

4.8 Revision Checklist for Analysis

Pure Substances

In chemistry, a pure substance is a single element or compound, not mixed with any other substance.

In everyday language, a pure substance can mean a substance that has had nothing added to it, so it is unadulterated and in its natural state, eg pure milk.

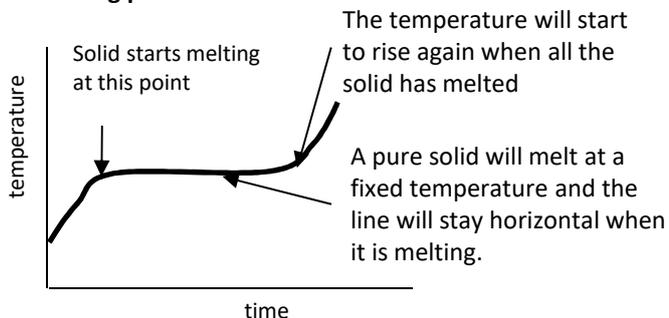
Pure elements and compounds melt and boil at specific temperatures.

Melting point and boiling point data can be used to distinguish pure substances from mixtures.

A **pure substance** will melt or boil at a **fixed temperature**.

A **mixture** or impure substance will melt over a **range of temperatures** and not a sharp melting point

Melting point curve



The temperature does not rise when the solid is melting because the heat is absorbed to break the bonds between the solid particles

Formulations

- A formulation is a **mixture** that has been **designed as a useful product**. Many products are complex mixtures in which each chemical has a particular purpose.
- Formulations are made by mixing the components in carefully measured quantities to ensure that the product has the required properties.
- Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods

Chromatography

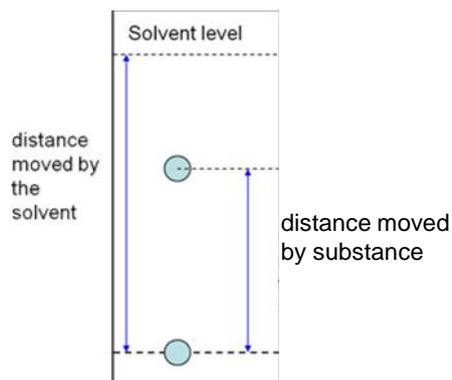
Chromatography can be used to separate mixtures and can give information to help identify substances.

In paper chromatography a solvent moves through the paper carrying different compounds different distances. The distance the substance moves depends on their attraction for the paper and their solubility in the solvent.

If a compound is more soluble in the solvent it will move further up the paper.

If a compound is not soluble in the solvent it will not move up the paper

Chromatography involves a **stationary phase** (paper) and a **mobile phase** (solvent). Separation depends on the distribution of substances between the phases.



Required Practical Method: chromatography

- draw a **pencil line** 1 cm above the bottom of the paper and mark spots for each sample, equally spaced along line.
- Add a **tiny drop** of each substance to a different spot
- Add solvent to beaker with a lid so that is no more than **1cm in depth**
- Place the paper into the beaker, **making sure that the level of the solvent is below the pencil line**. Replace the **lid to get a tight seal**.
- When the level of the solvent reaches about 1 cm from the top of the paper, remove the paper and mark the solvent level with a pencil.
- Calculate the R_f values of the observed spots.

pencil line – will not dissolve in the solvent
tiny drop – too big a drop will cause different spots to merge

Depth of solvent – if the solvent is too deep it will dissolve the sample spots from the plate
lid – to prevent evaporation of solvent

The ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent can be expressed as its R_f value:

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

Different compounds have different R_f values in different solvents, which can be used to help identify the compounds.

The compounds in a mixture may separate into different spots depending on the solvent. A pure compound will produce a single spot in all solvents.

Gas Tests

Gas	Test	Result
Hydrogen	burning splint held at the open end of a test tube of the gas.	Hydrogen burns rapidly with a pop sound .
oxygen	a glowing splint inserted into a test tube of the gas.	The splint relights in oxygen.
carbon dioxide	uses an aqueous solution of calcium hydroxide (lime water).	When carbon dioxide is shaken with or bubbled through limewater the limewater turns milky (cloudy).
chlorine	damp litmus paper	litmus paper is bleached and turns white .

