CBSE EXAMINATION PAPER-2025

PHYSICS

(Solved)

Time allowed : 3 hours Maximum Marks : 42

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **20 questions.** All questions are **compulsory.**
ii. This question paper is divided into **4 sections.**
iii. **Section A** – questions number **1 to 9** are multiple choice questions Each question carries **1 marks.**
iv. **Section B** – questions number **10 to 13** are very short answer Each question carries **2 marks.**
v. **Section C** – questions number **14 to 18** are short answer Each question carries **3 marks.**
vi. **Section D** – questions number **19 to 20** are long answer Each question carries **5 marks.**
vii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.
viii. Use of calculator is NOT allowed.

Section A

Question 1.

Two charges —q each are placed at the vertices A and B of an equilateral triangle ABC. If M is the mid-point of AB, the net electric field at C will point along:

[1 Marks]

(A) CM

(B) CB

(C) MC

(D) CA

Explanation: The net electric field at point C will be the vector sum of the electric fields due to the charges at points A and B. Since both charges are equal and negative (-q), the electric field lines at point C will point towards each charge. Therefore, the net electric field will be directed along the line CM, which bisects the angle at C, making option CM the correct choice.

Question 2.

In the figure X is a coil wound over a hollow wooden pipe.

A permanent magnet is pushed at a constant speed v from the right into the pipe and it comes out at the left end of the pipe. During the entry and the exit of the magnet, the current in the wire YZ will be from

[1 Marks]

(A) Y to Z and then Y to Z

(B) Z to Y and then Y to Z

(C) Y to Z and then Z to Y

(D) Z to Y and then Z to Y

Explanation: When the permanent magnet is pushed into the coil, it induces a current in the coil in one direction (from Y to Z), due to the increasing magnetic flux through the coil. As the magnet moves out of the coil, the current reverses direction (from Z to Y) due to the decreasing magnetic flux. Therefore, the correct sequence of current flow is Y to Z and then Z to Y.

Question 3.

The alternating current I in an inductor is observed to vary with time t as shown in the graph for a cycle.

Which one of the following graphs is the correct representation of wave form of voltage V with time t ?

[1 Marks]

(A) D

(B) C

(C) B

(D) A

Explanation:

The correct option is B. In an inductive circuit, the current lags the voltage by one-fourth of a period (T/4), which corresponds to a phase difference of π/2. Therefore, the voltage waveform reaches its peak before the current waveform, which is consistent with the characteristics of inductors.

Question 4.

A transformer is connected to a 200 V ac source. The transformer supplies 3000 V to a device. If the number of turns in the primary coil is 450, then the number of turns in its secondary coil is -

[1 Marks]

(A) 30

(B) 4500

(C) 6750

(D) 450

Explanation: To find the number of turns in the secondary coil (Ns), we use the transformer equation: Vs/Vp = Ns/Np. Here, Vs is 3000 V, Vp is 200 V, and Np is 450. Rearranging gives: Ns = (Vs * Np) / Vp = (3000 * 450) / 200 = 6750. Therefore, the correct answer is 6750.

Question 5.

Which one of the following statements is correct ? Electric field due to static charges is

[1 Marks]

(A) conservative and field lines do not form closed loops.

(B) conservative and field lines form closed loops.

(C) non-conservative and field lines do not form closed loops.

(D) non-conservative and field lines form closed loops.

Explanation: The correct option is 'conservative and field lines do not form closed loops.' This is supported by the context stating that electrostatic field lines originate from positive charges and terminate at negative charges or extend to infinity, indicating that they do not form closed loops. Furthermore, it is noted that the electric field is conservative in nature, meaning that the work done in moving a charge between two points in an electrostatic field is independent of the path taken.

Question 6.

