PCFGSTUDY

AQA GCSE Chemistry — Chemistry

Topic 8

Chemical analysis

Specification 8462 · AQA

Free edition

Revision notes for one topic, free to download.

These are the summary notes only. The full edition of this booklet also carries the worked examples, the required practicals and the formula sheets, with every topic in one place.

Colour Codes

Definitions

Diagrams

Notes and warnings

Sub-topic headings

This booklet is a study aid written from the published specification.
It is not affiliated with, endorsed by or approved by AQA.

Free to download and share for personal study.
Please do not sell or republish it as your own.
For enquiries, please email pcfgyrdi@gmail.com

Copyright © 2026 PCFGSTUDY

Define Pure substance (chemistry)

- a single element or compound, not mixed with any other substance.

Define Pure substance (everyday language)

- a substance with nothing added to it, unadulterated and in its natural state, eg pure milk.

Define Mixture

- two or more substances not chemically combined; melts and boils over a range.

Define Formulation

- a mixture designed as a useful product, made by mixing components in carefully measured quantities.

Define Chromatography

- separates mixtures and helps identify substances, using a stationary and a mobile phase.

Define Stationary phase

- the phase that does not move; in paper chromatography, the paper.

Define Mobile phase

- the phase that moves through it; in paper chromatography, the solvent.

Define Rf value

- the ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent.

Define Cation

- a positively charged ion, eg a metal ion.

Define Precipitate

- an insoluble solid formed when two solutions are mixed.

Define CHEMISTRY ONLY Flame test

- identifying a metal ion from the colour it gives a Bunsen flame.

Define CHEMISTRY ONLY Instrumental method

- identifying elements and compounds using a machine;

accurate, sensitive and rapid.

Define CHEMISTRY ONLY Flame emission spectroscopy

- an instrumental method for analysing metal ions in solutions, giving a line spectrum.

8.1 Purity, formulations and chromatography

Copyright © 2026 PCFGSTUDY

8.1.1 Pure substances

- In chemistry, a **pure substance** is a single element or compound, not mixed with any other substance.
- In everyday language, "pure" means a substance with nothing added to it — unadulterated and in its natural state, eg pure milk. Chemically, milk is a mixture.
- Pure elements and compounds melt and boil at specific temperatures; mixtures melt and boil over a range of temperatures.
- An impurity **lowers the melting point** and **raises the boiling point**, spreading both over a range — the wider the range, the more impure the sample.
- You must be able to use melting point and boiling point data to distinguish pure from impure substances.

ANALOGY

A formulation is a recipe. A cake is not "flour, eggs and sugar in any amounts" — the quantities are measured and each ingredient has a job. Change the proportions and you get a different product. Paint is a formulation; sea water is not, because nobody designed it.

8.1.3 Chromatography

- Chromatography can be used to separate mixtures and can give information to help identify substances. It involves a **stationary phase** and a **mobile phase**, and separation depends on the distribution of substances between the phases. In **paper chromatography** the stationary phase is the paper, the **mobile phase the solvent**.
- A substance more attracted to the mobile phase (more soluble in the solvent) travels further; one more attracted to the stationary phase travels less far, so the compounds separate into **different spots**.
- A pure compound produces a single spot in all solvents, while the compounds in a mixture may separate differently depending on the solvent — so chromatography distinguishes pure from impure substances: more than one spot means a mixture.
- Different compounds have different Rf values in different solvents, which helps identify them. Compare a sample with references run on the same paper.

