CBSE EXAMINATION PAPER-2023

PHYSICS

(Solved)

Time allowed : 3 hours | Maximum Marks : 85

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **40 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 16** are multiple choice questions Each question carries **1 marks.**

iv. **Section B** – questions number **17 to 25** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **26 to 32** are short answer Each question carries **3 marks.**

vi. **Section D** – questions number **33 to 34** are case based questions

vii. **Section E** – questions number **35 to 40** are long answer Each question carries **5 marks.**

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1.

A point charge situated at a distance 'r' from a short electric dipole on its axis, experiences a force F. If the distance of the charge is '2r', the force on the charge will be:

[1 Marks]

(A) F/16

(B) F/4

(C) F/2

(D) F/8

Question 2.

The potential difference across a cell in an open circuit is 8 V. It falls to 4 V when a current of 4 A is drawn from it. The internal resistance of the cell is:

[1 Marks]

(A) 3Ω

(B) 2Ω

(C) 1Ω

(D) 4Ω

Question 3.

A steady current flows through a metallic wire whose area of cross-section (A) increases continuously from one end of the wire to the other. The magnitude of drift velocity (vd) of the free electrons as a function of 'A' can be shown by:

[1 Marks]

(A) a

(B) b

(C) c

(D) d

Question 4.

A diamagnetic substance is brought near the north or south pole of a bar magnet. It will be :

[1 Marks]

(A) repelled by both the poles.

(B) attracted by both the poles.

(C) repelled by the north pole and attracted by the south pole.

(D) attracted by the north pole and repelled by the south pole.

Question 5.

A circular coil of radius 8.0 cm and 40 turns is rotated about its vertical diameter with an angular speed of 25/π rad s^-1 in a uniform horizontal magnetic field of magnitude 3.0*10^-2 T. The maximum emf induced in the coil is :

[1 Marks]

(A) 0·15 V

(B) 0·19 V

(C) 0·22 V

(D) 0·12 V

Question 6.

Figure shows a rectangular conductor PSRQ in which movable arm PQ has a resistance 'r' and resistance of PSRQ is negligible. The magnitude of emf induced when PQ is moved with a velocity v does not depend on :

[1 Marks]

(A) magnetic field (B)

(B) resistance (r)

(C) velocity (v)

(D) length of PQ

Question 7.

In the process of charging of a capacitor, the current produced between the plates of the capacitor is :

[1 Marks]

(A) 1/ε0 dϕE/dt

(B) 1/μ0 dϕE/dt

(C) ε0 dϕE/dt

(D) μ0 dϕE/dt

Question 8.

For a concave mirror of focal length 'f', the minimum distance between the object and its real image is:

[1 Marks]

(A) zero

(B) f

(C) 2f

(D) 4f

Question 9.

Hydrogen atom initially in the ground state, absorbs a photon which excites it to n = 5 level. The wavelength of the photon is :

[1 Marks]

(A) 975 nm

(B) 523 nm

(C) 740 nm

(D) 95 nm

Question 10.

The mass density of a nucleus of mass number A is :

[1 Marks]

(A) proportional to A^1/3

(B) proportional to A^3

(C) proportional to A^2/3

(D) independent of A

Question 11.

An ac source of voltage is connected in series with a p-n junction diode and a load resistor. The correct option for output voltage across load resistance will be :

[1 Marks]

(A) b

(B) a

(C) d

(D) c

Question 12.

When an intrinsic semiconductor is doped with a small amount of trivalent impurity, then :

[1 Marks]

(A) its resistance increases.

(B) it becomes a p-type semiconductor.

(C) dopant atoms become donor atoms.

(D) there will be more free electrons than holes in the semiconductor.

Question 13.

In the energy-band diagram of n-type Si, the gap between the bottom of the conduction band Ec and the donor energy level ED is of the order of :

[1 Marks]

(A) 10eV

(B) 1eV

(C) 0.1eV

(D) 0.01eV

Question 14.

Assertion (A) : When a bar of copper is placed in an external magnetic field, the field lines get concentrated inside the bar.

