

EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE – 2013/2014

FIRST SEMESTER (Proper/Repeat)

(May/ June - 2016)

PH 303 - NUCLEAR PHYSICS



01 hour.

ALL Questions

may find the following data useful:

$$W = 1.6 \times 10^{-13} \text{ J}$$

$$c = 931.5 \text{ MeV}/c^2$$

$$\text{Avogadro number} = 6.023 \times 10^{23} \text{ mol}^{-1}$$

$$\text{Electron rest mass} = 9.1 \times 10^{-31} \text{ kg}$$

Define the terms 'Radioactive decay' and 'Half-life time' for a radioactive substance.

Starting from the fundamental law of radioactive decay, show that the exponential law of decay is given by,

$$N = N_0 e^{-\lambda t}$$

where N_0 and N are the number of nuclei at time $t = 0$ and $t = t$, and λ is the decay constant.

Establish the following relationship between the half-life time ($T_{1/2}$) and the decay constant

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

A laboratory purchases 1 g of ${}^{235}_{92}\text{U}$ radioactive substance that has half-life time of 4.5×10^9 years. Calculate the decay constant and the radioactivity of the substance.

2. According to liquid-drop model the binding energy of a nucleus of nucleon number A , proton number Z , and neutron number N is given by,

$$\text{Binding energy} = aA + bA^{2/3} - c\frac{Z^2}{A^{1/3}} - d\frac{(N-Z)^2}{A} \pm e$$

- (a) Explain briefly the significance of each term in the above formula.
 (b) Show that for constant nucleon number the formula reduces to a parabolic form

$$M_A(A, Z). C^2 = \alpha A + \beta Z + \gamma Z^2 \mp e$$

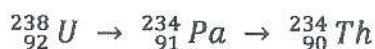
where α, β, γ and e are the functions of A .

- (c) Show that the energy released in a β^+ decay of an odd isobar is given by,

$$Q_{\beta^+} = 2\gamma \left(Z_0 - Z - \frac{1}{2} \right) - 2m_e c_l^2$$

where m_e and c_l are referring to the mass of electron and velocity of light.

- (d) Energy released in the following decay processes are 2.16 MeV and 1.9 MeV respectively.



Find the atomic number of the most stable nucleus in the decay series.