WATCH OUT

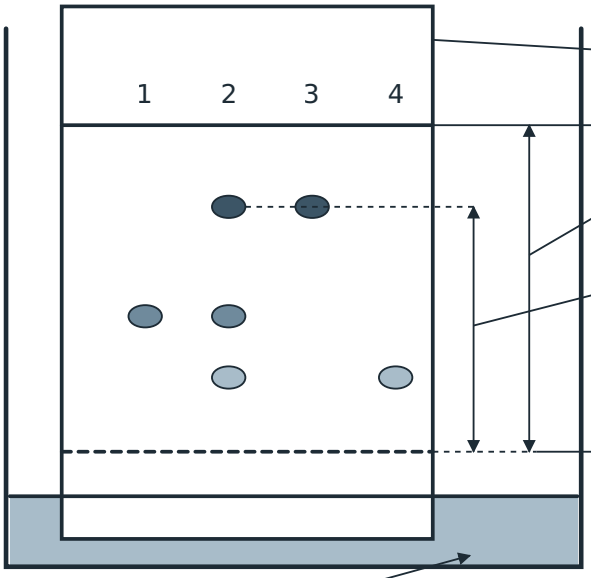
"Pure" on a food label is not "pure" in chemistry. "Pure orange juice" only means nothing has been added. Chemically it is a mixture of water, sugars, acids and coloured compounds, and it boils over a **range** rather than at a fixed temperature. In the exam, give the chemical meaning: a single element or compound.

8.1.2 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, made by mixing the components in carefully measured quantities so the product has the **required properties**.
- Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods. For example, paint contains a pigment (colour), a solvent (to spread it) and a binder (to stick the pigment to the surface).
- You must be able to identify formulations from given information — look for several named components in **exact measured proportions**, each with a job. You do not need the names of components in proprietary (brand-name) products.

Copyright © 2026 PCFGSTUDY

Paper chromatography and measuring an Rf value



stationary phase — the paper

solvent front

distance moved by solvent = 6.0 cm

distance moved by substance = 4.5 cm

pencil baseline — above the solvent level

mobile phase — the solvent, which moves up the paper

1 pure substance — one spot only

2 mixture — separates into three spots

3 reference substance A

4 reference substance B

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

Rf = 4.5 ÷ 6.0 = 0.75 (no units)

A pure compound gives a single spot in all solvents; a mixture separates into several spots.

Separation depends on the distribution of the substances between the two phases.

ANALOGY

Chromatography is a race up the paper. The solvent carries everyone along; the paper is a crowd grabbing at the runners. Substances that "stick" to the paper hardly move, while those held less tightly and more soluble in the solvent are carried furthest. All start on the same pencil line, so how far each gets identifies it.

8.2 Identification of common gases

8.2.1 Test for hydrogen

A **burning splint** is held at the **open end of a test tube** of the gas. Hydrogen burns rapidly with a pop sound.

8.2.2 Test for oxygen

A **glowing splint** is inserted into a test tube of the gas. The splint relights in oxygen.

8.2.3 Test for carbon dioxide

The test uses an aqueous solution of **calcium hydroxide (limewater)**. When carbon dioxide is shaken with or bubbled through limewater, the limewater turns milky (cloudy).

8.2.4 Test for chlorine

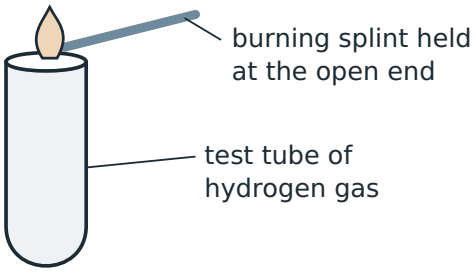
The test uses **litmus paper**: when damp litmus paper is put into chlorine gas, it is bleached and turns white.

Copyright © 2026 PCFGSTUDY

Gas	Test	Positive result
Hydrogen	Burning splint at the open end of the tube	Burns rapidly with a **pop**
Oxygen	Glowing splint inserted into the tube	The splint **relights**
Carbon dioxide	Bubble through, or shake with, **limewater**	Limewater turns **milky (cloudy)**
Chlorine	Damp litmus paper held in the gas	Litmus is **bleached, turning white**

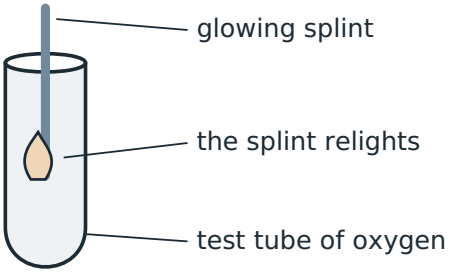
Tests for hydrogen, oxygen, carbon dioxide and chlorine

