Name _____ Date _____ Class _____

Reactivity of Alkaline Earth Metals

Small Scale Lab 16

Text reference: ***Chapter 6***

Introduction

The elements in Group 2A (2) of the periodic table are called the alkaline earth metals. Why do they have such a strange-sounding name? They were given that name because they were first isolated from compounds in which they were combined with oxygen. These were called earths by early chemists. The *alkaline* part of the name came from the fact that they formed basic, or alkaline, solutions in water. The group is composed of beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra).

All alkaline earth metals have two valence electrons, which they tend to give up rather easily, making them quite reactive. In fact, they are so reactive that they are never found uncombined in nature. In order for these shiny white metals to remain in their unreacted state, they must be protected from air and water. Magnesium and calcium, for example, are obtained in their elemental state by a chemical process called electrolysis, and then stored in airtight containers.

In this investigation, you will explore the reactivity of magnesium and calcium, two of the more common alkaline earth metals. You will then compare the reactivity of these metals with that of aluminum, which is a member of Group 3A (13).

Pre-Lab Discussion

Read the entire laboratory investigation and the relevant pages of your textbook. Then answer the questions that follow.

1. What are some of the properties shared by alkaline earth metals?

   _____

   _____

2. How many valence electrons do the alkaline earth metals have in their elemental state? _____

3. What are some of the hazards of working with metals that are as active as the alkaline earth metals? What precautions should you follow? _____

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4. If a piece of metal, such as calcium or magnesium, reacts with atmospheric oxygen, would you expect the product to have a greater or lesser mass than the reacting metal? Why? _____

_____

_____

5. What does a pink color with phenolphthalein solution indicate? _____

_____

6. How should you dispose of the products of the reaction of calcium and water? _____

Problem

How do the activities of the alkaline earth metals magnesium and calcium compare to each other and to aluminum?

Materials

chemical splash goggles
laboratory apron
3 petri dishes
wax marking pencil
forceps
magnesium ribbon (Mg)
calcium metal turnings (Ca)
aluminum foil (Al)
micropipet
distilled water
micropipet with phenolphthalein solution
steel wool
wash bottle with distilled water
lab burner
striker or matches
crucible tongs
wire gauze square
aluminum oxide (Al_2O_3)
microspatula

Safety

Wear your goggles and lab apron at all times during the investigation. Avoid touching calcium metal or calcium oxide directly. Any skin or clothing that comes into direct contact with calcium metal or its reaction products should be washed with large quantities of water. If the exposed skin feels slippery, continue to rinse it with water.

Make sure no open flames are present in the laboratory when reacting calcium with water because the gas that is produced can be explosive. Carry out this reaction in a covered petri dish.

Make sure that everyone is finished with Part A before doing Part B. Tie back hair and loose clothing to avoid any fire hazard. When you burn the magnesium, avoid looking directly at the flame, which is hot and very bright. Note the caution alert symbols here and with certain steps of the Procedure. Refer to page *xi* for the specific precautions associated with each symbol.

Procedure

Part A

1. Put on your goggles and lab apron. Label three petri dishes and their covers *Mg*, *Ca*, and *Al*, using the marking pencil.
2. Remove the covers of the petri dishes and rest them open side up on your lab table. Use the forceps to place the following metal samples in the labeled petri dish covers: a 4-cm piece of Mg ribbon, a small piece of Ca turning, and a piece of aluminum foil about the size of the Mg ribbon. **CAUTION:** *Do not touch the calcium turning with your hands. It is corrosive.* Record the appearance of each kind of metal in Data Table 1.
3. Place three micropipets of distilled water into each of the petri dishes.

4. With the forceps, move the piece of calcium turning from the petri dish cover and place it into its petri dish. Place the cover over the petri dish immediately. **CAUTION:** *The reaction products of calcium and water can cause skin irritation. Observe the reaction through the plastic cover.* Record your observations now and again in one minute.
5. If any piece of metal is unreacted, lift the cover at an angle away from you and gently squirt the metal with one more pipetful of water. Place the cover over the petri dish immediately. Repeat if necessary until there is no further reaction.
6. Open the petri dish and place a drop of phenolphthalein on the reaction products. Record the color change, if any, that occurs.
7. Obtain a bit of steel wool and use it to clean the Mg ribbon. Record the appearance of the clean Mg ribbon.
8. Using the forceps, move the piece of magnesium from its cover and place it in the water in the petri dish. You need not place the cover over this dish. Watch closely for any sign of reaction. Record your observations in Data Table 1.
9. Place a drop of phenolphthalein on the piece of metal. Record any color changes or additional signs of reactions that occur over the next three minutes.
10. Repeat Steps 8 and 9, using the piece of aluminum. Record your observations in Data Table 1.
11. Using the forceps, remove and dry the solid pieces of magnesium and aluminum for use in Part B.

