

# IDENTIFICATION OF AN UNKNOWN SALT

## Introduction

In this laboratory you will apply some of the descriptive chemistry you have learned over the course of the semester to determine the chemical identity of an unknown salt. Your salt will be composed of one cation and one anion from the list below.

### Possible Cations



### Possible Anions



You will use some simple tests, such as flame tests and solubility tests, to determine the chemical identity of your unknown salt.

## Dissolving Your Unknown Salt

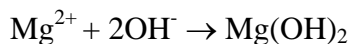
Your unknown will be provided as a solid salt. Most of the chemical tests you will be using to identify the ions present call for a solution of your unknown. Therefore, your first step should be preparing a solution of your unknown. To do this, weight out approximately 0.30-0.40 grams of the unknown salt and dissolve it in 10 mL of distilled water. This should be adequate for all of your chemical tests.

## Testing for the Cation

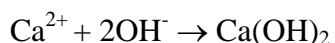
1. Several of the cations can be identified by their flame tests. To perform a flame test, obtain a length of Nichrome wire and make a small loop in the end of the wire. Dip the wire into your solution, being sure that some solution is caught in the loop. Insert the loop of wire into tip of the inner cone of a Bunsen burner flame and note the color that it imparts to the flame.

Exercise good judgement in performing flame tests. If left in the flame long enough, the wire itself may cause the flame to turn yellow-orange in color, which could be mistaken for a positive test for the sodium ion. If you have any doubts about the results of the test, try it with a known solution.

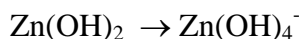
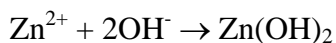
2. Several of the cations ions will precipitate with  $\text{OH}^-$ . Add approximately ten drops of your unknown solution and a few drops of 6 M NaOH. If  $\text{Mg}^{2+}$  is present a precipitate should form.



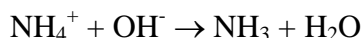
$\text{Ca}(\text{OH})_2$  will also precipitate, depending upon the concentrations of the ions.



Zinc will form a precipitate with dilute  $\text{OH}^-$  but this precipitate dissolves in excess  $\text{OH}^-$  to form a soluble complex ion. To test for the presence of zinc, add approximately 10 drops of your unknown solution to a test tube, followed by a few drops of 3M  $\text{NH}_3$ . If a milky-white precipitate forms, add a few drops of 6M NaOH. If this precipitate redissolves, the  $\text{Zn}^{2+}$  ion is present.

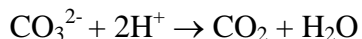


3. To test for the ammonium ion, add a small portion of solid unknown to a small test tube, followed by approximately 10 drops of 6M NaOH. Cautiously check for the odor of ammonia by wafting the air over the test tube towards your nose. (Do NOT stick your nose over the top of the test tube!)

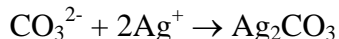
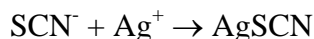
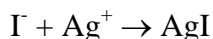
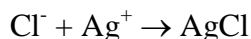


### Testing for the Anions

1. To test for the presence of the carbonate ion, add a small portion of solid unknown to a small test tube, followed by a few drops of 1M HCl. The evolution of a gas (carbon dioxide) indicates the presence of the carbonate ion.

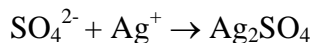


2. Nearly all of the anions will precipitate with the silver ion. Place approximately ten drops of unknown solution in a test tube and add a few drops of 0.10 M  $\text{AgNO}_3$ .



The colors of the above precipitates may give you some indication of the anion present in your known; AgI is a pale-yellow solid, whereas all of the others are white.

The sulfate ion may or may not also precipitate with  $\text{Ag}^+$ , depending upon the concentrations of the ions.



