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School of Maths & Science Science Practical

Unknown Inorganic Tests

◆ Aim

At the end of this experiment you should be able to:

1. Carry out a flame test
2. Carry out tests for various group II cations and group VII anions
3. Carry out tests for various common anions (e.g. SO_4^{2-} , CO_3^{2-} etc.)
4. Write equations / ionic equations where appropriate

◆ Introduction

Chemistry often involves the testing for ions in solution, e.g. Pb^{2+} , SO_4^{2-} . Some ions occur naturally, e.g. Cl^- , Na^+ and in medicinal drugs their presence is often allowed as long as it's below a certain limit. In this experiment you will learn how to identify some of the more common ions. The tests are *qualitative* rather than *quantitative* which means you are looking to see whether the ion is present or not, but not the quantity present.

- Identify metal ions in solids and solutions by use of flames tests
- Identify group II ions by their reactions and solubilities with sulfate and hydroxide
- Identify group VII ions by various reactions and product solubilities
- Identify the presence of common anions by appropriate tests

◆ Safety



Control Measures

- The wearing of **safety glasses** and a **laboratory coat** at all times will be sufficient to take account of most hazards and significant risks.
- All waste is to be placed in the labelled container immediately after use.
- You are reminded of the need of good laboratory practice in order to maintain a safe working environment.



Hazards

Corrosive

Conc. hydrochloric acid, sodium hydroxide, nitric acid, ammonia (both conc. and dil.), limewater, copper sulfate



Harmful/Irritant

magnesium chloride, barium chloride, copper (II) chloride, potassium bromide, potassium iodide, sodium bromide, calcium chloride, sodium sulfate, lithium bromide, sodium carbonate, potassium iodide, potassium sulfate, silver nitrate, calcium carbonate solid, sodium nitrate.



Toxic

Copper (II) chloride, barium chloride, silver nitrate, iron sulfate, conc ammonia

◆ Procedure 1; Flame Tests

The presence of certain metal ions in a solid or solution can be shown by the characteristic colour that they impart to a Bunsen burner flame. Flame tests are normally best performed on halides because these are the most volatile of the salts.

Solids:

If testing a solid, moisten a clean platinum wire with concentrated hydrochloric acid and bring into contact with the solid so that some of the latter adheres to the wire. Hold the wire on the edge of a non-luminous Bunsen flame. Observe the colour.

Solutions:

1. To clean the wire, dip it into the test tube of 1M of HCl and heat the wire in the hottest part of the flame until no colour shows.
2. When the platinum wire is clean, dip the wire in the test tube containing a 0.5 mol dm⁻³ solution and hold it in the hottest part of the flame. Record your observation of the colour of the flame on the data table.
3. Repeat the process of cleaning the platinum wire. Now get ready to test another solution.
4. Test all of the solutions and make sure that you record the colour of the flame for each element on the Data Table.
5. Check your flame colours to known results.

◆ Table of Observations

<u>Solid</u>	<u>Ion Of Interest</u>	<u>Colour Of Flame Observed</u>
lithium chloride		
barium chloride		
potassium bromide		
sodium bromide		
copper (II) chloride		
potassium iodide		
calcium carbonate solution		

◆ Procedure 2:

Test 1; Reactions of group I and II ions

Use test tubes for the following tests

<i>Test</i>	<i>Observation</i>
1. Add dilute sodium carbonate to a solution of potassium chloride solution	
2. Add dilute sodium carbonate to a solution of magnesium chloride solution	
3. Add dilute sodium carbonate to a solution of calcium chloride solution	
4. Add dilute sodium carbonate to a solution of barium chloride solution	

Write equations for the reactions observed (write ionic equations where possible):

1.

2.

3.

◆ **Test 2; Reactions of sulfates of Group 2 Ions**

Use test tubes for the following tests

<i>Test</i>	<i>Observation</i>
1. To a solution of sodium sulfate, add dilute HCl followed by $MgCl_2$ solution	
2. To a solution of potassium sulfate, add dilute HCl followed by $MgCl_2$ solution	
3. To a solution of sodium sulfate, add dilute HCl followed by $CaCl_2$ solution	
4. To a solution of potassium sulfate, add dilute HCl followed by $CaCl_2$ solution	
5. To a solution of sodium sulfate, add dilute HCl followed by $BaCl_2$ solution	
6. To a solution of potassium sulfate, add dilute HCl followed by $BaCl_2$ solution	

What are the reacting ions in the tests 5 and 6?

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Write an ionic equation for the reaction that occurs.

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What can you conclude about the relative solubilities of magnesium sulfate, calcium sulfate, and barium sulfate?

