CBSE Class XII 2025 Physics Set 2 (55/2/2) Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks :**70	**Total Questions :**33

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This paper consists of 33 questions. All questions are compulsory.
2. This paper is divided into five sections - A, B, C, D and E.
3. Section A Nos. 1 to 16 are Multiple Choice questions. Each carries 1 mark.
4. Section B Nos. 17 to 21 are Very Short Answer type. Each carries 2 marks. Answer to these questions should be in the range of 30 to 50 words.
5. Section C Nos. 22 to 28 are Short Answer (SA) type. Each carries 3 marks. Answer to these questions should be in the range of 50 to 80 words.
6. Section D Nos. 29 and 30 are of 3 source-based/case-based units of assessment carrying 4 marks each with sub-parts.
7. Section E Nos. 31 to 33 are Long Answer type. Each carries 5 marks. Answer to these questions should be in the range of 80 to 120 words.
8. There is no overall choice. However, an internal choice has been provided in some sections. Only one of the alternatives has to be attempted in such s.

Section A

1. Two identical point charges are placed at the two vertices A and B of an equilateral triangle of side l. The magnitude of the electric field at the third vertex P is E. If a hollow conducting sphere of radius $l/4$ is placed at P, the magnitude of the electric field at point P now becomes:

(A) $> E$

(B) E

(C) $\frac{E}{2}$

(D) zero

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2. A battery of e.m.f. 12 V and internal resistance 0.5 Ω is connected to a 9.5 Ω resistor through a key. The ratio of potential difference between the two terminals of the battery, when the key is open to that when the key is closed, is:

(A) 1.05

(B) 1

(C) 0.95

(D) 1.1

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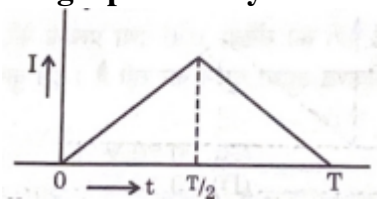
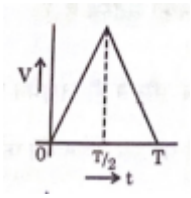
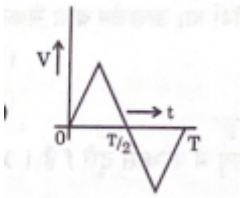
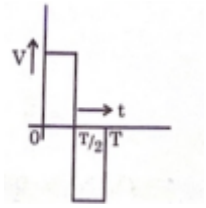
3. The alternating current I in an inductor is observed to vary with time t as shown in the graph for a cycle.

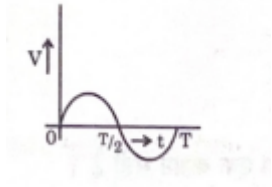


Which one of the following graphs is the correct representation of wave form of voltage V with time t?

(A) 

(B) 

(C) 

(D) 

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4. A diamagnetic substance is brought, one by one, near the north pole and the south pole of a bar magnet. It is:

(A) repelled by north pole and attracted by south pole

(B) attracted by north pole and repelled by south pole

(C) attracted by north pole as well as by south pole

(D) repelled by north pole as well as by south pole

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5. Two long solenoids of radii r_1 and r_2 ($> r_1$) and number of turns per unit length n_1 and n_2 respectively are co-axially wrapped one over the other. The ratio of self-inductance of inner solenoid to their mutual inductance is:

(A) $\frac{n_1}{n_2}$

(B) $\frac{n_2}{n_1}$

(C) $\frac{n_1 r_1^2}{n_2 r_2^2}$

(D) $\frac{n_2 r_2^2}{n_1 r_1^2}$

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6. A 1 cm straight segment of a conductor carrying 1 A current in x-direction lies symmetrically at the origin of Cartesian coordinate system. The magnetic field due to this segment at point (1m, 1m, 0) is:

(A) 1.0×10^{-9} T

(B) $-1.0 \times 10^{-9}\,\mathrm{T}$

(C) $\frac{5.0}{\sqrt{2}} \times 10^{-10}\,\mathrm{T}$

(D) $-\frac{5.0}{\sqrt{2}} \times 10^{-10}\,\mathrm{T}$

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7. A coil of an AC generator, having 100 turns and area 0.1 m² each, rotates at half a rotation per second in a magnetic field of 0.02 T. The maximum emf generated in the coil is:

(A) 0.31 V

(B) 0.20 V

(C) 0.63 V

(D) 0.10 V

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8. 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:

