Chemistry 14B
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Chemical Equilibrium Worksheet

1. For the following reaction, starting with reactant A, how do the concentrations of A, B, and C change with time before the reaction reaches equilibrium?

$$A \leftrightarrow B + C$$

[A] decreases
[B] and [C] increases

2. The following equilibrium was studied at 973K:

$$2SO_3 \leftrightarrow 2\,SO_2 + O_2$$

At this temperature, the value of Kc is $2.4\,x\,10^{-3}$.

a. What is Kc for the following reaction at 973K?

$$4\,SO_3 \leftrightarrow 4\,SO_2 + 2O_2$$

$5.8\,x\,10^{-6}$

b. What is Kc for the following reaction at 973K?

$$2\,SO_2 + O_2 \leftrightarrow 2\,SO_3$$

420

c. Given that all 3 reactions above involve the same compounds, and all the reactions are at equilibrium and same temperature, why are the equilibrium constant values different?

Only concentration of each compound remains the same in this situation, but not K. K depends on how reaction is written.

Note: This worksheet may contain problems adapted from Dr. Lavelle's past exams.

d. What is one important implication from part c?

In order to get the same K, a balanced chemical equation/equilibrium expression must have the same coefficients to result in the exact same K value, for a reaction at the same temperature.

3. For the following reaction:

$$Ni(CO)_4 \leftrightarrow Ni_{(s)} + 4\,CO$$

If the initial concentration of $Ni(CO)_4$ is 1.0M, and "x" is the equilibrium concentration of CO, what is the general expression for Kc, in terms of x?

$$\frac{x^4}{1.0-(x/4)}$$

4. The Haber process is used to synthesize ammonia gas (NH_3) from nitrogen gas (N_2) and hydrogen gas (H_2).

a. A system at equilibrium contains 1.85M H_2, 1.36M N_2, and $2.91\,x\,10^{-3}$ M NH_3 at constant temperature. What is K_c?

$9.83\,x\,10^{-7}$

b. The volume is suddenly halved. What are the new concentrations for $N_2,\ H_2,\ and\ NH_3$?

$5.82\,x\,10^{-3} M$

c. Given the new lower volume condition, which direction is the reaction going to proceed?

Towards the right (product)

d. After the volume change, the system returns to equilibrium. What are the new EQUILIBRIUM concentrations for $N_2,\ H_2,\ and\ NH_3$?

$N_2:\ 2.72M$
$H_2:\ 3.69M$
$NH_3:\ 11.7\ x\ 10^{-3}M$

5. The equilibrium constant Kc equals 0.045 at 250 degree Celsius for the decomposition reaction:

$$PCl_5 \leftrightarrow PCl_3 + Cl_2$$

Calculate the percentage of PCl_5 that dissociates if 0.05mol of PCl_5 is placed in a closed vessel (constant volume) at 250 degrees Celsius and 2.00 atm.

61%

6. If there are two positive “x” after solving for the quadratic equation, how do you determine which one to use when solving for final partial pressures?

   One will be too large to subtract from the initial partial pressure, leading to a negative final pressure which is impossible, so we choose the other one

7. For the following reaction: $Br_2 \leftrightarrow 2Br$

   What physical conditions favor the production of bromine atoms?

   High T
   Low P

8. For the following reaction:

   $$H_2 + I_{2\,(s)} \leftrightarrow 2\,HI$$

   The reaction is endothermic.
   Kc at 25 C is $4.3\,x\,10^{-5}$.

   What (reactant or product) is favored in the following scenarios?

   a. Temperature decreases.
      Reactant

   b. Some HI is removed.
      Product

   c. Small amount of I_2 is added.
      Neither