Sample Paper – 2014
Class – XII
Subject – Physics

Numerical problems of Wave Optics, Dual nature of Matter ,Atom and Nuclei

Q:1 (a) When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have he same frequency as the incident frequency. Explain why? (b) When light travels from a rarer to a denser medium, the speed decreases. Does the reduction in speed imply a reduction in the energy carried by the light wave? (c) In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determines the intensity of light in the photon picture of light.

Q:-2 What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations: (a) the screen is moved away from the plane of the slits; (b) the (monochromatic) source is replaced by another (monochromatic) source of shorter wavelength; (c) the separation between the two slits is increased; (d) the source slit is moved closer to the double-slit plane; (e) the width of the source slit is increased; (f) the monochromatic source is replaced by a source of white light?

Q:3 For what distance is ray optics a good approximation when the aperture is 3 mm wide and the wavelength is 500 nm?

Q:4 Discuss the intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroids?

Q:5 In a Young's double-slit experiment, the slits are separated by 0.28 mm and the screen is placed 1.4 m away. The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2 cm. Determine the wavelength of light used in the experiment.

Q:6 In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of light at a point where path difference is λ/3?

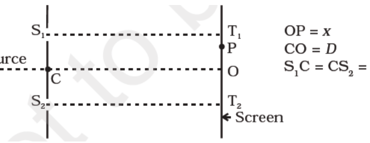
Q:7 In a double-slit experiment the angular width of a fringe is found to be 0.2° on a screen placed 1 m away. The wavelength of light used is 600 nm. What will be the angular width of the fringe if the entire experimental apparatus is immersed in water? Take refractive index of water to be 4/3.

Q:8 What is the Brewster angle for air to glass transition? (Refractive index of glass = 1.5.)
Q:9 A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find the width of the slit.

Q:9 A polariod (I) is placed in front of a monochromatic source. Another polatiod (II) is placed in front of this polaroid (I) and rotated till no light passes. A third polaroid (III) is now placed in between (I) and (II). In this case, will light emerge from

(II). Explain.

Q:10 Consider a two slit interference arrangements Fig. such that the distance of the screen from the slits is half the distancebetween the slits. Obtain the value of D in terms of ⌊ such that the first minima on the screen falls at a distance D from the centre O.



Q:11 The work function of caesium is 2.14 eV. Find (a) the threshold frequency for caesium, and (b) the wavelength of the incident light if the photocurrent is brought to zero by a stopping potential of 0.60 V.
Q:12 What is the de Broglie wavelength associated with (a) an electron moving with a speed of 5.4×10^6m/s, and (b) a ball of mass 150 g travelling at 30.0 m/s?

Q:13 An electron, an α-particle, and a proton have the same kinetic energy. Which of these particles has the shortest de Broglie wavelength?

Q:14 What is the de Broglie wavelength associated with an electron, accelerated through a potential difference of 100 volts?

Q:15 The energy flux of sunlight reaching the surface of the earth is 1.388×10^3 W/m_2. How many photons (nearly) per square metre are incident on the Earth per second? Assume that the photons in the sunlight have an average wavelength of 550 nm.

Q:16 Light of frequency 7.21×10^{14} Hz is incident on a metal surface. Electrons with a maximum speed of 6.0×10^5 m/s are ejected from the surface. What is the threshold frequency for photoemission of electrons?

Q:17 (a) For what kinetic energy of a neutron will the associated de Broglie wavelength be 1.40×10^{-10} m? (b) Also find the de Broglie wavelength of a neutron, in thermal equilibrium with matter, having an average kinetic energy of (3/2) $k\,T$ at 300 K.

Q:18 (a) An X-ray tube produces a continuous spectrum of radiation with its short wavelength end at 0.45 Å. What is the maximum energy of a photon in the radiation? (b) From your answer to (a), guess what order of accelerating voltage (for electrons) is required in such a tube?

Q:19 Ultraviolet light of wavelength 2271 Å from a 100 W mercury source irradiates a photo-cell made of molybdenum metal. If the stopping potential is –1.3 V, estimate the work function of the metal. How would the photo-cell respond to a high intensity ($<10^5$ W m_{-2}) red light of wavelength 6328 Å produced by a He-Ne laser?

Q:20 Crystal diffraction experiments can be performed using X-rays, or electrons accelerated through appropriate voltage. Which probe has greater energy? (For quantitative comparison, take the wavelength of the probe equal to 1

Å, which is of the order of inter-atomic spacing in the lattice) (m_e=9.11 × 10^{-31} kg).

Q:21 An electron microscope uses electrons accelerated by a voltage of 50 kV. Determine the de Broglie wavelength associated with the electrons. If other factors (such as numerical aperture, etc.) are taken to be roughly the same, how does the resolving power of an electron microscope compare with that of an optical microscope which uses yellow light?

Q:22 In a Geiger-Marsden experiment, what is the distance of closest approach to the nucleus of a 7.7 MeV α-particle before it comes momentarily to rest and reverses its direction?

Q:23 A difference of 2.3 eV separates two energy levels in an atom. What is the frequency of radiation emitted when the atom make a transition from the upper level to the lower level?

Q:24 The ground state energy of hydrogen atom is –13.6 eV. What are the kinetic and potential energies of the electron in this state?

Q:25 A hydrogen atom initially in the ground level absorbs a photon, which excites it to the *n* = 4 level. Determine the wavelength and frequency of photon.
Q:26 (a) Using the Bohr's model calculate the speed of the electron in a hydrogen atom in the *n* = 1, 2, and 3 levels. (b) Calculate the orbital period in each of these levels.

Q:27 The radius of the innermost electron orbit of a hyd
rogen atom is 5.3×10^{-11} m. What are the radii of the *n* = 2 and *n* =3 orbits?

Q:28 A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. What series of wavelengths will be emit

Q:29 The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV. (a) What is the kinetic energy of the electron in this state? (b) What is the potential energy of the electron in this state? (c) Which of the answers above would change if the choice of the zero of potential energy is changed?

Q:30 The half-life of 238 92U undergoing α-decay is 4.5 × 109 years. What is the activity of 1g sample of 238 92U

Q:31 Tritium has a half-life of 12.5 y undergoing beta decay. What fraction of a sample of pure tritium will remain undecayed after 25 y.

Q:32 The three stable isotopes of neon: Ne and Ne have respective abundances of 90.51%, 0.27% and 9.22%. The atomic masses of the three isotopes are 19.99 u, 20.99 u and 21.99 u, respectively. Obtain the average atomic mass of neon.

Q:33 The nucleus 23 Ne 10 Ne decays by β– emission. Write down the β-decay equation and determine the maximum kinetic energy of the electrons emitted. Given that: *m* (23 10 Ne) = 22.994466 u *m* (23 11 Na) = 22.089770 u.

Q: 34 Obtain the amount of 60 27Co necessary to provide a radioactive source of 8.0 mCi strength. The half-life of 60 27Co is 5.3 years.

Q:35 The half-life of 90 38Sr is 28 years. What is the disintegration rate of 15 mg of this isotope?

Q:36 How long can an electric lamp of 100W be kept glowing by fusion of 2.0 kg of deuterium? Take the fusion reaction as $^{2}H_{1}+ {}^{3}H \rightarrow$ 2He+n+3.27 MeV

Paper Submitted By:

Name AJAY YADAV
Email ajay3016@yahoo.com
Phone No. 09467853611