Quiz 20.1 – Radioactive Decay

Name: Key

Question 1

$^{214}_{83}Bi$ will undergo both alpha decay and beta decay. Write a balanced equation for both of these decay pathways.

$^{214}_{83}Bi \rightarrow {}^{4}_{2}\alpha + {}^{210}_{81}Tl$ $\quad$ $^{214}_{83}Bi \rightarrow {}^{0}_{-1}\beta + {}^{214}_{84}Po$

Question 2

What 2 different decay pathways can transform $^{11}_{6}C$ into $^{11}_{5}B$?

Positron emission and electron capture

Question 3

How could we experimentally determine which decay pathway is actually responsible for the transformation in Question 2?

Detect the emitted positrons (or absence thereof)

Question 4

A nuclide is relatively small and has too many neutrons to be stable. What method of decay is most likely for this nuclide?

β-decay

Question 5

Calculate the half-life of an isotope if a sample is reduced to 60% of its original mass after 8 years

$[A]_t = [A]_0 \cdot \frac{1}{2}^{n}$ $\quad n = 8\ years / t_{1/2}$

$0.6 = 1 \cdot \frac{1}{2}^{8/t_{1/2}} \rightarrow \ln 0.6 = \ln \frac{1}{2}^{8} - \ln \frac{1}{2}^{t_{1/2}}$

$\ln(0.6) = 8 \cdot \ln(0.5) - t_{1/2} \ln(0.5) \rightarrow t_{1/2} = 7.26\ years$

Question 6

A radioactive isotope has a half-life of $3.45\ years$. If a $15.0\ g$ sample of this isotope is left in a closet for $10\ years$, how many g of the isotope will remain?

$[A]_t = [A]_0 \cdot \frac{1}{2}^{t/t_{1/2}}$ $\quad m_t = 15.0g \cdot 0.5^{\left(\frac{10\ years}{3.45\ years}\right)} = 2.01\ g$