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## EXPERIMENT 24

# Lab Report

## Part A – Effect of Concentration Changes on Systems at Equilibrium

Observations for the reaction of  $\text{SbCl}_3$  and  $\text{H}_2\text{O}$ .

A white precipitate forms and solution turns cloudy when water is mixed with  $\text{SbCl}_3$

Observations for the addition of  $\text{HCl}$  to the  $\text{SbCl}_3$  reaction mixture.

After adding  $\text{HCl}$ , the white precipitate dissolves.

Did the addition of  $\text{HCl}$  favor the products or reactants? Did the relative concentrations of  $\text{SbCl}_3$ ,  $\text{H}_2\text{O}$ , and  $\text{SbOCl}$  increase or decrease? Justify your answer based on your observations from the previous step.

Adding  $\text{HCl}$  favored the reactants. The relative concentrations of  $\text{SbCl}_3$  and  $\text{H}_2\text{O}$  increased while  $\text{SbOCl}$  decreased (relatively).

The reaction is  $\text{SbCl}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{SbOCl}(\text{s}) + 2\text{HCl}(\text{aq})$ . If more

product is introduced, the reaction shifts towards the reactants to create more reactants to stay @ EQ.

Observations for the addition of distilled water to the  $\text{SbCl}_3$  reaction mixture.

By adding more water, the precipitate ( $\text{SbOCl}$ ) forms again.

How does the addition of  $\text{H}_2\text{O}$  affect the equilibrium? How did the relative concentrations of  $\text{SbCl}_3$ ,  $\text{SbOCl}$ , and  $\text{HCl}$  change after the addition of  $\text{H}_2\text{O}$ ? Justify your answer based on your observations from the previous step.

By adding more water, the reaction shifts to the right and  $[\text{SbCl}_3]$  and  $[\text{SbOCl}]$  decreases while  $[\text{HCl}]$  increases relatively.

$\text{H}_2\text{O}$  is a reactant, so by adding more reactant, products are favored which is why more precipitate was formed.

### Part B – Effect of Changing pH on a Complex Ion Equilibrium

Observations for the addition of  $\text{HCl}$  to the  $\text{Co}(\text{OH}_2)_6^{2+}$  reaction mixture.

After adding  $\text{HCl}$  to  $\text{Co}(\text{OH}_2)_6^{2+}$ , the react the solution turned dark blue/purple.

How did the addition of 12 M  $\text{HCl}$  affect the equilibrium?

By adding  $\text{HCl}$  the reaction shifted to the right to favor the products.

How did the relative concentrations of  $\text{Co}(\text{OH}_2)_6^{2+}$  and  $\text{CoCl}_4^{2-}$  change after the addition of 12 M  $\text{HCl}$ ? Justify your answer based on your observations from the previous step.

After adding  $\text{HCl}$  (relatively speaking)  $[\text{Co}(\text{OH}_2)_6^{2+}]$  decreased and  $[\text{CoCl}_4^{2-}]$  increased.

$\text{CoCl}_4^{2-}$  is blue and  $\text{Co}(\text{OH}_2)_6^{2+}$  is pink. The observed system turned blue upon addition of  $\text{HCl}$ .

Observations for the addition of 0.1 M  $\text{AgNO}_3$  to the  $\text{CoCl}_2$  reaction mixture.

Adding  $\text{AgNO}_3$  caused a white precipitate to be formed.

Is the equilibrium affected by the addition of 0.1 M  $\text{AgNO}_3$ ?

~~Yes. Adding  $\text{Ag}^+$  to  $\text{Cl}^-$  forms new product so the addition of  $\text{AgNO}_3$  removes some  $\text{Cl}^-$  ions causing reaction.~~

~~No. The color of the mixture does not change after adding  $\text{AgNO}_3$ .~~  
Yes.  $\text{Ag}^+$  reacts with  $\text{Cl}^-$ , decreasing the amount of reactants

How did the relative concentrations of  $\text{Co}(\text{OH}_2)_6^{2+}$  and  $\text{CoCl}_4^{2-}$  change after the addition of 0.1 M  $\text{AgNO}_3$ ? Justify your answer based on your observations from the previous step.

$[\text{CoCl}_4^{2-}]$  decreased while  $[\text{Co}(\text{OH}_2)_6^{2+}]$  increased. Since adding  $\text{AgNO}_3$  decreased  $\text{Cl}^-$  ions, less  $\text{CoCl}_4^{2-}$  ions could be formed

### Part C – Effect of Changing Reaction Temperature on an Equilibrium System

Observations of  $\text{CoCl}_2$  solution and  $\text{CoCl}_2 + 12 \text{ M HCl}$  solution

$\text{CoCl}_2$  is a pink color and adding  $\text{HCl}$  turns it purple

Why is  $\text{HCl}$  added to test tube 2?

$\text{HCl}$  is added to react with  $\text{CoCl}_2$  to observe the color change

Observations of  $\text{CoCl}_2 + 12 \text{ M HCl}$  solution in ice bath

the purple color turns lighter (back to pink) when it gets colder

Observations of  $\text{CoCl}_2 + 12 \text{ M HCl}$  solution in boiling water bath

By putting the beaker in hot water, the color turns darker purple

Based on your observations, is this reaction endothermic or exothermic? Justify your answer with an explanation.

The reaction is endothermic because as you add heat, the forward reaction is favored so heat is a reactant