The Alkaline Earth Metals — Lab 19

PRE-LAB DISCUSSION

The elements in Group 2 of the periodic table are called the alkaline earth elements. Like the elements in Group 1 (the alkali metals), the elements in Group 2 are chemically active and are never found in nature in the elemental state. Like all members of a group, or family, the elements in Group 2 share certain common characteristics.

The metallic character—the tendency to donate electrons during chemical reaction of the Group 2 elements increases as you go down the group. The more metallic of these elements typically react with water to form hydroxides and hydrogen gas. An example of such a reaction would be:

$$Ca_{(s)} + 2HOH \Rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$$

As metallic character increases (as you go down the group), the tendency for these elements to form ions increase. Also as you go down the group, the solubility of the hydroxides formed by the elements of this group increase. The more active is the metal, the more basic is its saturated hydroxide solution.

The solubility of alkaline earth compounds also show some interesting and useful tendencies. For example, the sulfate compounds of alkaline earth metals show decreasing solubility as you go down the group. This characteristic is used as a means of separating and identifying metallic ions of this group. Carbonates of all alkaline earth metals are quite insoluble.

In this experiment, you will observe some of the characteristics of the alkaline earth metals discussed here and will write balanced equations for all reactions.

PURPOSE

Investigate some reactions of some Group 2 elements and gain some insights into the properties of these alkaline earth elements.

EQUIPMENT

balance	pH paper	burner	stirrer
flame tester	test tube holder	filter paper	test tubes, 13 x 100-mm (3)
test tube rack	wood splints		

MATERIALS

calcium turnings (Ca)
magnesium ribbon (Mg)
magnesium sulfate crystals ($MgSO_4$)
calcium sulfate crystals ($CaSO_4$)
barium sulfate crystals ($BaSO_4$)
distilled water
phenolphthalein solution

saturated solutions of:
calcium hydroxide ($Ca(OH)_2$)
magnesium hydroxide ($Mg(OH)_2$)
barium hydroxide ($Ba(OH)_2$)
0.1 M solutions of:
sodium carbonate (Na_2CO_3)
magnesium chloride ($MgCl_2$)
calcium chloride ($CaCl_2$)
barium chloride ($BaCl_2$)

PROCEDURE

Record all observations and results in the "Observations and Data" section.

PART A

1. Pour about 5 mL of distilled water into a clean, dry test tube and place the tube in the test tube rack. Add calcium turning to the water in the tube. To collect the gas being released, invert a clean, dry test tube over the reactant tube, holding the inverted tube with a test tube holder (Figure 1).
2. Test for hydrogen gas by inserting a burning wood splint into the upper part of the inverted tube. (Figure 2)
3. Add a few drops of phenolphthalein solution to the reactant tube. After making your observations, discard the contents of the tube and clean and dry the tube.

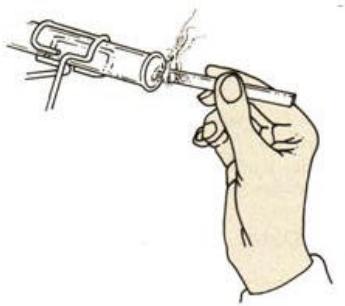

figure 1

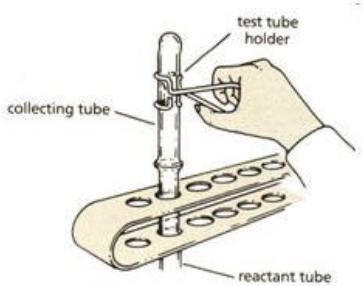

figure 2

4. Repeat step 1, using a 10-cm piece of magnesium ribbon in place of the calcium. If no visible reaction occurs, heat the water to boiling, using a test tube holder to hold the tube over the burner flame. CAUTION: Point the tube away from yourself and others while heating.

5. Once the water is boiling, stand the tube in a test tube rack and, using a test tube holder, invert a collecting tube over the reactant tube. After a few seconds, test for hydrogen gas.

6. Turn off the burner and add a few drops of phenolphthalein to the reactant tube. Record your observations. Discard the contents of the tube, and clean and dry the tube.

PART B

7. Obtain 5-mL samples of saturated solutions of calcium hydroxide, magnesium hydroxide, and barium hydroxide. Test each solution with pH paper. Record the pH of each solution.

PART C

8. Using the laboratory balance, measure out a 1-g sample of magnesium sulfate. Place it in a clean, dry test tube.

9. Repeat step 8 for calcium sulfate and barium sulfate.

10. Add 5 mL of distilled water to each tube. Using a glass stirring rod, stir each mixture thoroughly, getting as much of each solid to dissolve as possible. Record your observations of the relative solubilities of each of these compounds.

11. Conduct a flame test for calcium ions (Ca^{2+}) and for barium ions (Ba^{2+}). Dip the wire loop of a flame tester into the solution of calcium sulfate. Place the loop in the burner flame. Observe and record the color of the flame. Clean the loop and repeat the test on the barium sulfate solution.

PART D

12. Stand 3 clean, dry test tubes in the test tube rack. Using the 0.1 M solutions, add about 5 mL of the $MgCl_2$ solution to one tube, 5 mL of the $CaCl_2$ solution to a second tube, and 5 mL of $BaCl_2$ to the third tube.

13. To each of the solutions in the test tubes, add about 1 mL of the Na_2CO_3 solution. Record your observations.

OBSERVATIONS AND DATA

PART A

Ca + HOH: Result of test for H_2 gas

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Result of adding phenolphthalein

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Mg + HOH: Result of test for H_2 gas (before heating)

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Result of test for H_2 gas (after heating)

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_____

Result of adding phenolphthalein

_____

PART B

pH readings:

$Mg(OH)_2$ $Ca(OH)_2$ $Ba(OH)_2$

PART C

Apparent solubility:

$MgSO_4$ $CaSO_4$ $BaSO_4$

Flame test results:

Ca^{2+} Ba^{2+}

PART D

Observations:

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CONCLUSION AND QUESTIONS

1. Write balanced equations for each change that occurred as part of this experiment in steps 1, 4, 10, and 13.
2. Describe the reactivity of the metals in Group 2 in terms of their location in the group.
3. How does the reactivity of an alkaline earth metal compare with that of an alkali metal (Group 1) in the same period?
4. What oxidation states can the alkaline earth metals exhibit?
5. Why does the metallic character of the alkaline earth metals increase as you go down the group?