Answer on the question #67065, Chemistry / Physical Chemistry

Question:

A first-order reaction is 40% complete at the end of 50 min, in how many minutes will the reaction be 80% complete?

Solution:

The equation that describes kinetics for the first-order reaction is the following:

$$\ln[A]_t = -kt + \ln[A]_0,$$

where $[A]_t$ and $[A]_0$ are the concentrations of the reactant at time t and $t = 0$ (or initial concentration), and k is the rate constant of the reaction.

Let's find the rate constant of the reaction:

$$k = -\frac{\ln[A]_t - \ln[A]_0}{t} = \frac{1}{t} \cdot \ln\left(\frac{[A]_0}{[A]_t}\right) = \frac{1}{50(m)} \cdot \ln\left(\frac{100}{100-40}\right) = 0.0102\ m^{-1}$$

Then, we can find the time when the reaction will be 80% complete:

$$t = \frac{1}{k} \cdot \ln\left(\frac{[A]_0}{[A]_t}\right) = \frac{1}{0.0102(\ m^{-1})} \cdot \ln\left(\frac{100}{100-80}\right) = 157.5\ m$$

Answer: It will take 157.5 minutes for the reaction to complete at 80%.