

# PHYS143

## Physics for Engineers

### Tutorial - Chapter 44

#### Question 1

Calculate the difference in binding energy per nucleon for the nuclei  $^{23}_{11}\text{Na}$  and  $^{23}_{12}\text{Mg}$  (Mass of Neutral atom: Na: 22.989769, Mg: 22.994124, H: 1.007 825, and 1.008 665 for neutron).

#### Question 2

Calculate the minimum energy required to remove a neutron from the  $^{43}_{20}\text{Ca}$  nucleus. (Mass of Neutral atom:  $^{43}_{20}\text{Ca}$ : 42.958767,  $^{42}_{20}\text{Ca}$ : 41.958618 and 1.008 665 for neutron).

#### Question 3

A freshly prepared sample of a certain radioactive isotope has an activity of 10.0 mCi. After 4.00 h, its activity is 8.00 mCi. Find (a) the decay constant and (b) the half-life. (c) How many atoms of the isotope were contained in the freshly prepared sample? (d) What is the sample's activity 30.0 h after it is prepared?

#### Question 4

The radioactive isotope  $^{198}\text{Au}$  has a half-life of 64.8 h. A sample containing this isotope has an initial activity ( $t = 0$ ) of 40.0  $\mu\text{Ci}$ . Calculate the number of nuclei that decay in the time interval between  $t_1 = 10.0$  h and  $t_2 = 12.0$  h.

#### Question 5

Determine which decays can occur spontaneously.

- (a)  $^{40}_{20}\text{Ca} \rightarrow e^+ + ^{40}_{19}\text{K}$       (b)  $^{98}_{44}\text{Ru} \rightarrow ^4_2\text{He} + ^{94}_{42}\text{Mo}$   
 (c)  $^{144}_{60}\text{Nd} \rightarrow ^4_2\text{He} + ^{140}_{58}\text{Ce}$

Atomic Masses:  $^{40}\text{Ca}$  (39.962 591),  $^{40}\text{K}$  (39.963 998),  $^{98}\text{Ru}$  (97.905 287),  $^{94}\text{Mo}$  (93.905 088),  $^{144}\text{Nd}$  (143.910 087),  $^{140}\text{Ce}$  (139.905 439),  $m_e$  (0.000549),  $M_\alpha$  (4.002603).

#### Question 6

A  $^3\text{H}$  nucleus beta decays into  $^3\text{He}$  by creating an electron and an antineutrino according to the reaction

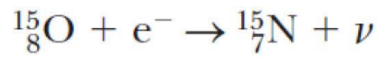
#### Question 7

Identify the unknown nuclide or particle (X).

- (a)  $X \rightarrow ^{65}_{28}\text{Ni} + \gamma$       (b)  $^{215}_{84}\text{Po} \rightarrow \bar{X} + \alpha$   
 (c)  $X \rightarrow ^{55}_{26}\text{Fe} + e^+ + \nu$

**Question 8**

The nucleus  $^{15}_8\text{O}$  decays by electron capture. The nuclear reaction is written



(a) Write the process going on for a single particle within the nucleus. (b) Disregarding the daughter's recoil, determine the energy of the neutrino. Atomic masses:  $^{15}\text{O}$  (15.003 066),  $^{15}\text{N}$  (15.000 109)