

2004 핵공학개론 I 중간고사 해답

$$1. N\left(\frac{C^{14}}{C}(t)\right) = N_0\left(\frac{C^{14}}{C}(t)\right)\exp[-\lambda t] = N_0\left(\frac{C^{14}}{C}(t)\right)\exp\left[-\frac{\ln 2}{t_{\frac{1}{2}}}t\right]$$

$$N \times \frac{0.082}{100} = N \times \frac{0.1}{100} \exp\left[-\frac{\ln 2}{5730} \times t\right]$$

$$\therefore t = -5730 \times \frac{\ln 0.82}{\ln 2} = 1640.5 \text{ [year]}$$

$$2. \text{아보가드로 수} = 6.023 \times 10^{23} \#/\text{mole}$$

$$\text{알루미늄} = 25.9826 \text{ g/mole}$$

$$\therefore N_{Al} = \frac{6.023 \times 10^{23} \#/\text{mole}}{25.9826 \text{ g/mole}} \times 2.55 \text{ g/cc} \times 0.9 \text{ (fraction)} = 5.32 \times 10^{22} \#/\text{cc}$$

$$3.(a) (1) Co_{27}^{60} \rightarrow Ni_{28}^{(60)} + \beta^- + \bar{\nu}$$

$$(2) \beta^- \text{ 붕괴}$$

$$(3) Q = \{[M(Co) - 27m_0] - [(M(Ni) - 28m_0) + m_0]\}c^2 = [M(Co) - M(Ni)]c^2 \\ = (59.9525 - 59.9498)u \times (2.9979 \times 10^{10} \text{ cm/s})^2 \times 1.660438 \times 10^{-24} \text{ g/u} \\ \times \frac{1}{1.6021 \times 10^{-12}} \text{ eV/erg} \times 10^{-6} \text{ MeV/eV} = 2.515 \text{ MeV}$$

$$(b) (1) Na_{11}^{22} + \beta^- \rightarrow Ne_{10}^{(22)} + \nu$$

$$(2) \text{E.C}$$

$$(3) Q = \{(M(Na) - 11m_0) + m_0\} - \{(M(Ne) - 10m_0)\}c^2 = [M(Na) - M(Ne)]c^2 \\ = (22.0013 - 21.9983)u \times (2.9979 \times 10^{10} \text{ cm/s})^2 \times 1.660438 \times 10^{-24} \text{ g/u} \\ \times \frac{1}{1.6021 \times 10^{-12}} \text{ eV/erg} \times 10^{-6} \text{ MeV/eV} = 2.794 \text{ MeV}$$

$$(c) (1) Na_{11}^{22} \rightarrow Ne_{10}^{(22)} + \beta^+ + \nu$$

$$(2) \text{양전자 붕괴}$$

$$(3) Q = \{(M(Na) - 11m_0) - [(M(Ne) - 10m_0) + m_0]\}c^2 = [M(Na) - M(Ne) - 2m_0]c^2 \\ = (22.0013 - 21.9983 - 2 \times 0.000548597)u \times (2.9979 \times 10^{10} \text{ cm/s})^2 \times 1.660438 \times 10^{-24} \text{ g/u} \\ \times \frac{1}{1.6021 \times 10^{-12}} \text{ eV/erg} \times 10^{-6} \text{ MeV/eV} = 1.772 \text{ MeV}$$

$$4. N_{Pb}(t) = N_{Pb}(0)\exp[-\lambda_{Pb}t]$$

$$N_{Bi}(t) = N_{Bi}(0)\exp[-\lambda_{Bi}t] + \frac{\lambda_{Pb}N_{Pb}(0)}{\lambda_{Bi} - \lambda_{Pb}} \{ \exp[-\lambda_{Pb}t] - \exp[-\lambda_{Bi}t] \}$$

$$\lambda_{Pb} = \frac{\ln 2}{t_{\frac{1}{2}}} = \frac{0.693}{22 \times 365} = 8.63 \times 10^{-5} \text{ [}/day]$$

$$\lambda_{Bi} = \frac{\ln 2}{t_{\frac{1}{2}}} = \frac{0.693}{5} = 0.1386 \text{ [}/day]$$

