

Exercise walk-through

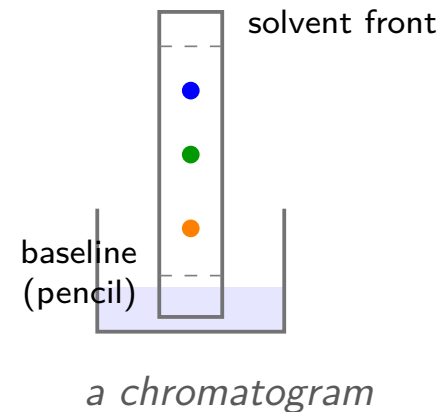
12.4

Separation and purification

IGCSE Chemistry

What we will cover

- 1 Apparatus & key words
- 2 Titration
- 3 Chromatography
- 4 Separation & purification
- 5 Tests for ions
- 6 Tests for gases & flames



The apparatus, and the words that go with it

Measuring

Volume: a measuring cylinder, pipette or burette. Time: a **stop-watch**. Temperature: a **thermometer**. Mass: a balance.

Simple distillation

Simple distillation separates a solvent – the liquid – from a solution; fractional distillation separates two liquids.

Saturated solution

A **saturated solution** holds the most solute that will dissolve at that temperature.

Purity

Check purity with the **melting point** and boiling point: a pure substance melts and boils at sharp fixed temperatures, and impurities lower the melting point and raise the boiling point.

“Pure” in chemistry means one substance – not the everyday sense of clean or natural.

Exam tips

- Pick apparatus by the measurement: a **burette** or **pipette** for accurate volumes, a measuring cylinder for a rough volume, a gas syringe for a gas volume, a balance for mass.
- $R_f = \frac{\text{distance moved by the substance}}{\text{distance moved by the solvent}}$, so it is always less than 1. A pure substance gives a single spot.
- Learn the anion tests: a **carbonate** fizzes and the gas turns limewater milky; halides with silver nitrate give a chloride *white*, bromide *cream*, iodide *yellow* precipitate; a **sulfate** gives a white precipitate with barium nitrate.
- Learn the gas tests: **hydrogen** gives a squeaky pop, **oxygen** relights a glowing splint, **carbon dioxide** turns limewater milky, **chlorine** bleaches damp litmus, **ammonia** turns damp red litmus blue.
- For cations, add sodium hydroxide and read the precipitate colour: copper(II) light blue, iron(II) green, iron(III) red-brown.

Exercises 2.1-2.3

2.1 Name the method to separate an insoluble solid from a liquid. [1]

2.2 State how impurities affect the melting point of a substance. [1]

2.3 Name the method used to obtain pure water from sea water, and state the principle it relies on. [2]

Exercises 2.1-2.3

2.1 Name the method to separate an insoluble solid from a liquid. [1]

2.1

- an insoluble solid from a liquid: **filtration**

2.2 State how impurities affect the melting point of a substance. [1]

2.2

- impurities **lower** the melting point

2.3 Name the method used to obtain pure water from sea water, and state the principle it relies on. [2]

2.3

- **simple distillation**
- water boils, is condensed and collected; dissolved salts **stay behind**

Exercises 2.4·2.5

2.4 Explain why the baseline in chromatography is drawn in pencil and above the solvent level. [2]

2.5 A spot travels 2.7 cm and the solvent front 9.0 cm. Calculate the R_f value. [2]

Exercises 2.4·2.5

2.4 Explain why the baseline in chromatography is drawn in pencil and above the solvent level. [2]

2.4

- **pencil**, because ink would dissolve and separate
 - **above the solvent**, so the spots are not washed off
-

2.5 A spot travels 2.7 cm and the solvent front 9.0 cm. Calculate the R_f value. [2]

2.5

$$R_f = \frac{\text{distance moved by the spot}}{\text{distance moved by the solvent}} = \frac{2.7 \text{ cm}}{9.0 \text{ cm}} = \mathbf{0.30}$$

Exercise 3.1

3.1 To separate two liquids with different boiling points, you would use:

[1]

☐

A filtration

B crystallisation

C fractional distillation

D chromatography

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3.1 To separate two liquids with different boiling points, you would use: [1]

☐

A filtration

B crystallisation

C fractional distillation

D chromatography

3.1 C

- two liquids with different boiling points: **fractional distillation**
- A is solid/liquid; B is a solid from solution; D is dyes

Exercise 3.2 (a)

3.2 A student wants pure water from salty water.

(a) Name the method to use.

[1]

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(a) Name the method to use.

[1]

(a)

- simple distillation

Exercise 3.2 (b)

3.2 A student wants pure water from salty water.

(b) Describe how it separates the water from the salt.

[2]

Exercise 3.2 (b)

3.2 A student wants pure water from salty water.

(b) Describe how it separates the water from the salt.

[2]

(b)

- water **boils off** and is cooled in the condenser
- the **salt is left** in the flask

Exercise 3.3

3.3 Explain how you could check that a sample of a solid is pure.

[2]

Exercise 3.3

3.3 Explain how you could check that a sample of a solid is pure.

[2]

3.3

- measure its **melting (or boiling) point**
- a pure substance melts at a **sharp, fixed** temperature; impurities **lower** it

Exercise 3.4 (a)

3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. 78 °C) and water.

(a) Name the method used to remove the sand, and state which part of the apparatus retains it. [2]

Exercise 3.4 (a)

3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. 78 °C) and water.

(a) Name the method used to remove the sand, and state which part of the apparatus retains it. [2]

(a)

- **filtration**
- sand is the **residue** in the filter paper

Exercise 3.4 (b)

3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. $78\text{ }^{\circ}\text{C}$) and water.

(b) Describe how the student would obtain solid salt from the remaining solution, and explain why crystallisation is preferred to boiling the solution dry. [3]

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(b) Describe how the student would obtain solid salt from the remaining solution, and explain why crystallisation is preferred to boiling the solution dry. [3]

(b)

- evaporate to crystallisation, cool, filter and dry
- crystallisation is preferred because boiling dry can **decompose** the solid or leave impurities

Exercise 3.4 (c)

3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. $78\text{ }^{\circ}\text{C}$) and water.

(c) Name the method used to separate the ethanol from the water, and describe how it works. [4]

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3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. $78\text{ }^{\circ}\text{C}$) and water.

(c) Name the method used to separate the ethanol from the water, and describe how it works. [4]

(c)

- **fractional distillation**
- ethanol has the **lower boiling point**, so it vaporises first
- water vapour condenses in the column and runs back
- ethanol vapour is cooled in the condenser and collected

Exercise 3.4 (d)

3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. 78°C) and water.

(d) State which liquid is collected first and explain why.

[2]

Exercise 3.4 (d)

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(d) State which liquid is collected first and explain why. [2]

(d)

- **ethanol** is collected first
- $78\text{ }^{\circ}\text{C}$ is lower than water's $100\text{ }^{\circ}\text{C}$

Exercise 3.4 (e)

3.4 A student is given a mixture of sand, salt and water, and separately a mixture of ethanol (b.p. 78 °C) and water.

(e) The student also uses chromatography on a food dye. One spot moves 4.4 cm while the solvent front moves 8.0 cm. Calculate the R_f value and state what could be concluded if a known dye gives the same value. [3]

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(e)

$$R_f = \frac{\text{distance moved by the spot}}{\text{distance moved by the solvent}} = \frac{4.4 \text{ cm}}{8.0 \text{ cm}} = \mathbf{0.55}$$

- the same R_f as a known dye means the unknown is **likely that dye**