chemical equation for this reaction is shown in *Equation 1,* where the abbreviations (aq) and (s) refer to aqueous solutions and solid precipitates, respectively.

$$CaCl_2(aq) + Na_2CO_3(aq) \rightarrow CaCO_3(s) + 2NaCl(aq) \quad \textit{Equation 1}$$

calcium chloride *sodium carbonate* *calcium carbonate* *sodium chloride*

Experiment Overview

The purpose of this experiment is to identify periodic trends in the activity and solubility of the alkaline earth metals. In Part A, the reactions of magnesium, calcium, and aluminum with water and acids will be compared in order to determine the trend in metal activity within a group (Mg vs. Ca) and across a period (Mg vs. Al) in the periodic table. In Part B, the solubility of magnesium, calcium, strontium, and barium compounds will be studied and used to identify an unknown alkaline earth metal.

Pre-Lab Questions

1. Read the entire procedure and the recommended safety precautions. Do you think extra pieces of calcium or magnesium metal should be disposed of down the drain? Why or why not?

2. The ionization energy of an element is defined as the amount of energy required to remove an electron from an individual atom. The following table gives the ionization energy (in units of kilojoules per mole) for five metals, listed in alphabetical order. Locate each of these metals on the periodic table and arrange them in order of rows and columns as in the periodic table.

   (a) Describe the periodic trend in the ionization energy of elements within a group.

   (b) Describe the periodic trend in the ionization energy of elements across a period.

Metal	Calcium	Magnesium	Potassium	Sodium	Strontium
Ionization Energy	590	738	419	496	549

Materials

Aluminum foil, Al, 2-cm square, 2
Barium chloride, $BaCl_2$, 0.1 M, 3 mL
Calcium, turnings, Ca, 2 pieces
Calcium chloride, $CaCl_2$, 0.1 M, 3 mL
✓Magnesium ribbon, Mg, 1-cm piece, 2
Magnesium chloride, $MgCl_2$, 0.1 M, 3 mL
Strontium chloride, $SrCl_2$, 0.1 M, 3 mL
Unknown metal chloride solution, 0.1 M, 3 mL
Water, distilled or deionized
Matches (optional)
Hydrochloric acid, HCl, 0.5 M, 3 mL
Potassiun iodate, KIO_3, 0.2 M, 5 mL
Sodium carbonate, Na_2CO_3, 1 M, 5 mL
Sodium sulfate, Na_2SO_4, 1 M, 5 mL
Forceps
Litmus paper, red, 3 pieces
Paper, white and black, 1 sheet each
Pipets, Beral-type, 10
Reaction plate, 24-well
Thermometer

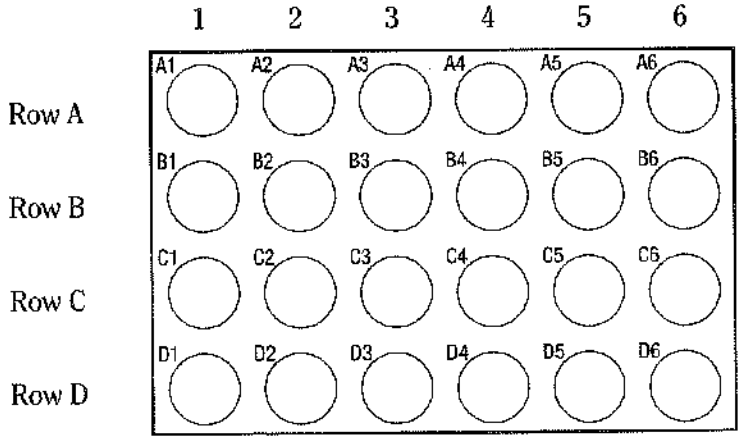
Safety Precautions

Calcium and magnesium are reactive, flammable solids and possible skin irritants. Use forceps or a spatula to handle these metals. Hydrochloric acid is toxic by ingestion and inhalation and is corrosive to skin and eyes; avoid contact with body tissues. Strontium and barium compound are toxic by ingestion. Potassium iodate solution is moderately toxic and a strong irritant. Avoi contact of all chemicals with eyes and skin. Wear chemical splash goggles and chemical-resistant gloves and apron. Always wash hands thoroughly before leaving the laboratory.

