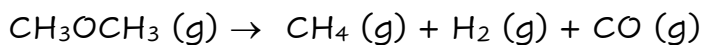


Integrated Rate Laws and Half-Life

1. Dimethyl ether, CH_3OCH_3 , decomposes at $525.0\text{ }^\circ\text{C}$. The rate constant is $7.6 \times 10^{-4}\text{ s}^{-1}$.



If the initial pressure of CH_3OCH_3 is 143 mmHg, what is its pressure after 1126 seconds?

From the units of k , this is first order.

$$\ln\left(\frac{[\text{CH}_3\text{OCH}_3]_t}{[\text{CH}_3\text{OCH}_3]_o}\right) = -kt \quad [\text{CH}_3\text{OCH}_3]_t = ? \quad [\text{CH}_3\text{OCH}_3]_o = 143\text{ mmHg}$$

$$T = 1126\text{ s} \quad k = 7.6 \times 10^{-4}\text{ s}^{-1}$$

Solve equation for $\ln[\text{CH}_3\text{OCH}_3]_t$

$$\ln[\text{CH}_3\text{OCH}_3]_t = -kt + \ln[\text{CH}_3\text{OCH}_3]_o$$

$$\ln[\text{CH}_3\text{OCH}_3]_t = -7.6 \times 10^{-4}\text{ s}^{-1} \times 1126\text{ s} + \ln(143\text{ mmHg}) = 4.107$$

$$\ln[\text{CH}_3\text{OCH}_3]_t = 4.107 \quad \text{take antilog of both sides of equation}$$

$$[\text{CH}_3\text{OCH}_3]_t = e^{4.107} = \mathbf{60.8\text{ mmHg}}$$

2. The decomposition of NO_2 at 310°C has a rate constant of $0.544\text{ M}^{-1}\text{s}^{-1}$. If the initial concentration of NO_2 was 0.0480 M , what is the concentration after 0.250 hr ?

According to the units of k , this is second order.

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_o} \quad k = 0.544\text{ M}^{-1}\text{s}^{-1} \quad [A]_o = 0.0489\text{ M} \quad t = 900\text{ s}$$

$$\frac{1}{[A]_t} = 0.544\text{ M}^{-1}\text{s}^{-1} \times 900\text{ s} + \frac{1}{0.0489\text{ M}} = 510\text{ M}^{-1}$$

$$[A]_t = 1/510\text{ M}^{-1} = \mathbf{1.96 \times 10^{-3}\text{ M}}$$

3. The half-life for the first order dissociation of I_2 at $352\text{ }^\circ\text{C}$ is 2.56 s . If we start with 0.0450 M I_2 , how much will remain after 4.52 s ?

$$\text{Find } k \text{ using half-life. } t_{1/2} = \frac{0.693}{2.56\text{ s}} = 0.2707/\text{s}$$

$$\ln\left(\frac{[\text{I}_2]_t}{[\text{I}_2]_o}\right) = -kt \quad [\text{I}_2]_o = 0.0450\text{ M} \quad [\text{I}_2]_t = ? \quad t = 4.52\text{ s} \quad k = 0.2707/\text{s}$$

$$\ln\left(\frac{[\text{I}_2]_t}{0.0450\text{ M}}\right) = -0.2707\text{ s}^{-1} \times 4.52\text{ s} = -1.22 \quad \text{take antilog of both sides}$$

$$\frac{[\text{I}_2]_t}{0.0450\text{ M}} = e^{-1.22} \quad [\text{I}_2]_t = e^{-1.22} \times 0.0450\text{ M} = \mathbf{0.0133\text{ M}}$$