PHYS143
Physics for Engineers
Tutorial - Chapter 44

Question 1
Calculate the difference in binding energy per nucleon for the nuclei $^{23}_{11}$Na and $^{23}_{12}$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 $^{43}_{20}$Ca nucleus. (Mass of Neutral atom: $^{43}_{20}$Ca: 42.958767, $^{42}_{20}$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}Au has a half-life of 64.8 h. A sample containing this isotope has an initial activity (t = 0) of 40.0 μCi. 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}Ca (39.962 591), ^{40}K (39.963 998), ^{98}Ru (97.905 287), ^{94}Mo (93.905 088), ^{144}Nd (143.910 087), ^{140}Ce (139.905 439), m_e (0.000549), M_α (4.002603).

Question 6
A ^{3}H nucleus beta decays into ^{3}He by creating an electron and an antineutrino according to the reaction

Question 7
Identify the unknown nuclide or particle (X).

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

Question 8

The nucleus $^{15}_{8}O$ decays by electron capture. The nuclear reaction is written

$$^{15}_{8}O + e^{-} \rightarrow {}^{15}_{7}N + \nu$$

(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}O (15.003 066), ^{15}N (15.000 109)