AP LAB 07I: Le Châtelier's Principle

ADAPTED FROM VONDERBRINK: Lab Experiments for AP Chemistry

Aim To investigate Le Chatelier's Principle

Apparatus Test tubes, 100. mL beaker, stirring rod, test tube rack, 10.0 mL measuring cylinder, funnel, filter paper

Chemicals 3.0 M HCl, 0.100 M HCl, solid Na_2HPO_4, 0.100 M NaOH, 0.200 M iron (III) nitrate, solid KSCN, bromothymol blue Indicator solution, 0.002 M KSCN, solid NaCl, solid NH_4Cl, phenolphthalein, 0.1 M NH_3, 1.5 M NH_3

Method

Part 1. $NaCl_{(s)} \leftrightarrows Na^+_{(aq)} + Cl^-_{(aq)}$

Pour solid NaCl into a test tube to a depth of about 1.00 cm and then add water until the tube is about half full. Cork and shake the tube. If the solid completely dissolves, add more solid NaCl until a solution is formed with some excess solid that remains undissolved. Filter this saturated solution into a second test tube. Add a few drop of concentrated (3.0 M) HCl to the saturated solution. Record your observations.

Part 2. $HIn_{(aq)} \leftrightarrows H^+_{(aq)} + In^-_{(aq)}$ (HIn is Yellow, $H^+ + In^-$ is Blue)

Half-fill a test tube with distilled water and add a few drops of bromothymol blue Indicator. Add a few drops of 0.100 M HCl and stir. Record your observations.

Now add a few drops of 0.100 M NaOH with stirring until no further color change is observable. Record your observations.

Part 3. $Fe^{3+}_{(aq)} + SCN^-_{(aq)} \leftrightarrows [FeSCN]^{2+}_{(aq)}$ ($Fe^{3+}_{(aq)} + SCN^-$ is colorless, $Fe[SCN]^{2+}$ is red)

Pour 10.0 mL of 0.002 M KSCN solution into a beaker. Add 10.0 mL of distilled water and 5 drops of 0.200 M $Fe(NO_3)_3$ solution. Stir the solution and record your observations.

Split the solution in the beaker equally into three separate test tubes. Carry out the following experiments, each time recording your observations.

To one test tube add 3 crystals of solid KSCN.
To one test tube add, with stirring, 6 drops of $Fe(NO_3)_3$ solution.
To one test tube add, with stirring, a few small crystals of Na_2HPO_4.

Part 4. $NH_{3(l)} + H_2O_{(l)} \leftrightarrows NH_4^+{}_{(aq)} + OH^-_{(aq)}$ (Phenolphthalein is pink in the hydroxide ions).

Take a few drops of 0.1 M NH_3 solution and add two drops of phenolphthalein. Add a few crystals of solid NH_4Cl. Add a few drops of 1.5 M NH_3. Add a few drops of 3.0 M HCl. Record your observations after each addition.

Part 5. **(DEMO)** $Co(H_2O)_6^{2+}{}_{(aq)} + 4Cl^-_{(aq)} \leftrightarrows CoCl_4^{2-}{}_{(aq)} + 6H_2O_{(l)}$ (ΔH = +50.0 kJ/mol)
Pink Blue

A sealed pipet containing the purple equilibrium mixture is immersed it in hot water, then immersed in an ice bath. In each case record your observations.

Results

Part 1.

Result of adding conc. HCl to saturated NaCl	Explanation

Part 2.

Result of adding HCl	Explanation

Result of adding NaOH	Explanation

Part 3.

Color of $Fe(NO_3)_3$	
Color of KSCN	
Color of complex ion $[Fe(SCN)]^{2+}$	

Complex Solution	Observations AND Explanation
Test tube with solid KSCN added	
Test tube with $Fe(NO_3)_3$ added	
Test tube with Na_2HPO_4 added	

Part 4.

Result of adding Phenolphthalein	Explanation

Result of adding NH_4Cl solid	Explanation

Result of adding 1.5M NH_3	Explanation

Result of adding 3.0M HCl	Explanation

Part 5 **(DEMO)**.

Effect of heating the pipet	Explanation

Effect of cooling the pipet	Explanation

Conclusion/Calculations

1. State Le Chatelier's Principle.

2. Consider the equilibrium below, which is known to release energy as $XO_{(g)}$ is formed.

$$X_{2(g)} + O_{2(g)} \leftrightarrows 2XO_{(g)}$$

Predict and explain the effect of making the following changes on this equilibrium

(i) Adding more $X_{2(g)}$

(ii) Adding more $O_{2(g)}$

(iii) Increasing the pressure

(iv) Increasing the temperature