CBSE EXAMINATION PAPER-2025

PHYSICS

(Solved)

Time allowed : 3 hours | Maximum Marks : 82

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **38 questions.** All questions are **compulsory.**

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

iii. **Section A** – questions number **1 to 2** are case based questions

iv. **Section B** – questions number **3 to 18** are multiple choice questions

v. **Section C** – questions number **19 to 24** are very short answer

vi. **Section D** – questions number **25 to 32** are short answer

vii. **Section E** – questions number **33 to 38** are long answer

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 capacitor is a system of two conductors separated by an insulator. In practice, the two conductors have charges Q and -Q with potential difference $V = V_1 - V_2$ between them. The ratio Q/V is a constant, denoted by C and is called the capacitance of the capacitor. It is independent of Q or V. It depends only on the geometrical configuration (shape, size, separation) of the two conductors and the medium separating the conductors. When a parallel plate capacitor is charged, the electric field E_0 is localized between the plates and is uniform throughout. When a slab of a dielectric is inserted between the charged plates (charge density σ), the dielectric is polarized by the field. Consequently,

opposite charges appear on the faces of the slab, near the plates, with surface charge density of magnitude σ_p. For a linear dielectric, σ_p is proportional to E_0. Introduction of a dielectric changes the electric field, and hence, the capacitance of a capacitor, and thus the energy stored in the capacitor.

Like resistors, capacitors can also be arranged in series or in parallel or in a combination of series and parallel.

(1)

Consider a capacitor of capacitance C, with plate area A and plate separation d, filled with air [Fig. (a)]. The distance between the plates is increased to 2d and one of the plates is shifted as shown in Fig. (b). The capacitance of the new system now is :

(a)C/4 (b) C/2

(c) 2C (d) 4C

[1 Marks]

(2)

A slab (area A and thickness d_1) of a linear dielectric of dielectric constant K is inserted between charged plates (charge density σ) of a parallel plate capacitor [plate area A and plate separation d (> d1)] and opposite charges with charge density of magnitude σ_p appear on the faces of the slab. The dielectric constant K is given by :

[1 Marks]

(3)

An electric field E is established between the plates of an air filled parallel plate capacitor, with charges Q and Q. V is the volume of the space enclosed between the plates. The energy stored in the capacitor is :

[1 Marks]

(4)

Three capacitors A, B and M, each of capacitance C are connected to a capacitor N of capacitance 2C and a battery as shown in the figure. If the charges on A and N are Q and Q' respectively, then is :Q'/Qis:

(a) 1/6 (b)1/3

(c) 3 (d) 6

[1 Marks]

(5)

A slab (area A and thickness d/2) of dielectric constant K is inserted in a parallel plate capacitor of plate area A and plate separation d. If C and C_o are the capacitances of the capacitors with and without the dielectric, then C/C_o is:

[1 Marks]

Question 2.

Extrinsic semiconductors are made by doping pure or intrinsic semiconductors with suitable impurity. There are two type of dopants used in doping, Si or Ge, and using them p-type and n-type semiconductors can be obtained. A p-n junction is the basic building block of many semiconductor devices. Two important processes occur during the formation of a p-n junction : diffusion and drift. When such a junction is formed, a 'depletion layer' is created consisting of immobile ion-cores. This is responsible for a junction potential barrier. The width of a depletion layer and the height of potential barrier changes when a junction is forward-biased or reverse-biased. A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for application of an external voltage. Using diodes, alternating voltages can be rectified.

(1)

Which of the following is a donor impurity atom for Ge ?

(A) Boron (B) Antimony

(C) Aluminium (D) Indium

[1 Marks]

(2)

When a pentavalent atom occupies the position of an atom in the crystal lattice of Si, four of its electrons form covalent bonds with four silicon neighbours, while the fifth remains bound to the parent atom. The energy required to set this electron free is about :

A) 0.5 eV (B)0.1 eV

(C) 0.05 eV (D) 0.01 eV

[1 Marks]

(3)

During the formation of a p-n junction:

(A) a layer of negative charge on n-side and a layer of positive charge on p-side appear.

