2026

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 :

$$c = 3 \times 10^8 \, m/s$$

$$\pi = \frac{22}{7}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \, C^2 N^{-1} m^{-2}$$

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

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

$$\tan 5^\circ = 0.0875$$

Question Nos. 1 to 10 are 'Multiple Choice Type' questions carrying 1 mark each. Choose the correct answer out of the four alternatives and rewrite the correct answer.

1. Equipotential surface at a large distance from a collection of charge whose total sum is not zero are – 1

(A) ellipsoids (B) planes

(C) paraboloids (D) spheres

2. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of the resulting system – 1

(A) increases by a factor 4
(B) decreases by a factor of 2
(C) remains the same
(D) increases by a factor of 2

3. An unknown resistance R_1 is connected in series with a resistance of 10 ohms. This combination is connected to one gap of a meter bridge, while a resistance R_2 is connected in the other gap, the balance point is obtained at a distance of 50cm. When 10 ohms resistance is removed the balance point shifts to 40cm. The value of R_1 is – 1

(A) 10 ohms
(B) 20 ohms
(C) 40 ohms
(D) 60 ohms

4. In a plane electromagnetic wave the electric field oscillates sinusoidally with a frequency 2.5×10^{10}Hz and amplitude 480V/m. The amplitude of the oscillating magnetic field will be – 1

(A) 1.52×10^{-8} weber/m^2
(B) 1.52×10^{-7}weber/m^2
(C) 1.6×10^{-6} weber/m^2
(D) 1.6×10^{-7}weber/m^2

5. For which of the following media with respect to air the value of critical angle is maximum? 1

(A) crown glass
(B) flint glass
(C) diamond
(D) water

6. Maximum kinetic energy of emitted photoelectron depends on the frequency of incident photon when the frequency of the incident radiation is – 1

(A) equal to the threshold frequency

(B) half of threshold frequency

(C) greater than the threshold frequency

(D) one-third of threshold frequency

7. Bohr model of atom cannot be directly applied to calculate the energy level of an atom with many electrons. This is because – 1

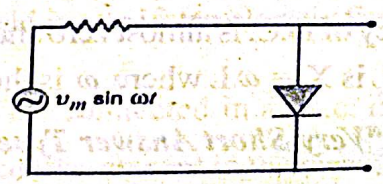
(A) the electrons are not subjected to a central force

(B) the electrons are colliding with each other

(C) of screening effect

(D) the force between nucleus and electron will not be given by Coulomb's law

8.



A circuit consists of a diode biased with an emf source $V_m \sin \omega t$ through a resistor as shown in figure. The output obtained will be – 1

(A) zero

(B) like a half wave rectifier with positive cycle in output

(C) like a half wave rectifier with negative cycle in output

(D) like that of a full wave rectifier

Question Nos. 9 and 10 are Assertion (A) and Reason (R) type questions.

Two statements are given one labelled Assertion (A) and the other Reason (R). Select the correct answer to the 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.

9. Assertion (A) : The magnetic field strength due to a bar magnet on its axial line at a distance r is double than at the equatorial line at the same distance.

Reason (R) : Magnetic field strength at a point on the axial line is $B_a = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$ and on the equatorial line is $B_{eq} = \frac{\mu_0}{4\pi}\frac{M}{r^3}$. 1

10. Assertion (A) : The impedance offered by an ideal inductor to the flow of direct current is zero.

Reason (R) : The frequency of D.C. is almost zero and the inductive reactance of inductor L is $X_L = \omega L$ where ω is the angular frequency. 1

Question Nos. 11 to 17 are "Very Short Answer Type" questions carrying 1 mark each.

11. If the current flowing in a copper wire be allowed to flow in another copper wire of same length but of doubled the radius then what will be the effect on the drift velocity of the electron? 1

12. Why does magnetization of paramagnet increases on cooling? 1

13. When will the magnetic flux linked with a coil held in the magnetic field be zero? 1

14. Why cannot a transformer be used to step up direct current (D.C.)? 1

15. Draw the diagram of wave front produced by a point source of light. 1

16. Give one point of difference between nuclear fission reaction and nuclear fusion reaction. 1

17. Why is the conductivity of n-type semiconductor greater than that of p-type semiconductor even if both of these have the same level of doping? 1

Question Nos. 18 to 27 are "Short Answer Type-II" questions carrying 2 marks each.

18. A uniformly charged conducting sphere of 2.4m diameter has a surface charge density of $80.0\mu Cm^{-2}$. Calculate the total electric flux leaving the surface of the sphere. 2

19. Write any two factors on which the internal resistance of a cell depends. 2

20. An electron beam is projected perpendicular to a given field. How can we predict whether the given field is a uniform electric field? 2

21. An ideal inductor when connected in an a.c. circuit does not produce heating effect though it reduces the current in the circuit. Explain giving reason. 2

22. Name the electromagnetic wave used in LASIK eye surgery and give its frequency range. 2

23. Two independent light bulb fail to produce interference. Give reason. 2

24. Wave theory of light fails to explain the phenomenon of photoelectric effect. Give reason. 2

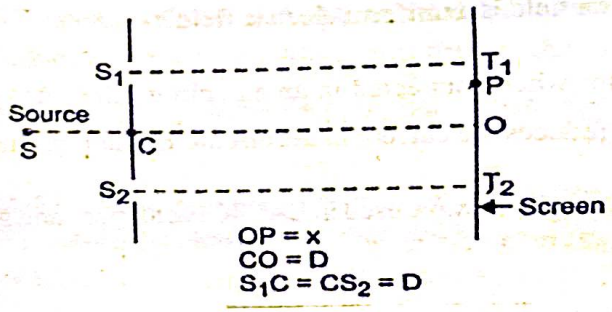
25. When the surface of a certain metal is illuminated with a light of wavelength λ the emitted photoelectrons possess a maximum kinetic energy 'K'. If the photoelectrons are to be ejected with a maximum kinetic energy of '2K' then find the probable expression for the wavelength of the light to be used. 2

26. Calculate the impact parameter of 5MeV alpha particle scattered by 10° when it approaches a gold nucleus. Take $Z = 79$ for gold. 2

27. Draw the circuit diagram for the experimental setup to determine the current voltage (I – V) characteristics of a p – n junction diode in the reverse biased mode. 2

Question Nos. 28 to 33 are "Short Answer Type-I" questions carrying 3 marks each.

