Answer on the question #67062, Chemistry / Physical Chemistry

Question:

A first-order reaction is 60% complete at the end of 90 min, what is the value of rate constant in sec-1?

Solution:

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

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

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

Rearranging the expression above, we get the rate constant of the reaction:

$$k = -\frac{1}{t}(\ln[A]_t - \ln[A]_0) = \frac{1}{t}(\ln[A]_0 - \ln[A]_t) = \frac{1}{t}\ln\frac{[A]_0}{[A]_t}$$

Thus, we have only to introduce the values to calculate the rate constant:

$$k = \frac{1}{90(\text{m}) \cdot 60(\text{s/m})} \cdot \ln\frac{100}{100 - 60} = 1.70 \cdot 10^{-4}(s^{-1})$$

Answer: The rate constant of the process is $1.70 \cdot 10^{-4}$ s^{-1}