**Kinetics 15.1**
Reaction Rates and the Rate Law
Worksheet

1) The data below shows the change in concentration of dinitrogen pentoxide over time, at 330 K, according to the following process.

$$2\ N_2O_5(g) \rightleftharpoons 4\ NO_2(g) + O_2(g)$$

$[N_2O_5]$	Time (s)
0.100	0.00
0.066	200.00
0.044	400.00

    a. Find the rate of disappearance of N_2O_5 from $t = 0$ s to $t = 200$ s.
    b. Find the rate of appearance of NO_2 from $t = 0$ s to $t = 200$ s.

2) Equal moles of $F_2(g)$ and $ClO_2(g)$ are drawn into a vacuum where the following process takes place.

$$F_2(g) + 2\ ClO_2(g) \rightleftharpoons 2\ FClO_2(g)$$
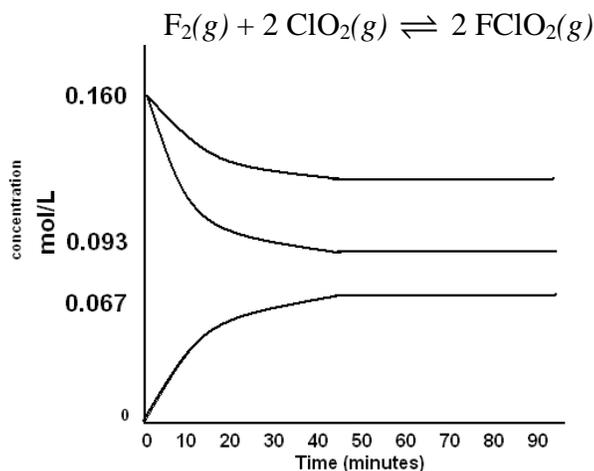
    a. Identify which curve on the graph is associated with which molecule in the reaction.
    b. At what time does the system reach equilibrium?
    c. Explain how the graph could be used to calculate the instantaneous rate of appearance of $FClO_2$ at $t = 15$ minutes. Draw on the graph to help with your explanation.
    d. Describe some additional experiments that would need to be conducted in order to find the rate law for the overall reaction. Justify your answer.

3) The rate law for a reaction between $NO(g)$ and $H_2(g)$ to produce $N_2(g)$ and $H_2O(g)$ is: Rate $= k[NO]^2[H_2]$.
    a. What is the order for the reaction with respect to NO?
    b. What is the order for the reaction with respect to H_2?
    c. What is the overall order of the reaction?
    d. What are the units for the rate constant, k?

    1

4) The reaction between ground level ozone and unburned hydrocarbons from automobiles produces smog in cities. One such reaction is outlined below, along with the results from experiments on initial reaction rates at $30^{\circ}C$.

$$C_2H_4(g) + O_3(g) \rightleftharpoons H_2CO(g) + H_2CO_2(g)$$

Experiment	$[C_2H_4]_{initial}$	$[O_3]_{initial}$	Initial Reaction Rate
1	5.0×10^{-8}	2.5×10^{-8}	1.51×10^{-25} M/min
2	5.0×10^{-8}	5.0×10^{-8}	3.00×10^{-25} M/min
3	1.0×10^{-7}	2.5×10^{-8}	3.00×10^{-25} M/min

a. Find the rate law for this reaction.
b. What is the overall order of this reaction?
c. Find the rate constant, k, for the reaction. (Include the units)

5) The table below outlines the results from three experiments involving the following reaction.

$$2\ ClO_2(aq) + 2\ OH^-(aq) \rightleftharpoons ClO_2^-(aq) + ClO_3^-(aq) + H_2O(l)$$

Experiment	$[ClO_2]_{initial}$	$[OH^-]_{initial}$	Initial Reaction Rate
1	0.050	0.050	0.0288 M/s
2	0.025	0.051	0.00733 M/s
3	0.025	0.152	0.0218 M/s

a. What is the order of the reaction with respect to ClO_2? Show your work.
b. What is the order of the reaction with respect to OH^-? Show your work.
c. Find the rate law for this reaction.
d. What is the overall order of this reaction?
e. Find the rate constant, k, for the reaction. (Include the units)

6) The table below outlines the results from three experiments involving the following gas phase acid/base reaction.

$$BF_3(g) + NH_3(g) \rightleftharpoons F_3BNH_3(g)$$
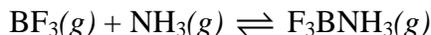
Experiment	$[BF_3]_{initial}$	$[NH_3]_{initial}$	Initial Reaction Rate
1	0.450	0.350	0.537 M/s
2	0.900	0.350	1.074 M/s
3	0.450	1.05	1.611 M/s

a. What is the order of the reaction with respect to BF_3?
b. What is the order of the reaction with respect to NH_3?
c. Find the rate law for this reaction.
d. What is the overall order of this reaction?
e. Find the rate constant, k, for the reaction. (Include the units)