INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL

B.Sc. (Applied Sciences) in Engg.

End – Semester Theory Examinations – November/December 2021

I SEMESTER – PHYSICS I (PH 111)

(Branch: Common to all)

Time: 3 Hours **Date: 23 NOV 2022** **Max. Marks: 50**

- ✓ **Answer ALL the questions.**
- ✓ **Missing data, if any, may be suitably assumed**

1 (a). Obtain an expression for intensity of light in double-slit interference. Draw a schematic plot of the intensity of light in double-slit interference against phase-difference. [5]

1 (b). A screen is placed 50.0 cm from a single slit, which is illuminated with light of wavelength 690 nm. If the distance between the first and third minima in the diffraction pattern is 3.00 mm, what is the width of the slit? [2]

1 (c). Light of wavelength 500 nm is incident normally on a diffraction grating. If the third-order maximum of the diffraction pattern is observed at 32.0°, (a) what is the number of rulings per centimeter for the grating? (b) Determine the total number of primary maxima that can be observed in this situation. [3]

2 (a). Using the energy and momentum conservation, derive an expression for the wavelength of the scattered photon (λ') in Compton effect experiment. [5]

2 (b). Un-polarized light is incident upon two polarizers that have their polarization axes at an angle of 45^{o}. If the incident intensity is I_o, what is the final intensity? [2]

2 (c). An electron is confined between two impenetrable walls 0.20 nm apart. Determine its energy, momentum and de Broglie wavelength in the ground state. [3]

3 (a) Show that the frequency (f) and wavelength (λ) of a freely moving quantum particle with mass m are related by the expression, $(\nu / c)^2 = 1/\lambda^2 + 1/\lambda_c^2$,

where $\lambda_c = h/mc$ is the Compton wavelength of the particle. [3]

3 (b) The wave function for H-atom in ground state is

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

Obtain an expression for the radial probability density of H-atom in ground state. Sketch schematically the plot of probability density of H atom in the ground and 2s state vs. radial distance. [4]

3 (c). An electron has a kinetic energy of 12 eV. The electron is incident upon a rectangular barrier of height 20 eV and thickness 1 nm. By what factor would the electron's probability of tunneling through the barrier increase assuming that the electron absorbs all the energy of a photon with wavelength 546 nm? [3]

4(a). Assuming the Fermi-Dirac distribution function , obtain an expression for the density of free- electrons in a metal with Fermi energy E_F, at zero K and, hence obtain expression for Fermi energy E_F in a metal at zero K. Given: density-of-states function

$$g(E)\,dE = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3} E^{1/2}\,dE$$

[4]

4 (b). Describe the principle of a laser using necessary schematic design and energy level diagram [3]

4 (c). Silver is a monovalent metal. Calculate (a) Fermi energy (b) Fermi speed and (c) the de Broglie wavelength corresponding to the Fermi speed. Density of silver = 10.5×10^3 Kg/m^3 Avagadro's number = 6.023×10^{23}/ mol; Molar mass of silver is 0.107 Kg/mol ; Mass of electron = 9.1×10^{-31} Kg; Planck's constant= 6.63×10^{-34} Js; 1 eV=1.6×10^{-19} J [3]

5 (a). Explain briefly the BCS theory of superconductivity in metals. Why all conductors are not superconductors? [3]

5 (b). Obtain an expression for rotational energy of a diatomic molecule. Sketch schematically these rotational energy levels. [4]

5 (c). A cobalt target is bombarded with electrons, and the wavelengths of its characteristic x-ray spectrum are measured. A second, fainter characteristic spectrum is also found, due to an impurity in the target. The wavelengths of the Kα lines are 178.9 pm (cobalt) and 143.5 pm (impurity). What is the impurity ? Atomic number of Cobalt is 27. [3]

©©©©©©©