

CBSE Class 12 Physics 2019 - 55/1/3 - 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 **27 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C, D.
- (iii) Section A - Questions 1 to 5 carry 1 mark each.
- (iv) Section B - Questions 6 to 12 carry 2 marks each.
- (v) Section C - Questions 13 to 24 carry 3 marks each.
- (vi) Section D - Questions 25 to 27 carry 5 marks each.
- (vii) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.
- (viii) Use of calculators is not permitted.

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. Name the most energetic electromagnetic radiation and write its frequency range.

OR

1. Name the electromagnetic radiation used in eye surgery or to kill germs in water purifiers. Write its frequency range.

2. Name the three basic units of a communication system.

3. Why is the mass of a nucleus always less than the sum of the masses of its constituents?

4. Estimate the frequency associated with a photon of energy 2 eV.

OR

4. In photoelectric effect, does the photoelectric current depend on the intensity of incident radiation? Give reasons.

5. Draw the magnetic field lines outside and inside a bar magnet.

Section B

6. Obtain the expression for the electric field at a point on the equatorial line of an electric dipole.

OR

6. Obtain the expression for potential energy of an electric dipole placed with its axis at an angle θ to an external electric field ($\vec{E}$). What is the minimum value of the potential energy?

7. Estimate the ratio of the wavelengths associated with the electron orbiting around the nucleus in the ground and second excited states of hydrogen atom.

8. Draw a sketch showing the sky wave mode of propagation. Why is its frequency range restricted up to about 30 MHz? Explain.

9. In a ceiling fan, each blade rotates in a circle of radius 0.5 m. If the fan makes 2 rotations per second and the vertical component of the earth's magnetic field is 8×10^{-5} T, calculate the emf induced between the inner and outer ends of each blade.

OR

9. A square loop of side 10 cm with its sides parallel to X and Y axes is moved with a velocity of 8 cm s^{-1} in the positive X-direction containing a magnetic field in the positive Z-direction. The field is non-uniform and has a gradient of $10^{-3} \text{ T cm}^{-1}$ along the negative X-direction (i.e. it increases by $10^{-3} \text{ T cm}^{-1}$ as one moves in the negative X-direction). Calculate the emf induced.

10. An electric field along the x-axis is given by $\vec{E} = 250\hat{i} \text{ N/C}$ for $x > 0$ and $\vec{E} = -250\hat{i} \text{ N/C}$ for $x < 0$. A right circular cylinder of length 24 cm and radius 5 cm lies parallel to the x-axis, with its centre at the origin and one face at $x = +12 \text{ cm}$, the other face at $x = -12 \text{ cm}$. Calculate the net outward flux through the cylinder.

11. A light bulb is in turn connected in series (a) across an LR circuit, (b) across an RC circuit, with an ac source. Explain, giving necessary mathematical formula, the effect on the brightness of the bulb in case (a) and (b), when the frequency of the ac source is increased.

12(a). Draw a graph of a linearly polarised em wave propagating in the z-direction showing the directions of the oscillating electric and magnetic fields.

12(b). Write the relations (i) between the speed of light and the amplitudes of electric and magnetic fields, (ii) for the speed of em wave in terms of a permittivity ϵ_0 and permeability μ_0 of the medium.

Section C

13(a). A particle of charge 'q' and mass 'm', moving with velocity ' $\vec{v}$ ' is subjected to a uniform magnetic field $\vec{B}$ perpendicular to its velocity. Show that the particle describes a circular path. Obtain expression for the radius of the circular path of the particle.

13(b). Explain how its path will be affected if the velocity $\vec{v}$ makes an angle θ ($\neq 90^\circ$) with the direction of the magnetic field.

OR

13. Draw a schematic sketch of a cyclotron. State its working principle and write its two uses.

14(a). Define the term power of a lens. Write its SI unit.

14(b). Derive the expression for the power of two thin lenses placed coaxially in contact with each other.

15(a). Define the terms 'drift velocity' and 'relaxation time' giving their physical significance.

15(b). A conductor of length L is connected across a dc source of emf E. If the conductor is replaced by another of the same material and area of cross-section, but of length 5L, by what factor will the drift velocity change?

OR

15. Two cells of emf and internal resistance ε_1, r_1 and ε_2, r_2 are connected in parallel. Derive the expressions for the emf and internal resistance of a cell which can replace this combination.

16(a). You are required to select a carbon resistor of resistance $470 \Omega \pm 5\%$ from a shopkeeper. What would be the sequence of colour bands required to code the desired resistor?

16(b). Explain briefly why electric power from power stations to homes/factories is delivered via transmission cables at high voltages.

17(a). Write the principle of a semiconductor device which is used as a voltage regulator.

17(b). With the help of a circuit diagram explain its working.

17(c). Draw its I-V characteristics.

OR

17(a). Write the truth tables of (i) AND gate and (ii) NOT gate.