(A) Balmer series

(B) Paschen series

(C) Lyman series

(D) Neither Balmer, nor Paschen nor Lyman series

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9. The focal length of a concave mirror in air is f. When the mirror is immersed in a liquid of refractive index $\frac{3}{5}$, its focal length will become:

(A) $\frac{5}{3}f$

(B) $\frac{3}{5}f$

(C) $\frac{2}{3}f$

(D) f

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

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

(B) non-conservative and field lines form closed loops

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

(D) conservative and field lines form closed loops

11. When the resistance measured between p and n ends of a p-n junction diode is high, it can act as a/an:

(A) resistor

(B) inductor

(C) capacitor

(D) switch

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12. 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:

(A) 2

(B) 3

(C) 4

(D) 5

For Questions 13 to 16, two statements are given – one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:

13. 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.

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

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

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

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

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14. Assertion (A): In an ideal step-down transformer, the electrical energy is not lost.

Reason (R): In a step-down transformer, voltage decreases but the current increases.

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

of Assertion (A).

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

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

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

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15. Assertion (A): In Bohr model of hydrogen atom, the angular momentum of an electron in nth orbit is proportional to the square root of its orbit radius r_n.
Reason (R): According to Bohr model, electron can jump to its nearest orbits only.

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

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16. Assertion (A): In a semiconductor diode, the thickness of the 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.

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

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17. 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 volt and a resistor of 1000 Ω. Find the value of V when the current drawn is 15 mA.

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18. Show the refraction of light wave at a plane interface using Huygens' principle and prove Snell's law.

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19. Two convex lenses A and B, each of focal length 10.0 cm, are mounted on an optical bench at 50.0 cm and 70.0 cm respectively. An object is mounted at 20.0 cm. Find the nature and position of the final image formed by the combination.

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20. Radiations of two frequencies are incident on a metal surface of work function 2.0 eV one by one. The energies of their photons are 2.5 eV and 4.5 eV respectively. Find

the ratio of the maximum speed of the electrons emitted in the two cases.

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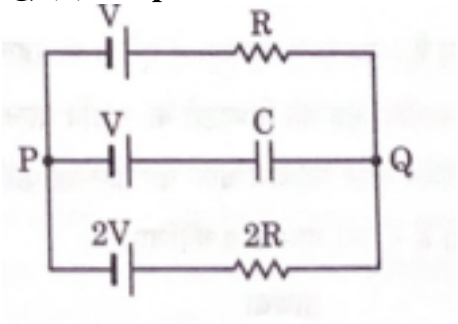
21. (a) Two wires of the same material and the same radius have their lengths in the ratio 2:3. They are connected in parallel to a battery which supplies a current of 15 A. Find the current through the wires.

OR

(b) 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, (ii) the potential difference across capacitor C.



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22. (a) Define resistivity of a conductor. Discuss its dependence on temperature of the conductor and draw a plot of resistivity of copper as a function of temperature.

(b) (i) "A low voltage battery from which high current is required must have low internal resistance." Justify.

(ii) "A high voltage battery must have a large internal resistance." Justify.

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23. (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 fiber with a diagram.

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24. Differentiate between the peak value and root mean square value of an alternating current. Derive the expression for the root mean square value of alternating current, in

terms of its peak value.

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25. (a) How is an electromagnetic wave produced?

(b) An electromagnetic wave is travelling in vertically upward direction. At an instant, its electric field vector points in west direction. In which direction does the magnetic field vector point at that instant?

(c) Estimate the ratio of shortest wavelength of radio waves to the longest wavelength of gamma waves.

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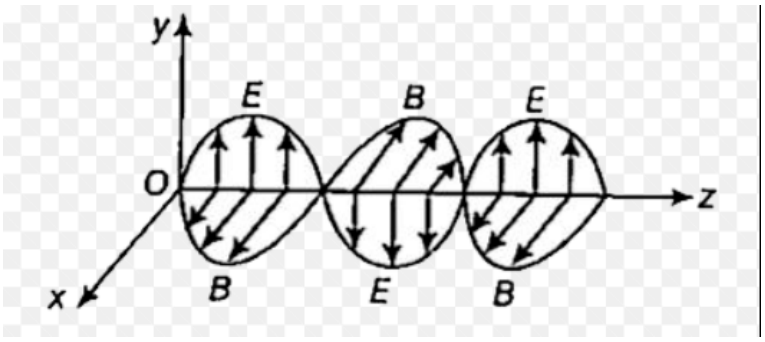
26. (a) In a region of a uniform electric field E, a negatively charged particle is moving with a constant velocity v $= -v_0\hat{i}$ near a long straight conductor coinciding with XX' axis and carrying current I towards -X axis. The particle remains at a distance d from the conductor.

