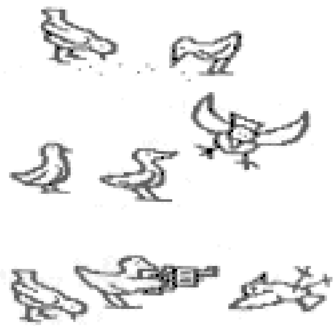
APPLICATIONS OF LeCHATELIER’S PRINCIPLE



If a system in equilibrium

is subjected to a stress,

the system will react to relieve the stress.

GENERAL DISCUSSION

A system at equilibrium may be disturbed by subjecting the system to a stress. A stress is a change of conditions, such as changing the concentration of one of the participants or changing the temperature. LeChatelier’s Principle indicates that the system readjusts so as to minimize the stress and restore equilibrium.

In this experiment you will investigate the equilibrium system

$Fe^{+3} + SCN^{-1} \sim Fe(SCN)^{+2}$

You will vary the concentrations of the reactants and observe, by color changes which occur, how the system has shifted to regain equilibrium.

PROCEDURE:

1. Examine solutions of KCl, KSCN, $FeCl_3$, and $Hg(NO_3)_2$. Write the color of each ion listed in Table I. Remember, a colorless solution can only have colorless ions. You will have to do Procedure 4 before you can observe the color of $Fe(SCN)^{+2}$.

TABLE 1

ION	COLOR
K^{+1}	
Cl^{-1}	
SCN^{-1}	
Fe^{+3}	
$Fe(SCN)^{+2}$	
Hg^{+2}	
$Hg(SCN)^{-2}$	Colorless
$FeCl_4^{-1}$	Colorless

2. Assume the wells in your spot plate are numbered in this manner:

	1	
2	5	4
	3	

3. Place one drop of 0.1 M $FeCl_3$ solution into well # 5 and add two drops of 0.1 M KSCN.
4. Get some pure water in a clean beaker. Add 25 drops of pure water to the solution in well # 5 and mix thoroughly by drawing up into the eyedropper and returning to the well several times. Now you can observe the color of $Fe(SCN)^{+2}$.
5. Place five drops of the solution in well # 5 into each of the cells 1 through 4. Return the excess to # 5. All five occupied well should appear to have the same color. If # 5 looks darker because of a greater depth of solution, remove and discard a drop or two. Well # 5 will remain untouched throughout the rest of lab and will be used to compare color changes to the original color.
6. To well # 1 add a few small crystals of $FeCl_3$.

   To well # 2 add a few small crystals of NaCl.

   To well # 3 add 4 drops of 0.1 M KSCN.

   To well # 4 add 1 drop of $Hg(NO_3)_2$.
7. Stir each well and record any color changes in TABLE II.
8. Pour your well plate into the waste beaker and then rinse and dry it. Rinse your eyedropper with pure water.

TABLE II

Species added	Color change
Fe^{+3} from $FeCl_3$	
Cl^{-1} from KCl	
SCN^{-1} from KSCN	
Hg^{+2} from $Hg(NO_3)_2$	

QUESTIONS:

Remember you were applying stresses to the equilibrium system

Fe^{+3} + SCN^{-1} ˜ $Fe(SCN)^{+2}$ On the blank lines fill in the colors of the ions.

________ ________ __________

1.a. In the first change did the color change indicate a shift the the left of the right? (Did the concentration of the red ion on the right increase or decrease?)

b. Can you explain why the addition of iron III ions shifted the equilibrium in that direction.

2.a. In the second change did the color change indicate a shift the the left of the right? (Did the concentration of the red ion on the right increase or decrease?)

b. Can you explain why the addition of Cl^{-1} ions from KCl shifted the equilibrium in that direction? Look for a clue in Table I.

3.a. In the third change did the color change indicate a shift the the left of the right? (Did the concentration of the red ion on the right increase or decrease?)

b. Can you explain why the addition of SCN^{-1} ions from KSCN shifted the equilibrium in that direction?

4.a. In the third change did the color change indicate a shift the the left of the right? (Did the concentration of the red ion on the right increase or decrease?)

b. Can you explain why the addition of Hg^{+1} ions from KCl shifted the equilibrium in that direction? Look for a clue in Table I.

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PRINCIPLE

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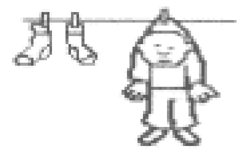
is subjected to a stress,



the system will react to relieve the stress.

PART II

In this part of the experiment you will investigate the equilibrium

$Cr_2O_7^{-2} + H_2O \sim 2\,CrO_4^{-2} + 2\,H^{+1}$

Procedure:

1. Examine solutions of $K_2Cr_2O_7$ and K_2CrO_4. Fill in Table III.
2. Put three drops of K_2CrO_4 into a well. Add three drops HNO_3. Record any color change. Record your observations in Table IV.
3. Place three drops of $K_2Cr_2O_7$ into an adjacent well. Add 3 drops of 0.1 M NaOH solutions. Record your observations in Table IV.
4. Pour your well plate into the waste beaker and then rinse and dry it.

TABLE III

ION	COLOR
CrO_4^{-2}	
$Cr_2O_7^{-2}$	

TABLE IV

Ion in Original Solution	Species added To original Solution	Color Change
CrO_4^{-2}	H^{+1} from HNO_3	
$Cr_2O_7^{-2}$	OH^{-1} from NaOH	

QUESTIONS: You worked with this equilibrium system. Fill in the ion colors on the lines.

$$Cr_2O_7^{-2} \quad + \quad H_2O \quad \sim \quad 2\,CrO_4^{-2} \quad + \quad 2\,H^{+1}$$

__________ __________

1. Why did the yellow chromate solution turn orange when acid was added?

2. Why did the orange dichromate solution turn yellow when a base was added?