Procedure

Part A. Activity of Metals

1. In a weighing dish or small beaker, obtain 2 small pieces of calcium turnings.
2. Obtain 2 small pieces of magnesium ribbon, approximately 1-cm each, and a short piece of aluminum foil.
3. Place a 24-well reaction plate on top of a sheet of white paper, as shown in the following figure. Note that each well is identified by a unique combination of a letter and a numbe where the letter refers to a horizontal row and the number to a vertical column.



4. Use a pipet to add 20 drops of distilled water to wells A1–A3.
5. Test the water in wells A1–A3 with a piece of red litmus paper and record the initial colo for this "~~litmus~~ test" in Data Table A.
6. Use forceps to add one piece of calcium (step 1) to well A1.
7. Use forceps to add one piece of magnesium ribbon to well A2.
8. Tear off a 2-cm piece of aluminum foil and roll it into a loose ball. Add the aluminum metal to well A3.
9. Observe each well and record all immediate observations in Data Table A. If no changes are observed in a particular well, write NR (No Reaction) in the data table.
10. Test the water in wells A1–A3 with a piece of red litmus paper and record the color changes for this litmus test in Data Table A.

11. Continue to watch each well for 1–2 minutes. Record any additional observations comparing the *rates of reaction* in Data Table A.
12. Use a pipet to add 20 drops of 0.5 M HCl to wells C1–C3 (the first three wells in Row C). Measure the initial temperature of the solutions in well C1–C3 and record the values as an "observation" in Data Table A.
13. Use forceps to add one piece of calcium turnings (Step 1) to well C1.
14. Use forceps to add one piece of magnesium ribbon to well C2.
15. Tear off a 2-cm piece of aluminum foil and roll it into a loose ball. Add the aluminum metal to well C3.
16. Observe each well and record all immediate observations in Data Table A. If no changes are observed in a particular well, write NR in the data table.
17. Using a thermometer, measure the temperature of each solution in wells C1–C3. Record the temperature of each solution as an observation in Data Table A.
18. *(Optional)* Is there evidence that a gas is being produced in wells C1–C3? Test the combustion property of the gas by bringing a lit match to the space just above each well C1–C3. Record any observations for this "match test" in Data Table A.
19. Continue to watch each well for 1–2 minutes. Record any additional observations comparing the *rates of reaction* in Data Table A.
20. Dispose of the well contents as instructed by your teacher. Rinse the reaction plate with distilled water before using the plate again in Part B.

Part B. Solubility of Alkaline Earth Metal Compounds

21. Place the 24-well reaction plate on top of a sheet of *black paper*.
22. Referring to Data Table B as a guide, use a pipet to add 20 drops of alkaline earth metal solutions to the appropriate wells, as follows:
    - Magnesium chloride to wells A1–C1
    - Calcium chloride to wells A2–C2
    - Strontium chloride to wells A3–C3
    - Barium chloride to wells A4–C4.
23. Use a clean pipet to add 20 drops of the unknown alkaline earth metal solution to wells A5–C5.
24. Referring to Data Table B as a guide, use a clean pipet to add 20 drops of testing solution to the appropriate wells, as follows:
    - Sodium carbonate to wells A1–A5
    - Sodium sulfate to wells B1–B5
    - Potassium iodate to wells C1–C5
25. Record observations in Data Table B as follows: if a solid forms in a well, write PPT (precipitate) in the appropriate circle in the data table. If no solid is observed, write NR (no reaction) in the appropriate circle in the data table.
26. Dispose of the contents of the reaction plate as instructed by your teacher.

Name: _____

Class/Lab Period: _____

Periodic Trends and the Properties of Elements

Data Table A. *Activity of Metals*

		Calcium	Magnesium	Aluminum
Reaction with H_2O	Observations			
	Litmus test			
Reaction with HCl	Observations			
	Match test (optional)			

Data Table B. *Solubility of Alkaline Earth Metal Compounds*