Solution:

(i) Draw diagram showing direction of electric and magnetic fields. The electric field E is uniform and directed, say, in the positive y-direction. The magnetic field B produced by the current in the conductor will form concentric circles around the conductor, with the direction of the magnetic field given by the right-hand rule.

Diagram:



(ii) What are the various forces acting on the charged particle?

(iii) Find the value of v_0 in terms of E, d, and I.

OR

(b) Two infinitely long conductors kept along XX' and YY' axes are carrying current I_1 and I_2 along -X axis and -Y axis respectively. Find the magnitude and direction of the net magnetic field produced at point P(X, Y).

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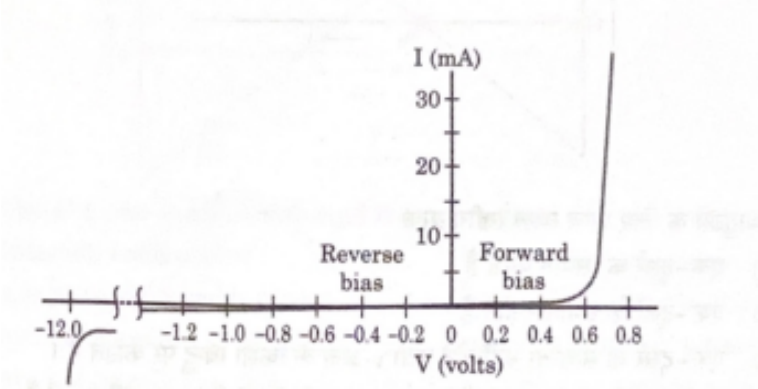
27. (a) What are majority and minority charge carriers in an extrinsic semiconductor?

(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. Estimate the dynamic resistance of the diode at $V = -0.6$ V.



28.(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 nucleus 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?

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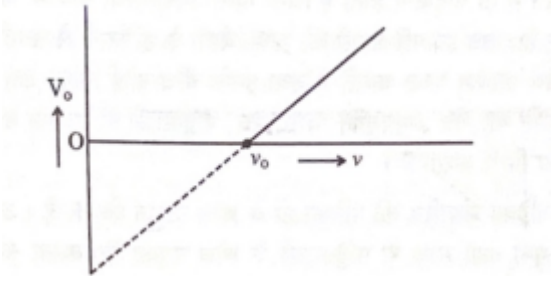
29. When a photon of suitable frequency is incident on a metal surface, a photoelectron is emitted from it. If the frequency is below a threshold frequency ν_0 for the surface, no photoelectron is emitted. For a photon of frequency $\nu(\nu > \nu_0)$, the kinetic energy of the emitted photoelectron is $K_m = h(\nu - \nu_0)$. The photocurrent can be stopped by applying a potential V_0, called 'stopping potential' on the anode. Thus maximum kinetic energy

of photoelectrons $K_m = eV_0 = h(\nu - \nu_0)$. The experimental graph between V_0 and ν for a metal is shown in the figure. This is a straight line of slope m.



(i) The straight line graphs obtained for two metals:

(A) coincide each other.

(B) are parallel to each other.

(C) are not parallel to each other and cross at a point on ν-axis.

(D) are not parallel to each other and do not cross at a point on ν-axis.

(ii) The value of Planck's constant for this metal is:

(A) $\frac{e}{m}$

(B) $\frac{1}{m}$

(C) $\frac{me}{e}$

(D) $\frac{m}{e}$

(iii) The intercepts on ν-axis and V_0-axis of the graph are respectively:

(A) $\frac{h\nu_0}{e}$, V_0

(B) ν_0, $h\nu_0$

(C) $\frac{h\nu_0}{e}$, eV_0

(D) $h\nu_0$, $h\nu_0$

OR

(iii) When the wavelength of a photon is doubled, how many times its wave number and frequency become, respectively?

(iv) The momentum of a photon is 5.0×10^{-29} kg $\cdot$ m/s. Ignoring relativistic effects (if any), the wavelength of the photon is:

30.A parallel plate capacitor has two parallel plates which are separated by an insulating medium like air, mica, etc. When the plates are connected to the terminals of a battery, they get equal and opposite charges and an electric field is set up in between them. This electric field between the two plates depends upon the potential difference applied, the separation of the plates and nature of the medium between the plates.

