Ch En 386

**Winter 2014 Homework**

**Homework #3 (20 points)**

**Due Friday, January 24**

*Conditioning Problems (0.5 points each- you may not work with other students):*

1. When using the CSTR equation VR = FA0 \* XA / (-rA), name two key assumptions that must be met for this equation to be valid.
2. Given k values for different temperatures, what would you plot to obtain the activation energy?
3. For reactions, how are the forward and reverse rate constants related to the equilibrium constant?
4. How would you write the rate law for A (rA) for a reversible elementary reaction of   
   A + 2B ↔ C if you were given the forward rate constant kB and the reverse rate constant k-B?

Magnitude and Reasonableness Problems *(0.5 points each)*

1. For gas phase reactions, a typical E value is on the order of \_\_\_\_\_\_\_\_ kJ/mol.
2. What are the typical sizes for industrial batch reactors and CSTRs? Hint, see Chapter 1.

*Lesson 6: Building Blocks: Rate laws*

1. (4 points) Fogler P3-10 a-b. For each reaction in part a, write the rate law for each species involved in the reaction. Only use rate constants associated with the first reactant (e.g. kC2H6 for part a). In all cases, a rate law must satisfy the equilibrium constraint (i.e. when the rate is zero at equilibrium, the rate law should agree with the equilibrium law). If desired for part (a), you can re-label each species as A, B, C, … For part (b), which scenario, if any, is consistent with the reaction being an elementary reaction. Note that for all other cases, the reaction would not be elementary.
2. (2 points) During pasteurization of milk in a constant-volume batch process, bacteria (A) in the milk are killed at a rate rA = -kCA. If pasteurization occurs at 63 ºC it only takes 30 min. If pasteurization occurs at 74 ºC it only needs 15 sec for the same result. Find the activation energy of this sterilization process. (Problem B16, Chapter 1 from Levenspiel)
3. (3 points) Fogler P3-4 a-c. Note that this problem is connected to activation energies and frequency factors so you should answer the questions in relation to these parameters. The frequency and running rates are proportional to rate constants.

*Lesson 7: Building Blocks: Rate laws based on pssh*

1. (4 points) Fogler P7-3 a-b. For part b, assume the reactions occur in an isothermal constant-volume batch reactor where O2 and HCl are constant. For the sketching part, just show a qualitative sketch of H∙ with time for two cases where k4(O2) >> k5 (HCl) and where k5 (HCl) >> k4 (O2). Which case would you want to have for extinguishing the flame?
2. (4 points) Fogler P7-7 a,b. The motor oil is RH. Under what conditions would the rate in part (b) revert to the rate in part (a)?