HOMEWORK #12

12.4

	Z	N
^{6}Li	3	3
^{13}C	6	7
^{40}K	19	21
^{102}Pd	46	56

12.8

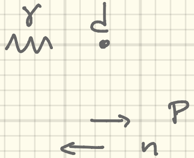
$\rho_N = 2.3 \times 10^{17}\ kg/m^3$

$$\rho_{H_2O} = 1g/cc \left(\frac{kg}{1000\,g} \right) \left(\frac{100\,cm}{m} \right)^3$$

$$= \frac{10^6}{10^3} = 10^3\ kg/m^3$$

$$\frac{\rho_N}{\rho_{H_2O}} = 2.3 \times 10^{14}$$

12.13 $\gamma + d \rightarrow n + p$



momentum $p_\gamma + \cancelto{0}{p_d} = p_p + p_n$

$p_\gamma = p_p + p_n$

energy $E_\gamma + E_d = E_p + E_n = E_f \rightarrow$ treat as single m and p

$$hf + m_d c^2 = \sqrt{(pc)^2 + (m_p + m_n)^2 c^4}$$

$$(\underset{\substack{\uparrow \\ pc}}{hf} + m_d c^2)^2 = (pc)^2 + (m_p + m_n)^2 c^4$$

same p

$$\cancel{(pc)^2} + (m_d c^2)^2 + 2 pc\, m_d c^2 = \cancel{(pc)^2} + (m_p + m_n)^2 c^4$$

looking for pc

$$2pc = \frac{(m_p + m_n)^2 c^4 - m_d^2 c^4}{m_d c^2}$$

$$2pc = \frac{(m_p + m_n)^2 c^4 - m_d^2 c^4}{m_d c^2}$$

from book $B_d = (m_p + m_n - m_d)c^2$ $\qquad (m_p + m_n)c^2 = B_d + m_d c^2$

$$2pc = \frac{(B_d + m_d c^2)^2 - m_d^2 c^4}{m_d c^2} = \frac{B_d^2 + m_d^2 c^4 + 2B_d m_d c^2 - m_d^2 c^4}{m_d c^2}$$

$$2pc = \frac{B_d^2 + 2B_d m_d c^2}{m_d c^2} = B_d\left(\frac{B_d}{m_d c^2} + 2\right) = 2hf$$

$$hf = B_d\left(1 + \frac{B_d}{2m_d c^2}\right)$$ which I think is equation 12.14

12.17 $\quad {}^{A-1}_{Z}Y + {}^{1}n$ is the composite of ${}^{A}_{Z}X = {}^{A-1}_{Z}Y + {}^{1}n$

a) so

$$B = \left[M({}^{A-1}_{Z}X) + m({}^{1}n) - M({}^{A}_{Z}X)\right]c^2$$

b) most loosely bound n:

$M({}^{5}Li) = 5.012540u$ $\qquad M({}^{6}Li) = 6.015122u$ $\qquad m_n = 1.008665u$

$M({}^{16}O) = 15.994915u$ $\qquad M({}^{15}O) = 15.003065u$

$M({}^{207}Pb) = 206.975881u$ $\qquad M({}^{206}Pb) = 205.974449u$

$$B(Li) = \left[M({}^{5}Li) + m(n) - M({}^{6}Li)\right]c^2$$

$$= \left[5.012540u + 1.008665u - 6.015122u\right]c^2 \cdot 931.49\frac{MeV}{c^2 u}$$

$B(Li) = 5.67\ MeV$

$B(O) = 15.7\ MeV$

$B(Pb) = 6.74\ MeV$

12.26

$$B(^{A}_{Z}X) = \underset{\substack{\uparrow \\ 15.8\text{ MeV}}}{a_v} A - \underset{\substack{\uparrow \\ 18.3\text{ MeV}}}{a_A} A^{2/3} - 0.72\, z(z-1)\, A^{-1/3} - \underset{\substack{\uparrow \\ 23.2\text{ MeV}}}{a_s} \frac{(N-Z)^2}{A} + \delta$$

a)

$$B(^{18}_{6}C) = (15.8)(18) - (18.3)(18)^{2/3} - 0.72\,(6)(5)\,18^{-1/3} - 23.2\,\frac{(12-6)}{18} + \underset{\substack{\shortparallel \\ (33)(18)^{-3/4} \\ = 3.78}}{\delta}$$

$$= 284.4 - 127 - 8.32 - 7.3 + 3.78$$

$$= 145.6$$

$$B/A = 8.1 \text{ MeV.}$$

b)

	$^{18}_{7}N$	$^{18}_{8}O$	$^{18}_{10}Ne$	$^{18}_{6}C$
N	11	10	18	12
P	7	8	10	6
δ	$-\Delta$	$+\Delta$	$+\Delta$	$+\Delta$
N-p	4	2	8	6

$\uparrow$

most stable

(N-Z) small

$\delta \quad +\Delta$

c) Binding formula $^{18}_{6}O$ $\longrightarrow$ B = 139.8 MeV , B/A = 7.8 MeV

12.27 $\quad {}^{60}Co \quad T_{1/2} = 5.271\,y$

$$R = 4.4\times10^{7}\,Bq.$$

$N = \frac{R}{\lambda}$ so need λ: $\quad \lambda = \frac{\ln 2}{T_{1/2}} = \frac{\ln 2}{(5.271y)(\pi\times10^{7}s/y)} = 4.2\times10^{-9}\,s^{-1}$

$N = \frac{4.4\times10^{7}}{4.2\times10^{-9}} = 1.06\times10^{16}$ atoms.

$$m = (1.06\times10^{16})\left(\frac{1\,mol}{6.022\times10^{23}}\right)\left(\frac{60g}{mol}\right) = 1.05\mu g$$

12.37 free proton decay. $p \xrightarrow{?} n + e^+$

$$Q = (m_p - m_n - m_e)c^2$$

$$= (1.0072876 - 1.008665 - 0.00054858)\,u \cdot c^2$$

$$Q = -0.79 \text{ MeV} \quad < 0$$

12.50 need nuclides close to age of earth.

^{40}K, ^{87}Rb ^{138}La ^{147}Sm

^{87}Rb $\downarrow$ reasonable abundances

^{147}Sm $\downarrow$ reasonable abundances

12.51

$$R' = \frac{1-e^{-\lambda t}}{e^{-\lambda t}} = e^{\lambda t} - 1$$

$$R' + 1 = e^{\lambda t}$$

$$\ln(R'+1) = \lambda t$$

$$t = \lambda \ln(R'+1)$$

$$t = \frac{4.47 \times 10^9}{\ln 2} \ln(1.01) = 6.4 \times 10^7 y$$