

CBSE Class 12 Physics 2025 - 55/S/2 - Compartment



Question Paper

Conducted by the Central Board of Secondary Education (CBSE)

Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **33 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C, D, E.
- (iii) Section A - Questions 1 to 16 carry 1 mark each.
- (iv) Section B - Questions 17 to 21 carry 2 marks each.
- (v) Section C - Questions 22 to 28 carry 3 marks each.
- (vi) Section D - Questions 29 to 30 carry 4 marks each.
- (vii) Section E - Questions 31 to 33 carry 5 marks each.
- (viii) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.

You may use the following values of physical constants wherever necessary:

$$\begin{aligned}c &= 3 \times 10^8 \text{ m/s} \\h &= 6.63 \times 10^{-34} \text{ Js} \\e &= 1.6 \times 10^{-19} \text{ C} \\\mu_0 &= 4\pi \times 10^{-7} \text{ T m A}^{-1} \\\epsilon_0 &= 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \\\frac{1}{4\pi\epsilon_0} &= 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}\end{aligned}$$

$$\begin{aligned}\text{Mass of electron } (m_e) &= 9.1 \times 10^{-31} \text{ kg} \\\text{Mass of neutron} &= 1.675 \times 10^{-27} \text{ kg} \\\text{Mass of proton} &= 1.673 \times 10^{-27} \text{ kg} \\\text{Avogadro's number} &= 6.023 \times 10^{23} \text{ per gm mole} \\\text{Boltzmann constant} &= 1.38 \times 10^{-23} \text{ JK}^{-1}\end{aligned}$$

Section A

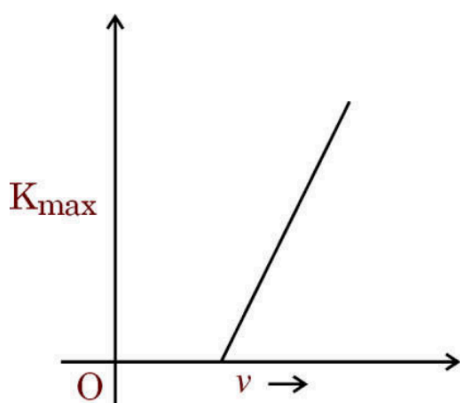
1. A point charge of 10 nC is fixed at the origin of x-y plane. A second point charge of -20 nC is moved from point (5 cm, 0) to point (0, 5 cm). The change in the potential energy of the system of the two charges is:

- (A) $36 \mu\text{J}$ (B) $-36 \mu\text{J}$
(C) $72 \mu\text{J}$ (D) 0

2. In Bohr model of the hydrogen atom, the potential energy of electron in the ground state is:

- (A) 13.6 eV (B) -13.6 eV
(C) 27.2 eV (D) -27.2 eV

3. The figure shows the variation of maximum kinetic energy ($K_{\max}$) of emitted electrons as a function of the frequency ν of radiation incident on a photosensitive surface. The slope of the curve is:



- (A) h (B) $\frac{h}{\nu}$
(C) $\frac{h}{e}$ (D) he

4. A charge Q is enclosed by a spherical Gaussian surface of radius R . If the radius is doubled, then the total electric flux through the surface:

- (A) becomes four times (B) remains the same
(C) becomes half (D) becomes twice

5. A galvanometer having a coil resistance of 48Ω shows full-scale deflection for a current of 2.0 A. It can be converted into an ammeter of range (0 – 10 A) by connecting:

- (A) in series a resistance of 8Ω (B) in parallel a resistance of 8Ω
(C) in parallel a resistance of 12Ω (D) in series a resistance of 12Ω

6. Welders wear special glass goggles or face masks with glass windows to protect their eyes from:

- (A) UV rays (B) X-rays
(C) IR rays (D) Gamma rays

7. The potential energy of a pair of nucleons is minimum when they are separated by about:

- (A) 0.8×10^{-15} m (B) 0.8×10^{-10} m
(C) 2.0×10^{-13} m (D) 2.0×10^{-14} m

8. Which of the following assumptions has been used to obtain the relation $\frac{v_s}{v_p} = \frac{N_s}{N_p}$ for a transformer?

- (A) The resistance of the primary coil is large. (B) The same flux links both the primary and the secondary coils.
(C) The resistance of secondary coil is large. (D) The transformer is 100% efficient.

