

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 2 Hours

Maximum Marks: 35

General Instructions

- (i) This question paper contains **12 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C.
- (iii) Section A - Questions 1 to 3 carry 2 marks each.
- (iv) Section B - Questions 4 to 11 carry 3 marks each.
- (v) Section C - Question 12 carries 5 marks.
- (vi) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.
- (vii) 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. Explain the formation of the barrier potential in a p-n junction.

2. (a) Draw the circuit diagram of an illuminated photodiode and its I-V characteristics.

(b) How can a photodiode be used to measure the light intensity?

3(a). (i) Distinguish between isotopes and isobars.

(ii) Two nuclei have different mass numbers A_1 and A_2 . Are these nuclei necessarily the isotopes of the same element? Explain.

3(b). (i) Name the factors on which photoelectric emission from a surface depends.

(ii) Define the term 'threshold frequency' for a photosensitive material.

Section B

4. (a) Calculate the frequency of a photon of energy 6.5×10^{-19} J.

(b) Can this photon cause emission of an electron from the surface of Cs of work function 2.14 eV? If yes, what will be maximum kinetic energy of the photoelectron?

5. Monochromatic light of wavelength 600 nm is incident from air on a water surface. The refractive index of water is 1.33. Find the (i) wavelength, (ii) frequency and (iii) speed, of reflected and refracted light.

6(a). Electromagnetic waves of wavelengths λ_1 , λ_2 and λ_3 are used in radar systems, in water purifiers and in remote switches of TV, respectively.

- (i) Identify the electromagnetic waves, and
- (ii) Write one source of each of them.

6(b). (i) State two conditions for two light sources to be coherent.

(ii) Give two points of difference between an interference pattern due to a double-slit and a diffraction pattern due to a single slit.

7. State Bohr's postulate to explain stable orbits in a hydrogen atom. Prove that the speed with which the electron revolves in n^{th} orbit is proportional to $(1/n)$.

8. Draw the energy band diagrams for conductors, semiconductors and insulators. Which band determines the electrical conductivity of a solid? How is the electrical conductivity of a semiconductor affected with rise in its temperature? Explain.

9. A narrow beam of protons, each having 4.1 MeV energy is approaching a sheet of lead ($Z = 82$). Calculate:

- (i) the speed of a proton in the beam, and
- (ii) the distance of its closest approach.

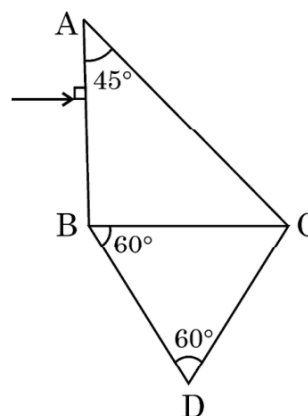
10. How is the spacing between fringes in a double slit experiment affected if:

- (i) the slits separation is increased,
- (ii) the colour of light used is changed from red to blue,
- (iii) the whole apparatus is submerged in a oil of refractive index 1.2?

Justify your answer in each case.

11(a). Write two necessary conditions for total internal reflection.

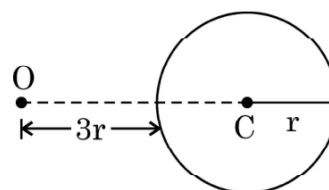
(b) Two prisms ABC and DBC are arranged as shown in figure.



The critical angles for the two prisms with respect to air are 41.1° and 45° respectively. Trace the path of the ray through the combination.

11(b). (a) An object is placed in front of a converging lens. Obtain the conditions under which the magnification produced by the lens is (i) negative and (ii) positive.

(b) A point object is placed at O in front of a glass sphere as shown in figure.



Show the formation of image by the sphere.

12. A compound microscope consists of two converging lenses. One of them, of smaller aperture and smaller focal length is called objective and the other of slightly larger aperture and slightly larger focal length is called eye-piece. Both the lenses are fitted in a tube with an arrangement to vary the distance between them. A tiny object is placed in front of the objective at a distance slightly greater than its focal length. The objective produces the image of the object which acts as an object for the eye-piece. The eye piece, in turn produces the final magnified image.

I. In a compound microscope the images formed by the objective and the eye-piece are respectively (A) virtual, real (B) real, virtual (C) virtual, virtual (D) real, real

II. The magnification due to a compound microscope does not depend upon (A) the aperture of the objective and the eye-piece (B) the focal length of the objective and the eye-piece (C) the length of the tube (D) the colour of the light used

III. Which of the following is not correct in the context of a compound microscope? (A) Both the lenses are of short focal lengths. (B) The magnifying power increases by decreasing the focal lengths of the two lenses. (C) The distance between the two lenses is more than $(f_o + f_e)$. (D) The microscope can be used as a telescope by interchanging the two lenses.

IV. A compound microscope consists of an objective of 10X and an eye-piece of 20X. The magnification due to the microscope would be (A) 2 (B) 10 (C) 30 (D) 200

V. The focal lengths of objective and eye-piece of a compound microscope are 1.2 cm and 3.0 cm respectively. The object is placed at a distance of 1.25 cm from the objective. If the final image is formed at infinity, the magnifying power of the microscope would be (A) 100 (B) 150 (C) 200 (D) 250

- End of Question Paper -