Chapter 11 – Problem Set 1

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January 28, 2020

1. Given the following data for the reaction of NO with H_2, calculate k

[NO]	[H_2]	Rate
0.0064	0.0022	0.000026
0.0128	0.0022	0.0001
0.0064	0.0045	0.000051

$$\begin{aligned} \frac{.26}{1} &= \left(\frac{64}{128}\right)^m \\ m &= 2 \\ \frac{.26}{.51} &= \left(\frac{22}{45}\right)^n \\ n &= 1 \\ .0001 &= k[.0128]^2[.0022] \\ k &= 277\left[\frac{1}{\mathrm{M}^2\,\mathrm{s}}\right] \end{aligned} \tag{1}$$

2. How long will it take a first order substance with $k = .27\left[\frac{1}{\mathrm{s}}\right]$ to be reduced to $\frac{1}{3}$ the original concentration?

$$\begin{aligned} t_{1/3} &= \frac{\ln(3)}{.27} \\ &= 4.069[\mathrm{s}] \end{aligned} \tag{2}$$

3. How long will it take a first order substance with $k = .59\left[\frac{1}{\mathrm{s}}\right]$ to be reduced to 25% of original?

$$\begin{aligned} t_{1/4} &= \frac{\ln(4)}{.59} \\ &= 2.35[\mathrm{s}] \end{aligned} \tag{3}$$

4. The decomposition of NO_2 is second order with a rate of $0.002\left[\frac{\text{mol}}{\text{L s}}\right]$ when the concentration is 0.08[M]. Calculate the rate when the concentration of NO_2 is 0.02[M].

$$\begin{aligned} .002 &= k[.08]^2 \\ k &= .3125\left[\frac{\text{L}}{\text{mol s}}\right] \\ rate &= .3125 \cdot [.02]^2 \\ &= .000125 = 1.25 \cdot 10^{-4} \end{aligned} \tag{4}$$

5. For the first order reaction $SO_2Cl_2 \longrightarrow SO_2 + Cl_2$ the rate constant is $0.000022\left[\frac{1}{\text{s}}\right]$. If you start with 0.0248[M] of the reactant, what is the concentration of SO_2Cl_2 after 4.5[h]?

$$\begin{aligned} 1[\text{h}] &\longrightarrow 3600[\text{s}] \\ \ln(x_f) &= \ln(.0248) - .000022(4.5)(3600) \\ x_f &= e^{\ln(.0248)-.000022(4.5)(3600)} \\ &= .0174\,[\text{M}] \end{aligned} \tag{5}$$

6. The half-life of ethyl bromide at 720[° K] is 650 [s] for the first order reaction. Find the time required for the concentration to drop from 0.05[M] to 0.0125[M].

$$\begin{aligned} \frac{.0125}{.05} &= \frac{1}{4} \\ 650 \cdot 2 &= 1300[\text{s}] \end{aligned} \tag{6}$$

7. The first order reaction of diazomethane has a half-life of 17.3[min] at 873[° K]. If the concentration is 0.058[M] after 10[min], what is the original concentration?

$$\begin{aligned} 17.3 &= \frac{\ln(2)}{k} \\ k &= \frac{\ln(2)}{17.3} \\ k &= .04\left[\frac{1}{\text{min}}\right] \\ \ln(x_o) &= \ln(.058) + .04(10) \\ x_o &= e^{\ln(.058)+.4} \\ x_o &= .087[\text{M}] \end{aligned} \tag{7}$$