9. The electric field due to an infinitely long, straight, uniformly and positively charged wire at a point at distance r from the wire is:

- (A) proportional to $\frac{1}{r}$ and is directed outward
 (B) proportional to $\frac{1}{r^2}$ and is directed outward
 (C) proportional to $\frac{1}{r}$ and is directed inward
 (D) proportional to $\frac{1}{r^2}$ and is directed inward

10. Whenever a magnet is moved either towards or away from a conducting coil, an emf is induced whose magnitude is independent of the:

- (A) number of turns in the coil
 (B) resistance of the coil
 (C) speed with which the magnet is moved
 (D) area of the coil

11. Consider two long, straight, parallel conductors A and B separated by a distance d . They carry steady current I in the same direction. The force acting on unit length of conductor B due to conductor A is:

- (A) $\frac{\mu_0 I^2}{2\pi d}$ and is attractive
 (B) $\frac{\mu_0 I^2}{2\pi d}$ and is repulsive
 (C) $\frac{\mu_0 I^2}{4\pi d}$ and is attractive
 (D) $\frac{\mu_0 I^2}{4\pi d}$ and is repulsive

12. A rectangular loop of area vector $\vec{A} = [\hat{i} + \sqrt{3}\hat{j}] \times 10^{-2} \text{ m}^2$ is placed in a magnetic field $\vec{B} = [4.0t^2 + 2.0]\hat{i}$, where B is in tesla and t in seconds. At $t = 1.0 \text{ s}$, the magnitude of induced emf in the loop is:

- (A) 80 mV
 (B) 0.11 V
 (C) 0.22 V
 (D) 0.8 V

Question numbers 13 to 16 are Assertion (A) and Reason (R) type questions. Two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.

(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)

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

13. Assertion (A): The electrical conductivity of a pure Ge crystal increases with increase in its temperature.

Reason (R): The number of electrons excited by thermal excitation from the valence band to the conduction band, in a semiconductor, increases with increase in temperature.

14. Assertion (A): In process of photoelectric emission using a monochromatic light, all emitted electrons do not have the same kinetic energy.

Reason (R): If radiation falling on a photosensitive surface consists of different wavelengths, the energy of emitted photoelectrons by absorbing photons of different wavelengths, shall be different.

15. Assertion (A): The image of an object placed between f and $2f$ from a convex lens can be seen on a screen. If the screen is removed, image is not formed.

Reason (R): Rays from a given point on the object placed between f and $2f$, after passing through a convex lens, do not converge on a point in space.

16. Assertion (A): Electrostatic force is a conservative force.

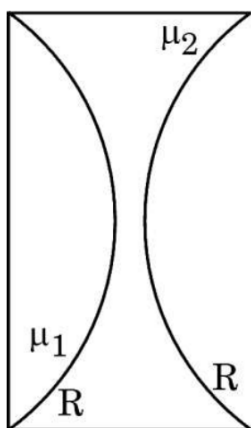
Reason (R): In an electrostatic field, the work done between two points per unit positive charge depends on the path followed.

Section B

17. Monochromatic light of frequency 7.0×10^{14} Hz is produced by a laser. The power emitted is 21 mW. Calculate (i) the energy of a photon in the light beam, and (ii) the number of photons per second, on an average, emitted by the source.

18. With the help of a circuit diagram, describe the method to obtain the p-n junction diode characteristic when it is forward biased. Draw the shape of the characteristic.

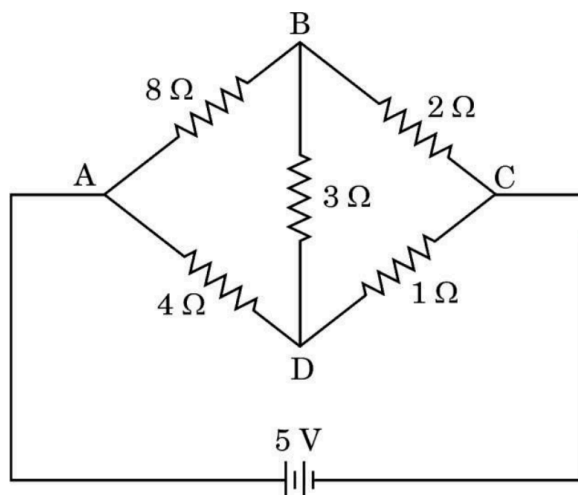
19. (a) A plano-convex lens of refractive index μ_1 is placed coaxially in contact with a biconcave lens of refractive index μ_2 , as shown in the figure. All curved faces are of radius of curvature R each. Obtain the expression for the focal length of the combined lens.



OR

(b) A convex lens is kept coaxially on the left side of a concave mirror at a distance of $5f$ from it where f is focal length of each of them. An object is kept at a distance of $2f$ on the left side of the convex lens. Draw the ray diagram showing the formation of image by this combination. Find the distance of the final image from the mirror.

20. The figure shows a network of resistors connected across a battery. Find the current supplied by the battery of emf 5 V and internal resistance $\frac{2}{3} \Omega$.