Testing for positive ions

Required practical

Chemistry only

Flame tests

Flame tests can be used to identify metal ions which produce distinctive colours. (Mainly group 1 and 2 metals ions).

Lithium compounds – crimson red flame
sodium compounds – yellow flame
potassium compounds – lilac flame
calcium compounds – orange red flame
copper compounds – green flame.

Method

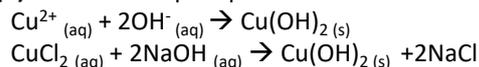
A nichrome wire or damp splint is dipped in the substance to be tested then put in Bunsen flame and the colour is observed.

If a sample containing a mixture of ions is used, some flame colours can be masked.

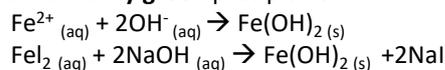
Sodium hydroxide tests

Sodium hydroxide solution is added to other metal ion solutions can identify the metal ion by the formation of precipitates (solids)

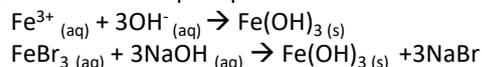
Copper(II) forms a **blue** precipitate



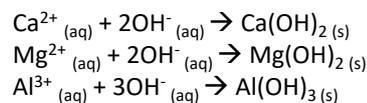
iron(II) forms a **dirty green** precipitate



iron(III) forms a **brown** precipitate



Aluminium, calcium and magnesium ions form **white precipitates** but **only the aluminium hydroxide** precipitate dissolves in excess sodium hydroxide solution to form a colourless solution.



Testing for negative ions

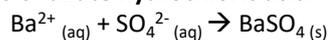
Required practical

Chemistry only

Carbonates (CO_3^{2-}) react with dilute acids (e.g. hydrochloric acid) to form carbon dioxide. One would observe **fizzing**. The Carbon dioxide produced would turn limewater milky.

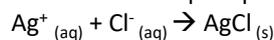


Sulfate (SO_4^{2-}) ions in solution produce a **white precipitate** with **barium chloride solution** in the presence of **dilute hydrochloric acid**.

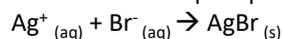


Halide ions in solution produce silver halide precipitates with **silver nitrate (AgNO_3)** solution in the presence of **dilute nitric acid**.

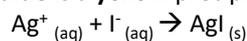
Silver **chloride** is a **white** precipitate



silver **bromide** is a **cream** precipitate



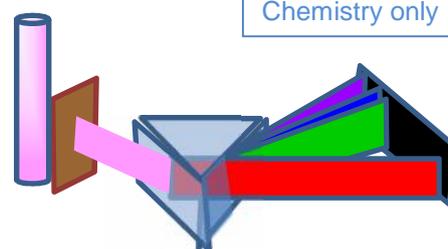
silver **iodide** is a **yellow** precipitate



Flame emission spectroscopy

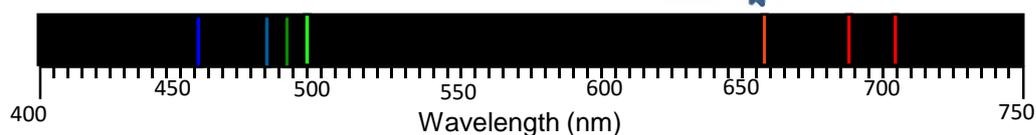
Flame emission spectroscopy is an example of an instrumental method used to analyse metal ions in solutions.

The sample is put into a flame and the light given out is passed through a spectroscope. The output is a line spectrum that can be analysed to identify the metal ions in the solution and measure their concentrations.



Chemistry only

Strontium emission spectrum



Each element has its own unique line spectra (fingerprint). Elements can be identified by their emission spectra by matching the lines.

Instrumental methods.

Elements and compounds can be detected and identified using instrumental methods.

Compared to chemical tests, Instrumental methods are **accurate, sensitive and rapid** and are particularly useful when the amount of a sample is **very small**.