Question Paper

Exam Date & Time: 01-Feb-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATION - DECEMBER 2022
I SEMESTER B.Sc (Applied Sciences) in Engg.
PHYSICS - I [IPH 111]

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Missing data, if any, may be suitably assumed

Useful constants

Planck's constant h = 6.63 x 10^{-34} Js,
Charge on electron = 1.6x10^{-19} C.
Mass of proton = 1.67 x 10^{-27} kg.
Stefan-Boltzmann Constant: 5.67 x 10^{-8} W/m^2K^4

Velocity of light c = 3x 10^8 ms^{-1}.
Mass of electron = 9.1 x 10^{-31} kg.
Boltzmann constant: 1.38 x 10^{-23} J/K
Avogadro's number : 6.022 × 10^{23}

1)	A)	Light of wavelength 500 nm enters a human eye. Assuming a pupil diameter of 2 mm, estimate the limiting angle of resolution for this eye, assuming its resolution is limited only by diffraction. Further, determine the minimum separation distance between two point sources that the eye can distinguish if the point sources are a distance 25 cm from the observer	(4)
	B)	Obtain an expression for the fringe-width in case of an interference of light of wavelength λ, from a double-slit of slit-separation d.	(4)
	C)	Explain Polarization by reflection using a schematic.	(2)
2)	A)	What is photoelectric effect? What are the classical predictions and experimental observations made in photoelectric effect?	(4)
	B)	An electron has a kinetic energy of 3.0 eV. Find its de Broglie wavelength. Also find the wavelength of a photon having the same energy.	(3)
	C)	The first-order diffraction maximum is observed at 12.6° for a crystal having a spacing between planes of atoms of 0.250 nm. What wavelength x-ray is used to observe this first-order pattern and how many orders can be observed for this crystal at this wavelength?	(3)
3)	A)	For an electron in a one dimensional infinite potential well of width 1Å, calculate (i) Separation between the two lowest energy levels	(4)

(ii)The frequency and wavelength of the photon corresponding to a transition between these two levels
(iii) In what region of electromagnetic spectrum is this wavelength fall ?

B) Give a brief account of tunneling of a particle through a potential energy barrier. (3)

C) Write the expression for Fermi-Dirac distribution function. Sketch schematically the plots of this function for O K and for T > O K. (3)

4) Calculate the most probable value of r for an electron in the ground state of the H-atom, given the wavefunction of ground state H-atom: . (4)

A)

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

Is most probable value same as the expectation value of r in the ground state ?

B) Explain the following terms with reference to lasers: (3)
(i) stimulated emission
(ii) metastable state
(iii) population inversion

C) An HCl molecule is excited to its first rotational energy level, corresponding to J = 1. If the distance between its nuclei is r_o = 0.1275 nm, what is the angular speed (ω) of the molecule about its centre of mass ? (3)

5) Sodium is a monovalent metal having a density of 971 kg/m^3 and a molar mass of 0.023 kg/mol. Use this information to calculate the density of charge carriers and the Fermi energy. Express this energy in electron volts. (Given M = 23 g/mol, ρ = 0.971 g/ cm^3) (4)

A)

B) Obtain an expression for Vibrational energy of a diatomic molecule. Sketch schematically its energy levels and mention which region of electromagnetic spectrum does this energy fall ? (4)

C) Give a brief account of BCS theory of superconductivity. (2)

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