CBSE EXAMINATION PAPER-2023

PHYSICS

(Solved)

Time allowed : 3 hours | Maximum Marks : 87

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **41 questions.** All questions are **compulsory.**

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

iii. **Section A** – questions number **1 to 18** are multiple choice questions Each question carries **1 marks.**

iv. **Section B** – questions number **19 to 27** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **28 to 34** are short answer Each question carries **3 marks.**

vi. **Section D** – questions number **35 to 35** are case based questions

vii. **Section E** – questions number **36 to 41** 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.

An electron experiences a force $(1{\cdot}6 \times 10^{16}\ \text{N})\ \hat{\imath}$ in an electric field E. The electric field E is:

[1 Marks]

(A) $(1{\cdot}0 \times 10^{3}\ N/C)\ \hat{i}$

(B) $(1{\cdot}0 \times 10^{-3}\ N/C)\ \hat{i}$

(C) $-(1{\cdot}0 \times 10^{3}\ N/C)\ \hat{i}$

(D) $-(1{\cdot}0 \times 10^{-3}\ N/C)\ \hat{i}$

Question 2. Which one of the following is not a scalar quantity?

[1 Marks]

(A) Electric field

(B) Voltage

(C) Resistivity

(D) Power

Question 3.

The current density due to drift of electrons in a conductor is given by:

(symbols have their usual meanings)

[1 Marks]

(A) n e v_d

(B) n e A v_d

(C) n v_d/e A

(D) n A v_d/e

Question 4.

Which of the following graphs correctly represents the variation of the magnitude of the magnetic field outside a straight infinite current carrying wire of radius 'a' as a function of distance 'r' from the centre of the wire?

[1 Marks]

(A) Graph A

(B) Graph D

(C) Graph C

(D) Graph B

Question 5.

A particle of mass m and charge q moving with a uniform velocity $v = v_0 \hat{x} i + v_0 \hat{y} j$ enters a region with a magnetic field $B = B_0\hat{j}$. After some time, an electric field $E = E_0 \hat{j}$ is also switched on in the region. The resulting path described by the particle will be:

[1 Marks]

(A) a helix with increasing pitch

(B) a circle in x-z plane

(C) a helix with constant pitch

(D) a parabola in x-y plane

Question 6.

An inductor, a capacitor and a resistor are connected in series across an ac source of voltage. If the frequency of the source is decreased gradually, the reactance of :

[1 Marks]

(A) inductor decreases and the capacitor increases.

(B) inductor increases and the capacitor decreases.

(C) both the inductor and the capacitor decreases.

(D) both the inductor and the capacitor increases.

Question 7.

The electromagnetic radiations used to kill germs in water purifiers are called :

[1 Marks]

(A) Ultraviolet rays

(B) Gamma rays

(C) Infrared waves

(D) X-rays

Question 8.

In the wave picture of light, the intensity I of light is related to the amplitude A of the wave as :

[1 Marks]

(A) I∝1/A^2

(B) I∝A

(C) I∝A^2

(D) I∝√A

Question 9.

In a single-slit diffraction experiment, the width of the slit is halved. The width of the central maximum, in the diffraction pattern, will become :

[1 Marks]

(A) one-fourth

(B) four times

(C) half

(D) twice

Question 10.

A graph is plotted between the stopping potential (on y-axis) and the frequency of incident radiation (on x-axis) for a metal. The product of the slope of the straight line obtained and the magnitude of charge on an electron is equal to :

[1 Marks]

(A) h

(B) h/2c

(C) 2h/c

(D) h/c

Question 11.

Light of frequency 6·4 *10^14 Hz is incident on a metal of work function 2·14 eV. The maximum kinetic energy of the emitted electrons is about :

[1 Marks]

(A) 0·25 eV

(B) 1·02 eV

(C) 0·10 eV

(D) 0·51 eV

Question 12.

The ratio of maximum frequency and minimum frequency of light emitted in Balmer series of hydrogen spectrum, in Bohr's model is

[1 Marks]

(A) 16/7

(B) 11/7

(C) 9/5

(D) 11/9

Question 13.

At a certain temperature in an intrinsic semiconductor, the electrons and holes concentration is 1·5*10^16 m-3. When it is doped with a trivalent dopant, hole concentration increases to 4·5 10^22 m-3. In the doped semiconductor, the concentration of electrons (ne) will be :

[1 Marks]

(A) 5*10^9 m-3

(B) 5*10^7 m-3

(C) 6.75*10^38 m-3

(D) 3*10^6 m-3

Question 14.

If a p-n junction diode is reverse biased,

[1 Marks]

(A) the potential barrier remains unaffected.

(B) the potential barrier is lowered.

(C) the potential barrier is raised.

(D) the current is mainly due to majority carriers.

Question 15.

A voltage signal is described by :

for a cycle. Its rms value is :

[1 Marks]

(A) $V0/\sqrt{2}$

(B) V0

(C) V0/2

(D) $\sqrt{2}$ V0

Question 16.

Assertion (A) : The internal resistance of a cell is constant.

Reason (R) : Ionic concentration of the electrolyte remains same during use of a cell.

[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 false and Reason (R) is also false.

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

Question 17.

Assertion (A) : When radius of a circular loop carrying a steady current is doubled, its magnetic moment becomes four times.

Reason (R): The magnetic moment of a circular loop carrying a steady current is proportional to the area of the loop.

[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 false and Reason (R) is also false.

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

Question 18.

Assertion (A): The nucleus 7/3 X is more stable than the nucleus 4/3 Y.

Reason (R): 7/3 X contains more number of protons.

[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 false and Reason (R) is also false.

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

Section B

Question 19. A wire of length l is in the form of a circular loop A of one turn. This loop is reshaped into loop B of three turns. Find the ratio of the magnetic fields at the centres of loop A and loop B for the same current through them.

