Equilibria Quiz

1) Define the following terms: (2 points each)

- equilibrium:

- K_{sp}:

- reversible:

2) The Haber process for the manufacture of ammonia from hydrogen and nitrogen can be expressed by the following equation:

$$3\ H_{2(g)} + 1\ N_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$$

At equilibrium, the concentration of H_2 is 0.060 M, the concentration of N_2 is 0.020 M, and the concentration of NH_3 is 0.0021 M. Using this information, determine the equilibrium constant for the Haber process. (6 points)

3) The concentration of a saturated solution of $CaSO_4$ is 0.0084 M. Based on this information, find the solubility product of $CaSO_4$. (6 points)

4) State Le Châtelier's principle. (3 points)

5) Are the following double displacement reactions practical under normal conditions? Explain each answer in the space below. (4 points each)

a) $3\ NaF + Fe(OH)_3 \rightarrow NaOH + FeF_3$ $K_{sp}[Fe(OH)_3] = 2.64 \times 10^{-39}$

b) $CaBr_2 + 2\ NaOH \rightarrow 2\ NaBr + Ca(OH)_2$ $K_{sp}[Ca(OH)_2] = 4.68 \times 10^{-6}$

c) $MgF_2 + Ba(OH)_2 \rightarrow Mg(OH)_2 + BaF_2$ $K_{sp}[Mg(OH)_2] = 5.61 \times 10^{-12}$
$K_{sp}[BaF_2] = 1.84 \times 10^{-7}$

6) State the conditions of temperature and pressure that would shift the equilibrium to the product side. (2 points each)

a) $3\ H_{2(g)} + 1\ N_{2(g)} \rightarrow 2\ NH_{3(g)}$ $\Delta H = -49.16$ kJ/mol

b) $1\ CaCO_{3(s)} \rightarrow 1\ CaO_{(s)} + 1\ CO_{2(g)}$ $\Delta H = -178.3$ kJ/mol

Equilibria Quiz – Solutions

1) Define the following terms: (2 points each)

- equilibrium: **A reversible reaction where the rate of the forward and back reaction are the same.**
- K_{sp}: **Solubility product, equal to $(\Sigma[\text{products}]^x)/(\Sigma[\text{reagents}]^y)$**
- reversible: **A process that can proceed either from reagents to products or products to reagents.**

2) The Haber process for the manufacture of ammonia from hydrogen and nitrogen can be expressed by the following equation:

$$3\ H_{2(g)} + 1\ N_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$$

At equilibrium, the concentration of H_2 is 0.060 M, the concentration of N_2 is 0.020 M, and the concentration of NH_3 is 0.0021 M. Using this information, determine the equilibrium constant for the Haber process. (6 points)

$$K_{eq} = \frac{[NH_3]^2}{[H_2]^3\,[N_2]} = (0.0021)^2 / [(0.060)^2\,(0.020)] = 0.103$$

3) The concentration of a saturated solution of $CaSO_4$ is 0.0084 M. Based on this information, find the solubility product of $CaSO_4$. (6 points)

$$K_{sp} = (Ca^{+2})(SO_4^{-2}) = (0.0084)(0.0084) = 7.1 \times 10^{-5}$$

4) State Le Châtelier's principle. (3 points)
An equilibrium system that has been disturbed tends to correct itself to find a new equilibrium point that minimizes the initial disturbance.

5) Are the following double displacement reactions practical under normal conditions? Explain each answer in the space below. (4 points each)

a) $3\ NaF + Fe(OH)_3 \rightarrow NaOH + FeF_3$ $K_{sp}[Fe(OH)_3] = 2.64 \times 10^{-39}$
This reaction is not practical because one of the reagents is insoluble in water and both products are soluble in water.

b) $CaBr_2 + 2\ NaOH \rightarrow 2\ NaBr + Ca(OH)_2$ $K_{sp}[Ca(OH)_2] = 4.68 \times 10^{-6}$
This reaction is practical because both reagents are soluble in water and only one of the products is insoluble.

c) $MgF_2 + Ba(OH)_2 \rightarrow Mg(OH)_2 + BaF_2$ $K_{sp}[Mg(OH)_2] = 5.61 \times 10^{-12}$ $K_{sp}[BaF_2] = 1.84 \times 10^{-7}$
This reaction is not practical because both products are insoluble in water.

6) State the conditions of temperature and pressure that would shift the equilibrium to the product side. (2 points each)

a) $3\ H_{2(g)} + 1\ N_{2(g)} \rightarrow 2\ NH_{3(g)}$ $\Delta H = -49.16$ kJ/mol
High pressure, low temperature

b) $1\ CaCO_{3(s)} \rightarrow 1\ CaO_{(s)} + 1\ CO_{2(g)}$ $\Delta H = -178.3$ kJ/mol
Low pressure, low temperature

Suggested Grading Scale

37 = A+
33 – 36 = A
32 = B+
30 – 31 = B
28 – 29 = C+
26 – 27 = C
25 = D+
22 – 24 = D
< 24 = F