1a) $A = \lambda N = \left(\frac{\ln 2}{5730 \text{ yr} \times 3.15\times10^{7} \frac{s}{yr}}\right)\left(10^{-6} g / 14 \frac{g}{mole}\right) \times 6.022\times10^{23}/mol$

$A = (3.84\times10^{-12}/s)(4.30\times10^{16}) = \underline{\underline{1.65\times10^{5}/s}} = Bq$

$\to 4.46\ \mu Ci$

1b) $Z_A = \left(\frac{A}{2}\right)\frac{81}{80 + 0.6(A)^{2/3}} = \left(\frac{66}{2}\right)\frac{81}{80 + 0.6(66)^{2/3}}$

* need to lower Z thus β^+/ec decay *

$Z_A = (33)\frac{81}{80 + 9.80} = \underline{\underline{29.8}}$

1c) $A = R(1 - e^{-\lambda t_b}) = 2\times10^{6}/s\left(1 - e^{-\frac{\ln 2 \times 30 min}{20.4 min}}\right)$

$A = 2\times10^{6}/s\,(1 - \underbrace{e^{-1.019}}_{0.3608}) = 1.3\times10^{6}\ Bq$

$A = 1.3\times10^{6}\ Bq / 3.7\times10^{10}\ Bq/Ci = 3.5\times10^{-5}\ Ci$ [0.35 μCi]

1d) two terms in mass formula are:

$-a_c Z^2/A^{1/3}$ Coulomb term for repulsion among protons in nucleus

$-a_A \frac{(A-2Z)^2}{A}$ Asymmetry term to account for equal force between neutrons & protons

(excess neutrons good for Coulomb but bad overall)

1e) $A = A_0 e^{-\lambda t} \rightarrow \ln\left(\frac{A}{A_0}\right) = -\lambda t \Rightarrow t = \frac{1}{\lambda}\ln\left(\frac{A_0}{A}\right)$

$$t = \frac{2.29 \times 10^3\,\text{yr}}{\ln 2}\ln\left[\frac{5.20 \times 10^{13}}{1.54 \times 10^{13}}\right] = \frac{2.29 \times 10^5\,\text{yr}}{\ln 2}(1.217)$$

$$t = 4.02 \times 10^5\,\text{yr}$$

1f) $^{63}_{29}Cu_{34}$ $\quad \pi(1p^1_{3/2}) \quad \nu(1f^6_{7/2})$

S P D F
0 1 2 3

parity = odd

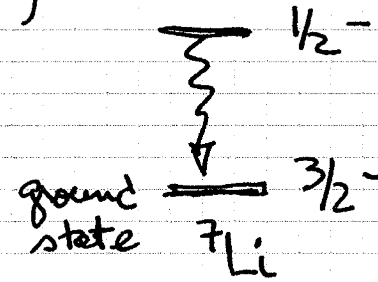
$I = 3/2$

1g) – Mirror nuclei are related (can be created) by the exchange of neutron and proton numbers.

– $^7_3Li_4 \leftrightarrow {}^7_4Be_3$ etc.

– no difference between neutrons & protons with regard to nuclear force

1h)



$\Delta L = \frac{3}{2} - \frac{1}{2} = 1\hbar$ $\quad \Delta$ parity = NO

$$\left|\frac{3}{2} - \frac{1}{2}\right| \leq L \leq \frac{3}{2} + \frac{1}{2}$$

$$1 \leq L \leq 2$$

① lowest L value w/ no parity change ⇒ M1

② $\lambda^{sp}(M1) = 3.15 \times 10^{13}(E_\gamma)^3 /s$

$$= 3.15 \times 10^{13}(0.478\,\text{MeV})^3 /s$$

$$= 3.44 \times 10^{12} /s$$

2) $^{64}_{29}Cu_{35} \longrightarrow \, ^{64}_{30}Zn^{+}_{34} + \beta^{-} + \bar{\nu} + Q_{\beta^-}$

(1)

$^{64}_{29}Cu_{35} \longrightarrow \, ^{64}_{28}Ni^{-}_{36} + \beta^{+} + \nu + Q_{\beta^+}$

(2) $Q_{\beta^+} = \Delta(^{64}Cu) - \Delta(^{64}Ni) - 2m_e c^2$

$= -65.424 - (-67.099) - 2(0.511)$

$= 0.653$ MeV

(3) β^+ emission is allowed because $Q_{\beta^+} > 0$