Test for hydrogen



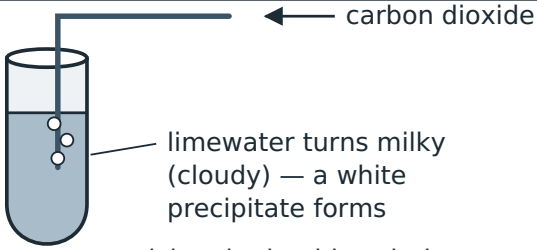
Hydrogen burns rapidly with a 'pop' sound — a squeaky pop.

Test for oxygen



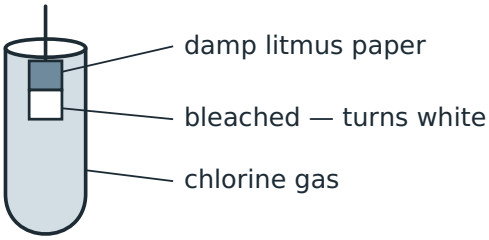
A glowing splint inserted into the tube relights in oxygen.

Test for carbon dioxide



limewater = calcium hydroxide solution
Bubble the gas through limewater, or shake the gas with limewater.

Test for chlorine



Damp litmus paper is bleached and turns white in chlorine gas.

8.3 CHEMISTRY ONLY Identification of ions by chemical and spectroscopic means

Copyright © 2026 PCFGSTUDY

8.3.1 CHEMISTRY ONLY Flame tests

- Flame tests can be used to identify some metal ions (cations). Clean a nichrome loop in dilute hydrochloric acid until it gives no colour, dip it in the solid and hold it in a **blue Bunsen flame**.
- Lithium, sodium, potassium, calcium and copper compounds produce distinctive colours: **lithium crimson**, **sodium yellow**, **potassium lilac**, **calcium orange-red**, **copper green**.
- If a sample containing a mixture of ions is used, some flame colours can be masked — sodium's yellow especially. Flame colours of other metal ions are not required knowledge.

NOTE

IONIC EQUATIONS — THE SAME REACTIONS, WRITTEN MORE NEATLY

The spec requires **balanced equations**; the ionic version shows only the ions that react:

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ blue · **$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$** green · **$Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$** brown

$Mg^{2+} + 2OH^- \rightarrow Mg(OH)_2(s)$, **$Ca^{2+} + 2OH^- \rightarrow Ca(OH)_2(s)$**, **$Al^{3+} + 3OH^- \rightarrow Al(OH)_3(s)$** — all white. Check the **charges** balance as well as the atoms.

8.3.5 CHEMISTRY ONLY Sulfates

Sulfate ions in solution produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid. Do not swap the acids — hydrochloric acid in the halide test would add chloride ions.

CHEMISTRY ONLY **Ion test summary**

8.3.2 CHEMISTRY ONLY Metal hydroxides

- Sodium hydroxide solution can be used to identify some metal ions (cations). Add a few drops of dilute NaOH(aq) to a solution of the compound, note the precipitate, then add excess.
- Solutions of aluminium, calcium and magnesium ions form white precipitates, but only the aluminium hydroxide precipitate dissolves in excess sodium hydroxide solution — that is how you tell aluminium from the other two. To separate calcium from magnesium, use a **flame test** (calcium is orange-red).
- Solutions of copper(II), iron(II) and iron(III) ions form coloured precipitates: **copper(II) blue**, **iron(II) green**, **iron(III) brown**. These stay put in excess.

8.3.3 CHEMISTRY ONLY Carbonates

Carbonates react with dilute acids to form carbon dioxide gas, which can be identified with limewater: **fizzing** and **milky limewater** means **carbonate ions, CO_3^{2-}**.