(B) a layer of positive charge on n-side and a layer of negative charge on p-side appear.

(C) the electrons on p-side of the junction move to n-side initially.

(D) initially diffusion current is small and drift current is large.

[1 Marks]

(4)

(a) In reverse-biased p-n junction :

(A) the drift current is of the order of few mA.

(B) the applied voltage mostly drops across the depletion region.

(C) the depletion region width decreases.

(D) the current increases with increase in applied voltage.

[1 Marks]

(5)

The output frequency of a full-wave rectifier with 50 Hz as input frequency is :

(A) 25 Hz (B) 50 Hz

(C) 100 Hz (D) 200 Hz

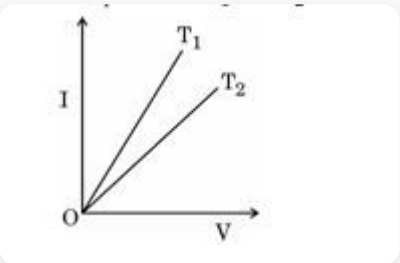
[1 Marks]

Section B

Question 3.

The figure shows the voltage (V) versus the current (I) graphs for a wire at two temperatures T_1 and T_2. One can conclude that:

[1 Marks]



(A) $T_1 < T_2$

(B) $T_1 = T_2 / 3$

(C) $T_2 = 2T_1$

(D) $T_1 > T_2$

Question 4.

If R_s and R_p are the equivalent resistances of n resistors, each of value R, in series and parallel combinations respectively, then the value of $(R_s - R_p)$ is:

[1 Marks]

(A)

(D) $\frac{(n^2+1)R}{n^2}$

(B)

(A) $\left(\frac{n^2-1}{n^2}\right)R$

(C)

(B) $\left(\frac{n^2+1}{n^2-1}\right)R$

(D)

(C) $\left(\frac{n^2-1}{n}\right)R$

Question 5.

A piece of a diamagnetic material, free to move when placed in a uniform magnetic field:

[1 Marks]

(A) moves opposite to the field

(B) does not move at all

(C) moves perpendicular to the field

(D) moves along the field

Question 6.

A proton and an α-particle enter with the same velocity v in a uniform magnetic field B such that v⊥B. The ratio of the radii of their paths is:

[1 Marks]

(A) 1/2

(B) 1/4

(C) 4

(D) 2

Question 7.

The work function of a material is 2.21 eV. Which of the following cannot produce photoelectrons from it?

[1 Marks]

(A) Violet light

(B) Green light

(C) Blue light

(D) Red light

Question 8.

Assertion (A): In a reflecting telescope, the image does not have chromatic aberration.

Reason (R): Chromatic aberration occurs only due to refraction of light through an optical medium.

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are false.

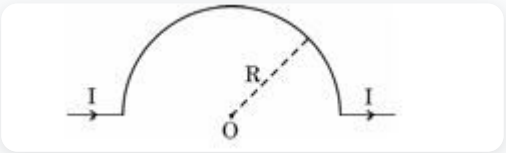
(C) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

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

Question 9.

The value of magnetic field at point O in the given figure is :

[1 Marks]



(A)

(C) $\frac{\mu_0 I}{4R}$

(B)

(A) $\frac{\mu_0 I}{2\pi R}$

(C)

(D) $\frac{\mu_0 I}{R}$

(D)

(B) $\frac{\mu_0 I}{\pi R}$

Question 10.