21. In a Young's double-slit experiment with monochromatic light of wavelength 600 nm, and slit separation of 2 mm, fringes are observed on a screen at some distance. Calculate the change in fringe width if the screen is moved towards the slits by 10 cm.

Section C

22. Write Coulomb's law in vector form. Two point charges $q_1 = 10 \mu\text{C}$ and $q_2 = 20 \mu\text{C}$ are located, respectively, in the x-y plane at points (0, 0) and (3 cm, 4 cm). Find (i) the magnitude of the force exerted on q_2 by q_1 , and (ii) the angle that the force makes with the x-axis.

23. (a) A $20 \mu\text{F}$ capacitor is connected to a $220 \text{ V}, \frac{125}{\pi} \text{ Hz}$ ac source.

(i) Find the capacitive reactance and the peak value of current in the circuit.

(ii) If the frequency of the ac source is doubled, by what factor will the capacitive reactance and the current be changed?

OR

(b) An electron (mass $9 \times 10^{-31} \text{ kg}$ and charge $1.6 \times 10^{-19} \text{ C}$) is moving in a circle with a speed of $3.2 \times 10^7 \text{ m/s}$ in a magnetic field of $4.5 \times 10^{-4} \text{ T}$ perpendicular to it. Calculate: (i) the radius of the circular path, (ii) its frequency of rotation, and (iii) its energy.

24. Depict the variation of electric and magnetic fields in an electromagnetic wave as it propagates along the z-axis. In a plane electromagnetic wave in free space, the electric field oscillates sinusoidally at a frequency of $1.5 \times 10^{10} \text{ Hz}$ with amplitude 36 Vm^{-1} . Find:

(a) the wavelength of the wave, and

(b) the amplitude of the associated magnetic field.

25. Define binding energy (BE) of a nucleus. An unstable nucleus has mass number $A = 240$ and $\frac{BE}{A} = 7.6 \text{ MeV}$. It splits in two fragments, each of $A = 120$ with $\frac{BE}{A} = 8.5 \text{ MeV}$. Calculate the energy released.

26. Give an example of fission reaction. Calculate the energy released by the fission of 1 kg of ${}_{92}^{235}\text{U}$ in kWh. The energy released per fission is 200 MeV.

27. Define 'emf' of a cell. Derive expression for the equivalent emf and the equivalent internal resistance of two cells connected in series.

28. A circular loop of wire of radius 7.0 cm carrying a current of 1.0 A is placed in a magnetic field $\vec{B} = (0.5\hat{i} + 0.4\hat{k}) \text{ T}$ such that the outward unit vector normal to the plane of the loop is $[0.60\hat{i} + 0.80\hat{j}]$. Calculate: (a) the magnetic moment $\vec{m}$ of the loop, and (b) the torque $\vec{\tau}$ acting on the loop. (Take $\pi = \frac{22}{7}$)

Section D

Question numbers 29 and 30 are Case Study-based questions. Read the following paragraphs and answer the questions that follow.

29. According to the band theory of solids, a semiconductor has a valence band and a conduction band separated by a gap, known as energy band gap. Pure semiconductors are called intrinsic semiconductors. At room temperature, some electrons from the valence band can acquire enough energy to cross the band gap and enter the conduction band. The number of conduction electrons is equal to the number of holes in an intrinsic semiconductor. The number of charge carriers can be changed by doping of a suitable impurity in a pure semiconductor. Such semiconductors are known as extrinsic semiconductors. These are of two types (n-type and p-type).

A p-n junction is the basic building block of semiconductor devices. Two important processes occur during formation of a p-n junction: diffusion and drift. A 'depletion layer' is formed in a p-n junction. This is responsible for a junction potential barrier. A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for the application of an external voltage. A diode can be forward-biased or reverse-biased. The barrier height and the depletion layer width in a p-n junction changes depending on the nature of the biasing.

29(i). Which of the following statements is not true?

- | | |
|--|---|
| (A) The resistance of an intrinsic semiconductor decreases with the increase of temperature. | (B) Doping pure Si with trivalent impurities gives p-type semiconductors. |
| (C) The majority charge carriers in n-type semiconductors are holes. | (D) A p-n junction can act as a semiconductor diode. |

OR

29(i). In a unbiased p-n junction:

- | | |
|--|--|
| (A) the diffusion current is zero everywhere. | (B) the drift current is zero everywhere. |
| (C) the electric potential is zero everywhere. | (D) the drift current and the diffusion current cancel each other. |

29(ii). The impurity atoms with which pure Ge should be doped to convert it into an n-type semiconductor, is:

- | | |
|---------------|-----------------|
| (A) Boron | (B) Phosphorous |
| (C) Aluminium | (D) Indium |