3. The  $\text{SCN}^-$  ion forms the blood-red complex ion  $\text{FeSCN}^{2+}$  when a solution containing the  $\text{Fe}^{3+}$  ion is added. Place approximately ten drops of unknown solution in a test tube and add a few drops of a 0.10 M  $\text{Fe}(\text{NO}_3)_3$ .

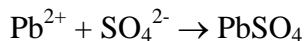
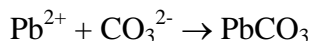


Usually this reaction is used to test for the presence of  $\text{Fe}^{3+}$  ion. In a sense we are doing the reverse of this and using it to test for the presence of the  $\text{SCN}^-$  ion.

4. The  $\text{I}^-$  ion forms a yellow-orange precipitate with  $\text{Pb}^{2+}$ . Place approximately ten drops of unknown solution into a test tube and add a few drops of 0.10 M  $\text{Pb}(\text{NO}_3)_2$ .



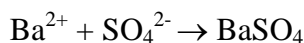
The carbonate and sulfate ions will form a white precipitate with the  $\text{Pb}^{2+}$  ion. However, these precipitates are white in color.



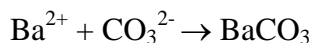
The chloride ion may also precipitate with  $\text{Pb}^{2+}$ , depending upon the concentration of the ions. This precipitate is also white in color.



5. The  $\text{SO}_4^{2-}$  ion forms an insoluble salt with the  $\text{Ba}^{2+}$  ion. Place approximately ten drops of unknown solution into a test tube and add a few drops of  $\text{Ba}(\text{NO}_3)_2$  solution.



Once again, a few of the other ions may precipitate with the  $\text{Ba}^{2+}$  ion.



6. You may conclude the nitrate ion is present only after all of the other anion tests have failed.

If you have doubts regarding any of the chemical tests above, it is recommended that you perform the test on a known. The following known solutions will be provided:

$\text{NH}_4^+$  known – (solid ammonium chloride)

$\text{Li}^+$  known – (0.10 M lithium chloride)

$\text{Na}^+$  known (0.10 M sodium nitrate)

$\text{K}^+$  known (0.10 M potassium nitrate)

$\text{Mg}^{2+}$  known (0.10 M magnesium nitrate)

$\text{Ca}^{2+}$  known (0.10 M calcium nitrate)

$\text{Zn}^{2+}$  known (0.10 M zinc nitrate)

$\text{CO}_3^{2-}$  known (solid sodium carbonate)

$\text{Cl}^-$  known – (0.10 M sodium chloride)

$\text{I}^-$  known – (0.10 M sodium iodide)

$\text{SO}_4^{2-}$  known (0.10 M sodium sulfate)

$\text{SCN}^-$  known (0.10 M potassium thiocyanate)

<b>Pre-Laboratory</b>	<b>Name:</b>
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1. Several of the cation and anion combinations listed CANNOT be used because they form a salt that is not soluble in water. Consult a general textbook for general solubility rules and list at least two salts that fall into this category.

2. Which of the possible cations can be identified by their flame tests? List these ions and the colors associated with their flame tests.

3. Which of your anions form a precipitate with the  $\text{Ag}^+$  ion? Which precipitate with the  $\text{Pb}^{2+}$  ion? Which precipitate with the  $\text{Ba}^{2+}$  ion?

4. The test for  $\text{Cl}^-$  involves precipitation as  $\text{AgCl}$ . However, several other anions precipitate with  $\text{Ag}^+$ . How will you know for sure if your unknown contains the  $\text{Cl}^-$  ion?

<b>In-Laboratory Report Page 1</b>	<b>Name:</b>
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**Unknown Number:**

**Identity of Cation:**

**Identity of Anion:**

Record your observations regarding any chemical tests that you performed in the space below.

<b>In-Laboratory Report Page 2</b>	<b>Name:</b>
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**Unknown Number:**

**Identity of Cation:**

**Identity of Anion:**

Record your observations regarding any chemical tests that you performed in the space below.