A galvanometer can be converted into an ammeter of desired range by connecting a :

[1 Marks]

(A) small resistance in series

(B) large resistance in series

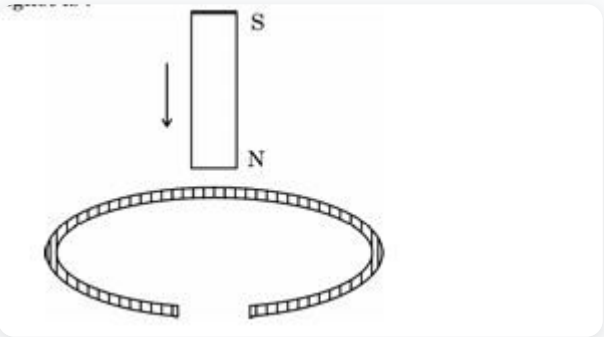
(C) large resistance in parallel

(D) small resistance in parallel

Question 11.

A vertically held bar magnet is dropped along the axis of a copper ring having a cut as shown in the diagram. The acceleration of the falling magnet is :

[1 Marks]



(A) zero

(B) g

(C) greater than g

(D) less than g

Question 12.

An ac source is connected to a resistor and an inductor in series. The voltage across the resistor and inductor are 8 V and 6 V respectively. The voltage of the source is :

[1 Marks]

(A) 10 V

(B) 12 V

(C) 14 V

(D) 16 V

Question 13.

Two coherent waves, each of intensity I0, produce interference pattern on a screen. The average intensity of light on the screen is :

[1 Marks]

(A) I_0

(B) $4I_0$

(C) zero

(D) $2I_0$

Question 14.

The momentum (in kg m/s) of a photon of frequency $6.0 * 10^{14}$ Hz is :

[1 Marks]

(A) 1.326×10^{-27}

(B) 2.652×10^{-26}

(C) 6.63×10^{-25}

(D) 3.978×10^{-24}

Question 15.

Inside a nucleus, the nuclear forces between proton and proton, proton and neutron, neutron and neutron are F_{pp}, F_{pn} and F_{nn} respectively. Then :

[1 Marks]

(A) $F_{pp} = F_{pn} = F_{nn}$

(B) $F_{pp} > F_{pn} > F_{nn}$

(C) $F_{pn} > F_{nn} > F_{pp}$

(D) $F_{nn} > F_{pp} > F_{pn}$

Question 16.

Assertion (A) : A hole is an apparent free particle with effective positive electronic charge.

Reason (R) : A hole is not necessarily a vacancy left behind by an electron in the valence band.

[1 Marks]

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

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

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

(D) Both Assertion (A) and Reason (R) are false.

Question 17.

Assertion (A) : X-rays are produced when slow moving electrons are stopped by a metal target of high atomic number.

Reason (R) : X-rays consist of low-energy photons.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are false.

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

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

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

Question 18.

Assertion (A) : The binding energy per nucleon is practically constant for mass number in the range (30 < A < 170).

Reason (R) : Nuclear forces between the nucleons for mass numbers in the range (30 < A < 170) are not short-range.

[1 Marks]

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

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

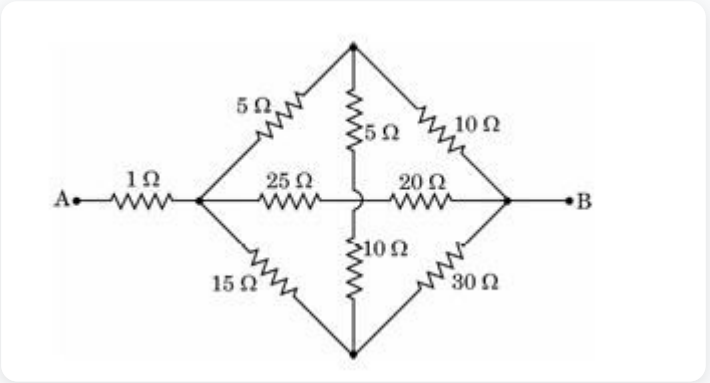
(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

Section C

Question 19. Find the equivalent resistance between points A and B for the network shown in the figure.

[2 Marks]



Question 20.