Reason (R) : Copper is a paramagnetic substance.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

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

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

Question 15.

Assertion (A) : The phase difference between any two points on a wavefront is zero.

Reason (R) : All points on a wavefront are at the same distance from the source and thus oscillate in the same phase.

[1 Marks]

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

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

(C) Assertion (A) is false and Reason (R) is also false.

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

Question 16.

Assertion (A) : Photoelectric effect demonstrates the particle nature of light.

Reason (R) : Photoelectric current is proportional to intensity of incident radiation for frequencies more than the threshold frequency.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

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

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

Section B

Question 17.

An alpha particle is projected with velocity v = (3·0 *10^5 m/s) ^ i into a region in which magnetic field B = [(0·4 T) ^ i + (0·3 T) ^ j] exists. Calculate the acceleration of the particle in the region. ^ i , ^ j and ^ k are unit vectors along x, y and z axis respectively and charge to mass ratio for alpha particle is 4·8 *10^7 C/kg.

[2 Marks]

Question 18.

Consider an induced magnetic field due to changing electric field and an induced electric field due to changing magnetic field. Which one is more easily observed ? Justify your answer.

[2 Marks]

Question 19.

(a) Using Huygen's principle, draw a ray diagram showing the propagation of a plane wave refracting at a plane surface separating two media. Also verify Snell's law of refraction.

[2 Marks]

Question 20.

Two coherent monochromatic light beams of intensities I and 4I superpose each other. Find the ratio of maximum and minimum intensities in the resulting beam.

[2 Marks]

Question 21.

The ground state energy of hydrogen atom is -13.6 eV. What is the potential energy and kinetic energy of an electron in the third excited state ?

[2 Marks]

Question 22.

(a) Differentiate between intrinsic and extrinsic semiconductors.

[2 Marks]

Question 23.

Briefly explain how the diffusion and drift currents contribute to the formation of potential barrier in a p-n junction diode.

[2 Marks]

Question 24.

(b) Why is a reflecting telescope preferred over a refracting telescope? Justify your answer giving two reasons.

[2 Marks]

Question 25.

(b) Draw the circuit arrangement for studying the V -I characteristics of a p-n junction diode in forward bias and reverse bias. Show the plot of V- I characteristic of a silicon diode.

[2 Marks]

Section C

Question 26.

(a) Twelve negative charges of same magnitude are equally spaced and fixed on the circumference of a circle of radius R as shown in figure (i). Relative to potential being zero at infinity, find the electric potential and electric field at the centre C of the circle.

(b) If the charges are unequally spaced and fixed on an arc of 120 degrees of radius R as shown in Fig (ii), find electric potential at the centre of the arc.

[3 Marks]

Question 27.

(a) How does the resistance differ from impedance? With the help of a suitable phasor diagram, obtain an expression for impedance of a series LCR circuit, connected to a source $v = v_m \sin(\omega t)$.

[3 Marks]

Question 28.

A long solenoid of radius r consists of n turns per unit length. A current $I = I_0 \sin(\omega t)$ flows in the solenoid. A coil of N turns is wound tightly around it near its center. What is

(a) the induced emf in the coil?

(b) the mutual inductance between the solenoid and the coil ?

[3 Marks]

Question 29.

How does Einstein's photoelectric equation explain the emission of electrons from a metal surface? Explain briefly.

Plot the variation of photocurrent with:

(a) collector plate potential for different intensity of incident radiation, and

(b) intensity of incident radiation.

[3 Marks]

Question 30.

(a) Draw the energy level diagram for a hydrogen atom. Mark the transitions corresponding to the series lying in the ultraviolet region, visible region, and infrared region.

[3 Marks]

Question 31.

(b) Find the condition for resonance in a series LCR circuit connected to a source $v = v_m \sin(\omega t)$, where ω can be varied. Give the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing the variation of electric current with frequency in a series LCR circuit.

[3 Marks]

Question 32.

(b) Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei and mention its two features. Why do lighter nuclei usually undergo nuclear fusion?

[3 Marks]

Section D

Question 33.

