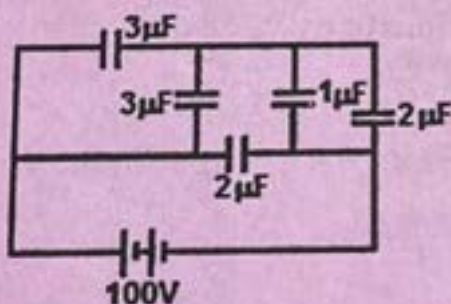
1. What is meant by induction of charge? 1
2. The electric potential at a distance r from a charge q is V . When the charge is replaced by $5q$, what will be the potential at that point? 1

P.T.O.

3. Why do higher range of resistors mostly made from carbon ? 1
4. State the condition for maximum current to be drawn from a cell. 1
5. What happens to the voltage sensitivity of the galvanometer when the current sensitivity of a moving coil galvanometer is doubled by doubling the number of turns of the coil ? 1
6. What is the condition for resonance in series LCR circuit ? 1
7. What is Photo-electric emission ? 1
8. The work function of a metal is 0.1 eV, what is the threshold frequency for the metal. 1
9. State law of radioactive decay. 1
10. Why is a semiconductor damaged by a strong current ? 1

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

11. In the given network, calculate the total charge and energy stored in the network. 2



12. In a potentiometer arrangement, a cell of emf 1.5 V gives a balance point at 30 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 40 cm, what is the emf of the second cell ? 2

13. The range of a voltmeter is 10 V and its internal resistance is $50\ \Omega$. To convert it to a voltmeter of range 15 V, how much resistance is to be added? 2
14. An ideal inductor consumes no electric power in a.c. circuit. Explain. 2
15. A $50\ \mu\text{F}$ capacitor is connected to a 200 V, 50 Hz a.c. supply. Determine the rms value of the current in the circuit. 2
16. Write two basic properties of electromagnetic waves. 2
17. The focal length of a biconvex lens of refractive index $\frac{3}{2}$ is 15 cm. What will be the focal length of the lens when it is immersed in a liquid of refractive index $\frac{3}{4}$? 2
18. A light wave enters from air to glass. How will the following be affected? 2
 - (a) Energy of the wave
 - (b) Frequency of the wave
19. Write two points of difference between interference and diffraction. 2
20. What are n-type and p-type semiconductors? 2

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

21. Deduce $\sigma = \frac{ne^2}{m} \tau$, where the symbols have their usual meaning. 3

22. How is the mutual inductance of a pair of coils affected when

(a) Separation between the coils is increased

(b) The number of turns of each coil is increased

(c) A thin iron sheet is placed between two coils, other factors remaining the same.

Explain the answer in each case.

3

23. Prove law of reflection using Huygen's principle.

3

24. An electron is accelerated from rest through a potential V . Obtain the expression for the de Broglie wavelength associated with it.

3

25. It is found experimentally that 13.6 eV energy is required to separate a hydrogen atom into a proton and an electron. Compute the orbital radius and the velocity of the electron in a hydrogen atom.

3

26. What are the three postulates of Bohr's Model of an atom?

3

27. Draw a neat diagram of a half-wave rectifier and explain its working.

3

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

28. Derive an expression for the electric field intensity at a point on the axial line of an electric dipole.

3+2=5

Two point charges $+10^{-8}C$ and $-10^{-8}C$ are placed 2 cm apart in air.

Calculate the electric field at the mid-point of the line joining the two charges.

OR

Deduce the expression for the torque acting on a dipole of dipole moment $\vec{p}$ in the presence of a uniform electric field $\vec{E}$. 3+2=5

An electric dipole of length 10 cm having charges $6 \times 10^{-3} \text{C}$, placed at 30° with respect to a uniform electric field, experiences a torque of 6 N-m. Calculate the magnitude of the electric field.

29. Write the formula of Biot-Savart law in vector form. Obtain an expression of magnetic field due to a circular current-loop of radius R at a point P distant x from its centre along the axis of the loop. 1+4=5

OR

Derive an expression for the force acting on a current carrying conductor placed in a uniform magnetic field. Write the condition for which this force will have

(a) maximum value

(b) minimum value 4+1=5

30. Draw a labelled ray diagram to show the formation of image of same size as that of object in case of converging lens. Using this ray diagram establish the relation between u, v and f for this lens. 2+3=5

OR

Draw a labelled ray diagram of compound microscope when the final image is formed at the near point. Hence derive the expression for its magnifying power. 2+3=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. In the magnetic meridian of a certain place, the horizontal component of earth's magnetic field is 0.26G and dip angle is 60° . The magnetic field of the earth at this location is – 1
- (A) 0.50G
(B) 0.52G
(C) 0.54G
(D) 0.56G
32. When medium of electromagnetic waves changes from air to water, their speed – 1
- (A) increases
(B) decreases
(C) remains same
(D) may increase or decrease
33. A convex lens is immersed in a liquid of refractive index greater than that of glass. It will behave as a – 1
- (A) convergent lens
(B) divergent lens
(C) plane glass
(D) homogeneous liquid

34. When a reverse bias is applied to a p - n junction, it –

- (A) raises the potential barrier
- (B) increases the majority carrier current
- (C) lowers the potential barrier
- (D) increases the minority carrier current