17(b). Show how an OR gate may be obtained with a combination of NAND gates.

18(a). In a moving coil galvanometer, why is the magnetic field required to be radial?

18(b). A 100 turn closely wound circular coil of radius 10 cm carries a current of 3.2 A. Calculate (i) the magnetic field at the centre of the coil, and (ii) its magnetic moment.

19. Draw a ray diagram to show the formation of a virtual image of an object by a convex lens. Using this diagram, obtain the expressions for the lens formula.

OR

19. Draw a ray diagram to show the formation of an erect image of an object kept in front of a concave mirror. Hence deduce the mirror formula.

20(a). Plot a graph showing the variation of photoelectric current with collector plate potential for different frequencies but of same intensity of incident radiation.

20(b). Green and blue light of same intensity are incident separately on the same photosensitive surface. If both of these cause photoelectric emission, which one will emit photoelectrons (i) having greater kinetic energy, and (ii) producing larger photocurrent? Justify your answer.

21(a). Draw the circuit diagram for studying the characteristics of an n-p-n transistor in common emitter configuration.

21(b). With the help of its input and output characteristics, how would you find the input resistance and the current gain from these characteristics?

22(a). Using necessary diagrams, explain the amplitude modulation of a sinusoidal carrier wave using a modulating signal.

22(b). For a given amplitude modulated wave, the maximum amplitude is 20 V and the minimum amplitude is 5 V. Calculate the modulation index.

23(a). Hydrogen atoms are excited with an electron beam of energy 12.5 eV. Find the highest energy level up to which the hydrogen atoms will be excited.

23(b). Find the longest wavelengths in the (i) Lyman series, (ii) Balmer series of the spectrum of these hydrogen atoms.

24(a). Explain how a diffraction pattern is formed due to interference of secondary wavelets of light waves from a slit.

24(b). Sodium light consists of two wavelengths, 5900 Å and 5960 Å. If a slit of width 2×10^{-4} m is illuminated by sodium light, find the separation between the first secondary maxima of the diffraction pattern of the two wavelengths on a screen placed 1.5 m away.

Section D

25(a). Can two independent monochromatic light sources be used to obtain a steady interference pattern? Justify your answer.

25(b). Explain the formation of interference fringes in Young's double slit experiment and obtain an expression for the fringe width.

25(c). In an interference experiment using monochromatic light of wavelength λ , the intensity of light of a point, where the path difference is λ , on the screen is K units. Find out the intensity of light at a point when path difference is $\frac{\lambda}{4}$.

OR

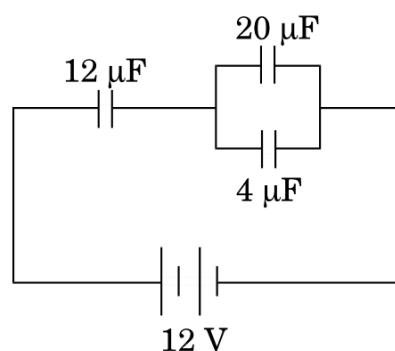
25(a). Sketch the refracted wavefront for the incident plane wavefront of light from a distant object passing through a convex lens.

25(b). Using Huygens' principle, verify the laws of refraction when light from a denser medium is incident on a rarer medium.

25(c). For yellow light of wavelength 590 nm incident on a glass slab, the refractive index of glass is 1.5. Estimate the speed and wavelength of yellow light inside the glass slab.

26(a). Obtain the expressions for the resultant capacitance when the three capacitors C_1 , C_2 and C_3 are connected (i) in parallel and then (ii) in series.

26(b). In the circuit shown in the figure, the charge on the capacitor of $4 \mu\text{F}$ is $16 \mu\text{C}$. Calculate the energy stored in the capacitor of $12 \mu\text{F}$ capacitance.



OR

26(a). Using Gauss' law, obtain expressions for the electric field (i) inside, and (ii) outside a positively charged spherical shell.

26(b). Show graphically the variation of the electric field as a function of the distance r from the centre of the sphere.

26(c). A square plane sheet of side 10 cm is inclined at an angle of 30° with the direction of a uniform electric field of 200 NC^{-1} . Calculate the electric flux passing through the sheet.

27(a). Obtain the expression for the average power dissipated in a series LCR circuit driven by an ac source of voltage $V = V_m \sin \omega t$ supplying the current $i = i_m \sin(\omega t + \phi)$.

27(b). Define the terms: (i) Wattless current, and (ii) Q-factor of LCR circuit.

OR

27(a). State Faraday's laws of electromagnetic induction.

27(b). Derive an expression for the emf induced across the ends of a straight conductor of length l moving at right angles to a uniform magnetic field B with a uniform speed v .

27(c). Obtain the expression for the magnetic energy stored in a solenoid, in terms of the magnetic field B , area A and length l of the solenoid through which a current i is passed.

- End of Question Paper -