Answer on the Question #55539 - Chemistry - Other

Question:

1. Some PCl5 is pumped into a 500 mL flask. The PCl3 at equilibrium is 1.50 M. What was the initial [PCl5]?
PCl_5 <---> PCl_3+ Cl_2
K_{eq}= 2.14

2. Keq for the reaction 2HI <----> H_2 +I_2 has a value of 1.85x 10^-2 at 425 degrees celsius. If 0.18 mol of HI is placed in a 2.0 L flask and allowed to come to equilibrium at this temperature. What will the equilibrium of [I2} be?

3. 0.020 mol of each SO2 and O2 and So3 is placed in a 1.0 L flask and allowed to come to equilibrium. The equilibrium of [SO2] is found to be 0.0080M. What is the value of keq for the reaction: 2SO2+O2<----> 2SO3

4. A 3.00 L flask contains 6.00M H2, 6.00M Cl2, 3.00M HCl at equilibrium. An additional 15 mol of HCl is injected into the flask. What is the [Cl2] when equilibrium is re- established?.

Answer:

1. Some PCl_5 is pumped into a 500 mL flask. The PCl_3 at equilibrium is 1.50 M. What was the initial [PCl_5]?
PCl_5 <---> PCl_3+ Cl_2
K_{eq}= 2.14

Let's consider the reaction equation. One can note, that the number of the moles of PCl_5 consumed in the reaction is equal to the number of the moles of PCl_3 and Cl_2 produced (simple stechiometry). Then if we will look at the expression for the equilibrium constant, we can substitute the values of $[PCl_5]$ and $[\,Cl_2]$ by $(c_0 - [PCl_3])$ and $[PCl_3]$, respectively. Using simple algebra, we derive the initial concentration of phosphorus pentachloride c_0:

$$PCl_5 \rightleftarrows PCl_3 + Cl_2$$

$$K_{eq} = \frac{[PCl_3] \cdot [\,Cl_2]}{[PCl_5]} = \frac{[PCl_3]^2}{(c_0 - [PCl_3])} = 2.14$$

$$c_0 = \frac{[PCl_3]^2 + \, 2.14 * [PCl_3]}{2.14} = 2.6\ M$$

2. Keq for the reaction 2HI <----> H2 +I2 has a value of 1.85x 10^-2 at 425 degrees celsius. If 0.18 mol of HI is placed in a 2.0 L flask and allowed to come to equilibrium at this temperature. What will the equilibrium of [I2} be?

The equilibrium constant expression is:

$$K_{eq} = \frac{[H_2] \cdot [I_2]}{[HI]^2} = 1.85 \cdot 10^{-2}$$

The equilibrium concentration of hydrogen is equal to the concentration of iodine $[H_2] = [I_2]$. Also, the equilibrium concentration of hydrogen iodide can be expressed as the difference between the initial concentration and the amount of free iodine produced: $[HI] = c_0 - 2[I_2]$.

$$K_{eq} = \frac{[I_2]^2}{(c_0 - 2[I_2])^2}$$

Initial concentration of hydrogen iodide is the ratio of number of the moles to volume of the system:

$$c_0 = \frac{n}{V} = \frac{0.18}{2.0} = 0.09\, mol\, L^{-1}$$

Using this value and solving the square equation, equilibrium iodine concentration is calculated:

$$[I_2] = 0.0096\, mol\, L^{-1}$$

3. 0.020 mol of each SO2 and O2 and So3 is placed in a 1.0 L flask and allowed to come to equilibrium. The equilibrium of [SO2] is found to be 0.0080M. What is the value of keq for the reaction: 2SO2+O2<----> 2SO3

Let's write the reaction equation and understand what is going on in the system.

$$2SO_2 + O_2 \rightleftarrows 2SO_3$$

c_0	0.02	0.02	0.02
Δ	$-2x$	$-x$	$+2x$
$[c]$	$(0.02 - 2x)$	$(0.02 - x)$	$(0.02 + 2x)$

Then, the x is:

$$x = \frac{0.02 - 0.008}{2} = 0.006$$

And equilibrium constant is:

$$K_{eq} = \frac{(0.02 - x)\ \cdot (0.02 + 2x)^2}{0.008^2} = \frac{0.014 \cdot 0.032^2}{0.008^2} = 0.224$$

4. A 3.00 L flask contains 6.00M H2, 6.00M Cl2, 3.00M HCl at equilibrium. An additional 15 mol of HCl is injected into the flask. What is the [Cl2] when equilibrium is re- established?

The reaction equation is:

$$2HCl \rightleftarrows Cl_2 + H_2$$

The equilibrium constant is:

$$K_{eq} = \frac{[Cl_2][H_2]}{[HCl]^2} = \frac{6 * 6}{3^2} = 4$$

When HCl is added, the concentration of Cl_2 will increase by x, also H_2 concentration will increase by x, and the HCl concentration will decrease by $2x$:

$$K_{eq} = \frac{(6 + x)(6 + x)}{(15 + 3 - 2x)} = 4$$

$$x = 1.662$$

Then, new equilibrium concentration of Cl_2 will be:

$$[Cl_2] = 6 + x = 7.66\, mol\, L^{-1}$$