

LeChatelier's Principle

MATERIALS

Well plate

Chromate ion solution CrO_4^{2-}

Dichromate ion solution $\text{Cr}_2\text{O}_7^{2-}$

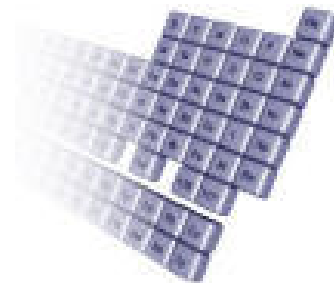
1 M sodium hydroxide (NaOH)

1 M hydrochloric acid (HCl)

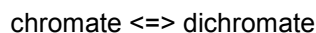
2 M ammonia (NH_3)

1 M sulfuric acid (H_2SO_4)

SAFETY GOGGLES



Chemical equilibrium is reached when the rate of the forward reaction is equal to the rate of the reverse reaction. Chemical equilibrium can be recognized when macroscopic properties, such as color, pressure or solubility become constant. In this investigation, you will qualitatively study three systems at equilibrium. You will then impose certain changes/stresses on each system and observe changes in color or solubility.



1. Prepare the well plate by adding 5 drops of chromate to each of wells A1, A2 and A3. Add 5 drops of dichromate to each of wells B1, B2 and B3. In the observation table, under step 1, record the color of the chromate and dichromate ion solutions (both are dissolved in water).
2. Add 1 M NaOH drop by drop (like a titration) to the chromate ion in A2 and the dichromate ion in B2 (alternate between the two) until *one* of the solutions changes color. Record your results in the observation table under step 2.
3. Add 1 M HCl drop by drop to the chromate ion in A3 and the dichromate ion in B3 (alternate between these two as well) until *one* of the solutions changes color. Record your results in the observation table under step 3.
4. Add 1 M NaOH drop by drop in the same manner to the HCl/chromate mixture in A3 and the HCl/dichromate mixture in B3 until *both* of the solutions change color. Record your results in the observation table under step 4.

**READ
ALL
INSTRUCTIONS
BEFORE
PROCEEDING**

SAFETY NOTE

You may not perform unauthorized experiments such as mixing chemicals beyond the instructions provided. Such unauthorized experiments will result in a zero for this laboratory grade and the great displeasure of your instructor.

change color. Record your results in the observation table under step 4.

5. Add 1 M HCl drop by drop in the same manner to the NaOH/chromate mixture in A2 and the NaOH/dichromate mixture in B2 until *both* of the solutions change color. Record your results in the observation table under step 5.
6. Discard the solutions, rinse and dry the well plate.
7. **Repeat steps 1 through 5**, adding five drops of chromate ion solution to wells A1, A2, and A3, and adding five drops of dichromate ion solution to wells B1, B2 and B3. Substitute the 2 M NH_3 for the 1 M NaOH; substitute the 1 M H_2SO_4 for the 1M HCl. Record all results in the second observation table.

■ QUESTIONS

HCl and H_2SO_4 are acids; they form H^+ ions in water. NaOH and NH_3 are bases; they form OH^- ions in water.

8. Balance the reaction in acidic solution by adding water to one side of the reaction and hydrogen ions to the other.

According to LeChatelier, which direction should the reaction move if an acid is added?

9. Balance the reaction in a basic solution by adding water to one side of the reaction and hydroxide ions to the other.

According to LeChatelier, which direction should the reaction move if a base is added?

10. What can you conclude concerning the equilibrium of chromate and dichromate ions and their dependence on hydrogen and hydroxide ions?
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