(i) The electric field between the plates of a parallel plate capacitor is E. Now the separation between the plates is doubled and simultaneously the applied potential difference between the plates is reduced to half of its initial value. The new value of the electric field between the plates will be:

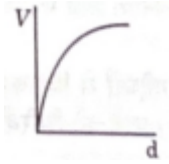
(A) E

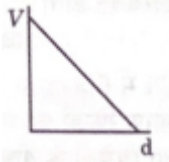
(B) $2E$

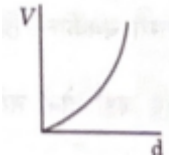
(C) $\frac{E}{4}$

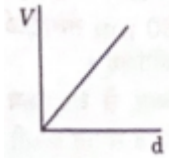
(D) $\frac{E}{2}$

(ii) A constant electric field is to be maintained between the two plates of a capacitor whose separation d changes with time. Which of the graphs correctly depict the potential difference (V) to be applied between the plates as a function of separation between the plates (d) to maintain the constant electric field?

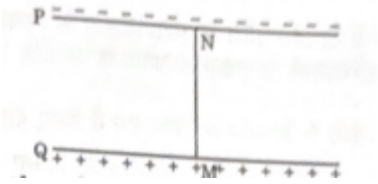
(A) 

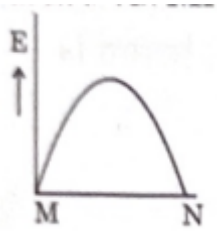
(B) 

(C) 

(D) 

(iii) In the above figure, P and Q are the two parallel plates of a capacitor. Plate Q is at positive potential with respect to plate P. MN is an imaginary line drawn perpendicular to the plates. Which of the graphs shows correctly the variations of the magnitude of electric field strength E along the line MN?



(A)


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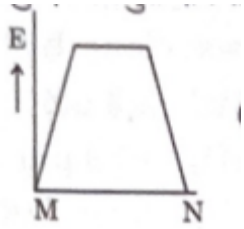

(C)


(D)


(iv) Three parallel plates are placed above each other with equal displacement d between neighbouring plates. The electric field between the first pair of the plates is E_1, and the electric field between the second pair of the plates is E_2. The potential difference between the third and the first plate is:

(A) $(E_1 + E_2) \cdot d$

(B) $(E_1 - E_2) \cdot d$

(C) $(E_2 - E_1) \cdot d$

(D) $\frac{d(E_1+E_2)}{2}$

OR

(iv) A material of dielectric constant K is filled in a parallel plate capacitor of capacitance C. The new value of its capacitance becomes:

(A) C

(B) $\frac{C}{K}$

(C) CK

(D) $C\left(1+\frac{1}{K}\right)$

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31. (a) (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.

(b) 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 mm apart.

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

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

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32. (a) (i) A small conducting sphere A of radius r charged to a potential V, is enclosed by a spherical conducting shell B of radius R. If A and B are connected by a thin wire, calculate the final potential on sphere A and shell B.

(ii) Write two characteristics of equipotential surfaces. A uniform electric field of 50

NC^{-1} is set up in a region along the x-axis. If the potential at the origin $(0, 0)$ is 220 V, find the potential at a point $(4m, 3m)$.

(b) What is the difference between an open surface and a closed surface?

(ii) Define electric flux through a surface. Give the significance of a Gaussian surface. A charge outside a Gaussian surface does not contribute to total electric flux through the surface. Why?

(iii) A small spherical shell S_1 has point charges $q_1 = -3\,\mu C$, $q_2 = -2\,\mu C$ and $q_3 = 9\,\mu C$ inside it. This shell is enclosed by another big spherical shell S_2. A point charge Q is placed in between the two surfaces S_1 and S_2. If the electric flux through the surface S_2 is four times the flux through surface S_1, find charge Q.

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33. (a) (i) What is the source of force acting on a current-carrying conductor placed in a magnetic field? Obtain the expression for the force acting between two long straight parallel conductors carrying steady currents and hence define Ampère's law.

(ii) A point charge q is moving with velocity v in a uniform magnetic field B. Find the work done by the magnetic force on the charge.

(iii) Explain the necessary conditions in which the trajectory of a charged particle is helical in a uniform magnetic field.

(b) (i) A current-carrying loop can be considered as a magnetic dipole placed along its axis. Explain.

(ii) Obtain the relation for magnetic dipole moment M of a current-carrying coil. Give the direction of M.

(iii) A current-carrying coil is placed in an external uniform magnetic field. The coil is free to turn in the magnetic field. What is the net force acting on the coil? Obtain the orientation of the coil in stable equilibrium. Show that in this orientation the flux of the total field (field produced by the loop + external field) through the coil is maximum.
