CHEM 3423 001 Spring 2024 **Name:**
ID:

Worksheet#13 (Total number of **extra credit** 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?

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

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

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

2. (Suppose we have a reaction 2A + B ⇒ 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?

slope: −k

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

In equilibrium: $k_{lr}\,[A]_{eq} = k_{rl}\,[B]_{eq}$

$\Rightarrow \frac{k_{lr}}{k_{rl}} = \frac{[B]_{eq}}{[A]_{eq}}$