

Purity and Formulations

Substances are often not 100% pure — they might have other stuff that you can't see mixed in with them. The purity of a substance might need to be checked, before, say, a drug is made from it.

Purity is Defined Differently in Chemistry to Everyday

- 1) Usually when you refer to a substance as being pure you mean that nothing has been added to it, so it's in its natural state. For example, pure milk or beeswax.
- 2) In chemistry, a pure substance is something that only contains one compound or element throughout — not mixed with anything else.

The Boiling or Melting Point Tells You How Pure a Substance Is

- 1) A chemically pure substance will melt or boil at a specific temperature.
- 2) You can test the purity of a sample by measuring its melting or boiling point and comparing it with the melting or boiling point of the pure substance (which you can find in a data book).
- 3) The closer your measured value is to the actual melting or boiling point, the purier your sample is.
- 4) Impurities in your sample will lower the melting point and increase the melting range of your substance.
- 5) Impurities in your sample will also increase the boiling point and may result in your sample boiling over a range of temperatures.

Formulations are Mixtures with Exact Amounts of Components

- 1) Formulations are useful mixtures with a precise purpose that are made by following a 'formula' (a recipe). Each component in a formulation is present in a measured quantity, and contributes to the properties of the formulation so that it meets its required function.

Take a look at p.24 for more on mixtures.

For example, paints are formulations composed of:

Pigment — gives the paint colour (for example titanium oxide is used as a pigment in white paints).

Solvent — used to dissolve the other components and alter the viscosity (runniness).

Binder (resin) — forms a film that holds the pigment in place after it's been painted on.

Additives — added to further change the physical and chemical properties of the paint.

Depending on the purpose of the paint, the chemicals used and their amounts will be changed so the paint produced is right for the job.



- 2) Formulations are really important in the pharmaceutical industry. For example, by altering the formulation of a pill, chemists can make sure it delivers the drug to the correct part of the body at the right concentration, that it's consumable and has a long enough shelf life.
- 3) In everyday life, formulations can be found in cleaning products, fuels, cosmetics, fertilisers (see p.190), metal alloys (see p.61) and even food and drink.
- 4) When you buy a product, you might find that it has information about its composition on the packaging. For example, the ratio or percentage of each component. This tells you the product's a formulation. It also lets you choose a formulation with the right composition for your particular use.

Make sure you can use data to identify pure and impure substances...

Knowing how pure a product is can be vital in industries such as pharmaceuticals and the food industry. Extra stuff in it by mistake could change the properties of the product, and even make it dangerous.

Testing for Gases

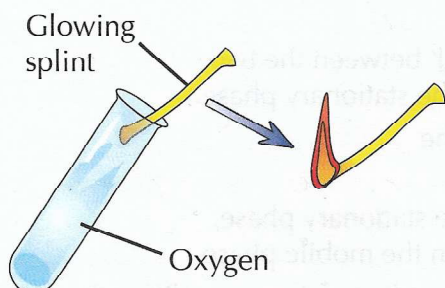
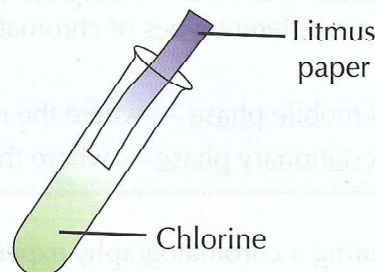
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Ahh... tests, glorious tests. Luckily, these aren't the kind of tests you have to revise for, but you should probably revise these tests for your exam — it's swings and roundabouts really...

There are Tests for Four Common Gases

1) Chlorine

Chlorine bleaches damp litmus paper, turning it white.
(If you use blue litmus paper it may turn red for a moment first though — that's because a solution of chlorine is acidic.)

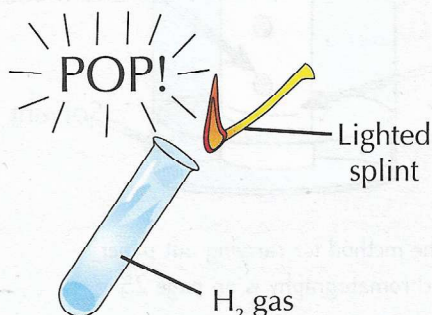
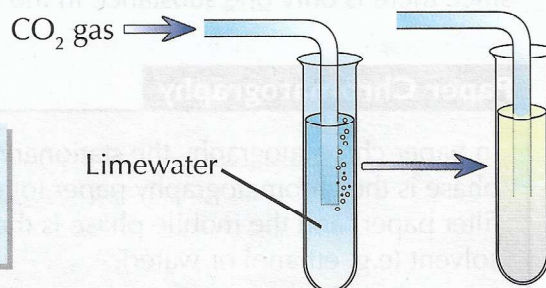


2) Oxygen

If you put a glowing splint inside a test tube containing oxygen, the oxygen will relight the glowing splint.

3) Carbon Dioxide

Bubbling carbon dioxide through (or shaking carbon dioxide with) an aqueous solution of calcium hydroxide (known as limewater) causes the solution to turn cloudy.