29(iii). The energy band gap in Ge at 0 K is about:

- | | |
|-------------|------------|
| (A) 0.72 eV | (B) 1.1 eV |
| (C) 3.0 eV | (D) 5.4 eV |

29(iv). In a p-n junction diode under reverse bias, the barrier height:

- | | |
|---|---|
| (A) is reduced and the depletion layer width decreases. | (B) is reduced and the depletion layer width increases. |
| (C) increases and the depletion layer width also increases. | (D) increases and the depletion layer width decreases. |

30. A compound microscope is an optical instrument used for observing highly magnified images of tiny objects. It consists of two convex lenses. The lens near the object is called the objective and the lens near the eye is called the eyepiece. The magnifying power of a compound microscope is given by $m = m_o m_e$, where m_o is the magnification produced by objective lens and m_e is the magnification produced by eyepiece lens. The expression for m_e depends on whether the final image is formed at the near point or at infinity (normal adjustment).

30(i). A compound microscope consists of an objective lens of focal length $f_o = 2.0$ cm and an eyepiece of focal length $f_e = 6.25$ cm separated by a distance 15 cm. How far should an object be placed from the objective so that the final image is formed at infinity?

- (A) 3.45 cm (B) 5 cm
(C) 1.29 cm (D) 2.59 cm

OR

30(i). A person with normal near point 25 cm, using a compound microscope with an objective of focal length 0.8 cm and eyepiece of focal length 2.5 cm can bring an object placed at 0.9 cm from the objective in sharp focus. If the image formed by the objective is at a distance of 2.27 cm from the eyepiece, the separation between the two lenses is:

- (A) 7.47 cm (B) 8.47 cm
(C) 9.47 cm (D) 10.47 cm

30(ii). A compound microscope consists of an objective of focal length 2 cm and an eyepiece of focal length 10 cm. The eyepiece is kept 20 cm away from the objective. Find the magnifying power of the microscope if the final image is formed at infinity.

- (A) 7 (B) 10
(C) 14 (D) 16

30(iii). The intermediate image formed in a compound microscope is:

- (A) real, inverted and magnified (B) real, erect and magnified
(C) virtual, erect and magnified (D) virtual, inverted and magnified

30(iv). The focal lengths of the objective and the eyepiece of a compound microscope are f_o and f_e respectively. Which of the following statements is correct, in normal adjustment?

- (A) The object is at a distance less than f_o from the objective. (B) The object is at a distance more than f_o and less than $2f_o$ from the objective.
(C) The intermediate image is formed at a distance slightly more than f_e from the eyepiece. (D) The intermediate image is formed at $2f_e$ from the eyepiece.

Section E

31. (a) A ray of light is incident on one face of a triangular glass prism of refractive index n and is refracted out from the opposite face. Deduce the expression for refractive index of glass prism in terms of the angle of minimum deviation and angle of the prism. Write the condition on n for refraction to take place on the opposite face.

OR

(b) State Huygens principle. Using it, draw a diagram and discuss the case of refraction of plane wave of light from a rarer medium to a denser medium at their plane interface. Hence derive Snell's law.

32. (a) (i) A series combination of L , C and R is connected to an ac source $V = V_m \sin \omega t$. Obtain:

(I) the impedance of the circuit using phasor diagram,

(II) the expression for the instantaneous current I , and

(III) the phase relationship of current to the applied voltage.

(ii) Define power factor of an ac circuit. State the conditions under which it is: (I) maximum, (II) minimum.

OR

(b) (i) Prove that the voltage is ahead of the current in phase by $\frac{\pi}{2}$ rad in an ac circuit containing an ideal inductor.

(ii) The currents through two inductors of self-inductance 12 mH and 24 mH are increasing with time at the same rate. Draw graphs showing the variation of the: (I) magnitude of emf induced with the rate of change of current in each inductor. (II) energy stored in each inductor with the current flowing through it.

33. (a) (i) A parallel plate capacitor A of capacitance C is charged by a battery to a potential 'V'. The battery is disconnected and an uncharged identical capacitor B is connected across it. Calculate for the capacitor A the new value of the: (I) charge (II) potential difference (III) energy stored. Justify your answers.

(ii) Draw the pattern of electric field lines due to: (I) a positively charged conducting sphere, and (II) an electric dipole.

OR

(b) (i) Write Coulomb's law of electrostatics in vector form. Apply it to determine the electric field at a point due to a system of point charges.

(ii) ABC is an equilateral triangle of side l . Two point charges $+2\mu\text{C}$ each, are located at points B and C. Find the sign and magnitude of the point charge q to be kept at the midpoint M of the side BC, so that the net electric field at point A becomes zero.

- End of Question Paper -