12. Equilibrium and LeChatlier's Principle

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Lab 12. Equilibrium and Le Chatlier's Principle

Purpose:

To investigate Le Chatlier's Principle and how it relates to equilibrium/how equilibrium shifts.

Procedure:

1. Thoroughly rinse and dry a 50mL beaker with a paper towel and then use the markings on the side to measure out 20mL of ethanol into the beaker.
2. Rinse and dry 5 test tubes of about the same size.
3. Examine the solid Cobalt(II) chloride, noting both it's color and the formula for the compound as shown on the label.
4. Place a small amount of the solid in the beaker of ethanol. Stir to dissolve the solid until solution is a purple color.
5. Fill the 5 test tubes with 2-3mL of the alcoholic cobalt solution. Get roughly equal amounts. Leave some solution in the beaker for steps 8/9. One test tube will be your control.
6. In one of the test tubes, add drops, or until there is a change, of distilled water, one at a time while recording observations after each drop. Gently swirl to mix the contents. Duplicate the process with the other 3 test tubes until all 4 are the same color.
7. A.
   Take one of the test tubes from step 6 to a fume hood. Use a dropper to add 5 drops(or until there is a change) of 12M hydrochloric acid, one drop at a time, to the solution in the test tube. Gently swirl the test tube, recording observations.

   B.
   In a second test tube, add 2 small clumps of solid calcium chloride. Gently stir to dissolve, taking observations.

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C.
To a third test tube, add 25 drops of acetone until a permanent color change occurs. Record observations.

D.
To a fourth test tube, add 5 drops of silver nitrate, $AgNO_3$, one at a time. Gently swirl to mix. Record observations.

8. To the solution remaining in the beaker, add distilled water to get a purple color, about half way between the blue and pink. Place the beaker on a hot plate until a color change occurs. Record observations.

9. Chill the beaker in an ice bath to see if the color change is reversible. Record observations.

Observations:

step 4: Ethanol and cobalt chloride solution is a dark blue color.

step 6: Changed from deep blue to to deep purple, then to pink.

step 7a: Solution turned light blue, then settle to a dark blue at the bottom.

step 7b: Calcium chloride turned a light blue and the solution around it turned a dark blue.

step 7c: Solution turned a dark purple. then turned dark blue, then dark purple.

step 8: Turned a dark blue when heated

step 9: Returned to a pink when chilled.

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Conclusion:

Net-ionic equation for the equilibrium:

(pink complex) $Co(H_2O)_6^{2+}(aq) + 4Cl^{-}(aq) \leftrightarrow CoCl_4^{2}\text{-}(aq) + 6H_2)(l)$ (blue complex)

1. The pink cobalt complex was favored when adding water because the increase in water shifted the equilibrium to the left, favoring the reverse reaction.
2. The blue cobalt complex, $CoCl_2$, was favored when the HCl or Calcium chloride was added because it dissociates in the solution, causing an increase in Cl^- ions, which is a common ion in both of the reagent, shifting the equilibrium to the right, favoring the forward.
3. When acetone was added, it effectively removed some of the water from the system, shifting the equilibrium to the right to replace the water, favoring the forward reaction and the blue cobalt complex.
4. When silver nitrate was added, it decreased the Cl^- ions because when the silver nitrate dissociate, it releases Ag^+ ions, which react with the free Cl^- ions forming AgCl. This causes the equilibrium to shift to the left, favoring the reverse reaction and the pink cobalt complex to form.
5.
6. Heating the solution favored the blue cobalt complex and cooling it favored the pink cobalt complex.
   $Co(H_2O)_6^{2+}(aq) + 4Cl^{-}(aq) + heat \leftrightarrow CoCl_4^{2}\text{-}(aq) + 6H_2)(l)$ $\Delta H=+50$ KJ/mol
   Since it turned blue when heating and pink when cooling, that means that heat is a reactant and the solution is endothermic. Adding heat causes the equilibrium to shift right, favoring the forward reaction and the blue cobalt complex. Removing heat shifts the equilibrium to the left, favoring the reverse reaction and the pink cobalt complex.