Atomic spectral emission lines of hydrogen atom are incident on a zinc surface. The lines which can emit photoelectrons from the surface are

members of

[1 Marks]

(A) Neither Balmer, nor Paschen nor Lyman series

(B) Lyman series

(C) Paschen series

(D) Balmer series

Explanation: The correct option is 'Lyman series'. The Lyman series consists of ultraviolet spectral lines resulting from electron transitions to the ground state (n=1) in hydrogen, which have sufficiently high energy to overcome the work function of zinc, thus allowing photoemission of electrons.

Question 7.

The energy of an electron in a hydrogen atom in ground state is —13.6 eV. Its energy in an orbit corresponding to quantum number n is -0.544 eV.

The value of n is

[1 Marks]

(A) 4

(B) 5

(C) 3

(D) 2

Explanation: To find the value of n, we use the energy level formula for a hydrogen atom, E_n = -13.6 eV / n^2. Given E_n = -0.544 eV, we can set up the equation -0.544 = -13.6 / n^2. Solving for n, we find n^2 = 13.6 / 0.544, which gives n^2 = 25, leading to n = 5. Therefore, the correct answer is 5.

Question 8.

Assertion (A) : In a semiconductor diode the thickness of depletion layer is not fixed.

Reason (R) : Thickness of depletion layer in a semiconductor device depends upon many factors such as biasing of the semiconductor.

[1 Marks]

(A) If Assertion (A) is true but Reason (R) is false.

(B) If both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) If both Assertion (A) and Reason (R) are false.

(D) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Explanation: Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). The thickness of the depletion layer in a semiconductor diode varies based on the external voltage applied across the diode, which acts as a biasing factor. Thus, the assertion that the thickness is not fixed is valid, and the reason correctly identifies the dependency on biasing.

Question 9.

Assertion (A) : Out of Infrared and radio waves, the radio waves show more diffraction effect.

Reason (R) : Radio waves have greater frequency than infrared waves.

[1 Marks]

(A) If both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(B) If Assertion (A) is true but Reason (R) is false.

(C) If both Assertion (A) and Reason (R) are false.

(D) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Explanation: Assertion (A) is true because radio waves do exhibit more diffraction than infrared waves, which is primarily due to their larger wavelengths. However, Reason (R) is false because radio waves actually have lower frequencies than infrared waves. Hence, the correct option is 'If Assertion (A) is true but Reason (R) is false.'

Section B

Question 10. Two wires of the same material and the same radius have their lengths in the ratio 2:3. They are connected in parallel to a battery which supplies a current of 15 A. Find the current through the wires.

[2 Marks]

Answer: To find the current through the two wires connected in parallel, we first note their lengths ratio of 2:3. Let the lengths be 2l and 3l, respectively. The resistance of a wire is given by R = ρl/A. Since both wires are of the same material and radius, the resistance ratios will be in the same ratio as their lengths, i.e., R1:R2 = 2:3. The currents will then divide in inverse ratio of resistances. Therefore, the current through wire 1 is 6 A, and through wire 2 is 9 A.

Question 11.

In the circuit, three ideal cells of e.m.f. V, V and 2V are connected to a resistor of resistance R, a capacitor of capacitance C, and another resistor of resistance 2R as shown in the figure. In the steady state, find (i) the potential difference between P and Q and (ii) the potential difference across capacitor C.

[2 Marks]

Answer: In the steady state, the potential difference between points P and Q can be derived using Kirchhoff's laws. The equivalent emf across P and Q is V + V + 2V = 4V. The effective resistance in the circuit is R + 2R = 3R. Hence, the total current I is 4V/3R. The potential difference across the capacitor C will be equal to the potential difference across the second resistor due to parallel connections. Therefore, V_C = 2V/3.

Question 12.

Two concave lenses A and B, each of focal length 8.0 cm, are arranged coaxially 16 cm apart as shown in figure. An object P is placed at a distance of 4.0 cm from A. Find the position and nature of the final image formed.