12. Using the wash bottle, rinse the products of the calcium metal reaction into the container your teacher has provided for calcium waste. Pour the solutions from the other petri dishes down the drain. Wash all the petri dishes with water and dry them.

13. If you do not go directly on to Part B, clean up your work area and wash your hands before leaving the laboratory.

Part B

14. Put on your goggles and lab apron. Place three micropipets of distilled water into the petri dishes labeled *Mg* and *Al*.

15. Light the lab burner. **CAUTION:** *The gases produced in Part A are explosive. Before lighting the burner, make sure everyone is finished with Part A.* Hold the magnesium ribbon over the flame with the crucible tongs. As soon as it lights, hold the burning magnesium over the wire gauze square. **CAUTION:** *Do not look directly at the burning magnesium, as it can damage your eyes. Keep loose hair and clothing away from the fire.* When the fire is out, examine the products of the burn and record your observations in Data Table 2.

16. Place the product of the burn into the water in the petri dish labeled *Mg* and add a drop of phenolphthalein solution. Record your observations.

17. Repeat Steps 15 and 16 with the aluminum foil. Record your observations. If attempts to burn the aluminum are unsuccessful, drop a microspatula of aluminum oxide into the water of the petri dish. Place a drop of phenolphthalein solution on the aluminum oxide and record your observations.

18. Wash the contents of the two petri dishes down the drain with excess water and dry the dishes. Clean up your work area and wash your hands before leaving the laboratory.

Observations

DATA TABLE 1 Observations of Alkaline Earth Metals

Step	Observations
(2) unreacted Ca	
(2) unreacted Mg	
(2) unreacted Al	
(4) Ca + water	
(5) Ca + water reaction products	
(6) Ca + water + phenolphthalein	
(7) Mg after cleaning with steel wool	
(8) Mg + water	
(9) Mg + water + phenolphthalein	
(10) Al + water	
(10) Al + water + phenolphthalein	

DATA TABLE 2 Comparisons of Alkaline Earth Metals

Reaction	Observations
(15) Mg burning	
(16) burned Mg + phenolphthalein	
(17) Al burning	
(17) burned Al (or Al_2O_3) + phenolphthalein	

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Critical Thinking: Analysis and Conclusions

Part A

1. Elemental (unreacted) calcium and magnesium metal are shiny when they are pure. If the metals you worked with were not shiny, explain why this was so. *(Making inferences)* _____

2. Would you describe the reaction of calcium in water as being exothermic (energy releasing) or endothermic (energy absorbing)? Use your observations as evidence to support your answer. *(Interpreting data)*

3. Phenolphthalein appears pink in a basic, or alkaline, solution. Did the reactions of the alkaline earth metals with water produce alkaline solutions? Explain your answer. *(Drawing conclusions)* _____

4. When a solution of calcium hydroxide, $Ca(OH)_2(aq)$, becomes saturated, a white solid, calcium hydroxide $Ca(OH)_2(s)$, appears. Did your calcium hydroxide solution become saturated? How do you know? *(Drawing conclusions)* _____

5. Did magnesium metal react with water to form a gas and an alkaline solution? Explain your answer in light of your observations. *(Drawing conclusions)* _____

6. Groups of metals change in reactivity from the top to the bottom of the periodic table. What evidence do you have that there was a pattern of reactivity in the alkaline earth metals? *(Making comparisons)* _____

7. Was there any evidence that aluminum reacted with water? *(Interpreting data)* _____

8. Are magnesium and calcium more reactive with oxygen in the air than is aluminum? Support your answer. *(Interpreting data)* _____

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9. What can you conclude from the color of the solutions made from the magnesium and aluminum oxides when phenolphthalein was added? *(Drawing conclusions)* _____

Critical Thinking: Applications

1. Look at strontium (Sr) in the periodic table. Would you expect it to be more or less reactive than calcium? Explain. *(Making predictions)* _____

2. Which of the metals in this lab could you use for camera flashbulbs? Why? *(Applying concepts)* _____

3. Would you expect to find calcium metal used in conducting wire or structural materials? Why or why not? *(Making inferences)* _____

4. Aluminum is a metal commonly used in making conducting wires, equipment, and structural materials. Use the results of your experiment to help to explain why it is used. *(Applying concepts)* _____

Going Further

1. Research some of the commercial uses of magnesium and calcium. Relate the properties of these metals to their uses. Write a report summarizing your findings.
2. Calcium and magnesium compounds are commonly found in living systems. Use biochemical or biological reference materials in the library to determine what role these compounds play. Use this information to create a bulletin board display.
3. Alkaline earth compounds are sometimes incinerated in order to dispose of them. Research Chapters 18 and 19 in your text, or information in other chemistry books, to determine which oxides commonly form. Find out what environmental problems these materials create when disposed of in this fashion. Report your findings to your class in a brief oral report.