60

RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree
Second Year – Semester II Examination – March/April 2014

PHY 2105 - QUANTUM MECHANICS

Answer any **two** questions Time: One hour

Use of a non-programmable calculator is permitted.

Symbols have their usual meaning.

Some fundamental constants and physical data:

Electron mass, $m_e = 9.1 \times 10^{-31}$ kg	Planck constant, $h = 6.626 \times 10^{-34}$ J s
Speed of light in vacuum, $c = 3.0 \times 10^{8}$ m s^{-1}	Electron charge, $e = 1.6 \times 10^{-19}$ C
Electron volt, $eV = 1.6 \times 10^{-19}$ J	Acceleration due to gravity, $g = 9.8$ m s^{-2}
Rydberg constant, $R_H = 1.097 \times 10^{7}$ m^{-1}	Proton mass, $m_p = 1.672 \times 10^{-27}$ kg

1. (a) Show that the allowed energies and the wave function of a particle confined to move inside a one-dimensional infinite well of width L is given by $E = \frac{n^2\pi^2\hbar^2}{2mL^2}$, $\psi_n(x) = A\,\mathrm{Sin}\left(\frac{n\pi x}{L}\right)$ respectively. A is the normalization constant, n is an integer and m is the mass of the particle. [20 marks]

(b) Calculate the three lowest energies (in eV) for an electron inside a one-dimensional infinite potential well of width 2Å. Also determine the corresponding normalized eigenfunctions. [15 marks]

(c) Can we measure the energy levels of a ball of mass 10 g moving in a one-dimensional box of length 10 cm? Explain. [15 marks]

Contd.

2. (a) Describe the double-slit experiment using an electron beam. Show that the results of this experiment can be explained only if the uncertainty principle is assumed to be valid. [20 marks]

(b) Calculate the uncertainty in the momentum of a proton confined in a nucleus of radius 10^{-14} cm. From this result, estimate the kinetic energy of the proton. [20 marks]

(c) If matter has a wave nature, why is this wave-like character is not observable in our daily experiences? [10 marks]

3. (a) What is Photoelectric effect? [10 marks]

(b) A stopping potential of 0.82 V is required to stop the emission of photoelectrons from the surface of a metal by light of wavelength 4000 Å. For light of wavelength 3000 Å, the stopping potential is 1.85 V. Find the value of Planck's constant from these results. [25 marks]

(c) At stopping potential, if the wavelength of the incident light is kept fixed at 4000 Å, but the intensity of light is increased two times, will photoelectric current be obtained? Give reasons for your answer. [15 marks]

End.