The following figure shows a circuit diagram. We can find the currents through and potential differences across different resistors using Kirchhoff's rules.

(1) Which points are at the same potential in the circuit?

[1 Marks]

(2) What is the current through arm bg?

[1 Marks]

(3)

Find the potential difference across resistance R3.

[2 Marks]

(4)

What is the power dissipated in resistance R2?

[2 Marks]

Question 34.

Strontium titanate is a rare oxide-a natural mineral found in Siberia. It is used as a substitute for diamond because its refractive index and critical angle are 2.41 and 24.5

degrees, respectively, which are approximately equal to the refractive index and critical angle of diamond. It has all the properties of diamond. Even an expert jeweller is unable to differentiate between diamond and strontium titanate. A ray of light is incident normally on one face of an equilateral triangular prism ABC made of strontium titanate.

Answer the following questions based on the above :

(1)

Trace the path of the ray showing its passage through the prism.

[1 Marks]

(2) Find the velocity of light through the prism.

[1 Marks]

(3)

Briefly explain two applications of total internal reflection.

[2 Marks]

(4)

Define total internal reflection of light. Give two conditions for it.

[2 Marks]

Section E

Question 35.

(a) (i) State Coulomb's law in electrostatics and write it in vector form, for two charges.

(ii) Gauss's law is based on the inverse-square dependence on distance contained in the Coulomb's law. Explain.

(iii) Two charges A (charge q) and B (charge 2q) are located at points (0, 0) and (a, a) respectively. Let ^ i and ^ j be the unit vectors along x-axis and y-axis respectively. Find

the force exerted by A on B, in terms of ^ i and ^ j.

[5 Marks]

Question 36.

(a) (i) State Biot-Savart's law for the magnetic field due to a current carrying element. Use this law to obtain an expression for the magnetic field at the centre of a circular loop of radius 'a' and carrying a current 'I'. Draw the magnetic field lines for a current loop indicating the direction of magnetic field.

(ii) An electron is revolving around the nucleus in a circular orbit with a speed of 10^7 ms^-1 . If the radius of the orbit is 10^-10 m, find the current constituted by the revolving electron in the orbit.

[5 Marks]

Question 37.

(a) (i) 1. Write two points of difference between an interference pattern and a diffraction pattern.

2. Name any two factors on which the fringe width in a Young's double-slit experiment depends.

(ii) In Young's double-slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate :

(1) the angular separation in radians between the central maximum and the adjacent maximum.

(2) the distance between these two maxima on a screen 50 cm from the slits.

[5 Marks]

Question 38.

(b) (i) Derive an expression for the electric field at a point on the equatorial plane of an electric dipole consisting of charges q and -q separated by a distance 2a.

(ii) The distance of a far off point on the equatorial plane of an electric dipole is halved. How will the electric field be affected for the dipole ?

(iii) Two identical electric dipoles are placed along the diagonals of a square ABCD of side $\sqrt{2}$ m as shown in the figure. Obtain the magnitude and direction of the net electric field at the centre (O) of the square.

[5 Marks]

Question 39.

(b) (i) Derive an expression for the force acting on a current carrying straight conductor kept in a magnetic field. State the rule which is used to find the direction of this force. Give the condition under which this force is (1) maximum, and (2) minimum.

(ii) Two long parallel straight wires A and B are 2.5 cm apart in air. They carry 5.0 A and 2.5 A currents respectively in opposite directions. Calculate the magnitude of the force exerted by wire A on a 10 cm length of wire B.

[5 Marks]

Question 40.

(b) (i) A spherical surface of radius of curvature R separates two media of refractive indices n1 and n2 . A point object is placed in front of the surface at distance u in medium of refractive index n1 and its image is formed by the surface at distance v, in the medium of refractive index n2. Derive a relation between u and v. \

(ii) A solid glass sphere of radius 6.0 cm has a small air bubble trapped at a distance 3.0 cm from its centre C as shown in the figure. The refractive index of the material of the sphere is 1 5. Find the apparent position of this bubble when seen through the surface of the sphere from an outside point E in air.

[5 Marks]