$$N_{Pb}(0) = \frac{30 \times 10^6 \text{ dps} \times 60 \text{ sec}/\text{min} \times 60 \text{ min}/\text{hour} \times 24 \text{ hour}/\text{day}}{\lambda_{Pb}} = 3.003 \times 10^{16} \#$$

$$N_{Bi}(0) = \frac{15 \times 10^6 \text{ dps} \times 60 \text{ sec}/\text{min} \times 60 \text{ min}/\text{hour} \times 24 \text{ hour}/\text{day}}{\lambda_{Bi}} = 9.351 \times 10^{12} \#$$

$$\begin{aligned} & (1) \therefore N_{Bi}(10) \times \lambda_{Bi} \\ &= N_{Bi}(0) \lambda_{Bi} \exp[-\lambda_{Bi} \times 10] + \frac{\lambda_{Pb} \lambda_{Bi} N_{Pb}(0)}{\lambda_{Bi} - \lambda_{Pb}} \{ \exp[-\lambda_{Pb} \times 10] - \exp[-\lambda_{Bi} \times 10] \} \\ &= 9.351 \times 10^{12} \# \times 0.1386 \text{ [}/day] \times \exp[-0.1386 \text{ [}/day] \times 10 \text{ [day]}] \\ &+ \frac{8.63 \times 10^{-5} \text{ [}/day] \times 0.1386 \text{ [}/day] \times 3.003 \times 10^{16} \#}{0.1386 \text{ [}/day] - 8.63 \times 10^{-5} \text{ [}/day]} \\ &\times \{ \exp[-8.63 \text{ [}/day] \times 10 \text{ [day]}] - \exp[-0.1386 \text{ [}/day] \times 10 \text{ [day]}] \} \times \frac{1}{24} \text{ day}/\text{hour} \times \frac{1}{3600} \text{ hour}/\text{sec} \\ &= 2.62 \times 10^7 \text{ [dps]} \end{aligned}$$

(2) $N_{Bi}(0) = 0$ 인 곳으로 시간을 변환

$$N_{Bi}(t') = \frac{\lambda_{Pb} N_{Pb}(0)}{\lambda_{Bi} - \lambda_{Pb}} \{ \exp[-\lambda_{Pb} t'] - \exp[-\lambda_{Bi} t'] \}$$

$$\rightarrow N_{Bi}(t') \times \lambda_{Bi} = \lambda_{Bi} \frac{\lambda_{Pb} N_{Pb}(0)}{\lambda_{Bi} - \lambda_{Pb}} \{ \exp[-\lambda_{Pb} t'] - \exp[-\lambda_{Bi} t'] \}$$

$$\rightarrow N_{Bi}(t') \times \lambda_{Bi} = \lambda_{Bi} \frac{\lambda_{Pb}}{\lambda_{Bi} - \lambda_{Pb}} \frac{N_{Pb}(t')}{\exp[-\lambda_{Pb} t']} \{ \exp[-\lambda_{Pb} t'] - \exp[-\lambda_{Bi} t'] \}$$

$$\rightarrow N_{Bi}(t') \times \lambda_{Bi} = \lambda_{Bi} \frac{\lambda_{Pb}}{\lambda_{Bi} - \lambda_{Pb}} N_{Pb}(t') \{ 1 - \exp[-(\lambda_{Bi} - \lambda_{Pb}) t'] \}$$

$$\rightarrow 15 \times 10^6 = 30 \times 10^6 \times \frac{0.1386}{0.1386 - 8.63 \times 10^{-5}} \{ 1 - \exp[-(0.1386 - 8.63 \times 10^{-5}) t'] \}$$

$$\therefore t' = 5.03 \text{ [day]}$$

5. PWR : Pressurized Water Reactor

CANDU-PHWR : CANada Deutrium Uranium Pressurized Heavy Water

	연료	감속재	냉각재
PWR	농축우라늄	경수(H_2O)	경수(H_2O)
CANDU	천연우라늄	중수(D_2O)	중수(D_2O)