4) Hydrogen

If you hold a burning splint at the open end of a test tube containing hydrogen, you'll get a "squeaky pop". (The noise comes from the hydrogen burning quickly in the oxygen in the air to form water.)



These are all really useful tests to know...

The method you use to collect a gas will depend on whether it's lighter or heavier than air. If it's heavier (like chlorine), you have the test tube the right way up and the gas will sink to the bottom. If it's lighter (like hydrogen), you have the test tube upside-down and the gas will rise to fill it.

PRACTICAL**Paper Chromatography**

You met chromatography on page 25. Now it's time to see how it works.

Chromatography uses Two Phases

Chromatography is an analytical method used to separate the substances in a mixture. You can also use information from a chromatography experiment to help identify the substances that you have separated. There are different types of chromatography, but they all have two 'phases':

A mobile phase — where the molecules can move. This is always a liquid or a gas.

A stationary phase — where the molecules can't move. This can be a solid or a really thick liquid.

- 1) During a chromatography experiment, the substances in the sample constantly move between the mobile and the stationary phases — an equilibrium is formed between the two phases.
- 2) The mobile phase moves through the stationary phase, and anything dissolved in the mobile phase moves with it.
- 3) How quickly a chemical moves depends on how it's 'distributed' between the two phases — whether it spends more time in the mobile phase or the stationary phase.
- 4) The chemicals that spend more time in the mobile phase than the stationary phase will move further through the stationary phase.
- 5) The components in a mixture will normally separate through the stationary phase, so long as all the components spend different amounts of time in the mobile phase.
- 6) The separated components form spots. The number of spots formed may change in different solvents as the distribution of the chemical will change depending on the solvent.
- 7) A pure substance will only ever form one spot in any solvent, since there is only one substance in the sample.

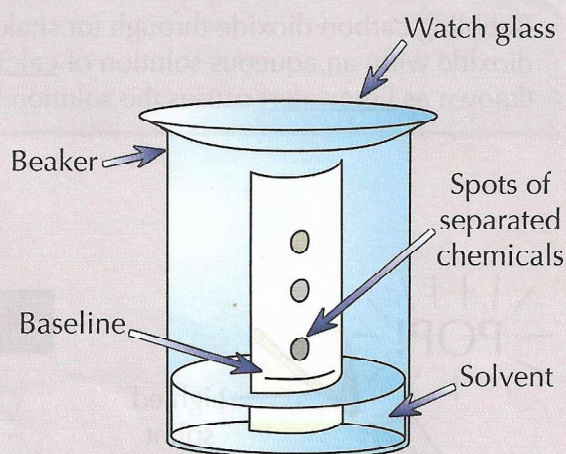
Paper Chromatography

In paper chromatography the stationary phase is the chromatography paper (often filter paper) and the mobile phase is the solvent (e.g. ethanol or water).

The amount of time the molecules spend in each phase depends on two things:

- How soluble they are in the solvent.
- How attracted they are to the paper.

Molecules with a higher solubility in the solvent, and which are less attracted to the paper, will spend more time in the mobile phase — and they'll be carried further up the paper.



The method for carrying out paper chromatography is on page 25.

Chromatography revision — it's a phase you have to get through...

Chromatography works because each of the chemicals in a mixture spends different amounts of time dissolved in the mobile phase and stuck to the stationary phase. It's great — all you need is some paper and a bit of solvent. There's more about using it to identify chemicals coming up on the next page.

Paper Chromatography

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Now that you know a bit of the theory behind how paper chromatography works, here's how you can use a chromatogram to analyse a particular substance and find out what's in it.

You can Calculate the R_f Value for Each Chemical

- 1) The result of chromatography analysis is called a chromatogram.

- 2) An R_f value is the ratio between the distance travelled by the dissolved substance (the solute) and the distance travelled by the solvent.

- 3) You can calculate R_f values using this formula:

$$R_f = \frac{\text{distance travelled by substance (B)}}{\text{distance travelled by solvent (A)}}$$

This is the distance from the baseline to the centre of the spot.

Distance moved by solvent (solvent front)

Spot of chemical

Baseline (Origin)

A

B

- 4) The further through the stationary phase a substance moves, the larger the R_f value.

- 5) Chromatography is often carried out to see if a certain substance is present in a mixture. To do this, you run a pure sample of that substance (a reference) alongside the unknown mixture. If the R_f values of the reference and one of the spots in the mixture match, the substance may be present (although you haven't yet proved they're the same).

The R_f Value is Affected by the Solvent

- 1) The R_f value of a substance is dependent on the solvent you use — if you change the solvent the R_f value for the substance will change.
- 2) You can test both the mixture and the reference in a number of different solvents.
- 3) If the R_f value of the reference matches the R_f value of one of the spots in the mixture in all the solvents, then it's likely the reference compound is present in the mixture.
- 4) If the spot in the mixture and the spot in the reference only have the same R_f value in some of the solvents, then the reference compound isn't present in the mixture.

You need to learn the formula for R_f

Sometimes, when you're doing paper chromatography, you'll end up with a spot left sitting on the baseline, even after your solvent has run all the way up the paper. Any substance that remains on the baseline is insoluble in that solvent — you could rerun the experiment using a different solvent to try and identify it.