Question Paper

Exam Date & Time: 15-Jan-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATIONS NOVEMBER/DECEMBER 2023
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,	Velocity of light c = 3x 10^{8} ms^{-1}.
Charge on electron = 1.6x10^{-19} C.	Mass of electron = 9.1 x 10^{-31} kg.
Mass of proton = 1.67 x 10^{-27} kg.	Boltzmann constant: 1.38 x 10^{-23} J/K
Stefan-Boltzmann Constant: 5.67 x 10^{-8} W/m^2K^4	Avogadro's number: 6.022 × 10^{23}

1)	A)	Obtain an expression for the intensity of fringes in a Young's double slit experiment using phasor method.	(5)
	B)	The angle of incidence of a light beam onto a reflecting surface is continuously variable. The reflected ray in air is completely polarized when the angle of incidence is 56°. What is the index of refraction of the reflecting material ? If the air medium changes to a medium of refractive index 1.2, for what angle the reflected ray is completely polarized ?	(3)
	C)	A 100-mW laser beam is reflected back upon itself by a mirror. Calculate the force on the mirror.	(2)
2)	A)	Discuss the experimental observations and classical predictions in the experiment on photoelectric effect? How would you explain the dependency of Kinetic Energy on light frequency based on Einstein's photoelectric equation.	(5)
	B)	A 0.00160 nm (λ_o) photon scatters from a free electron. For what photon scattering angle does the recoiling electron have kinetic energy equal to the energy of the scattered photon?	(3)
	C)	The lifetime of an excited atom is given as $\delta t = 1.0 \times 10^{8}$ s. Using the uncertainty principle, compute the line width δf produced by this finite lifetime?	(2)

3) By solving the Schrödinger equation, obtain the normalized wave-function for a particle of mass m, trapped in an infinite potential well. (5)

A)

B) Find the probability that a particle in a box of length L can be found between 0.45L and 0.55L for the first excited state. (3)

C) A pendulum with a 1.00-g bob has a massless string 250 mm long. The period of the pendulum is 1.00s. The pendulum swings with a very small amplitude such that its bob rises a maximum of 1.00 mm above its equilibrium position. What is the corresponding quantum number? (2)

4) What is population inversion in lasers? Give a brief account of a He-Ne laser with the help of a energy level diagram. (5)

A)

B) Calculate the most probable value of r (= distance from nucleus) for an electron in the ground state of the H-atom. (3)

C) A tungsten target is struck by electrons that have been accelerated from rest through a 40.0-keV potential difference. Find the shortest wavelength of the radiation emitted. (2)

5) Assuming the Fermi-Dirac distribution function and the density-of-states function, obtain an expression for the density of free-electrons in a metal. (5)

A)

B) The frequency of photon that causes v = 0 to v = 1 transition in the CO molecule is 6.42×10^{13} Hz. Ignoring any changes in the rotational energy, calculate the force constant k for the molecule (3)

C) The J = 0 to J = 1 rotational transition of the CO molecule occurs at a frequency of 1.15×10^{11}Hz. Using this information, calculate the moment of inertia of the molecule. (2)

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