[2 Marks]

Question 20.

What is meant by the term 'displacement current' ? Briefly explain how this current is different from a conduction current.

[2 Marks]

Question 21.

(a) State Huygens principle. How did Huygens' explain the absence of the backwave?

[2 Marks]

Question 22.

The refractive indices of two media A and B are 2 and $\sqrt{2}$ respectively. What is the critical angle for their interface?

[2 Marks]

Question 23.

(a) Draw a graph showing the variation of binding energy per nucleon as a function of mass number A. The binding energy per nucleon for heavy nuclei (A > 170) decreases with the increase in mass number. Explain.

[2 Marks]

Question 24. Explain the roles of diffusion current and drift current in the formation of the depletion layer in a p-n junction diode.

[2 Marks]

Question 25. Explain the property of a p-n junction which makes it suitable for rectifying alternating voltages. Differentiate between a half-wave and a full-wave rectifier.

[2 Marks]

Question 26.

(b) Use Huygens' principle to show reflection/ refraction of a plane wave by (i) concave mirror, and (ii) a convex lens.

[2 Marks]

Question 27.

(b) Using Bohr's postulates, obtain the expression for radius of nth stable orbit in a hydrogen atom.

[2 Marks]

Section C

Question 28. A potential difference V is applied across a conductor of length l and uniform cross-section area A. How will the (i) electric field E, (ii) drift velocity v_d, and (iii) current density j be affected when (a) V is doubled and (b) l is halved (keeping other factors constant)?

[3 Marks]

Question 29.

What is meant by the term 'mutual inductance' of a pair of coils? Obtain an expression for the mutual inductance of two long coaxial solenoids, each of length l but having different number of turns N_1 and N_2 and radii r_1 and r_2 ($r_2 > r_1$).

[3 Marks]

Question 30.

An ac source v = v_m sin(ωt) is connected across an ideal capacitor. Derive the expression for the (i) current flowing in the circuit, and (ii) reactance of the capacitor. Plot a graph of current i versus ωt.

[3 Marks]

Question 31.

Calculate the wavelength of de Broglie waves associated with a proton having (500/1.673) eV energy. How will the wavelength be affected for an alpha particle having the same energy?

[3 Marks]

Question 32.

(a) (i) Prove that the nuclear density is the same for all nuclei.

(ii) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Draw two inferences from this plot.

[3 Marks]

Question 33.

A series combination of an inductor L, a capacitor C and a resistor R is connected across an ac source of voltage in a circuit. Obtain an expression for the average power consumed by the circuit. Find power factor for (i) purely inductive circuit, and (ii) purely resistive circuit.

[3 Marks]

Question 34.

(i) Draw a graph to show the variation of the number of scattered particles detected (N) in Geiger-Marsden experiment as a function of scattering angle (θ).

(ii) Discuss briefly two conclusions that can be drawn from this graph and how they lead to the discovery of the nucleus in an atom.

[3 Marks]

Section D

Question 35.

Diffraction of light is bending of light around the corners of an object whose size is comparable with the wavelength of light. Diffraction actually defines the limits of ray optics. This limit for optical instruments is set by the wavelength of light. An experimental arrangement is set up to observe the diffraction pattern due to a single slit.

Answer the following questions based on the above :

(1) How will the width of central maximum be affected if the wavelength of light is increased?

[1 Marks]

(2) Under what condition is the first minimum obtained?

[1 Marks]

(3)

Write two points of difference between interference and diffraction patterns.

[2 Marks]

(4)

Two students are separated by a 7 m partition wall in a room 10 m high. If both light and sound waves can bend around obstacles, how is it that the students are unable to see each other even though they can converse easily?

[2 Marks]

Section E

Question 36.

(a) (i) Define electric flux and write its SI unit.

(ii) Use Gauss' law to obtain the expression for electric field due to a uniformly charged infinite plane sheet.

(iii) A cube of side L is kept in space, as shown in the figure. An electric field $E = (Ax + B)\ i$ N/C exists in the region. Find the net charge enclosed by the cube.

[5 Marks]

Question 37.

(a) (i) Write the principle and explain the working of a moving coil galvanometer. A galvanometer as such cannot be used to measure the current in a circuit.

(ii) Why is the magnetic field made radial in a moving coil galvanometer? How is it achieved?

[5 Marks]

Question 38.

(a) (i) Draw a ray diagram showing the formation of a real image of an object placed at a distance 'u' in front of a concave mirror of radius of curvature 'R'. Hence, obtain the relation for the image distance 'v' in terms of u and R.

(ii) A 1.8 m tall person stands in front of a convex lens of focal length 1 m, at a distance of 5 m. Find the position and height of the image formed.

[5 Marks]

Question 39.

(b) (i) Define electric potential at a point and write its SI unit.

(ii) Two capacitors are connected in series. Derive an expression of the equivalent capacitance of the combination.

(iii) Two point charges +q and -q are located at points (3a, 0) and (0, 4a) respectively in x-y plane. A third charge Q is kept at the origin. Find the value of Q, in terms of q and a, so that the electrostatic potential energy of the system is zero.

[5 Marks]

Question 40.

(b) (i) Derive an expression for magnetic field on the axis of a current carrying circular loop.

(ii) Write any two points of difference between a diamagnetic and a paramagnetic substance.

[5 Marks]

Question 41.

(b) (i) Draw a ray diagram showing refraction of a ray of light through a triangular glass prism. Hence, obtain the relation for the refractive index (μ) in terms of angle of prism (A) and angle of minimum deviation (δm).

(ii) The radii of curvature of the two surfaces of a concave lens are 20 cm each. Find the refractive index of the material of the lens if its power is -5·0 D.

[5 Marks]