

Name _____

Date _____

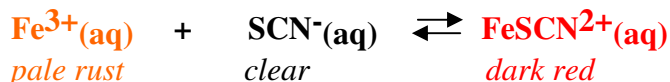
Chemistry 12 Experiment 19A Investigating Chemical Equilibrium

Objectives:

1. To make predictions of which way equilibria will shift when certain stresses are applied.
2. To make predictions of what will be observed when certain stresses are applied to systems at equilibrium.
3. To test the predictions made.

PART 2-EQUILIBRIUM INVOLVING THE THIOCYANATOIRON (III) ION**Information Needed:**

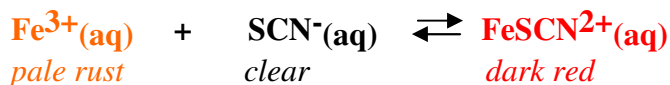
1. The equilibrium equation involved is:



2. The Cl^{-} ion reacts with the Fe^{3+} ion to **decrease** its concentration in solution.
The reaction is: $\text{Fe}^{3+}(\text{aq}) + 4\text{Cl}^{-}(\text{aq}) \rightarrow \text{FeCl}_4^{-}(\text{aq})$. The FeCl_4^{-} does not interfere with the original equilibrium.
3. The Fe^{3+} ion reacts with the OH^{-} ion to produce the precipitate $\text{Fe}(\text{OH})_3$.
This **decreases** the $[\text{Fe}^{3+}]$ in solution.
4. In this equilibrium, a **darkening** would indicate a shift to the _____

Procedure:

1. Fill in the **prediction** columns in the table on the next page.
2. To check the predictions do Part II - Procedures 1-8 on pages 209-210 in the Heath Lab Manual. NOTE HAZARD ON TOP LEFT MARGIN OF P. 210. Fill in the rest of the chart while you are doing the experiment.

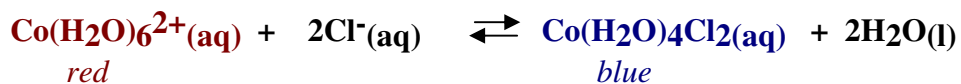


Test tube	Active Ion	Predicted Shift	Predicted Observation	Actual Observation	Reason for the Shift (increase or decrease of $[\text{Fe}^{3+}]$ or $[\text{SCN}^{-}]$)
B	Cl^{-}				
C	Fe^{3+}				
D	SCN^{-}				
E	OH^{-}				

PART 3 - EQUILIBRIUM INVOLVING THE COBALT (II) COMPLEXES

Information Needed:

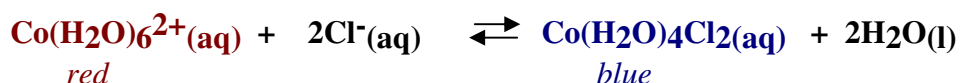
- The equilibrium equation involved is:



- The reaction as written is **endothermic** (ie. Heat is on the left side)
- In this case, the "active ion" in HCl is the Cl^{-} ion. (H^{+} is a spectator)
- Read the "Hazards" for part III in the left margin of page 210.
- Instead of a bunsen burner, use a hot-plate in procedure 5.

Procedure:

- Read procedures 1-6 on Part III on page 210. Fill in the **prediction** columns in the table on the next page:



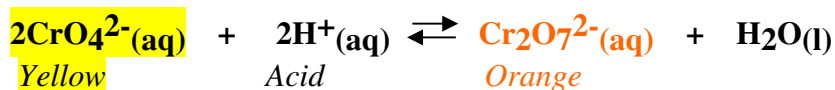
Step	Stress	Predicted Shift (Lor R)	Predicted Observations (What colour?)	Actual Observations
2	Inc[Cl ⁻]			
3	Add H ₂ O			
4	Add H ₂ O			
5	Adding Heat			
6	Remove Heat			

2. Follow steps 1-6 on Part III on page 210 of the Heath Lab Manual. Be careful with the heating. **Make sure you wear goggles throughout this part of the experiment!** Fill in the "Actual Observations" Column on the chart above.

