Question Paper

Exam Date & Time: 15-Nov-2018 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
FIRST SEMESTER B.SC. Applied Sciences in Engg.
END - SEMESTER THEORY EXAMINATIONS NOVEMBER - 2018
PHYSICS - I [IPH 111 - S2]

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

Answer 5 out of 8 questions.

Constants

Charge on electron : 1.60×10^{-19}C Electron Mass : 9.11×10^{-31}kg

Planck's constant: 6.63×10^{-34} J.s Speed of light in vacuum: 3.0×10^{8} m/s

Proton/neutron mass: 1.67×10^{-27} kg Boltzmann constant: 1.38×10^{-23} J/K

Compton wavelength: 2.42×10^{-12} m

Stefan-Boltzmann Constant: 5.67×10^{-8} W/m^{2}K^4

1) A) What is interference of light waves? Write the conditions for constructive and destructive interferences. How path difference and phase differences are related? (4)

B) Obtain an expression for the intensity distribution in a double slit interference using phasor method. Give the schematic plot. (8)

C) (a) Find the sum of the following quantities either by phasor or by algebraic method. (8)

$y_1 = 12 \sin(\omega t)$ and $y_2 = 15.0 \sin(\omega t + 30Â°)$

(b) A soap film (n=1.33) in air is 320nm thick. If it is illuminated with a white light at normal incidence, what color (wavelength) will it appear to be in the reflected light?

2) A) Draw phasor diagrams representing central maxima and first minima assuming the slit is divided into eight equal parts. (4)

B) Give the qualitative discussion of Fraunhofer diffraction at a single slit. Compare interference bands with diffraction (8)

bands.

C) (a) Find the ratio of the intensities of the secondary maxima to the intensity of central maximum for the single slit Fraunhofer diffraction pattern. (8)
(b) Light of λ = 589nm is used to view an object under a microscope. If the aperture of the objective lens has a diameter of 0.9 cm, what is the limiting angle of resolution? If we were possible to use visible light of any wavelength, what would be the maximum limit of resolution for this microscope?

3) Derive - i) Bragg's Law ii) Grating equation. (4)

A)

B) Deduce Malus' law. Explain the phenomena of double refraction. (8)

C) (a) In a double slit experiment, the distance of the screen from the slits D=56cm, the wavelength used is 500nm, the slit separation d = 0.12 mm and the slit width a = 0.025 mm. i) what is the spacing between adjacent fringes in the central diffraction pattern? ii) what is the distance from the central maximum to the first diffraction minimum? (8)
(b) An airtight chamber 5.0 cm long with glass windows is placed in one arm of a Michelson's interferometer. Light of wavelength 500nm is used. When the air is slowly evacuated from the chamber, 60 fringes are observed to pass through the field of view. Calculate the refractive index of air precisely from this data.

4) What are the assumptions made in Planck's hypothesis on black body radiation. Write the mathematical equation obtained by Max Planck. (4)

A)

B) Draw the graphs: i) photo-electric current verses applied voltage and ii) K_{max} of the photo electron verses frequency of the incident light. Explain various aspects of the graph. (8)

C) a) Caesium has a work function of 2.1 eV. (a) Find the cut off wavelength and cut off frequency for the photoelectric effect. (b) What is the stopping potential if the incident (8)

light has wavelength of 190 nm?

b) Calculate the energy and momentum of a photon of wavelength 700nm. Will it be same for an electron or a proton?

5) Write notes on - i) de Broglie matter waves and ii) Heisenberg uncertainty principle. (4)

A)

B) Explain Compton effect and arrive at an expression for Compton shift. (8)

C) a) The speed of an electron is measured to be 0.005m/s to an accuracy of 0.002%. Find the minimum uncertainty in determining the position of this electron. (8)

b) X-rays of wavelength 0.200nm are scattered from a block of material. The scattered x-rays are observed at an angle 45Â° to the incident beam. Calculate the wavelength and energy of scattered photon. What energy is carried away by the recoiling electron?

6) What is the significance of a wave function? (4)

A)

B) Arrive at an expression for the energy Eigen value for a particle trapped in a one dimensional box (infinite potential well). (8)

C) a) A 0.800 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 160m/s determine the quantum number of the state in which the baseball resides. (8)

b) An alpha particle in a nucleus can be modelled as a particle moving in a box of length 1.0×10^{-14} m. Using this model, estimate the energy an momentum of an alpha particle in its lowest energy state (mass of alpha particle m = $4 \times 1.66 \times 10^{-27}$ kg)

7) Draw the graph of wave functions and probability densities of a particle confined in a finite potential well for first two energy states (4)

A)

B) (8)

What is a simple harmonic oscillator? Deduce Schrodinger equation for this oscillator and write down its eigen function and eigen value . Compare a classical oscillator with that of a quantum oscillator.

C) a) A 45 eV electron is incident on a square barrier of height 55 eV. What is the probability that the electron will tunnel through the barrier if its width is (A) 10.0 nm? (B) 0.10 nm? (8)

b) A quantum oscillator consists of an electron bound by a restoring force constant 9.5N/m. What is the longest wavelength of light that can excite the oscillator?

8) Write two specific applications of lasers and super conductors. (4)

A)

B) Explain in brief the (i) Energy band theory of solids. (ii) Extrinsic semiconductor. Draw a representative graph of resistance Vs temperature for a superconductor explain the term critical temperature. (8)

C) a) A Helium Neon laser emits light at a wavelength 632.8nm and has an output power of 4.5 mW. How many photons are emitted each minute by this laser while operating? (8)

b) The energy gap of silicon at 300K is 1.14 eV. Find the a) lowest frequency photon that will promote an electron from the valence band to the conduction band b) the wavelength corresponding to this photon.

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