●不可使用電子計算機

Chemistry (不可使用電子計算機)

1. Write the formula for: (A) calcium sulfate (3 points) (B) sodium dichromate (3 points) (C) aluminum hydroxide (3 points) (D) iron(III) oxide (3 points) (E) ammonium nitrate (3 points)

2. Describe the four laws of thermodynamics as simple as possible. (8 points)

3. A typical reaction mechanism is show in the following:

$$A + B \xrightarrow{k_1} AB$$

$$AB \xrightarrow{k_{-1}} A+B$$

$$AB \xrightarrow{k_2} P$$

(A) Based on rate law, write the reaction rate of disappearance for A and the reaction rate of formation for AB and P. (6 points).

(B) Using steady-state approximation for [AB], determine the overall reaction rate in terms of [A], [B], and the rate constants. (5 points)

4. Consider the high pressure reaction A→Q. In reality, the reaction might proceed by the following steps:

$$A + A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} A^* + A$$

$$A^* \xrightarrow{k_3} Q \text{ (slow)}$$

where A* is a free radical. Please derive an expression for the rate of product formation. (6 points)

5. (A) A sample of nitrogen gas has a volume of 32.4 L at 20°C. The gas is heated to 220 °C at constant pressure. What is the final volume of nitrogen? (4 points)

(B) A gas evolved during the fermentation of sugar was collected at 22.5 °C and 702 mmHg. After purification, its volume was found to be 25.0 L. How many moles of gas were collected? (4 points)

6. Given the following thermochemical equations:

Fe_2O_3 (s) + 3 CO (g) → 2 Fe (s) + 3 CO_2 (g)　$\Delta H° = -28.0$ kJ

3 Fe (s) + 4 CO_2 (g) → 4 CO (g) + Fe_3O_4 (s)　$\Delta H° = +12.5$ kJ

Calculate the value of $\Delta H°$ for the following reaction:

3 Fe_2O_3 (s) + CO (g) → CO_2 (g) + 2 Fe_3O_4 (s)　$\Delta H° = ?$ (7 points)

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7. (A) Calculate the molality of C_2H_5OH in a water solution that is prepared by mixing 100 mL of C_2H_5OH with 250 mL of H_2O at 20°C. The density of the C_2H_5OH is 0.79 g/mL at 20°C? (5 points)
(B) How many grams of sodium hydroxide, NaOH, are needed to prepare 500 mL of 2 N solution? (5 points)
(C) What is the concentration of the solution prepared by diluting 200 mL of 2 M solution to a final volume of 800 mL? (5 points)

8. Urea [$(NH_2)_2CO$] is prepared by reacting ammonia with carbon dioxide: $2\,NH_{3(g)} + CO_{2(g)} \longrightarrow (NH_2)_2CO_{(aq)} + H_2O_{(l)}$
In one process, 629.0 g of NH_3 are allowed to react with 1320.0 g of CO_2. (A) Which of the two reactants is the limiting reagent? (5 point) (B) Calculate the mass of $(NH_2)_2CO$ formed. (5 point) (C) How much of the excess reagent (in grams) is left at the end of the reaction? (5 point)

9. Initially 1 mole of oxygen is contained in a 1-liter vessel, and 5 mole of nitrogen are in a 2-liter vessel; the two vessels are connected by a tube with a stopcock. If the stopcock is opened and the gases mix, what is the entropy change? (15 points)