Question Paper

Exam Date & Time: 15-Nov-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATIONS
NOVEMBER-2019
I SEMESTER B.Sc. (Applied Sciences)
PHYSICS - I [IPH 111]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Useful constants

Planck's constant h = 6.63 x 10^{-34} Js,Velocity of light c = 3x 10^{8} ms-1. Charge on electron e = 1.6x10^{-19} C. Mass of electron= 9.1 x 10^{-31} kg.Mass of proton = 1.67 x 10^{27} kg.
Missing data, if any, may be suitably assumed.

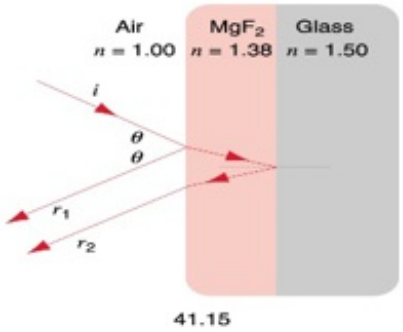
1) What are coherent waves? Explain the mechanism of obtaining the same. (5)

A)

B) Obtain an expression for the intensity distribution in a double slit interference using phasor method. Give the schematic plot of intensity distribution on the screen. (5)

C) In a double slit experiment, the distance between slits is 5.22 mm and the slits are 1.36 m from the screen. Two interference patterns are observed on the screen, one due wavelength 480 nm and the other due to wavelength 612 nm. Find the separation on the screen between third order interference fringes of the two different patterns. (5)

D) Lenses are often coated with thin films of transparent substances such as MgF2 (n=1.38) to reduce the reflection from the glass surface (n=1.50) as in the figure. How thick a coating is needed to produce a minimum reflection at l = 550 nm. (5)



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2) What is diffraction of light? Distinguish between Fresnel and Fraunhofer classes of diffraction. (4)

A)

B) Give the qualitative discussion of Fraunhofer diffraction at a single slit. (6)

C) i) For what value of slit width the first minimum of red light of wavelength 0.650 mm fall at 15° ? ii) What is the wave length λ' of the light whose first diffraction maximum (not counting the central maximum) falls at same position as that of the red light of part (i) ? (5)

D) A navy cruiser employs radar with a wavelength of 1.57 cm. The circular antenna has a diameter of 2.33 m. At a range of 6.25 km, what is the smallest distance that two speed boats can be from each other and still be resolved as two separate objects by the radar system? (5)

3) Distinguish between interference and diffraction bands. (4)

A)

B) What is polarization of light waves? Give the schematic representation of polarised and unpolarised light. Deduce Malus' law. (6)

C) A diffraction grating 2.86 cm wide produces a deviation of 33.2° in the second order with light of wavelength 612nm. Find the total number of rulings on the grating. (5)

D) A beam of light is linearly polarised in the vertical direction. The beam falls at normal incidence on a polarising sheet with its polarising direction at 58.8 ° to the vertical. The transmitted beam falls, also at normal incidence, on the second polarising sheet with its polarising direction horizontal. The intensity of the original beam is 43.3 W/m^2. Find the intensity of the beam transmitted by the second sheet. (5)

4) State and Explain - i) Stefan's law ii) Wien's law iii) Ultraviolet catastrophe. (6)

A)

B) What is photo-electric effect? What are classical predictions on it? (4)

C) The radius of the sun is 6.96 x 10^8 m, and its total power output 3.77 x 10^{26} W. (i) Assuming sun's surface emits like a black body, calculate its surface temperature. (ii) Find the λ_{max} for the sun. (5)

D) In the study of photoelectric effect for two metals the following observations are made: (i) the stopping potential for photo-electrons released from metal 1 is 1.48 V larger than metal 2 and (ii) the threshold frequency for metal 1 is 40% smaller than for metal 2. Determine the work functions of each metal. (5)

5) Derive an expression for the Compton shift. (6)

A)

B) What is a quantum particle? Why the wave nature of macro particles are not obvious? (4)

C) A 0.00160 nm photon scatters from a free electron. For what photon scattering angle does the recoiling electron have kinetic energy equal to the energy of scattered photon? (6)

D) An electron and a bullet (m= 20gm) each have a velocity of 500m/s accurate to within 0.010%. Within what limits could we determine the positions of the objects along the direction of the velocity? (4)

6) What is the significance of a wave function? What are the mathematical requirements of a well behaved wave function? (5)

A)

B) Solve Schrodinger equation for the Eigen value of a particle confined in an infinite potential well of one dimension. (5)

C) A 0.500 kg baseball is confined between two rigid walls of a stadium that can be modelled as a box of length 100m. Calculate i) the minimum speed of the ball ii) If the ball now moves with a speed of 150m/s determine the quantum number of the state in which the baseball resides. (5)

D) Show that the wave function $[\psi = Ae^{(\omega t - kx)}]$ is a solution to Schrodinger equation, where k=$\frac{2\pi}{\lambda}$ and U=0 (5)

7) Distinguish between conductors, semiconductors and insulators on the basis of band theory of solids (6)

A)

B) What is a simple harmonic oscillator? Distinguish between a classical and a quantum oscillator. (4)

C) Calculate the energy of a conduction electron in silver at 800 K, assuming the probability of finding the electron in that state to be 0.950. Given : Fermi energy at that temperature is 5.48 eV. (6)

D) Each atom of gold contributes one electron to the metal. Compute the Fermi energy for gold. Given : the concentration of free electrons in gold is 5.90 x $10^{28}/m^3$. (4)

8) Explain the terms : i) Metastable state (ii) Population inversion (iii) Resonant cavity. (6)

A)

B) What are the essentials of quantum free electron theory? Write down and explain Fermi-Dirac distribution function. (4)

C) Calculate the most probable value of the position for an electron in the ground state of the hydrogen atom. Given : (5)

$$\Psi_{1s}(r) = \frac{1}{\sqrt{\pi a_o^3}} e^{\frac{-r}{a_o}}$$

D) A ruby laser delivers a 10 ns pulse of 1.00 MW average power. If the photons have a wavelength of 694.3 nm, how many are contained in the pulse? (5)

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