Chem 485
Sp / 2010

1) $A = \lambda N = \underbrace{\left(\frac{\ln 2}{1.29\times10^{9}\,y \times 3.15\times10^{7}\,\frac{s}{y}} \right)}_{1.71\times10^{-17}/s} N$

$N = \left(\frac{0.0117\ {}^{40}K}{100\ K} \right) \left(\frac{1\ g\ KCl}{74.551\ g/mol\,KCl} \right) \left(\frac{1\ K}{1\ KCl} \right) 6.022\times10^{23}/mol$

$N = 9.45\times10^{17}$

$A = (1.71\times10^{-17}/s)\ 9.45\times10^{17} = 16.1\ Bq$

2) $A = \rho_A \sigma \phi \left(1 - e^{-\lambda t}\right) = 3.0\times10^{20}/cm^2 \left(0.3\times10^{-24}\,cm^2\right) 6\times10^{12}/s \left(1 - e^{-\lambda t}\right)$

$1\ barn = 10^2\ fm^2 \times \left(10^{-13}\ \frac{cm}{fm}\right)^2 = 10^{-24}\ cm^2$

$A = 5.40\times10^{8}/s \underbrace{\left(1 - e^{-\underbrace{\frac{\ln 2 \times 180\ m}{109.8\ m}}_{-1.136}}\right)}_{0.321} = 3.7\times10^{8}/s$

3) ${}^{15}_{8}O_{7} \longrightarrow {}^{15}_{7}N_{8}^{*} + \beta^{+} + \nu + Q_{\beta^+}$

4) Position emission requires the creation of an electron and a position with a total energy cost of 1.022 MeV not needed for electron capture decay

5) (a) $^{233}_{92}U \rightarrow {}^{229}_{90}Th^{2-} + {}^{4}He^{2+} + Q_\alpha$

(b) reverse rxn $V_{Coul} = \dfrac{90 \times 2 \times 1.439 \text{ MeV-fm}}{1.2\,(229^{1/3} + 4^{1/3})\text{ fm}} = 28.0 \text{ MeV}$

$229^{1/3} = 6.12$, $4^{1/3} = 1.59$, sum $= 7.705$

6) $^{39}_{19}K_{20}$ $\pi(1d_{3/2}^{-1})\ \nu(1d_{3/2}^{4})$

or $\pi(1d_{3/2}^{3})\ \nu(1d_{3/2}^{4})$ $\rightarrow I = 3/2^{+}$

Parity = EVEN

7) the low energy neutron cross section is sensitive to the deBroglie wavelength of the neutron — this wavelength grows ~~as~~ as the kinetic energy drops

8) $^{18}O(^{1}p, ^{1}n)^{18}F$ shorthand is OK

OR

$^{18}_{8}O + {}^{1}_{1}p^{+} \rightarrow {}^{18}_{9}F^{+} + {}^{1}_{0}n + Q$

9) $N = \dfrac{A}{\lambda}$, $\text{Mass} = \dfrac{A}{\lambda} \times \dfrac{MM}{N_A} = \dfrac{60 \times 10^{3} \times 3.7 \times 10^{10} \times 18}{\left(\dfrac{\ln 2}{109.8_{min} \times 60\, s/m}\right) 6.022 \times 10^{23}}$

$\left(\dfrac{\ln 2}{109.8 \times 60}\right) = 1.05 \times 10^{-4}/s$

$\text{Mass} = 6.3 \times 10^{-4}\, g$ $(630\, \mu g)$