

1. The rate constant for the first-order reaction is $1.20 \times 10^{-2} \text{ s}^{-1}$ at 45°C , and the initial concentration of N_2O_5 is 0.00500 M .



$$[\text{A}]_0 = 0.00500 \text{ M}$$

$$k = 1.2 \times 10^{-2} \text{ s}^{-1}$$

- a. How long will it take for the concentration to decrease to 0.00110 M ?

$$\ln[\text{A}] = -akt + \ln[\text{A}]_0 \quad t = \ln\left(\frac{0.001100}{0.00500}\right)$$

$$\ln[\text{A}] - \ln[\text{A}]_0 = -akt \quad \frac{- (1) 1.20 \times 10^{-2} \text{ s}^{-1}}$$

$$\ln\left(\frac{[\text{A}]}{[\text{A}]_0}\right) = -akt \quad t = \frac{-1.514}{-1.20 \times 10^{-2} \text{ s}^{-1}} = \boxed{126 \text{ s}}$$

$$\frac{\ln\left(\frac{[\text{A}]}{[\text{A}]_0}\right)}{-ak} = t$$

- b. How much longer will it take for a further decrease to 0.000900 M ?

$$t = \ln\left(\frac{0.000900}{0.00500}\right) \quad t = \frac{-1.7147}{-1.20 \times 10^{-2} \text{ s}^{-1}}$$

$$\frac{- (1) 1.20 \times 10^{-2} \text{ s}^{-1}}{t = 142.89 \text{ s}}$$

This is about $\boxed{16.9 \text{ or } 17 \text{ s}}$ more

2. The first order rate constant for the radioactive decay of radium-223 is 0.0606 day^{-1} . What is the half-life of radium-223? Radioactive decay is first order, with the equation showing 1 mole of radium decomposing.

$$t_{1/2} = \frac{0.693}{ak} = \frac{0.693}{(1) (0.0606 \text{ day}^{-1})} = \boxed{11.4 \text{ days}}$$

3. In the first order reaction $\text{A} \rightarrow \text{products}$, $[\text{A}] = 0.724 \text{ M}$ initially and 0.586 M after 16.0 min .

- a. What is the value of the rate constant, k ?

$$\ln\left(\frac{[\text{A}]}{[\text{A}]_0}\right) = -akt \quad \ln\left(\frac{[\text{A}]}{[\text{A}]_0}\right) = k = \ln\left(\frac{0.586}{0.724}\right) = \frac{-0.2147}{-16.0}$$

$$\frac{- (1) 16.0 \text{ min}}{k = 0.0132 \text{ min}^{-1}}$$

- b. What is the half-life of this reaction?

$$t_{1/2} = \frac{0.693}{ak} = \frac{0.693}{(1) (0.0132 \text{ min}^{-1})} = \boxed{52.5 \text{ min}}$$

- c. At what time will $[\text{A}] = 0.185 \text{ M}$?

$$\ln\left(\frac{[\text{A}]}{[\text{A}]_0}\right) = -akt \quad t = \ln\left(\frac{[\text{A}]}{[\text{A}]_0}\right) = \ln\left(\frac{0.185}{0.724}\right) = \frac{-1.3644}{-0.0132}$$

$$\frac{- (1) (0.0132)}{t = 103 \text{ min}}$$

- d. What will $[\text{A}]$ be after 2.5 hours?

$$\ln[\text{A}] = -akt + \ln[\text{A}]_0$$

$$= - (1) (0.0132 \text{ min}^{-1}) (150 \text{ min}) + \ln 0.724$$

$$= -1.98 + -0.32296$$

$$\ln[\text{A}] = -2.30296 \quad [\text{A}] = 0.09996 = \boxed{0.10 \text{ M}}$$

4. A certain temperature the reaction $2B \rightarrow C + D$ obeys the rate-law expression

$$\text{Rate} = (1.14 \times 10^{-3} \text{ M}^{-1}\text{s}^{-1}) [B]^2$$

2nd order

If 5.00 mol of B is initially present in a 1.00 L container at that temperature, how long would it take for 2.00 mol B to be consumed at constant temperature?

$$[A]_0 = 5.00 \text{ M}$$

$$[A] = 3.00 \text{ M}$$

$$\frac{1}{[A]} = a k t + \frac{1}{[A]_0}$$

$$\frac{\frac{1}{3.00 \text{ M}} - \frac{1}{5.00 \text{ M}}}{a k}$$

$$t = \frac{\frac{1}{3.00 \text{ M}} - \frac{1}{5.00 \text{ M}}}{(2)(1.14 \times 10^{-3} \text{ M}^{-1} \text{ s}^{-1})} = \boxed{585 \text{ s}}$$

5. At 300 K the reaction: $2 \text{NOCl} \rightarrow 2 \text{NO} + \text{Cl}_2$

obeys the rate law: $\text{Rate} = k[\text{NOCl}]^2$ where $k = 2.8 \times 10^{-5} \text{ M}^{-1} \cdot \text{s}^{-1}$.

Suppose 1.0 mole of NOCl is introduced into a 2.0 liter container at 300 K. What is the half-life of the reaction?

$$t_{1/2} = \frac{1}{a k [A]_0} = \frac{1}{(2)(2.8 \times 10^{-5} \text{ M}^{-1} \text{ s}^{-1})(0.50 \text{ M})} \quad \frac{1.0 \text{ mol}}{2 \text{ L}} = 0.50 \text{ M}$$

$$t_{1/2} = 35714.285 \text{ sec}$$

$$\boxed{t_{1/2} = 3.6 \times 10^4 \text{ sec}} \quad \text{or} \quad 595 \text{ hr} \approx 600 \text{ hr} \quad 25 \text{ DAYS}$$

6. If a first-order reaction ($3A \rightarrow B$) has a rate constant equal to 3.0 min^{-1} , what is the half-life for the reaction if 3 mol of A is introduced into a 1.0 L container at 298 K?

$$t_{1/2} = \frac{0.693}{a k} = \frac{0.693}{3(3.0 \text{ min}^{-1})} = \boxed{0.077 \text{ min}} \quad \text{or} \quad 4.6 \text{ sec}$$

7. If a zero-order reaction ($2A \rightarrow B$) has a rate constant equal to 3.0 min^{-1} , what is the half-life for the reaction if 6 mol of A is introduced into a 2.0 L container at 298 K?

$$t_{1/2} = \frac{[A]}{2 a k} = \frac{3.0}{2(2)(3.0 \text{ min}^{-1})}$$

$$\frac{6 \text{ mol}}{2 \text{ L}} = 3 \text{ M}$$

$$t_{1/2} = \boxed{0.25 \text{ min}} \quad \text{or} \quad 15 \text{ sec}$$