The Open University of Sri Lanka
B.Sc. Degree Programme – Level 5
Department of Physics
Atomic and Nuclear Physics - PHU 3143 / PHE 5143
Open Book Test – 2009/2010
Duration: 1½ hrs.

Date: 03-04-2010   **Time: 10.00 p.m. to 11.30 p.m.**

Answer _all_ Questions

1. (a) What are alpha particles? State their properties.

   (b) Describe briefly the Rutherford's atomic model and Rutherford's alpha particle scattering theory?

   (c) Using Rutherford's atomic model, find the probability per unit solid angle of scattering of alpha particles of energy E through an angle θ from a foil of thickness t containing N atoms per unit volume. State your assumptions, if any, clearly.

   (d) An alpha particle, having an impact parameter 150 fm, is found to scatter through 30º when incident on a silver foil. Calculate the energy of the alpha particle.

                                                                              (30 marks)

2. (a) The Bohr theory of the hydrogen atom is based on several assumptions. Discuss these assumptions and their significance.

   (b) In hydrogen atom, the quantum number n can increase without limit. Because of this does the frequency of possible spectral lines emitted from the hydrogen also increase without limit?

   (c) The Balmer series for hydrogen atom corresponds to electronic transitions from higher energy states to the state with quantum number $n = 2$.
      (i) Find the longest wavelength photon emitted in the Balmer series and determine its frequency and energy.
      (ii) Find the shortest wavelength photon emitted in the same series and determine its frequency and energy.

                                                                              (35 marks)

3. (a) (i)   State the main differences (at least three differences) between alpha, beta and gamma rays.

    (ii)   Explain how they are produced in an atomic system?

    (b) Can carbon-14 dating be used to measure the age of a stone? Explain.

    (c) A 50.0 g sample of carbon is taken from a skeleton and is found to have carbon-14 decay rate of 200.0 decays per minute. It is known that 1.0 g carbon from a living organism has a decay rate of 15.0 decays per minute and that carbon-14 has a half-life of 5730 years. Find the age of the skeleton.

                                                                          (35 marks)

Some useful physical constants

Electron mass, m_e,   = 9.109×10^{-31} kg

Elementary charge, e,   = 1.602×10^{-19} C

Permittivity of free space, ε_0,   = 8.854×10^{-12} $C^2 N^{-1} m^{-2}$

Planck's constant, h,   = 6.626×10^{-34} J s

Speed of light, c,   = 2.998×10^8 m s^{-1}

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