FACTFILE:
GCE CHEMISTRY

QUALITATIVE TESTS

Rewarding Learning

Qualitative Tests

Students should be able to:

1.10.1 use a chemical test for the gases H_2, O_2, Cl_2, CO_2, HCl and NH_3;

1.10.2 demonstrate understanding of how to carry out a flame test using nichrome wire;

1.10.3 use cation tests including:

- flame tests to identify the metal ions Li^+, Na^+, K^+, Ca^{2+}, Ba^{2+}, and Cu^{2+};
- adding sodium hydroxide solution and warming to identify ammonium ion;

1.10.4 use anion tests including:

- adding barium chloride solution to identify sulfate ion;
- adding acidified silver nitrate solution to distinguish between chloride, bromide and iodide (followed by adding dilute and concentrated ammonia solution);
- adding dilute acid to test for carbonate ion, and identifying the gas produced; and

1.10.5 use starch to identify iodine.

Qualitative Analysis

Qualitative analysis is the process of determining information about a chemical species, including its identity, in a non-numerical fashion. There are a series of diagnostic tests which can be used to identify gases, cations, anions and elements.

Gas Tests

The table below summarises the tests for some common gases and the expected result.

Gas	Test Method	Observations
Hydrogen gas, H_2	Apply a burning splint.	A squeaky pop
Oxygen gas, O_2	Apply a glowing splint	It relights
Chlorine gas, Cl_2	Apply damp blue litmus.	Litmus paper/universal indicator paper turns red and then is bleached white.
Carbon dioxide gas, CO_2	Bubble the gas through limewater (aqueous calcium hydroxide solution).	A milky precipitate due to the formation of insoluble calcium carbonate. Prolonged exposure leads to formation of a colourless solution as the calcium carbonate precipitate reacts to form soluble calcium hydrogencarbonate.
Hydrogen chloride gas, HCl	Expose to a glass rod dipped in concentrated ammonia solution/ stopper from bottle of concentrated ammonia solution	White fumes/smoke/solid (ammonium chloride)
Ammonia gas, NH_3	Expose to a glass rod dipped in concentrated hydrochloric acid/ stopper from bottle of concentrated hydrochloric acid	White fumes /smoke/solid (ammonium chloride)

Cation Tests

A number of metal cations can be identified by a flame test. The method is summarised as:

- Take a piece of nichrome wire and dip into concentrated hydrochloric acid. and then into the sample.

Metal Cation	Flame colour	Metal Cation	Flame colour
Lithium	Crimson	Calcium	Brick Red/ red
Sodium	Yellow / Orange	Copper	Blue-Green/ green-blue
Potassium	Lilac (pink through cobalt glass)	Barium	Green/ apple green

- Then place in blue Bunsen burner flame and record the colour observed.

The ammonium ion, NH_4^+, can be identified by warming with a solution of sodium hydroxide solution; A pungent smell is observed and the gas produced gives white fumes with a rod dipped in concentrated hydrochloric acid.

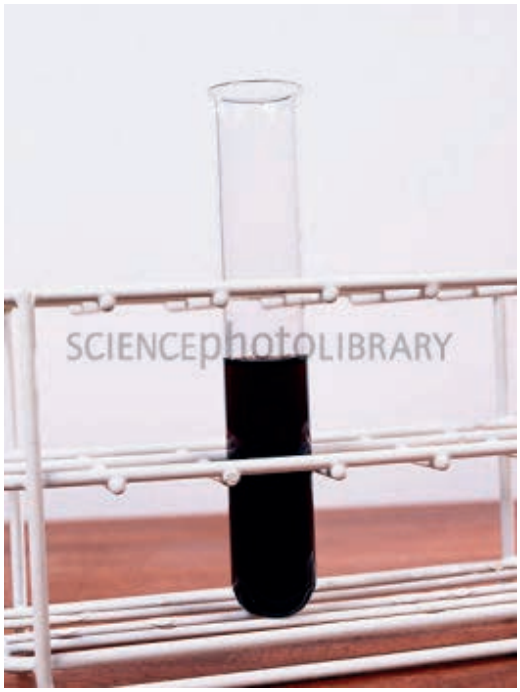
Anion Tests

The diagnostic tests used to identify selected anions are summarised in the table below.

Anion	Test Method	Observations
Sulfate, SO_4^{2-}	To a solution of the sulfate add a few drops of barium chloride solution or barium nitrate solution.	A white precipitate of barium sulphate. $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
Halide ions: Cl^-, Br^-, I^-	To a solution of the halide in dilute nitric acid, add a few drops of silver nitrate solution.	Cl^-: A white precipitate of silver chloride which dissolves in dilute ammonia solution. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ Br^-: A cream precipitate of silver bromide which dissolves in concentrated ammonia solution. I^-: A yellow precipitate of silver iodide which does not dissolve in dilute or concentrated ammonia solution.
Carbonate, CO_3^{2-}	Add dilute hydrochloric acid and bubble the gas produced through colourless limewater.	Limewater turns milky

Test for iodine

Addition of aqueous starch to iodine solution results in the formation of a blue-black / black-blue solution.



Revision Questions

1 A mixture of two salts (X and Y) produced the following results.

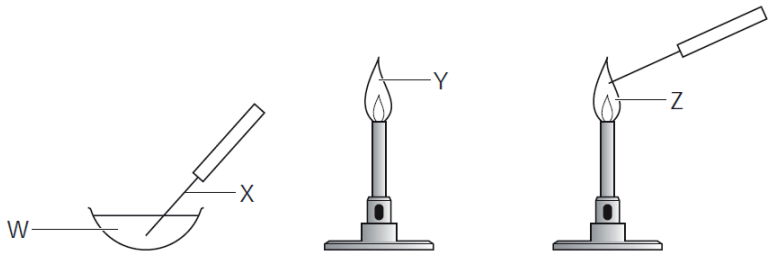
Test	Observation
Flame test	Yellow/orange colour
Addition of $HNO_3(aq)$	No effervescence
Addition of $AgNO_3(aq)$	Yellow precipitate
Addition of $BaCl_2(aq)$	White precipitate

X and Y could be

A potassium iodide and potassium carbonate
B sodium chloride and sodium carbonate
C sodium chloride and sodium sulfate
D sodium iodide and sodium sulfate

2 The presence of Cu^{2+} ions in copper(II) chloride can be shown using a flame test.

(i) The diagram below shows the equipment needed for the test. Identify the acid W, the metal wire X, the colour Y of the flame before the test and the colour Z during the test.



W ..... [1]

X ..... [1]

Y ..... [1]

Z ..... [1]

(ii) State **two** reasons for using W

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..... [2]

3 A solution of an unknown solid when sprayed into the blue flame of a Bunsen burner produced a crimson colour. When silver nitrate solution was added to this solution a white precipitate was observed. The solution contained

A calcium chloride.
B calcium sulfate
C lithium chloride.
D lithium sulfate

4 Complete the following table about the silver halides.

Silver halide	formula	colour	ionic/ covalent	soluble in dilute ammonia solution	soluble in concentrated ammonia solution
silver fluoride	AgF	white	ionic	yes	yes
silver chloride					
silver bromide					
silver iodide					

[4]