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Comparing Chemical Properties Within a Group

Background Information

The properties of elements repeat in a regular pattern across the periods in the periodic table. From left to right across each period, elements tend to be less metallic and more nonmetallic. Elements in the same group in the table have similar properties because they have the same number of valence electrons. A valence electron is an electron that is in the highest occupied energy level of an atom. These electrons play a key role in chemical reactions. The properties of elements within a group are not identical because the valence electrons are in different energy levels.

The elements in Group 2A in the periodic table are known as alkaline earth metals. Many properties of alkaline earth metals change in a predictable way from top to bottom within the group. One of those properties is reactivity, or the tendency to combine chemically with other substances. The reactivity of an element can be demonstrated by how the element reacts or how its compounds react with other substances.

The formation of a precipitate in a solution is one clue that a chemical change has occurred. A precipitate is a solid that forms and separates from a liquid mixture. In this investigation, you will mix solutions of similar alkaline earth compounds with a set of test solutions and observe whether or not precipitates form. You will use the results to predict how the reactivity of the alkaline earth metals changes from top to bottom within Group 2A.

Problem

How does reactivity vary among the alkaline earth metals?

Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

1. **Controlling Variables** Why is it important not to mix the test solution in one well with the solution in another well on your spot plate?

   _____

   _____

2. **Designing Experiments** Why is the order of the rows in the well plate the same as the order of elements in the periodic table?

   _____

   _____

3. **Controlling Variables** What are the manipulated, responding, and controlled variables in this investigation?

_____

_____

4. **Predicting** Write a prediction of how the reactivity of the alkaline earth metals will change from the top of Group 2A to the bottom.

_____

Materials *(per group)*

spot plate

sheet of notebook paper

dropper bottles containing solutions of the following compounds:

- magnesium nitrate
- barium nitrate
- calcium nitrate
- potassium carbonate
- potassium chromate
- potassium sulfate
- strontium nitrate

Safety

Put on safety goggles and a lab apron. Be careful to avoid breakage when working with glassware. Some chemicals used in this investigation are toxic. Always use special caution when working with laboratory chemicals, as they may irritate the skin or stain skin or clothing. Never touch or taste any chemical unless instructed to do so. Follow your teacher's instructions for disposing of used chemicals. Wash your hands thoroughly after carrying out this investigation. Note all safety alert symbols next to the steps in the Procedure and review the meaning of each symbol by referring to the Safety Symbols on page xiii.

Procedure

1. Place the spot plate in the center of a sheet of notebook paper, as shown in Figure 1. There should be four wells per column and three wells per row.
2. Along the side of the notebook paper next to each of the four rows of wells, write the names of the four alkaline earth metals that are present in each nitrate compound you are using. Write the names in the order shown in Figure 1. This is the order of these four elements in Group 2A.
3. Label the paper above each of the three columns of wells, as shown in Figure 1.

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4. Place 3 drops of potassium carbonate in each of the four wells under the label Potassium Carbonate. Place 3 drops of potassium sulfate in each of the four wells under the label Potassium Sulfate. Place 3 drops of potassium chromate in each of the four wells under the label Potassium Chromate. Make sure that each solution is placed in the wells of only column one. **CAUTION:** *Some chemicals used in this investigation are toxic. Be careful not to get the solutions on your skin.*

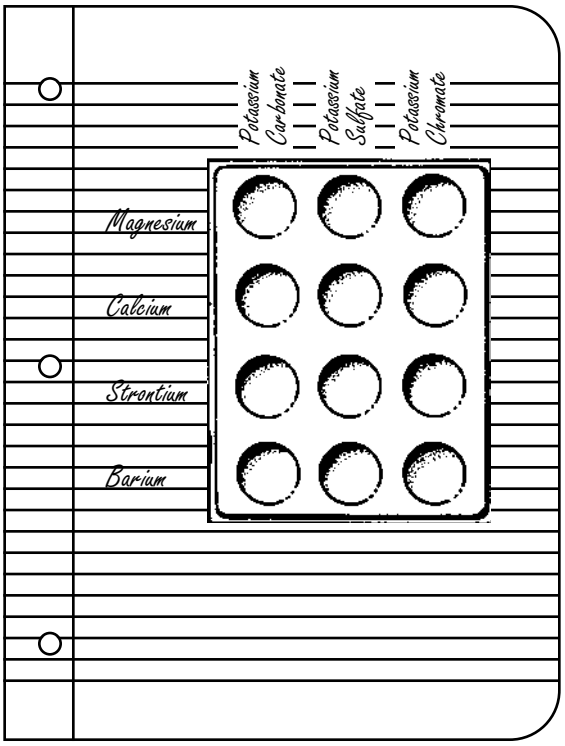

Figure 1

5. Place 3 drops of magnesium nitrate in each of the three wells in the row labeled Magnesium. Observe whether or not a precipitate forms in each well and record the results in the data table.
6. Place 3 drops of calcium nitrate in each of the three wells in the row labeled Calcium. Observe whether or not a precipitate forms in each well and record the results in the data table.
7. Place 3 drops of strontium nitrate in each of the three wells in the row labeled Strontium. Observe whether or not a precipitate forms in each well and record the results in the data table.
8. Place 3 drops of barium nitrate in each of the three wells in the row labeled Barium. Observe whether or not a precipitate forms in each well and record the results in the data table.
9. Follow your teacher's instructions for disposing of the chemicals on the spot plate. Wash the spot plate and your hands thoroughly with soap or detergent and warm water.

Observations

DATA TABLE

Alkaline Earth Metal	Carbonate	Sulfate	Chromate
Magnesium			
Calcium			
Strontium			
Barium			

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Analysis and Conclusions

1. **Observing** What evidence did you observe of a chemical change occurring in any of the wells?

_____

2. **Analyzing Data** Which alkaline earth metal formed the smallest number of precipitates?

_____

3. **Analyzing Data** Which alkaline earth metal formed the most precipitates?

_____

4. **Drawing Conclusions** Based on your data, list the alkaline earth metals in order of their reactivity, from most reactive to least reactive. What is the relationship between reactivity and the location of each alkaline earth metal in the periodic table?

_____

_____

_____

5. **Evaluating and Revising** Did your data support or contradict your prediction?

_____

6. **Predicting** Group 1A in the periodic table contains alkali metals. Based on your investigation of the Group 2A elements, which element in Group 1A, other than francium, would you predict to be most reactive? Least reactive?

_____

7. **Predicting** Can the results for reactivity in this investigation be applied to the elements in Group 7A? Explain your prediction.

_____

_____

_____

~~Go Further~~

~~If you had a solution containing a mixture of magnesium nitrate, strontium nitrate, and barium nitrate, how could you separate the mixture? (*Hint:* Review the information in the data table.)~~