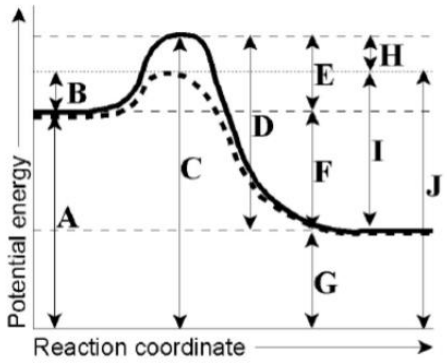
PLI 28
Monday July 11, 2016
Chapter 14 - Kinetics

1. Answer the following questions based on the reaction coordinate diagram below:



The reaction shown above is exothermic / endothermic.

Which letter represents the total energy of the reactants?

Which letter represents the total energy of the products?

Which letter represents ΔH for the catalyzed reaction?

Which letter represents ΔH for the uncatalyzed reaction?

Which letter represents the activation energy for the catalyzed reaction?

Which letter represents the activation energy for the uncatalyzed reaction?

Which letter represents the total energy of the transition state for the catalyzed reaction?

Which letter represents the total energy of the transition state for the uncatalyzed reaction?

2. The decomposition of ethanol (C_2H_5OH) on an alumina (Al_2O_3) surface was studied at 600 K.

$$C_2H_5OH\ (g) \rightarrow C_2H_4\ (g) + H_2O\ (g)$$

Concentration versus time data were collected for this reaction, and a plot of [A] versus time resulted in a straight line with a slope of −4.00 x 10^−5 M/s.

a) Determine the rate law, the integrated rate law, and the value of the rate constant for this reaction.

b) If the initial concentration of ethanol is 1.25 x 10^−2 M, calculate the half-life for this reaction.

c) How much time is required for all of the ethanol to decompose?

3. Consider the following reaction: NO_2 (g) +CO (g) ➔ NO (g) + CO_2 (g)

a) A proposed mechanism for the reaction is as follows:

Step1: Slow, endothermic	$2\ NO_2\ (g) \rightarrow NO(g) + NO_3(g)$
Step 2: Fast, exothermic	$NO_3(g) + CO(g) \rightarrow NO_2\ (g) + CO_2\ (g)$
Overall: Exothermic	$NO_2\ (g) + CO(g) \rightarrow NO(g) + CO_2\ (g)$

Draw a reaction coordinate diagram for this reaction. Indicate on this drawing the activation energy for each step, the overall reaction enthalpy, and where the reactants and products of the overall reactions are located. Also indicate where the products from step 1 are located. Label the y-axis.

b) What rate law does the proposed mechanism predict for the overall reaction? In a sentence, explain how you determined the rate law.

4. The gas-phase reaction $2N_2O_5$ (g) ➔ $4NO_2$ (g) + O_2 (g)
has an activation energy of 103 kJ/mol, and the rate constant is 0.0900 at 328.0 K. Find the rate constant at 308.9 K.

5. The mechanism for the reaction of CH_3OH and HBr is believed to involve two steps. The overall reaction is exothermic.

Step 1: Fast, endothermic
$CH_3OH + H^+ \leftrightarrows CH_3OH_2^+$

Step 2: Slow
$CH_3OH_2^+ + Br^- \rightarrow CH_3Br + H_2O$

Overall reaction equation (you solve):

What is the overall rate law, given that intermediaries should not appear in the rate law?

6. If the rate constant for a reaction doubles when the temperature rises from 3.00×10^2 K to 3.16×10^2 K, what is the activation energy of the reaction?

7. Assume a bottle of wine is an 11% ethanol (CH_3CH_2OH) aqueous solution by mass. If the bottle is chilled to -4°C, will the solution freeze and break your wine bottle? Kfp for water is -1.86 °C/m.