4.8 Revision Checklist for Analysis

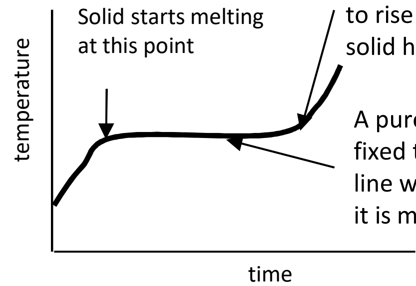
Pure Substances

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

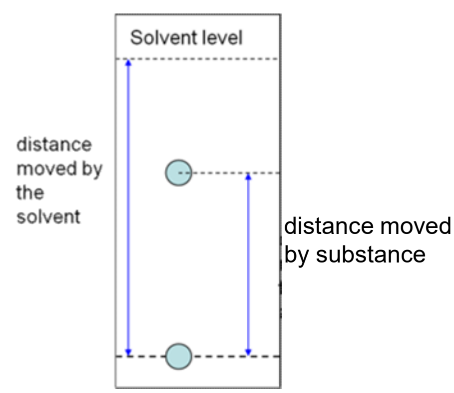
- A formulation is a **mixture** that has been **designed as a useful product**. Many products are complex mixtures in which each chemical has a particular purpose.
- Formulations are made by mixing the components in carefully measured quantities to ensure that the product has the required properties.
- 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 attracted to the paper it will move less far up the paper.
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**
a) draw a **pencil line** 1 cm above the bottom of the paper and mark spots for each sample, equally spaced along line.
b) Add a **tiny drop** of each substance to a different spot
c) Add solvent to beaker with a lid so that is no more than **1cm in depth**
d) 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.
e) 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.
f) Calculate the Rf 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 Rf value:

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

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.

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

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 is dipped in the substance to be tested then put in a Bunsen flame and the colour is observed.
The wire should be cleaned in acid before/between use.

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

$Cu^{2+}{}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow Cu(OH)_{2\,(s)}$

$CuCl_{2\,(aq)} + 2NaOH_{(aq)} \rightarrow Cu(OH)_{2\,(s)} + 2NaCl$

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

$Fe^{2+}{}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow Fe(OH)_{2\,(s)}$

$FeI_{2\,(aq)} + 2NaOH_{(aq)} \rightarrow Fe(OH)_{2\,(s)} + 2NaI$

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

$Fe^{3+}{}_{(aq)} + 3OH^-{}_{(aq)} \rightarrow Fe(OH)_{3\,(s)}$

$FeBr_{3\,(aq)} + 3NaOH_{(aq)} \rightarrow Fe(OH)_{3\,(s)} + 3NaBr$

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.

$Ca^{2+}{}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow Ca(OH)_{2\,(s)}$

$Mg^{2+}{}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow Mg(OH)_{2\,(s)}$

$Al^{3+}{}_{(aq)} + 3OH^-{}_{(aq)} \rightarrow Al(OH)_{3\,(s)}$

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.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + \mathbf{CO_2}$

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

$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4\,(s)}$

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

$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

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

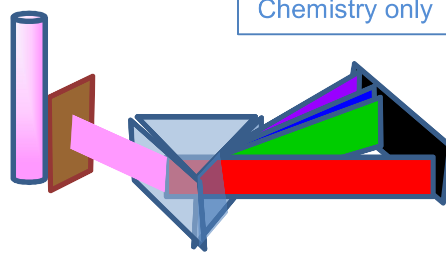
$Ag^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(s)}$

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

$Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$

Flame emission spectroscopy

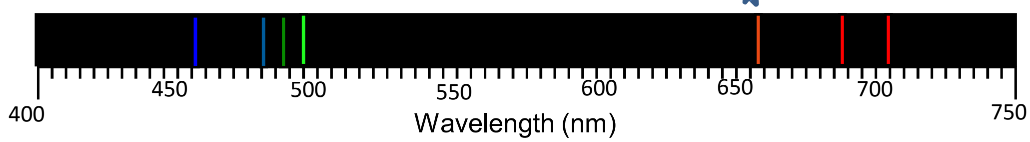
Chemistry only



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.

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**.