

Chromatography

5.8.1.3 · Chemistry · revision notes

Paper chromatography separates the substances in a mixture and helps identify them using R_f values. It is a required practical, so expect questions on the method, interpreting chromatograms and calculating R_f values.

Key facts

- Stationary phase = paper; mobile phase = solvent
- Measure from the start line to the centre of the spot
- Pure compound: a single spot in all solvents
- Same substance: same R_f value in the same solvent
- $R_f = \text{distance moved by substance} \div \text{distance moved by solvent}$
- R_f has no units and is between 0 and 1
- Mixture: two or more spots
- Start line in pencil; solvent level below the start line; lid on

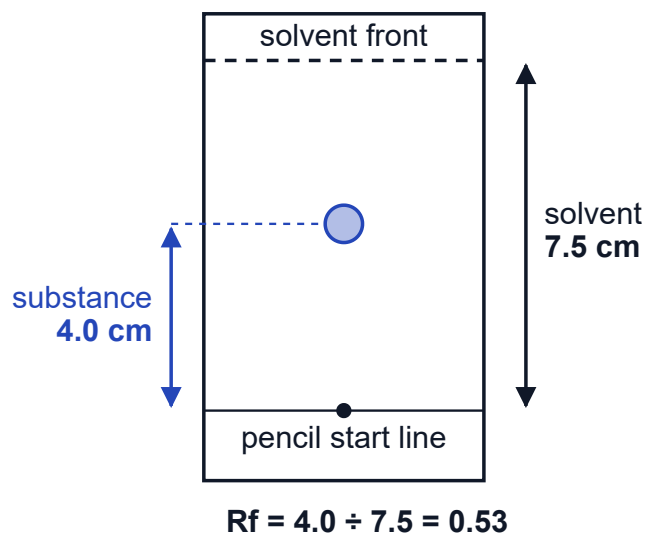
Notes

How paper chromatography works

- Chromatography separates the substances in a mixture and gives information to help identify them.
- It has a **stationary phase**, which does not move (the paper), and a **mobile phase**, which moves (the solvent).
- As the solvent moves up the paper it carries the substances with it. Different substances move different distances, so a mixture separates into several spots.
- A substance that does not dissolve in the solvent stays on the start line.

R_f values

- $R_f = \text{distance moved by substance} \div \text{distance moved by solvent}$.
- Measure both distances from the start line: to the **centre** of the spot, and to the solvent front.



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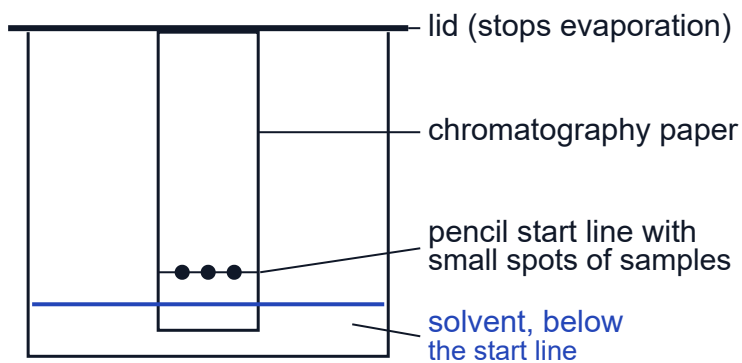
- R_f has no units and is always between 0 and 1, because a spot cannot move further than the solvent.
- Different compounds have different R_f values. A compound's R_f value changes with the solvent, so only compare R_f values measured with the same solvent.

Identifying substances and checking purity

- Run the unknown alongside known reference substances on the same paper. A spot at the same height (same R_f) as a reference suggests the same substance.
- A **pure** compound gives a **single spot** in all solvents. A mixture gives two or more spots.

Required practical: method

- Draw a start line in **pencil** near the bottom of the paper. Pencil does not dissolve in the solvent; ink would run.
- Put small spots of each sample on the line, spaced apart.
- Stand the paper in a container of solvent with the solvent level **below** the start line, so the spots do not dissolve into the solvent. Put a lid on to stop the solvent evaporating.



Solvent level below the pencil line, lid on, spots small and spaced apart.