28. Consider a double slit interference arrangement as shown in figure. The distance of the screen from the slit is half the distance between the slits. Obtain the value of D in terms of wavelength λ such that the first minimum on the screen falls at a distance D from O. 3



29. What are the conclusions drawn from Rutherford's α-particles scattering experiment? 3

30. Explain the formation of the barrier potential in a p – n junction. 3

31. A small town with a demand of 1Mw at 220V is situated 20km away from an electric power plant generating power at 440V. The resistance of two line wires carrying power is 0.5 Ω/km. Two step down transformers are available : 4000V – 220V and 1000000V – 220V at a substation in the town for supply of power. Which one will you prefer for use? Justify your answer with suitable calculation. 3

OR

Three sets of combinations of LCR are given viz.

(a) L=3H, C= 27μF, R= 20 Ω

(b) L=4H, C= 16μF, R= 10 Ω

(c) L=3.5H, C=30μF, R=15 Ω

Which of the above combination would you select for better tuning of an LCR circuits used for communication. Justify with proper calculation. 3

32. Define total internal reflection. State the essential conditions necessary for total internal reflection. 3

OR

What are optical fibres? Give any two applications of optical fibres. 3

Question number 33 is case study based question. Read the following paragraph and answer the questions that follow.

33. The resistance (R) of a conductor is the obstruction offered by it to the flow of current. It depends on a number of factors like length (l), area of cross section (A) and nature or type of the material of the conductor. The resistance of the conductor varies with temperature. For the same material and at constant temperature, the resistivity is given by $\rho = \frac{RA}{l}$. Its value is low for conductor, moderate for semiconductor and very high for insulator. The temperature coefficient of resistance is very low for manganin than for copper, aluminum etc.

Read the above paragraph carefully and answer the following questions.

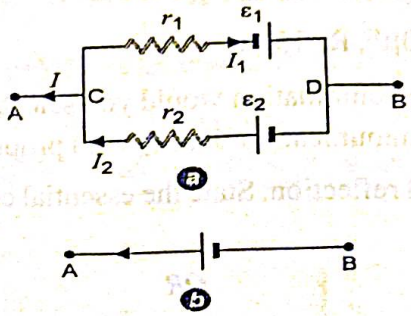
(i) How does the resistance of a conductor change when its length is increased three times?

(ii) Why do we prefer aluminium and copper over manganin (alloy) wire for our household wiring?

(iii) Why are manganin wire used for making standard resistors? 1+1+1=3

OR

A battery is a combination of two or more cells. In the following figure a single battery is represented in which two cells of emf E_1 and E_2 and internal resistance r_1 and r_2 respectively are connected.



Based on the above information answer the following questions.

(i) Find the equivalent emf of the combination.

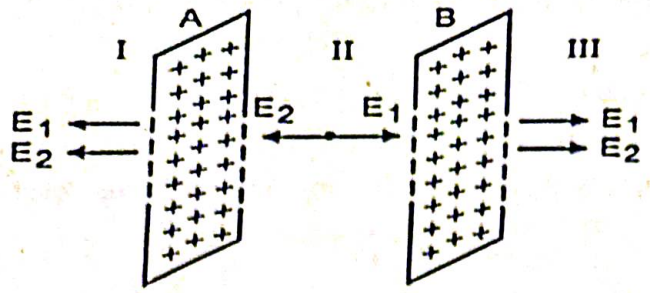
(ii) For terminal B to be negative what is the required condition? 2+1=3

Question Nos. 34 to 36 are "Long Answer Type" questions carrying 5 marks each.

34. Using theorem of superposition derive the expression for the electric field intensity due to a discrete charge distribution consisting of ' n ' charges.

If the charges are distributed continuously along a given length with charge density λ then deduce the expression for the electric field in this case. 3+2=5

OR



Two thin plane sheet of charge having charge density of σ_1 and σ_2 are placed parallel to each other. Derive the expression for the electric field intensities in the regions I, II and III as shown in figure. How will the intensity changed if the charge densities on the plates become σ and $-\sigma$ respectively? 3+2=5

35. Derive the expression for the force acting on a current carrying conductor placed in a uniform magnetic field. From the expression, deduce the condition when will the magnitude of the force be maximum and when will it be minimum. 3+1+1=5

OR

Derive the expression for the force between two parallel linear conductors carrying current in the same direction.

From the expression, define one ampere of current. How will the nature of the force be when the currents flow in the opposite direction? 3+1+1=5

36. Derive the expression for the magnifying power of an astronomical telescope for distinct vision.

In an astronomical telescope the focal length of the objective lens is 75cm and that of the eyepiece is 5cm. Calculate the magnifying power of the telescope for distinct vision. (d = 25 cm) 3+2=5

OR

Derive the expression for the magnifying power of a compound microscope for distinct vision.

A compound microscope uses an objective lens of focal length 4 cm and eyepiece lens of focal length 10 cm. An object is place at 6 cm from the objective lens. Calculate the magnifying power of the compound microscope for distinct vision. (d = 25cm) 3+2=5
