Question Paper

Exam Date & Time: 10-May-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
I SEMESTER B.Sc, (Applied Sciences) - End Semester Theory Examination - April / May 2019
Physics - I [PH 111]

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

Answer 5 out of 8 questions.

Missing data, if any, may suitably be assumed.
Useful constants
Planck's constant h = 6.63 x 10^{-34} Js, Velocity of light c = 3x 10^{8} ms^{-1}. Mass of electron = 9.1 x 10^{-31} kg. Mass of proton = 1.67 x 10^{-27} kg.
Stefan-Boltzmann Constant: 5.67 x 10^{-8} W/m^2K^4 Charge on electron = 1.6x10-^{19} C. Boltzmann constant: 1.38 x 10^{23} J/K

1) What are coherent waves? Explain with examples the mechanisms of obtaining the same. (6)

A)

B) Explain the terms- i) Optical path length ii) Reflection phase shift. (4)

C) A double-slit arrangement is illuminated by a light of wavelength = 600 nm. The slits are 0.10 mm apart and the screen is 60 cm away. i) What is the angular position of first minimum? ii) Of the tenth maximum? iii)What is the distance on the screen between adjacent maxima? (6)

D) Calculate the minimum thickness of a soap bubble film in air that results in constructive interference in the reflected light of wavelength 500 nm. (4)

2) What is diffraction of light? Distinguish between Fresnel and Fraunhofer classes of diffraction. How diffraction bands are different from interference bands? (6)

A)

B) What are phasors? Draw the phasor diagrams representing central maxima and first minima due to a single slit diffraction. Take, number of phasors to be 6. (4)

C) Light of wavelength 580nm is incident on a slit having width of 0.300mm. The viewing screen is 2.00m from the slit. Find the positions of the first dark fringes and the width of the central maxima. (5)

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

3) Draw a schematic diagram of intensity pattern for i) double slit interference ii) interference -diffraction combined. (4)

A)

B) i) What is polarization of light waves? Give the schematic representation of polarized and un-polarised light? ii) Derive Brewster's law. (6)

C) A converging lens 30 mm in diameter has a focal length of 25 cm. i) What angular separation must two distant point objects have to satisfy Rayleigh criterion? Assume wavelength = 550 nm. ii) How far apart are the centres of diffraction patterns in the focal plane of the lens? (4)

D) i) Find the polarising angle and the angle of refraction for glass of refractive index 1.5 ii) Two polarising sheets have their polarising directions parallel so that intensity Im of the transmitted light is maximum. Through what angle must either sheet be turned if the intensity is to drop by one-half? (6)

4) What is a black body? State and explain Rayleigh-Jeans law on black body and discuss its limitation. (4)

A)

B) What is Compton effect? What are classical predictions and experimental observations? (6)

C) Find the peak wavelength of the black body radiation emitted by the tungsten filament of a light bulb operating at 2000 K. Calculate the energy (in eV) of the emitted of photon at this wavelength. Given : Wien's constant = 2.898×10^{-3} mK. (4)

D) A sodium surface is illuminated with light having a wavelength of 300 nm. The work function for sodium metal is 2.46 eV. Find i) the maximum kinetic energy of the ejected photoelectrons and ii) the cut-off wavelength for sodium. (6)

5) What is photoelectric effect? Deduce Einstein photo electric equation. Draw the graph of photo-current vs. applied voltage. (5)

A)

B) What is a quantum particle? Why the wave nature of macro particles are not obvious? (5)

C) X- rays with λ = 100 pm are scattered from a carbon target. The scattered radiation is viewed at 90° to the incident beam. i) What is the Compton shift ? b) What kinetic energy is imparted to the recoiling electron? (6)

D) A 10-eV electron moves in the direction of increasing x with a speed of 1.88×10^6 m/s. Assuming a precision of 1.0% in this measurement, calculate the precision with which its momentum can be measured simultaneously. (4)

6) Explain - i) Wave function ii) Tunnelling. (4)

A)

B) Solve Schrodinger equation for the energy eigen value of a particle confined (6)

in an infinite potential well of one dimension.

C) A 0.450 kg baseball is confined between two rigid walls of a stadium that can be modelled as a box of length 120m. 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. (6)

D) Calculate the de Broglie wavelength of a proton accelerated through a potential difference of 200 V. (4)

7) What is an expectation value of a measurement? How it is obtained in quantum mechanics? (4)

A)

B) Explain Fermi-Dirac distribution function and use the function to define Fermi energy. (6)

C) A particle of mass m is confined to a one dimensional box between x=0 and x=L. Find the expectation value of the position x of the particle in the ground state. Given (6)

$$: \quad \Psi = [\sqrt{\frac{2}{L}}]\sin(\frac{\pi x}{L})$$

D) An electron has a kinetic energy of 20.0 eV. The electron is incident upon a rectangular barrier of height 30.0 eV and width 1 nm. What is the probability that the electron will tunnel through the barrier? (4)

8) Explain various components of a laser. (6)

A)

B) Draw R vs.T graph for both normal and super conducting materials and hence explain the terms super-conductivity and critical temperature. (4)

C) Calculate the most probable value and average value of the position for an electron in the ground state of the hydrogen atom. Given : (6)

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

D) A three level laser of emits light at a wavelength of 550 nm. i) What will be the ratio of population at 300 K of the upper level to that of lower level? ii) At what temperature the ratio of population would be 0.5? (4)

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