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CHMG – 142

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**Synthesis #1**: Nitrogen gas and chlorine gas will react to form nitrogen monochloride gas. 5 moles of nitrogen and 10 moles of chlorine are mixed in a previously evacuated 2 L flask at 500 K. After equilibrium has been established, there are 3 moles of NCl (g) present.

1. What is the equilibrium constant (Kc) for this reaction at 500 K?

1 N2 + 1 Cl2 ⇌ 2 NCl

Kc= -> (3 / 2)2 / ( (3.5 / 2) / (8.5 / 2) ) = **0.30252** (just a ratio, so unitless)

1. What is the equilibrium constant (Kp) for this reaction at 500 K?

Kp = -> P = M \* R \* T

= 1.5 M \* 0.0821 () \* 500 K = 61.5752 = 3791.480625 atm

= 1.75 M \* 0.0821 () \* 500 K = 71.8375 atm

= 4.25 M \* 0.0821 () \* 500 K = 174.4625 atm

3791.480625 atm / ( 71.8375 atm \* 174.4625 atm ) = **0.30252** (just a ratio, so unitless)

1. 10 moles of nitrogen and 25 moles of chlorine are mixed in a 2 L flask at 500 K. After equilibrium has been established, what is the total pressure in the flask?

= (10 mol / 2 L) \* 0.0821 () \* 500 K = 205.25 atm

= (25 mol / 2 L) \* 0.0821 () \* 500 K = 513.125 atm

= 205.25 atm + 513.125 atm = 718.375 atm

**Synthesis #2**: The following reaction occurs in solution to yield a deep red colored complex:

1. I dissolve 3.0 g of iron (III) nitrate and 2.0 g of potassium thiocyanate (KSCN) in 0.250 L of water at 298 K. Once equilibrium has been established, what is the concentration of the iron-thiocyanate complex? How much thiocyanate remains in solution?

3.0 g of iron (III) nitrate = 0.0124 moles / 0.250 L = 0.0496 M

2.0 g of potassium thiocyanate = 0.02058 moles / 0.250 L = 0.08232 M

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| Initial | 0.0496 M | 0.08232 M | 0 M |
| Change | -x | -x | +x |
| Equilibrium | 0.0496 - x | 0.08232 - x | 0 + x |

Kc = -> 125 \* [0.0496 - x] \* [0.08232 - x] = x

Plugging the formula into Wolfram Alpha gets:

x = 0.0414762

Thus, the concentration of the iron thiocyanate solution is **0.0414762 M**, and the remaining thiocyanate has a concentration of 0.0408438 M, which is **0.5931 grams**.

1. I mix 250 mL of 1.0 M iron (III) nitrate with 250 mL of 1.0 M KSCN at 298 K. Once equilibrium has been established, what is the concentration of the iron-thiocyanate complex? How much thiocyanate remains in solution?

|  |  |  |  |
| --- | --- | --- | --- |
| Initial | 0.5 M | 0.5 M | 0 M |
| Change | -x | -x | +x |
| Equilibrium | 0.5 - x | 0.5 - x | 0 + x |

Kc = -> 125 \* [0.5 - x] \* [0.5 - x] = x

Plugging the formula into Wolfram Alpha gets:

x = 0.440628

Thus, the concentration of the iron thiocyanate solution is **0. 440628 M**, and the remaining thiocyanate has a concentration of 0.059372 M, which is **1.7243 grams**.

1. I mix 250 mL of 1.0 M iron (III) nitrate with 250 mL of 0.001 M KSCN at 298 K. Once equilibrium has been established, what is the concentration of the iron-thiocyanate complex? How much thiocyanate remains in solution?

|  |  |  |  |
| --- | --- | --- | --- |
| Initial | 0.5 M | 0.0005 M | 0 M |
| Change | -x | -x | +x |
| Equilibrium | 0.5 - x | 0.0005 - x | 0 + x |

Kc = -> 125 \* [0.5 - x] \* [0.0005 - x] = x

Plugging the formula into Wolfram Alpha gets:

x = 0.000492

Thus, the concentration of the iron thiocyanate solution is **0. 000492 M**, and the remaining thiocyanate has a concentration of 8 \* 10-6 M, which is **0.0004647 grams**.