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◆ **Test 3; Reactions of group 2 Ions**

Add dilute aqueous sodium hydroxide dropwise to solutions of the following group II salts and record how many you need to add in order to observe a precipitate.

<i>Test solution</i>	<i>No. of drops before precipitate is observed</i>	<i>Colour of precipitate</i>
Magnesium salt		
Calcium salt		
Barium salt		

What is the trend in group II hydroxide solubility?

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When we add a dilute solution of sodium hydroxide to a dilute solution of the above ions we normally only observe a precipitate in one case. Which is it?

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Write an **ionic** equation for the reaction.

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Summarise

Based on the tests performed here, write a quick summary of the tests you would perform and results you would expect to distinguish between solutions containing K^+ , Ca^{2+} , Mg^{2+} , and Ba^{2+}

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◆ **Procedure 3; Reactions of group VII**

Group VII ions take part in redox and displacement reactions which depend on their strength as reducing agents. They also have important precipitation reaction

- 1) Add 1 cm³ of the silver nitrate solution to 2 cm³ of the halide solution in a test tube
- 2) Divide the resultant solution into two parts:
 - (a) To one part add dilute NH₃ solution (i.e. NH₄OH)
 - (b) To the second part add conc. NH₃ solution (in fumehood)

<i>Halide solution</i>	<i>On adding AgNO₃ Give name and colour of precipitate</i>	<i>Add Dil. NH₃</i>	<i>Add Conc. NH₃</i>
sodium chloride			
sodium bromide			
potassium iodide			

Write ionic equations for the reactions involving the halide ion and silver ion.

- 1.....
- 2.....
- 3.....

Which silver halide is soluble:

1. in dil aqueous ammonia
2. in conc aqueous ammonium
3. is barely soluble in concentrated aqueous ammonia

◆ **Procedure 4; Testing for common anions: CO_3^{2-} and SO_4^{2-}**

1) Test for a carbonate, CO_3^{2-}

Take 2 cm³ of sodium carbonate solution and place in a test tube. Add 1 cm³ of dilute hydrochloric acid. If effervescence is observed and a colourless gas is evolved, collect some gas in a pipette and bubble through limewater. If a carbonate is present, carbon dioxide will be evolved, which will turn limewater milky.

Write an ionic equation for the reaction that occurs

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2) Test for a sulfate, SO_4^{2-} , the Barium Chloride Test

Take 2 cm³ of the solution under test and add 1 cm³ of dilute hydrochloric acid, followed by 1 cm³ of barium chloride solution. A white precipitate of barium sulfate indicates the presence of a sulfate

(The acid is added to prevent the precipitation of other substances - barium sulfate is insoluble in dilute hydrochloric acid.)

Write an ionic equation for the reaction that occurs

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Introduction to Inorganic Tests

Preliminary Questions

◆ Required Reading

Background information for AS inorganic chemistry.

You are advised to remember the following solubility rules:

- ◆ All nitrates are soluble
- ◆ All salts of group I metals and ammonium salts are soluble
- ◆ All carbonates are **insoluble** except those of group I
- ◆ All sulfates are soluble except those of barium and lead
- ◆ All chlorides (bromides and iodides) are soluble except those of silver and lead

increase sol. up group

MgSO ₄	↑ most
soluble	
CaSO ₄	soluble
SrSO ₄	soluble

For hydroxides

- ◆ Hydroxides of group I, ammonium, calcium and barium are soluble. All other hydroxides are **insoluble**. (*In fact even calcium and barium hydroxides only will dissolve to give dilute solutions but treat as soluble.*)

decrease sol. down group

Mg(OH) ₂	↓ insoluble
Ca(OH) ₂	soluble
Ba(OH) ₂	most soluble

◆ Questions

Which of these will be soluble in water?

- ◆ Calcium carbonate
- ◆ Calcium chloride
- ◆ **Sodium hydroxide**
- ◆ Magnesium nitrate
- ◆ Silver iodide
- ◆ Barium sulfate
- ◆ Barium hydroxide
- ◆ Sodium carbonate
- ◆ Magnesium carbonate
- ◆ Barium nitrate
- ◆ Barium chloride
- ◆ Calcium hydroxide
- ◆ Magnesium hydroxide

Flame test:

Magnesium	-----
Calcium	brick (orangey) red
Strontium	crimson
Barium	apple green
Sodium	yellow
Potassium	lilac

Colours of Precipitates

Almost all precipitates you will encounter will be white except AgBr (cream) and silver iodide (yellow).

Read through the experiment and try and write as many of the ionic equations as you can.