Chemistry 204
Experiment 10 Post-Lab Thanksgiving Hints
Fall 2006

1. Given the following reaction mechanism:

$AC + 4\ B \rightarrow AB_4 + C$	*slow*
$C + AC \rightarrow AC_2$	*fast*
$AB_4 + AC_2 \rightarrow A_2C_2 + 4\ B$	*fast*
$A_2C_2 \rightarrow A_2 + C_2$	*fast*

a) Write down the overall balanced equation for this reaction.

Cancel out anything that appears as a <u>reactant</u> in one reaction and a <u>product</u> in another, kind of like cancelling spectator ions. Whatever is left is the net overall reaction.

b) Identify the reaction intermediate(s).

Intermediates are formed early in the reaction process and consumed later. So anything that is the product of one reaction and a reactant in a <u>later</u> reaction will be an intermediate.

c) Identify the catalyst.

Catalysts are consumed early and produced later. Anything that appears as a reactant first and a product in a later reaction is a catalyst. There's only one.

d) Write down the rate law for the overall process.

The rate law is determined from the slow step of the reaction by raising the reactants to their stoichiometric coefficients.

2. The reduction of nitric oxide, NO (g), by hydrogen, H_2 (g), is second order in NO (g) and first order in hydrogen. Write down the rate law for this reaction. Calculate the initial rate of NO (g) reduction if 5200.0 mg of NO (g) and 2000.0 mg of hydrogen are confined in a 3.00 L vessel. The rate constant for this reaction is 286 $M^{-2}s^{-1}$. Show your work.

Write down the rate law from the information given.
Calculate the molar concentration of each reactant (convert mg to grams and then to moles and then divide moles by the volume in liters to get molarity).
Plug the concentrations and rate constant into the rate law to determine the initial rate.

3. Consider the following reaction: $C_2B + 4\ A + 2\ D \rightarrow BD_2 + 2\ A_2C$

The rate law for this reaction is rate = $k[C_2B][A]^3$.

a) What is the reaction order with respect to C_2B? ***It's the exponent on C_2B in the rate law.***

b) What is the reaction order with respect to A? ***It's the exponent on A in the rate law.***

c) What is the reaction order with respect to D? ***D doesn't appear in the rate law, so the exponent must be...?***

d) If the concentrations of C_2B, A, and D are tripled, how will this affect the rate of the reaction?

If you plug in a value of 1 for the concentrations of C_2B and A in the rate law, you end up with rate = k. Now triple those concentrations – enter a value of 3 for the concentrations of C_2B and A. The calculated rate will be a multiple of k, and that's how much faster the reaction is.

4. For a reaction $X + 3Y \rightarrow Z$, a study of the initial reaction rate revealed that the amount of time required for the formation of 1 mole of Z decreased by a factor of 4 when the concentration of Y was doubled. When the concentration of X was decreased by a factor of 2, the amount of time required for the formation of 1 mole of Z doubled. Suggest a 2-step mechanism for the reaction.

I'll let you figure this one out on your own. Have fun! ☺

5. Three experiments were conducted to discover how the initial rate of consumption of ClO_2 (aq) in the following reaction varies as the concentrations of the reactants change.

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

	Initial concentrations ($mol \cdot L^{-1}$)		Initial Rate
Experiment	ClO_2	OH^-	($mol \cdot L^{-1} \cdot s^{-1}$)
1	0.017	0.058	1.09×10^{-3}
2	0.017	0.029	5.45×10^{-4}
3	0.034	0.058	8.71×10^{-3}

a) Use the experimental data provided in the table to determine the rate law for this reaction.

Doubling [ClO_2] (trials 1 and 3) increases rate by a factor of 8, so ClO_2 is ?th order. (2 raised to what power equals 8?)
Doubling [OH^-] (trials 2 and 1) increases rate by a factor of 2, so OH^- is ??st order.

$$rate = k[ClO_2]^{?}[OH^-]^{??}$$

b) Calculate the rate constant *k* for this reaction. Make sure to include units.

Pick data from any one of the three trials, plug it into the rate law equation, and solve for k.

c) Calculate the rate if the concentration of ClO_2 (aq) is 0.240 M and the concentration of OH^- (aq) is 0.810 M.

Use the rate law you determined in part a), the value for k that you calculated in part b), and the concentrations given in part c) to solve for the initial rate. The answer is surprisingly high!