Find the intensity at a point on the screen in Young's double slit experiment, at which the interfering waves of intensity I_0 each, have a path difference of (i) λ/3, and (ii) λ/2

[2 Marks]

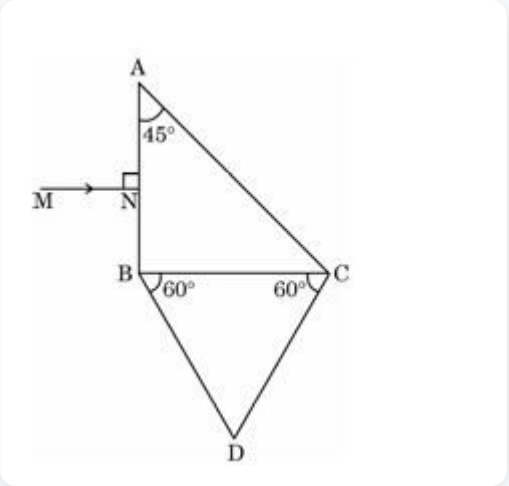
Question 21. A laser beam of frequency 3.0×10^{14} Hz produces average power of 9 mW. Find (i) the energy of photon of the beam, and (ii) the number of photons emitted per second on an average by the source.

[2 Marks]

Question 22.

A right angled isosceles glass prism ABC is kept in contact with an equilateral triangular prism DBC as shown in the figure. Both prisms are made of the same glass of refractive index 1·6. Trace the path of the ray MN incident normally on face AB as it passes through the combination.

[2 Marks]



Question 23.

In an n-type semiconductor electron-hole combination is a continuous process at room temperature. Yet the electron concentration is always greater than the hole concentration in it. Explain.

[2 Marks]

Question 24.

A point source of light in air is kept at a distance of 12 cm in front of a convex spherical surface of glass of refractive index 1·5 and radius of curvature 30 cm. Find the nature and position of the image formed.

[2 Marks]

Section D

Question 25.

What is the difference between 'emf' and 'terminal voltage' of a cell ?

Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 are connected in parallel. Derive an expression for the emf and internal resistance of the equivalent cell.

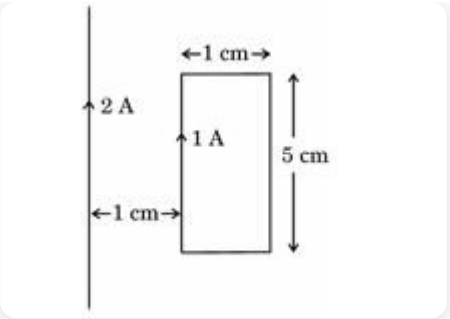
[3 Marks]

Question 26.

A rectangular loop carries a current of 1 A. A straight long wire carrying 2 A current is kept near the loop in the same plane as shown in the figure.

Find (i) the torque acting on the loop, and (ii) the magnitude and direction of the net force on the loop.

[3 Marks]



Question 27.

State Lenz's law. A rod MN of length L is rotated about an axis passing through its end M perpendicular to its length, with a constant angular velocity ω in a uniform magnetic field □□ parallel to the axis. Obtain an expression for emf induced between its ends.

[3 Marks]

Question 28. Name the electromagnetic wave used (i) in radar, (ii) in eye surgery and (iii) as a diagnostic tool in medicine. Write their wavelength range also.

[3 Marks]

Question 29. Draw a ray diagram showing the image formation when a concave mirror produces a real, inverted and magnified image of an object and hence obtain the mirror formula.

[3 Marks]

Question 30. How is the necessary force provided to an electron to keep it moving in a circular orbit according to the Bohr model of hydrogen atom? Derive an expression for the total energy of an electron moving in an orbit of radius r in the hydrogen atom. Give the significance of negative sign in this expression.

[3 Marks]

Question 31.

(a) Consider the so-called 'D-T reaction' (Deuterium-Tritium reaction). In a thermonuclear fusion reactor, the following nuclear reaction occurs:

(b) Show that the nuclear density is independent of mass number.

[3 Marks]

$$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + Q$$

Find the amount of energy released in the reaction.