8.3.4 CHEMISTRY ONLY Halides

Halide ions in solution produce precipitates with silver nitrate solution in the presence of dilute nitric acid: silver chloride is white, silver bromide is cream, silver iodide is yellow. The acid is added first to remove carbonate ions, which would give a false positive.

Copyright © 2026 PCFGSTUDY

Ion	Test	Positive result
Lithium, Li^+	Flame test	**Crimson** flame
Sodium, Na^+	Flame test	**Yellow** flame
Potassium, K^+	Flame test	**Lilac** flame
Calcium, Ca^{2+}	Flame test	**Orange-red** flame
Copper, Cu^{2+}	Flame test	**Green** flame
Aluminium, Al^{3+}	NaOH(aq) + excess	**White** ppt that dissolves in excess
Calcium, Ca^{2+}	NaOH(aq) + excess	White ppt, insoluble in excess
Magnesium, Mg^{2+}	NaOH(aq) + excess	White ppt, insoluble in excess
Copper(II), Cu^{2+}	NaOH(aq)	**Blue** precipitate
Iron(II), Fe^{2+}	NaOH(aq)	Green precipitate
Iron(III), Fe^{3+}	NaOH(aq)	**Brown** precipitate
Carbonate, CO_3^{2-}	Dilute acid, gas into limewater	Fizzing; **limewater milky**
Chloride, Cl^-	Nitric acid, then silver nitrate	White precipitate
Bromide, Br^-	Nitric acid, then silver nitrate	**Cream** precipitate
Iodide, I^-	Nitric acid, then silver nitrate	Yellow precipitate
Sulfate, SO_4^{2-}	Hydrochloric acid, then barium chloride	White precipitate

Copyright © 2026 PCFGSTUDY

CHEMISTRY ONLY Tests for cations and anions, and the results you should see

chemistry only

Flame tests — metal ions (cations)	
Clean a nichrome wire loop, dip it in the sample and hold it in a blue Bunsen flame.	
Metal ion	**Flame colour**
lithium, Li^+	crimson
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
copper, Cu^{2+}	green
If a mixture of ions is used, some flame colours can be masked.	

Sodium hydroxide solution — precipitates of metal hydroxides		
Metal ion	**Precipitate colour**	**In excess sodium hydroxide**
calcium, Ca^{2+}	white	precipitate stays
magnesium, Mg^{2+}	white	precipitate stays
aluminium, Al^{3+}	white	**redissolves — colourless solution**
copper(II), Cu^{2+}	blue	precipitate stays
iron(II), Fe^{2+}	green	precipitate stays
iron(III), Fe^{3+}	brown	precipitate stays
Example equation: $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$		

Tests for negative ions (anions)		
Ion	**Test**	**Positive result**
carbonate CO_3^{2-}	add a dilute acid, then test the gas given off with limewater	fizzing; the limewater turns milky (carbon dioxide)
halide ions Cl^-, Br^-, I^-	add dilute nitric acid, then silver nitrate solution	silver chloride white; bromide cream; iodide yellow
sulfate SO_4^{2-}	add dilute hydrochloric acid, then barium chloride solution	white precipitate (barium sulfate)
Instrumental methods, eg flame emission spectroscopy, are accurate, sensitive and rapid.		

8.3.6 CHEMISTRY ONLY Instrumental methods

- Elements and compounds can be detected and identified using instrumental methods, which are accurate, sensitive and rapid.
- Advantages over the chemical tests above: accurate (no judging colours by eye, and they measure how much is present); sensitive (they work on **very small samples** and on concentrations chemical tests would miss); rapid (results in minutes, run automatically).
- Disadvantages: expensive equipment needing special training, and results must be compared with a **reference set**. Hence their use by **forensic scientists**.

8.3.7 CHEMISTRY ONLY 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 (more intense lines = higher concentration).
- Unlike a flame test it works on **mixtures**: each ion gives its own lines, so none is masked.
- You must be able to **interpret an instrumental result** given data in chart or tabular form with a reference set in the same form.

Copyright © 2026 PCFGSTUDY