Answer on Question #67069 - Chemistry - Physical Chemistry

Question:

The half-life of a radioactive element with mass number 234 g is 2.5 x 105 years. How long after the isolation of a sample of this isotope will only one-six of the original mass be left?

Solution:

The reactions of radioactive decay are related to first-order reactions.

For a first-order reaction, the half-life is defined as: $t_{1/2} = \frac{ln2}{k}$.

The kinetic equation for the first-order reaction has the form: $k = \frac{1}{t} \cdot ln\frac{[X]_0}{[X]}$.

$$t = \frac{ln\frac{[X]_0}{[X]}}{k} = \frac{ln\frac{[X]_0}{[X]} \cdot t_{1/2}}{ln2} = \frac{ln\frac{234}{39} \cdot 2.5 \cdot 10^5}{ln2} = \frac{447939.87}{0.69} = 649188\ years \approx 6.5 \cdot 10^5\ years.$$

Answer: 6.5 x 10^5 years.