Notes for Section 13-2 (AP Chem) **Name** _____
Rate Laws from Experimental Data **Period** _____ **Date** _____

1. The reaction NH_4^+ (aq) + NO_2^- (aq) → N_2 (g) + 2 H_2O (*l*) was performed with the following concentrations and determined rates:

Experiment	Initial [NH_4^+], M	Initial [NO_2^-], M	Initial Rate, M/s
1	0.10	0.020	5.4×10^{-7}
2	0.20	0.020	10.8×10^{-7}
3	0.40	0.020	21.5×10^{-7}
4	0.020	0.20	10.8×10^{-7}
5	0.020	0.40	21.6×10^{-7}
6	0.020	0.60	32.4×10^{-7}

a. Based on the above data, what is the order of the reaction with respect to NH_4^+? 1st
Comparing expt. 2 to 1, doubling [NH_4^+] doubles the rate: 1st order.

b. Based on the above data, what is the order of the reaction with respect to NO_2^-? 1st
Comparing expt. 5 to 4, doubling [NO_2^-] doubles the rate: 1st order

c. Write the Rate Law for the reaction. Rate = $k[NH_4^+]^1[NO_2^-]^1$ (2nd order overall)

d. Calculate the rate constant, *k*.

$$5.4\times10^{-7}\ \text{M/s} = k[0.10\ \text{M}][[0.020\ \text{M}]\ \text{so}\ k = \frac{5.4\times10^{-7}\ \text{M/s}}{(0.10\ \text{M})(0.020\ \text{M})} = 2.7\times10^{-4}\ /\text{M}\cdot\text{s or } 2.7\times10^{-4}\ \text{M}^{-1}\text{s}^{-1}$$

e. What is the initial rate of the reaction when [NH_4^+] = 0.50 M and [NO_2^-] = 0.030 M?

Rate = $(2.7\times10^{-4}\ \text{M}^{-1}\text{s}^{-1})(0.50\ \text{M})(0.030\ \text{M}) = 4.1\times10^{-6}$ M/s

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2. For the reaction aA + bB → cC, the following data were collected.

Experiment	Initial [A], M	Initial [B], M	Initial Rate, M/s
1	0.10	0.10	4.0×10^{-5}
2	0.10	0.20	4.0×10^{-5}
3	0.20	0.10	16.0×10^{-5}

a. Based on the above data, what is the order of the reaction with respect to A? 2nd
Comparing expt 1 & 3, doubling [A] quadruples rate, so 2nd order in A

b. Based on the above data, what is the order of the reaction with respect to B? 0th
Comparing expt. 1 & 2, doubling [B] has no effect on rate, so 0th order in B

c. Write the Rate Law for the reaction. Rate = $k[A]^2$

d. Calculate the rate constant, *k*.

$$4.0\times10^{-5}\ \text{M/s} = k[0.10\ \text{M}]^2\ \text{so}\ k = \frac{4.0\times10^{-5}\ \text{M/s}}{(0.10\ \text{M})^2} = 4.0\times10^{-3}\ /\text{M}\cdot\text{s or } 4.0\times10^{-3}\ \text{M}^{-1}\text{s}^{-1}$$