CH 30 Assigned Homework

PHYS1Cb
2014 Spring

1. ${}^{32}_{15}P \rightarrow {}^{32}_{16}S + {}^{0}_{-1}\square$ ⇒ Beta decay ⇒ emits an (c) electron and (e) an antineutrino. //

(beta decay): ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + e^- + \bar{\nu}$

2. (i) Initial activity = $R_0 = N_0\lambda$, half-life = $T_{1/2} = \frac{0.693}{\lambda}$

2 sample are the same ⇒ λ are the same ⇒ $T_{1/2}$ must be the same.

(λ, the decay constant, depends on the nuclei.) ∴ (b)

(ii) After 5 half-lives ⇒ $t = 5T_{1/2}$ ∴ $R = R_0 e^{-\lambda t} = R_0 e^{-5\lambda T_{1/2}}$

we know that $R_{0G} = 2R_{0H}$, $\lambda_G = \lambda_H$, and $T_{1/2\,G} = T_{1/2\,H}$ ∴ $R_G = 2R_H$ ∴ (b)

3. In gamma decay, nucleus in an excited state decays to its ground state.

${}^{A}_{Z}X^* \rightarrow {}^{A}_{Z}X + \gamma$ ∴ (b) //

4. ${}^{40}_{18}X$ ⇒ 18 protons and 40 (protons + neutrons) ⇒ ∴ 18 protons and 22 neutrons ∴ (c) //

5. ${}^{234}_{90}Th \rightarrow {}^{A}_{Z}Ra + {}^{4}_{2}He$ ⇒ $\begin{cases} A+4 = 234 \\ Z+2 = 90 \end{cases}$ ∴ $A = 230$, $Z = 88$ ∴ (c) //

6. ${}^{144}_{60}Nd \rightarrow {}^{140}_{58}Ce + {}^{4}_{2}\square$ ⇒ alpha decay (b) //

7. ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + e^- + \bar{\nu}$ ∴ ${}^{95}_{36}Kr \rightarrow {}^{95}_{37}Rb + e^- + \bar{\nu}$ ⇒ 37 protons and 58 neutrons (a) //

8. ${}^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$. To answer it, rest masses of ${}^{9}_{4}Be$, ${}^{4}_{2}He$, ${}^{12}_{6}C$ and ${}^{1}_{0}n$ should be given: $M({}^{9}_{4}Be) = 9.012182\ u$, $M({}^{4}_{2}He) = 4.001506$, $M({}^{12}_{6}C) = 12.000000$ and $M({}^{1}_{0}n) = 1.008665$

∴ $Q = \left[M({}^{9}_{4}Be) + M({}^{4}_{2}He) - M({}^{12}_{6}C) - M({}^{1}_{0}n)\right]c^2$

$= (9.012182 + 4.001506 - 12.000000 - 1.008665)_{(u)} \cdot 931.494\ (MeV/u) = 4.68\ MeV$ //

9. $N = N_0 e^{-\lambda t}$, $T_{1/2} = \frac{0.693}{\lambda} = 3.6 \text{ days} \Rightarrow \lambda = \frac{0.693}{3.6} = 0.1925 \text{ days}^{-1}$

after 2 weeks = 14 days , $N(14) = N_0 \cdot e^{-\lambda \cdot t} = N_0 \cdot e^{-0.1925 \times 14} = N_0 \cdot e^{-2.695}$

$\Rightarrow \frac{N(t=14)}{N_0} = e^{-2.695} = 0.0675 \approx \frac{1}{15}$ $\therefore$ (d) //

10. Beta decays of protons and neutrons :

$p \rightarrow n + e^+ + \nu$, $T_{1/2} = 10^{32}$ years

$n \rightarrow p + e^- + \bar{\nu}$, $T_{1/2} = 10.3$ minutes (b)(c) //