RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree
Second Year – Semester II Examination - September/October 2013

PHY 2106- Atomic and Nuclear Physics

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

Electron mass m_e $= 9.1 \times 10^{-31}$ kg
Planck constant h $= 6.624 \times 10^{-34}$ J s
Elementary charge e $= 1.6 \times 10^{-19}$ C
Permittivity of free space ε_0 $= 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}
Electron volt eV $= 1.6 \times 10^{-19}$ J

Use of a non-programmable calculator is permitted.

Unless otherwise specified, symbols have their usual meaning.

1. (a) State the postulates of Bohr's theory of the hydrogen atom.

In a μ- mesonic atom, a muon with a charge $-e$ and mass 200 m_e moves in a circular orbit around the nucleus of charge $+3e$. Assuming that Bohr's model of atom is applicable to this system.

(i) Derive the expression for the radius of n^{th} Bohr orbit.
(ii) Find the value of n for which the radius of the orbit is approximately the same as that of Bohr's first orbit of hydrogen atom. (Bohr radius = 0.53×10^{-10} m.)
(iii) Calculate the first excitation potential of the atom.

(b) What is L-S coupling scheme?

(c) Distinguish between normal and anomalous Zeeman effect.

2. (a) Explain the term "Larmor precession".

Show that the angular velocity of precession is

$$\omega_L = \frac{eB}{2m_e}$$

Where e - charge of electron
m_e- mass of electron
B – external magnetic field

(b) What is the difference between nuclear fission and nuclear fusion?

Describe the construction and working principle of a nuclear reactor with suitable figures.

A reactor is developing energy at the rate of 32 x 10^6 W. How many atoms of ^{235}U undergo fission per second? Assume that on an average, energy of 200 MeV is released per fission.

3. (a) Explain what it is meant by radioactive equilibrium.

(b) Radon, the disintegration product of radium is in equilibrium with 1 g of Radium. Find the mass of Radon. Half lives of ^{226}Ra- 1590 years and ^{222}Rn- 3.82 days.

Hint: The Bateman equation, $N_2 = \frac{N_0 \lambda_1}{\lambda_2 - \lambda_1}\left[\exp^{-\lambda_1 t} - \exp^{-\lambda_2 t}\right]$ gives the number of daughter atoms at time t.

(c) What is it meant by half life ($t_{1/2}$) of a radioactive sample?

Two isotopes of a certain element have half lives T_1 and T_2. They are observed with abundances A_1 and A_2 respectively. Assuming that these isotopes were equally abundant at the time of formation of earth, calculate the age of the Earth in terms of T_1 and T_2.