Equilibrium

• Write the equilibrium expressions for the following reactions:
  • A.  \( 3 \text{O}_2(g) \rightleftharpoons 2 \text{O}_3(g) \)
  • B.  \( \text{SiH}_4(g) + 2 \text{O}_2(g) \rightleftharpoons \text{SiO}_2(s) + 2 \text{H}_2\text{O}(g) \)
  • C.  \( \text{MgO}(s) + \text{SO}_2(g) + \frac{1}{2} \text{O}_2(g) \rightleftharpoons \text{MgSO}_4(s) \)

Equilibrium

• At equilibrium the concentrations are listed in the table below for the reaction:
  • \( \text{H}_2(g) + \text{CO}_2(g) \rightleftharpoons \text{H}_2\text{O}(g) + \text{CO}(g) \)
  • \([\text{H}_2] \quad [\text{CO}_2] \quad [\text{H}_2\text{O}] \quad [\text{CO}]\)
  • 33.43 12.68 26.43 26.43
  • What is K for this reaction?
  • What is K for the reverse reaction?

Equilibrium

• Initially 0.84 mol of PCl\(_5\) (g) and 0.18 mol of PCl\(_3\) (g) are mixed together in a 1.0 L flask. At equilibrium the system is found to contain 0.72 mol of PCl\(_5\) (g). Calculate K for the reaction:
  \(- \text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g) \)
Equilibrium

- $K_p$ for the reaction:
  \[ 2 \text{HCN} (g) \rightleftharpoons \text{H}_2 (g) + \text{C}_2\text{N}_2 (g) \]
- Is $4.00 \times 10^{-4}$ at 500 °C. What is the equilibrium partial pressure of $\text{C}_2\text{N}_2$ if pure HCN was originally added to a pressure of 25.0 atm.

Equilibrium

- Calcium carbonate decomposes at high temperature to form solid CaO and gaseous CO$_2$.
  \[ \text{CaCO}_3 (s) \rightleftharpoons \text{CaO} (s) + \text{CO}_2 (g) \]
- If $K_c = 0.10$, how many grams of CO$_2$ are formed when equilibrium is established at that temperature in a 1.0L container?

Practice Problem

- For the reaction shown below, the equilibrium partial pressures of H$_2$ is 0.928 atm and that of N$_2$ is 0.432. What is the equilibrium pressure of NH$_3$ if $K_p = 1.45 \times 10^{-5}$
  \[ \text{N}_2 (g) + 3 \text{H}_2 (g) \rightarrow 2 \text{NH}_3 (g) \]
pH Problems

• Calculate the pH of the following solutions
  – A. 0.0051 M HNO₃
  – B. 0.0025 M NaOH

Practice Exercise

• What is the H⁺ concentration of a solution which has a pH of:
  – A. 3.74
  – B. 12.05

Calculate the pH of these solutions

• A. 0.0025M HOBr Ka= 2.0 x 10⁻⁹
• B. 0.0025M HBr
• C. 0.0025M KOH
Calculate the pH of these solutions

- D. Using information from a previous slide, what is the value of $K_b$ for OBr⁻?
- E. What is the pH of a 0.01M solution OBr⁻?
- F. What is the pH of a 0.01 M NaH solution?

General Problem

- If a solution of 0.10M acetic acid is prepared, what is the equilibrium concentration of all species present when the system comes to equilibrium, if the pH = 2.87.
- B. Calculate the value of $K_a$ for acetic acid?

General problem

- Calculate the pH and concentrations of all species present in a 0.50M aniline, $C_6H_5NH_2$ solution. $K_b = 4.3 \times 10^{-10}$
General problem

- A. If the $[OH^-] = 2.3 \times 10^{-4}$ in a particular solution, what is the $[H^+]$ for the solution?

pH of a Salt Solution

- Calculate the pH of a solution made by mixing 8.51 g of sodium hypochlorite, NaOCl, in enough water to make 500 ml of solution. (Ka for HOCl = 3.5 x 10^{-8})