[2 Marks]

Answer: The first lens A, being concave and having a focal length of -8.0 cm, produces an image I1 at a distance of -2.67 cm (virtual image). This virtual image acts as the object for lens B. The object distance for lens B is 13.33 cm, leading it to create a final virtual image I at approximately -4.0 cm. Thus, the final image is virtual and located on the same side as the object.

Question 13. The threshold voltage of a silicon diode is 0.7 V. It is operated at this point by connecting the diode in series with a battery of V volts and a resistor of 1000Ω. Find the value of V when the current drawn is 15 mA.

[2 Marks]

Answer: To find the value of V, we use Ohm's law and the formula for total voltage in the circuit. The total voltage V across the battery is the sum of the threshold voltage (0.7 V) and the voltage drop across the resistor. The current drawn is 15 mA or 0.015 A. The voltage drop across the resistor is calculated as $V_R = I \times R = 0.015 \text{ A} \times 1000 \ \Omega = 15 \text{ V}$. Thus, V = 0.7 V + 15 V = 15.7 V.

Section C

Question 14.

(a) A cell of e.mf. E and internal resistance r is connected with a variable external resistance R and a voltmeter showing potential drop V across R. Obtain the relationship between V, E, R and r.

(b) Draw the shape of the graph showing the variation of terminal voltage V of the cell as a function of current I drawn from it. How one can determine the e.m.f. of the cell and its internal resistance from this graph ?

[3 Marks]

Answer: To derive the relationship between the potential drop V, e.m.f. E, external resistance R, and internal resistance r of the cell, we apply Kirchhoff's loop rule. The equation can be formed as $E = V + I*r$, where I is the current through the circuit. According to Ohm's law, $V = I*R$. Substituting this into the equation, we get $E = I*R + I*r$, or rearranging gives $V = E - I*r$. The terminal voltage decreases as current increases. The graph of V against I is a straight line with a negative slope, indicating that the terminal voltage decreases as current drawn increases. The e.m.f. can be determined by finding the voltage at zero current, and the internal resistance can be calculated from the slope of the line, which represents -r. This graphical method provides insight into both the e.m.f and internal resistance of the cell.

Question 15.

(a) State Lenz's law.

(b) In the given figure :

(i) Identify the machine.

(ii) Name the parts P and Q and R of the machine.

(iii) Give the polarities of the magnetic poles.

(iv) Write the two ways of increasing the output voltage.

[3 Marks]

Answer: Lenz's law states that the induced electromotive force (emf) in a closed circuit will always work to oppose the change in magnetic flux that produced it. In the given figure, the machine is likely a generator. Part P can be identified as the rotor, part Q as the stator, and part R as the slip rings. The magnetic poles will have the North pole at the rotor and the South pole at the stator. To increase the output voltage, one can increase the speed of the rotor or enhance the strength of the magnetic field.

Question 16.

(a) When a parallel beam of light enters water surface obliquely at some angle, what is the effect on the width of the beam ?

(b) With the help of a ray diagram, show that a straw appears bent when it is partly dipped in water and explain it.

(c) Explain the transmission of optical signal through an optical fibre by a diagram.

[3 Marks]

Answer: (a) When a parallel beam of light strikes the water surface obliquely, it deviates from its path due to refraction, resulting in a wider spread of the beam in water compared to its original width in air. The angle of incidence determines how much the beam diverges. (b) A ray diagram demonstrating the bending of a straw would show a straight straw segment above water and a bent appearance at the water's surface due to light refraction. The light rays from the submerged part of the straw bend away from the normal as they exit the water, creating the illusion of bending. (c) Optical fibers use the principle of total internal reflection, where light signals are transmitted through glass fibers that reflect light internally, maintaining the signal strength over long distances.

Question 17.

(a) Show the variation of binding energy per nucleon with mass number. Write the significance of the binding energy curve.

(b) Two nuclei with lower binding energy per nucleon form a nuclei with more binding energy per nucleon.

(i) What type of nuclear reaction is it ?

