CHEMISTRY 3202
Unit 1 Section 1 Homework Portfolio

1. Propene, C_3H_6, is a reactive organic compound that undergoes an addition reaction with hydrogen bromide.

$$C_3H_6 + HBr \rightarrow C_3H_7Br$$

   (a) With reference to the collision theory, give two reasons why all collisions between propene and hydrogen bromide molecules do not result in the formation of a bromopropane.

   (b) In terms of kinetic energy, potential energy and activation energy, explain why heating the reactants increases the likelihood of a reaction.

2. Aqueous sodium oxalate reacts with aqueous potassium permanganate to produce a colourless liquid mixture and carbon dioxide gas. The net reaction equation is:

$$2\ MnO^-_{4(aq)} + 6\ H^+_{(aq)} + 5\ OOCCOO^{2-}_{(aq)} \rightarrow 2\ Mn^{2+}_{(aq)} + 10\ CO_{2(g)} + 8\ H_2O_{(l)}$$

   purple

   Describe at least two different ways to monitor the rate of the reaction.

3. Nitrogen and oxygen gas react to produce poisonous nitrogen monoxide. Assume the activation energy for the forward reaction is 270 kJ.

$$N_{2\ (g)} + O_{2\,(g)} \rightarrow 2\ NO_{\ (g)} \qquad \Delta H = +90\ kJ/mol$$

   (a) Sketch to scale and completely label a potential energy diagram for this reaction. Be sure to label the;

      1. potential energy of the reactants
      2. potential energy of the products
      3. the heat of reaction
      4. activated complex
      5. the activation energy of the forward and reverse reactions.

   (b) Classify the forward reaction as endothermic or exothermic. Justify your choice.

   (c) Consider the activation energy of the forward reaction. Is the forward reaction fast or slow? Why?

4. Limestone, $CaCO_3$, reacts with hydrochloric acid to produce calcium chloride, water and carbon dioxide.

$$CaCO_{3\,(s)} + 2\,HCl_{(aq)} \rightarrow CaCl_{2\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}$$

With reference to the collision theory of chemical reactions, describe the effect each change on the rate of the reaction.

(a) adding water to the reaction vessel.

(b) crushing the limestone into a powder.

(c) increasing the temperature of the acid from 25°C to 50°C.

(d) using 1.0 M HCl instead of 0.010 M HCl in the reaction.

5. Consider this proposed reaction mechanism and overall equation:

Step 1: $CH_3OH + HI \rightarrow CH_3I + H_2O$ (fast)

Step 2: $CH_3I + CO \rightarrow CH_3COI$ (slow)

Step 3: $CH_3COI + H_2O \rightarrow CH_3COOH + HI$ (fast)

Overall: $CH_3OH + CO \rightarrow CH_3COOH$

(a) Identify the rate determining step.

(b) Identify three reaction intermediates. **Justify your choices**.

(c) Identify the catalyst. **Justify your choice**.

(d) Which step has the highest activation energy? **Justify your choice**

(f) Sketch a potential energy diagram for this reaction mechanism. Assume that the heat of reaction is -80 kJ. (*Hint: there ought to be three bumps on your diagram – be sure to get their relative sizes right*.)

(g) What is the effect of increasing the concentration of $CO_{(g)}$ on the rate of the overall reaction? **Why?**

6. (a) What is the purpose of a catalytic converter?

(b) What effect does leaded gasoline have on the performance of catalytic converters?

(c) What are the benefits and disadvantages of MTBE as a fuel additive?