- Take the paper out before the solvent reaches the top, mark the solvent front in pencil straight away, then let it dry.

How to answer each type of question

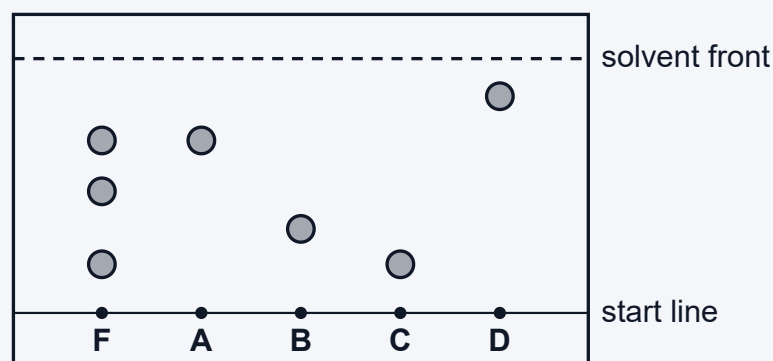
Interpret a chromatogram

1 to 3 marks

Grade 4

1. Count the spots for each sample: more than one spot means a mixture.
2. Compare heights with the reference substances: the same height means probably the same substance.
3. Name the matching substances, and say if any spot matches none of them.

Example. A food colouring, F, was tested on the same chromatogram as four known dyes, A, B, C and D. F produced three spots. Two of its spots were at the same heights as the spots of A and C. The third spot did not match any of the known dyes.



- (a) Is F a pure substance? Give a reason.
- (b) What can you conclude about the dyes in F?

Model answer. (a) No, because it produced more than one spot / three spots, so it is a mixture (1)
(b) F contains dyes A and C (1). F also contains a dye that is not A, B, C or D (1).

Calculate an R_f value

2 marks

Grade 5

1. Measure (or read) the distance from the start line to the centre of the spot.
2. Measure (or read) the distance from the start line to the solvent front.
3. Divide: spot distance ÷ solvent distance.
4. Round to the significant figures asked for. No units.

Example. On a chromatogram, the solvent front moved 8.4 cm from the start line. The centre of the spot of dye X moved 2.9 cm.
Calculate the R_f value of dye X. Give your answer to 2 significant figures.

Model answer. $R_f = 2.9 \div 8.4$ (1)
 $= 0.345... = 0.35$ (1)

Don't lose marks

- ✗ Measuring to the top of the spot, or from the bottom of the paper. Measure from the start line to the centre of the spot.
- ✗ Giving Rf a unit, or an answer greater than 1.
- ✗ Drawing the start line in ink: the ink dissolves and gives extra spots.
- ✗ Putting the solvent above the start line: the samples dissolve into the solvent instead of moving up the paper.
- ✗ Saying one spot proves a substance is pure. A pure compound gives a single spot in all solvents.
- ✗ Thinking a spot left on the start line is pure. It means that substance is insoluble in that solvent.

More tips

Memory tricks

- $R_f = \text{spot} \div \text{solvent}$: the smaller distance goes on top, so Rf is always less than 1. If you get more than 1, you divided the wrong way round.
- 'Pencil doesn't run, spots don't drown': pencil start line, solvent below it.
- Stationary stays still (paper); mobile moves (solvent).
- Same height, same paper, same solvent: probably the same substance.

Exam technique

- Write the Rf formula first, then substitute: this can earn a mark even if you misread a distance.
- Give Rf values to the significant figures asked for, or 2 significant figures if none are stated.
- When asked 'why' about a step, give the reason, e.g. 'lid on, to stop the solvent evaporating'.
- When comparing samples, refer to the heights or Rf values and name the substances that match.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Tell mixtures from pure substances on chromatograms

A mixture gives two or more spots; a pure substance gives a single spot.

Grade 4

Match spots to known reference substances

Spots of the same substance travel the same distance on the same paper with the same solvent.

Grade 4

Describe the paper chromatography method

Pencil start line, small spots, solvent below the line, lid on, mark the solvent front.

Grade 5

Calculate an Rf value

$R_f = \text{distance moved by substance} \div \text{distance moved by solvent}$, both measured from the start line.

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