(ii) Whether the total mass of nuclei increases, decreases or remains unchanged ?

(iii) Does the process require energy or produce energy ?

[3 Marks]

Answer: The binding energy per nucleon is represented graphically with mass number (A) on the x-axis and binding energy per nucleon (Ebn) on the y-axis. The curve shows that for mass numbers 30 to 170, the binding energy per nucleon is nearly constant at approximately 8 MeV. The significance of this curve is that it illustrates how stable nuclei are; higher binding energy indicates greater stability. In section (b), the nuclear reaction indicated is fusion, where lighter nuclei combine to form a heavier nucleus with a greater binding energy per nucleon, resulting in a decrease in total mass and the release of energy.

Question 18.

(a) What are majority and minority charge carriers in an extrinsic semiconductor ?

(b) A p-n junction is forward biased. Describe the movement of the charge carriers which produce current in it.

(c) The graph shows the variation of current with voltage for a p-n junction diode.

[3 Marks]

Answer: In an extrinsic semiconductor, the majority charge carriers are the ones introduced by doping; for n-type, these are electrons, while for p-type, they are holes. Minority charge carriers are the opposite; in n-type, they are holes, and in p-type, they are electrons. When a p-n junction is forward biased, electrons from the n-side move towards the p-side, while holes from the p-side move to the n-side. This charge movement leads to minority carrier injection and increased current flow, essential for junction operations.

Section D

Question 19.

i) A thin pencil of length (f/4) is placed coinciding with the principal axis of a mirror of focal length f. The image of the pencil is real and enlarged, just touches the pencil. Calculate the magnification produced by the mirror.

ii) A ray of light is incident on a refracting face AB of a prism ABC at an angle of 45°. The ray emerges from face AC and the angle of deviation is 15°. The angle of prism is 30°. Show that the emergent ray is normal to the face AC from which it emerges out. Find the refraction index of the material of the prism.

[5 Marks]

Answer: To solve part (i), the magnification (m) produced by the mirror is given by the formula m = -v/u. Since the image is real and enlarged, we know v > u. With u = -f/4 (considering convention), we find that magnification m = 4. For part (ii), using Snell's law at face AB, we calculate the angle of refraction r1. The angle of deviation D = i + e - A gives a relation to find $n = \frac{\sin(i)}{\sin(r)}$. Given the conditions, we find the emergent ray is normal as D = 15°.

Question 20.

i) Light consisting of two wavelengths 600 nm and 480 nm is used to obtain interference fringes in a double slit experiment. The screen is placed 1.0 m away from slits which are 1.0 nm apart.

(1) Calculate the distance of the third bright fringe on the screen from the central maximum for wavelength 600 nm.

(2) Find the least distance from the central maximum where the bright fringes due to both the wavelengths coincide.

ii) (1) Draw the variation of intensity with angle of diffraction in single slit diffraction pattern. Write the expression for value of angle corresponding to zero intensity locations.

(2) In what way diffraction of light waves differs from diffraction of sound waves ?

[5 Marks]

Answer: To find the distance of the third bright fringe for the wavelength 600 nm, we use the formula for fringe distance: y = (m * λ * D) / d, where m is the fringe order (3), λ is 600 nm (600 x 10^-9 m), D is the distance to the screen (1 m), and d is the distance between slits (1 x 10^-3 m). Plugging in values, y = (3 * 600 * 10^-9 * 1) / (1 * 10^-3) = 1.8 mm. For coinciding fringes, we determine the least distance from the central maximum using the least common multiple of the fringe separations from both wavelengths. The calculations yield that bright fringes coincide at 0.72 m. In single slit diffraction, the intensity is maximum in the center and decreases towards zero at certain angles, given by sin(θ) = mλ/a, with m being the integer for dark minima. Lastly, diffraction of light is much more pronounced due to its shorter wavelength compared to sound, where diffraction is less noticeable due to longer wavelengths leaving less chance for significant scattering in practical scenarios.