PART 4 - EQUILIBRIUM INVOLVING THE CHROMATE AND DICHROMATE IONS

Information Needed:

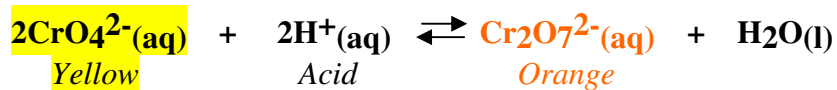
1. The equilibrium equation involved is:



2. HCl(aq) contributes H⁺ to this equilibrium
3. NaOH(aq) **reduces** the [H⁺] by reacting with it. (H⁺ + OH⁻ → H₂O)
4. Ba(NO₃)₂ is used as a **test for chromate (CrO₄²⁻)**. The Ba²⁺ ion forms a precipitate with CrO₄²⁻ but **not with Cr₂O₇²⁻**. So when barium nitrate is added to one of these solution, a cloudiness would indicate that some CrO₄²⁻ is present in the solution. The more the cloudiness, the more CrO₄²⁻ is present.

Procedure:

1. Read procedures 1-9 on Part IV on page 210-211. Fill in the **prediction** columns in the following chart. **Omit procedure 4!**



Step	Stress	Predicted Shift (L or R)	Predicted Observations	Actual Observations
2	OH ⁻			
3	H ⁺ (HCl)			
5	OH ⁻ Ba(NO ₃) ₂ as a test for chromate		What colour? _____ Will it be cloudy?_____	
6	H ⁺ (HCl)		What colour? _____ Will it stay cloudy?_____	
7	H ⁺ Ba(NO ₃) ₂ as a test for chromate		What colour? _____ Will it be cloudy?_____	
8	OH ⁻		What colour? _____ Will it turn cloudy?_____	
9	CrO ₄ ²⁻ Ba(NO ₃) ₂ as a test for chromate Cr ₂ O ₇ ²⁻ Ba(NO ₃) ₂ as a test for chromate			

Procedure

1. Read the "Hazard" warning on the margins of Part IV on pages 210-211.
2. Do procedures 1-3 on Part IV and record the results in the table above.
3. **Omit procedure 4!**
4. Carry out procedures 5-9 on Part IV on page 211 and record the results in the table above.

Questions for this Experiment

1. How did your observed results in Part 2, compare with the predicted ones?

If there were any differences, explain why here. _____

2. Write out the equilibrium equation for the reaction in Part 2.

3. Predict the effect of adding $\text{FeBr}_3(\text{aq})$ to this equilibrium. _____

4. Explain, using LeChatelier's Principle, why the addition of $\text{NaOH}(\text{aq})$ caused the colour of the solution to get lighter. Be detailed.

5. Write out the equation for the equilibrium reaction in **Part III**.

6. Is this reaction *endothermic* or *exothermic*? _____

7. $\text{Ag}^+(\text{aq})$ is known to form a precipitate with Cl^- ions. Predict the effect of adding aqueous silver nitrate to this equilibrium. _____

8. Paper soaked in CoCl_2 and dried could be used as a test for _____
9. Write out the equation for the equilibrium in Part IV.

10. Explain, using LeChatelier's Principle, why the solution turned orange when HCl was added to the Na_2CrO_4 solution. Refer to the equation in #9.

11. Explain, using LeChatelier's Principle, why the solution turned yellow when NaOH was added to the $\text{Na}_2\text{Cr}_2\text{O}_7$ solution. Refer to the equation in #9.

12. Explain why the solution was cloudy in Step 5. _____

13. Explain, using LeChatelier's Principle, why the cloudy colour disappeared in step 6, when the HCl was added. Be detailed!

14. Explain why there was a little bit of cloudiness in the second part of step 9, when $\text{Ba}(\text{NO}_3)_2(\text{aq})$ was added to the $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ solution. ($\text{Cr}_2\text{O}_7^{2-}$ does **not** form a precipitate with Ba^{2+}) _____

