

## Answer on the question #62338, Chemistry / General Chemistry

### Question:

Krypton-81m is used for lung ventilation studies. It's half life is 13 seconds. How long does it take the activity of this isotope to reach one-quarter of its original value?

### Solution:

The activity of the isotope is normally proportional to the number of isotope atoms. This number follows first-order rate law:

$$[{}^{81}_{36}\text{Kr}]_t = [{}^{81}_{36}\text{Kr}]_0 e^{-kt},$$

where  $k$  is the rate constant of the process.

According to the condition given:

$$\begin{aligned}\frac{[{}^{81}_{36}\text{Kr}]_t}{[{}^{81}_{36}\text{Kr}]_0} &= \frac{1}{4} \\ \frac{1}{4} &= e^{-kt} \\ \ln\left(\frac{1}{4}\right) &= -kt\end{aligned}$$

The half life is connected with the rate constant in the following way (for the first order reaction):

$$\begin{aligned}t_{1/2} &= \frac{0.693}{k} \\ \ln\left(\frac{1}{4}\right) &= -\frac{0.693}{t_{1/2}} t \\ t &= \ln 4 \cdot t_{1/2} / 0.693 \\ t &= 26 \text{ s}\end{aligned}$$

**Answer:** 26 seconds