EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE – 2013/2014

FIRST SEMESTER (Proper/Repeat)

(May/ June - 2016)

PH 303 - NUCLEAR PHYSICS

e: 01 hour.

wer ALL Questions

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may find the following data useful:

eV = $1.6\times10^{-13}\ J$

$_{eV}$ = 931.5 MeV/c^2

gadro number = $6.023\times10^{23}\ mol^{-1}$

ctron rest mass = $9.1\times10^{-31}\ kg$

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

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

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

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

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

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

c) A laboratory purchases 1 g of $^{235}_{92}U$ 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 nu proton number Z, and neutron number N is given by,

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

(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 respectively.

$$^{238}_{92}U \rightarrow {}^{234}_{91}Pa \rightarrow {}^{234}_{90}Th$$

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