**Le Chatelier’s Lab Activity Review:**

**Answer the following questions in your lab book:**

1. Iodine(I2) is only sparingly soluble in water (Equation 3). In the presence of potassium iodide (I-) ions, iodine reacts to form triiodide (I3-) ions (Equation 4).

I2(s) $\leftrightarrow $ I2(aq) Equation 3

I2(aq) + I-(aq) $\leftrightarrow $ I3-(aq) Equation 4

Use LeChatelier’s principle to explain why the solubility of iodine in water increases as the concentration of potassium iodide increases.

1. Although both N2and O2 are naturally present in the air we breathe, high levels of NO and NO2 in the atmosphere occur mainly in regions with large automobile or power plant emissions. The equilibrium constant for the reaction of N2 and O2 to give NO is very small. The reaction is, however, highly endothermic, with a heat of reaction equal to +180 kJ (equation 5).

N2(g) + O2(g) +180 kJ $\leftrightarrow $ 2NO(g) Equation 5

* 1. Use LeChatelier’s principle to explain why the concentration of NO at equilibrium increases when the reaction takes place at higher temperatures.
	2. Use LeChatelier’s principle to predict whether the concentration of NO at equilibrium should increase when the reaction takes place at high pressures.

**Materials\***

Iron(III) nitrate solution, Fe(NO3)3, 0.2 M, 5 drops Ice

Potassium nitrate, KNO3, 0.5 g Labeling or marking pen

Potassium thiocyanate, KSCN, 0.5 g Petri dish, disposable

Potassium thiocyanate solution, KSCN, 0.002 M, 20 mL Pipet, Beral-type, graduated

Sodium phosphate, monobasic, NaH2PO4zH2O, 0.5 g Spatulas, 2

Water, distilled or deionized Test tubes, 2

Water, tap Test tube holder

Beakers, 250-mL, 3 Test tube rack

Graduated cylinder, 50-mL Thermometer, digital

Hot plate Wash bottle

***Safety Precautions*** *Iron(III) nitrate solution may be a skin and body tissue irritant. Potassium thiocyanate is toxic by ingestion and emits a toxic gas if strongly heated—do not heat this solution and do not add acid. Sodium phosphate monobasic is moderately toxic by ingestion. Avoid contact of all chemicals with eyes and skin. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Please follow all laboratory safety guidelines.*

**Introductory Activity**

***Complex-Ion Equilibrium Reaction between Iron(III) Nitrate and Potassium Thiocyanate***

**Part A. Effect of Concentration**

1. Prepare hot-water and ice-water baths: Fill a 250-mL beaker half full with tap water. Place it on a hot plate and heat to 65–70 °C for use in Part B. In a second 250-mL beaker, add water and ice to prepare an ice-water bath for use in Part B.
2. Using a 50-mL graduated cylinder, measure 20 mL of potassium thiocyanate solution and pour the solution into a Petri dish. Record the initial color and all color changes that occur throughout the investigation (Parts A and B).
3. Add 3 drops of iron(III) nitrate solution to different spots in the Petri dish.
4. Swirl the solution until the color is uniform throughout.
5. Add ½ pea-size amount of potassium thiocyanate crystals in one spot. Wait 30 seconds and record any further changes to the solution. Swirl the solution to dissolve the crystals until the solution color becomes uniform throughout.
6. Add ½ pea-size amount of potassium nitrate crystals in one spot. Wait 30 seconds and record any further changes to the solution. Swirl the solution to dissolve the crystals until the solution color becomes uniform throughout.
7. Add ¼ pea-size amount of sodium phosphate monobasic crystals in one spot. Wait about 60 seconds and observe any changes to the solution.
8. Swirl the solution to dissolve the crystals. Record the solution color.
9. Add one drop of iron(III) nitrate solution in one spot off to the side. Do not stir. Record any color change.
10. Add a pea-size amount of potassium thiocyanate crystals in a different spot. Wait about 30 seconds and record any changes to the solution around the crystals.
11. Swirl the solution until it is uniform and keep the solution for use in Part B—Effect of Temperature

**Part B. Effect of Temperature**

1. Label two clean, dry test tubes A and B, and place them in a test tube rack.
2. Using a graduated Beral-type pipet, add about 10 mL of the complex-ion solution from Part A to each test tube.
3. Test tube A will be the control for the experiment.
4. Place test tube B in the ice-water bath. After 3–5 minutes, remove the test tube from the ice bath using a test tube holder and compare the color of the solution to the control in test tube A. Record the color comparison.
5. Using a test tube holder, place test tube B in a hot-water bath at 65–70 °C. After 2–3 minutes, remove the test tube from the hot-water bath and compare the color of the solution to the control in test tube A. Record the color comparison.
6. Empty the contents of both test tubes and the Petri dish into the wash beaker provided. Rinse the glassware with distilled water.

**Analyze the Results**

**Answer the following questions in your lab book:**

Form a working group with other students and discuss the following questions.

1. Write the chemical equation for the reversible reaction of iron(III) ions with thiocyanate ions. Use the information in your data table to write the color of each reactant and product underneath its formula.
2. How did the color of the solution change when additional reactant—either Fe(NO3)3 or KSCN—was added? Explain the observed color changes by discussing the rates of the forward and reverse reactions, as well as the concentrations of products and reactants.
3. In step 6, KNO3 was added to the solution. How did the color of the solution change in Part A when KNO3 was added? Explain this observation.
4. In step 7, H2PO4 – ions combined with iron(III) ions and removed them from solution. How did the color of the solution change in Part A when NaH2PO4 was added? Explain the observed color change by discussing the rates of the forward and reverse reactions, as well as the concentrations of the products and reactants.
5. How did the color of the solution change when Fe3+ ions were added in step 9 and SCN– ions were added in step 10? How do these observations demonstrate that both reactant ions are present at equilibrium?
6. How did the color of the solution change in Part B when it was cooled (step 15) or heated (step 16)? How do these results demonstrate that the reaction does indeed occur in both the forward and reverse directions?
7. Based on the color changes observed when the solution was cooled and heated, is the reaction between iron(III) ions and thiocyanate ions exothermic or endothermic? Write the Heat term on the correct side of the equation from Question 1.