Given :

$m\left(^{2}_{1}H\right) = 2.014102$ u

$m\left(^{3}_{1}H\right) = 3.016049$ u

$m\left(^{4}_{2}He\right) = 4.002603$ u

$m\left(^{1}_{0}n\right) = 1.008665$ u

1 u = 931 MeV/c^2

Question 32.

Define 'self-inductance' of a coil. Derive an expression for self-inductance of a long solenoid of cross-sectional area A and length l, having n turns per unit length.

[3 Marks]

Section E

Question 33.

(i) Write the principle of working of an ac generator. Draw its labelled diagram and explain its working.

(ii) A resistor of 400**Ω** , an inductor of (5/**π)** H and a capacitor of (50/**π) μ**F are joined in series across an ac source v = 140 sin (100**π**)t V. Find the rms voltages across these three circuit elements. The algebraic sum of these voltages is more than the rms voltage of source. Explain.

[5 Marks]

Question 34.

(i) Draw a ray diagram to show the image formation by a compound microscope. Obtain the expression for the total magnification of the microscope when the final image is formed at infinity.

(ii) In a compound microscope, an object is placed at a distance of 1.5 cm from the objective of focal length 1.25 cm. The eyepiece has a focal length of 5 cm. The final image is formed at infinity. Calculate the distance between the objective and the eyepiece.

[5 Marks]

Question 35.

(i) The electric field in a region is given by □□ = 40x $\hat{i}$ N/C. Find the amount of work done in taking a unit positive charge from a point (0, 3m) to the point (5m, 0).

(ii) A charge Q is distributed over two concentric hollow spheres of radii r and R (> r) such that their surface charge densities are equal. Find :

(I) the electric field, and

(II) the potential

at their common centre.

[5 Marks]

Question 36.

(i) Obtain an expression for the electric field □□ due to a dipole of diapole moment □□ at a point on its equatorial plane and specify its direction. Hence, find the value of electric field:

(I) at the centre of the dipole (r = 0), and

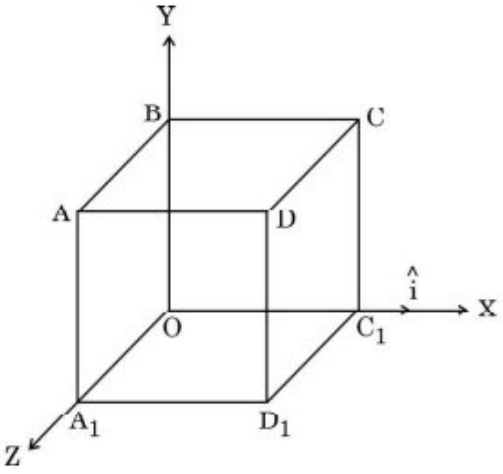
(II) at a point r >> a,

where 2a is the length of the dipole.

(ii) An electric field □□ = (10x + 5)$\hat{i}$ N/C exists in a region in which a cube of side L is kept as shown in the figure. Here x and L are in metres. Calculate the net flux through the cube.

[5 Marks]

(ii) An electric field $\vec{E} = (10x + 5)\hat{i}$ N/C exists in a region in which a cube of side L is kept as shown in the figure. Here x and L are in metres. Calculate the net flux through the cube.



Question 37.

(i) Write the principle of working of a transformer. With the help of a labelled diagram, explain the working of a step-up transformer.

(ii) An ideal transformer is designed to convert 50 V into 250 V. It draws 200 W power from an ac source whose instantaneous voltage is given by v=20 sin (100**π) t V.**

Find :

(I) rms value of input current.

(II) expression for instantaneous output voltage.

(III) expression for instantaneous output current.

[5 Marks]

Question 38.

(i) Using Huygens principle, explain the refraction of a plane wavefront, propagating in air, at a plane interface between air and glass. Hence verify Snell's law.

(ii) Use mirror formula to deduce that a convex mirror always produces a virtual image of an object kept in front of it.

[5 Marks]