# HW #11

42.15

$^{6}_{3}Li \qquad m_{Li} = 6.015122\,u$

6 nucleons, $3n + 3p$

$3 \times 1.007825\,u + 3 \times 1.008665\,u = 6.04947\,u$

$\Delta m = 0.034348\,u = 32\,MeV$

$E_B = 32.0/6 = 5.33\,MeV$ (per nucleon)

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$^{208}_{82}Pb \qquad m_{Pb} = 207.976635\,u$

208 nucleons, $126n + 82p$

$82 \times 1.007825\,u + 126 \times 1.008665\,u = 209.73344\,u$

$\Delta m = 1.756805\,u = 1636\,MeV$

$E_B = 1636/208 = 7.87\,MeV$ (per nucleon)

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42.28

$\alpha$-decay: $\quad {}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}X + {}^{4}_{2}He$

$$^{218}_{84}Po \rightarrow {}^{214}_{82}Pb + {}^{4}_{2}He$$

$\Delta m = m_{^{218}Po} - m_{^{214}Pb} - m_{^{4}He} =$

$= 218.008965\,u - 213.999798\,u - 4.002603\,u = 0.006564\,u =$

$= 6.11\,MeV$

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$\beta^-$-decay: $\quad {}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}X + e^- + \bar{\nu}_e$

$$^{218}_{84}Po \rightarrow {}^{218}_{85}At + e^- + \bar{\nu}_e$$

$\Delta m = m_{^{218}Po} - m_{^{218}At} =$

$= 218.008965\,u - 218.008681\,u = 2.84 \times 10^{-4}\,u =$

$= 0.265\,MeV$

42.42 $^{131}_{53}I$ 632 μg

I am dealing with magnitudes only

at $t=0$, activity $\Rightarrow \left(\frac{dN}{dt}\right)_0 = \lambda N_0$

$$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{8.0207 \times 24 \times 3600} = 1.00023 \times 10^{-6}\ s^{-1}$$

$$N_0 = 632 \times 10^{-6} \times \frac{6.02 \times 10^{23}}{130.906124} = 2.9064 \times 10^{18}$$

$$\left(\frac{dN}{dt}\right)_0 = \lambda N_0 = 1.00023 \times 10^{-6} \times 2.9064 \times 10^{18} = 2.907 \times 10^{12}\ s^{-1}$$

After 1 hour; activity $\Rightarrow \left(\frac{dN}{dt}\right) = \left(\frac{dN}{dt}\right)_0 e^{-\lambda t}$ 1 hour = 3600 s

$$\left(\frac{dN}{dt}\right) = 2.907 \times 10^{12} e^{-(1.00023 \times 10^{-6} \times 3600)} = 2.897 \times 10^{12}\ s^{-1}$$

After 6 months, activity $\Rightarrow \left(\frac{dN}{dt}\right) = \left(\frac{dN}{dt}\right)_0 e^{-\lambda t}$ 6 months = $6 \times 30 \times 24 \times 3600$ s

$$\left(\frac{dN}{dt}\right) = 2.907 \times 10^{12} e^{-(1.00023 \times 10^{-6} \times 1.555 \times 10^{7})} = 5.10 \times 10^{5}\ s^{-1}$$

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42.50

$$\frac{^{87}_{38}Sr}{^{87}_{37}Rb} = 0.0160 \qquad e^{-\lambda t} = 0.984$$

$$t = \frac{-\ln(0.984)\, T_{1/2}}{0.693} = \frac{-\ln(0.984) \times 4.75 \times 10^{10}\ yr}{0.693} = 1.1 \times 10^{9}\ yr$$

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42.53

$$0.01050 = e^{-\lambda t} \qquad \lambda = \frac{-\ln(0.01050)}{4 \times 3600} = 3.164 \times 10^{-4}\ s^{-1}$$

$$T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda} = 2.19 \times 10^{3}\ s \approx 36.5\ min \Rightarrow {}^{211}_{82}Pb$$

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42.63

$$\Delta N = \lambda N \Delta t \qquad \Delta t = \frac{\Delta N}{N}\frac{1}{\lambda} = \frac{\Delta N}{N}\frac{T_{1/2}}{0.693}$$

magnitudes only

Average weight $\approx$ 70 kg

$$N = 70 \times 10^{3}\ g \times \frac{6.02 \times 10^{23}}{18\ g\ (H_2O)} \times 10 = 2.34 \times 10^{28}$$

10 protons in a $H_2O$ molecule

$$\Delta t = \frac{10^{32}\ yrs}{2.34 \times 10^{28} \times 0.693} \approx 6100\ years$$