

Worksheet#12 (Total number of points you can is 3 pts)

1. How does the time required for a first-order reaction to go to 99% completion relate to the half-life of the reaction?

$$0.5 [A]_0 = [A]_0 \cdot \exp(-k t_{1/2}) \Rightarrow 0.5 = \exp(-k t_{1/2}) \Rightarrow t_{1/2} = \frac{\ln 2}{k}$$

$$0.01 [A]_0 = [A]_0 \cdot \exp(-k t_{0.01}) \Rightarrow 0.01 = \exp(-k t_{0.01}) \Rightarrow t_{0.01} = \frac{\ln 100}{k}$$

$$\Rightarrow \frac{t_{0.01}}{t_{1/2}} = \frac{\ln 100}{\ln 2} = \frac{4.605}{0.693} = 6.64$$

2. (Suppose we have a reaction $2A + B \Rightarrow Y$.

- a. Write down the rate of consumption of B in terms of concentration [B].

$$v_B = -\frac{d[B]}{dt}$$

- b. Write down the rate of consumption of A in terms of concentration [B].

$$v_A = -\frac{d[A]}{dt} = -2 \frac{d[B]}{dt}$$

- c. Write down the rate of reaction in terms of [B].

$$v = -\frac{d[B]}{dt}$$

- d. Suppose the concentration of A is so large that [A] can be considered constant and the above reaction is first-order, i.e.: $v = k[B]$. Write down [B] as function of time.

$$-\frac{d[B]}{dt} = k[B] \Rightarrow \int_{[B]_0}^{[B]} \frac{d[B]}{[B]} = \int_0^t k t \Rightarrow \ln \frac{[B]}{[B]_0} = -kt$$

$$\Rightarrow [B](t) = [B]_0 e^{-kt}$$

- e. Plot $\ln [B]$ vs. t. What is the slope?



3. What is the relation between rate constants k_{fr} and k_{rl} , and equilibrium concentrations [A] and [B] for a reaction $A \rightleftharpoons B$.

$$\text{In equilibrium: } k_{er} [A]_{eq} = k_{re} [B]_{eq}$$

$$\Rightarrow \frac{k_{er}}{k_{re}} = \frac{[B]_{eq}}{[A]_{eq}}$$