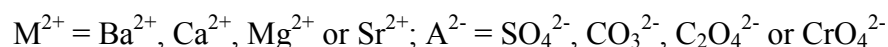
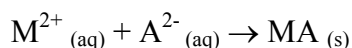


Lab # 5: The Behavior of Two Families in the Periodic Table**INTRODUCTION**

The Periodic Table arranges the elements in order of increasing atomic number in horizontal rows of such length that elements with similar properties recur periodically, i.e., they fall directly beneath each other in the table. The elements in a given vertical column are referred to as a family. By noting the gradual trends in properties of the members of a family, it is possible to arrange them in the order in which they fall in the Periodic Table. This is what you will be asked to do in this experiment for two particular families.

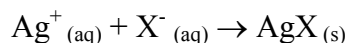
The families to be studied are the alkaline earths, Group IIA, and the halogens, Group VIIA. The alkaline earths are all active metals and include barium, beryllium, calcium, magnesium, radium and strontium. Beryllium compounds, rarely encountered, are often very poisonous and radium is highly radioactive, so we shall not include these two elements in the experiment. The elements in the halogen family are astatine, bromine, chlorine, fluorine and iodine. Of these we will omit astatine, which is radioactive, and fluorine, which is the most chemically reactive of all the elements and very dangerous to work with.

The experiments with the alkaline earths involve determining the relative solubilities of the salts formed by the alkaline earth cations with sulfate, carbonate, oxalate and chromate ions. When solutions containing these M^{2+} cations are mixed with the above A^{2-} anions, the following reaction will occur if the salt MA is not very soluble:

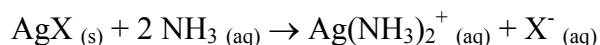


The trends in solubilities of these salts are consistent with the order of the IIA elements in the Periodic Table and can be used to establish that order.

The halides may be identified by the relative solubilities of the salts formed between the silver ion and the various halide ions. If a solution of silver nitrate, $AgNO_3$, is added to a solution of a halide salt, NaX , where X is a halide (Cl^- , Br^- or I^-) the following reaction will occur:



An insoluble precipitate of AgX forms immediately. This precipitate, although it is very insoluble in water, may dissolve in NH_3 solutions, since there the following reaction tends to occur:



Lab # 5: The Behavior of Two Families in the Periodic Table

The tendency for this reaction to proceed increases with increasing NH_3 concentration and with the increasing solubility of the silver halide.

The solubilities of the silver salts of the halides in NH_3 solutions will allow you to arrange the halogens in the order in which they should appear in the Periodic Table.

Given the properties of the alkaline earths and the halogens as observed in this experiment, it is possible to develop a systematic procedure for determining the presence of any IIA cation and any given halide ion in a solution. Your unknown solution will contain a single alkaline earth halide.

PROCEDURE

1. Obtain ONE unknown and record the unknown number.
2. Relative Solubilities of Some Salts of the Alkaline Earths. Add about 1 mL (approximately 12 drops) of 0.1 M solutions of the nitrate salts of barium, calcium, magnesium and strontium to separate small or medium test tubes. Add about 1 mL of your unknown to another separate test tube. To each tube add 1 mL of 1 M H_2SO_4 and shake the test tube gently to stir. Record your results in the table, noting whether a precipitate forms, as well as any characteristics that might distinguish it.

Repeat the experiment by mixing 1 mL of 1 M Na_2CO_3 (the precipitating reagent) with fresh portions in clean test tubes of the alkaline earth nitrate salts and your unknown. Record your observations. Then test for the solubilities of the oxalate salts using 1 mL of 0.25 M $(\text{NH}_4)_2\text{C}_2\text{O}_4$. Finally, determine the relative solubilities of the chromate salts. Mix 5 mL of K_2CrO_4 and 5 mL of acetic acid, then add 2 mL of this mixture to each alkaline earth cation solution and your unknown.

All wastes from this step must go in the Heavy Metal Waste container.

3. Solubilities of Silver Halide Salts. Add 1 mL of 0.1 M solutions of the three sodium halides to separate SMALL test tubes. Add 1 mL of your unknown to a separate SMALL test tube. Add 1 mL of 0.1 M AgNO_3 to each test tube and shake gently. Note the color of each precipitate. Centrifuge and discard the liquid. To the precipitate add 2 mL of 5 or 6 M NH_3 (NH_4OH) and stir well with a glass stirring rod. If the solid does not dissolve, centrifuge and decant the liquid and add 2 mL of concentrated (15 M) NH_3 (NH_4OH). Stir well with a glass stirring rod. Record your results.

All wastes from this step must go in the Heavy Metal Waste container.

Lab # 5: The Behavior of Two Families in the Periodic Table**DATA****1. Solubilities of Salts of the Alkaline Earths**

	Ba(NO₃)₂	Ca(NO₃)₂	Mg(NO₃)₂	Sr(NO₃)₂	Unknown
1 M H₂SO₄					
1 M Na₂CO₃					
0.25 M (NH₄)₂C₂O₄					
1 M K₂CrO₄ and 1 M acetic acid					

s = precipitate (solid) forms; aq = no precipitate (aqueous)

Note the color, amount or any other characteristic of the precipitates.

Consider the relative solubilities of the Group IIA cations in the various precipitating reagents. On the basis of the trends you observed, list the four alkaline earths in the order in which they should appear in the Periodic Table. **Start with the one which forms the most soluble oxalate.**

(most soluble **cation**)

(least soluble **cation**)

Why did you arrange the cations as you did?

NAME _____

General Chemistry I (FC, 09 - 10)

Lab # 5: The Behavior of Two Families in the Periodic Table**2. Solubilities of the Salts of the Halides**

	NaBr	NaCl	NaI	Unknown
AgNO₃				
Precipitate from first part of 2 and 6 M NH₃				
Any remaining precipitate from the second step and 15 M NH₃				

Again note solubility and any other distinguishing characteristics.

On the basis of the above tests, arrange the halide ions in the order in which they should be listed in the Periodic Table. Start with the one which forms the most soluble silver salt.

_____ (most soluble **anion**)

_____ (least soluble **anion**)

Instructor's Initials _____

RESULTS

Cation present _____

Anion present _____

Unknown # _____

Formula of the compound _____

Lab # 5: The Behavior of Two Families in the Periodic Table**PRESTUDY**

1. (1) Consider the solids MgCl_2 and MgI_2 . 54.25 g of magnesium chloride and 148 g of magnesium iodide will dissolve separately in 100 mL portions of cold water. Using the above information, would you expect magnesium fluoride to be more or less soluble than magnesium bromide? Why?

2. (9) Complete and balance the following equations. Include state notations for each of the products. Each reaction has only **one** precipitate and only **one** soluble compound formed. (You do not have to write net ionic equations.)

