Paper chromatography

Answers, marking points and revision notes | AQA Combined Science 8464 and AQA GCSE Chemistry 8462

GCSE science required practicals

This practical online

Answers

1 Explain why the start line is drawn in pencil and not in ink. (2 marks)

Pencil is graphite, which does not dissolve in the solvent, so it stays where it is. Ink would dissolve and move up the paper, mixing with the spots.

Marking points

- Pencil (graphite) does not dissolve / move
- Ink would dissolve and spread, confusing the results

2 Explain why the water level in the beaker must be below the start line. (2 marks)

If the spots were under the water, the colourings would dissolve into the water in the beaker instead of moving up the paper, so they would not separate.

Marking points

- Spots would dissolve into the solvent in the beaker
- So they would not travel up the paper / no separation

3 Give two variables Ella should keep the same if she wants to compare her R_f values with another class's results. (2 marks)

The solvent used (water) and the type of chromatography paper.

Marking points

- Same solvent
- Same type of paper (or same temperature)

4 Another pupil wants to use ethanol as the solvent. Give the hazard and a way to reduce the risk. (2 marks)

Ethanol is flammable and its vapour could catch fire. Keep all flames away and put a lid on the beaker to keep the vapour in.

Marking points

- Ethanol is flammable
- No naked flames nearby / lid on / good ventilation

5 Calculate the R_f value of the spot from B. (2 marks)

0.75

R_f = distance moved by spot / distance moved by solvent

$R_f = 6.3 / 8.4$

$R_f = 0.75$

Marking points

- 6.3 / 8.4
- 0.75

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

6 Calculate the R_f value of the spot from C. Give your answer to 2 significant figures. (2 marks)

0.52

$R_f = 4.4 / 8.4$

$R_f = 0.5238...$

$R_f = 0.52$ (2 significant figures)

Marking points

- 4.4 / 8.4
- 0.52

7 Use the results to say which colourings are in X. Explain your answer. (3 marks)

X contains A and C. X has two spots, so it is a mixture. One spot has an R_f of 0.25, the same as A, and the other has an R_f of 0.52, the same as C. It does not contain B, because there is no spot at 0.75.

Marking points

- X is a mixture (two spots)
- Contains A and C
- R_f values match (0.25 and 0.52); no spot matches B

8 Is food colouring B a pure substance? Explain your answer. (2 marks)

It is probably pure, because it only produced one spot. A mixture would usually have separated into two or more spots.

Marking points

- Probably pure
- Only one spot

9 Ella tests a green colouring in the same way. The solvent moves 8.4 cm again. One of its spots has an R_f value of 0.62. Calculate how far that spot moved from the start line. Give your answer to 2 significant figures. Show your working. (3 marks)

5.2 cm

R_f = distance moved by spot / distance moved by solvent

Distance moved by spot = R_f x distance moved by solvent

Distance moved by spot = 0.62 x 8.4

Distance moved by spot = 5.208

Distance moved by spot = 5.2 cm (2 significant figures)

Marking points

- Rearranges: distance moved by spot = R_f x distance moved by solvent
- 0.62 x 8.4 = 5.208
- 5.2 cm

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

10 **Higher tier**

Explain, in terms of the mobile phase and the stationary phase, why colouring B travels further up the paper than colouring A. (3 marks)

The mobile phase is the water moving up the paper and the stationary phase is the paper. Each substance spends some time dissolved in the water and some time stuck to the paper. B is more soluble in the water and less attracted to the paper than A, so it spends more time in the mobile phase and travels further.

Marking points

- Mobile phase = solvent (water); stationary phase = paper
- Substances are distributed between the two phases
- B is more attracted to / soluble in the mobile phase (less to the paper), so it moves further

11 **Higher tier**

A pupil in another school found an R_f of 0.41 for colouring C using ethanol as the solvent. Explain why this does not mean that either result is wrong. (2 marks)

R_f values depend on the solvent, because the solubility of the colouring is different in ethanol than in water. R_f values can only be compared when the same solvent and paper are used.

Marking points

- R_f depends on the solvent (solubility differs)
- Only compare R_f values using the same solvent / conditions

12 Ella's spots were large and smeared, which made it hard to measure to the centre. Suggest how she could improve this and explain why it helps. (2 marks)

Use a fine capillary tube to put on a very small spot, let it dry and add more on top. Small, concentrated spots separate into neat spots that are easier to measure accurately.

Marking points

- Small spots applied with a fine capillary, dried between applications
- Spots stay small and separate, so distances are measured more accurately

13 Ella took the paper out of the beaker but forgot to mark the solvent front straight away. By the time she marked it, the water had spread a little further up the damp paper, but the spots had not moved. Explain the effect on her R_f values. (2 marks)

The solvent distance she measured would be too large, so dividing by it gives R_f values that are too small.

Marking points

- Solvent distance too large (or front position wrong)
- So R_f values are too low

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

14 Plan an investigation, using paper chromatography, to find out whether the black ink in a pen found at a crime scene matches the ink in one of three suspects' pens. (6 marks)

Draw a pencil line 2 cm from the bottom of a sheet of chromatography paper and mark four crosses along it. Put a small dot of ink from the crime-scene pen on one cross and dots from each suspect's pen on the others, labelling each in pencil. Pour a suitable solvent, such as water or ethanol, into a beaker to a depth below the line. Hang the paper so it just dips into the solvent and put a lid on. When the solvent is near the top, remove the paper and mark the solvent front in pencil. Let it dry. Compare the spots: the matching pen will give the same number of spots, of the same colours, at the same heights. To be sure, measure the distances and calculate R_f = distance moved by spot / distance moved by solvent for each spot and check they match. If no spots move in water, repeat with a different solvent. Keep flames away if using ethanol.

Marking points (any 6, with the method in a logical order)

- Pencil start line above solvent level
- Small spot of each ink on separate labelled crosses on the same paper
- Paper dipped in solvent in a covered beaker
- Remove before the solvent reaches the top; mark solvent front
- Compare number, colour and position of spots
- Calculate R_f for each spot and compare
- Same paper and solvent for all inks so they can be compared
- Try another solvent if the ink does not move / safety with flammable solvent

How it is marked

- 5-6 marks: a clear method that would give a fair comparison of all four inks on the same chromatogram, with R_f values and a clear way of deciding which pen matches.
- 3-4 marks: a workable chromatography method, but with little about how the match is decided or some practical detail missing.
- 1-2 marks: one or two relevant steps such as spotting ink on paper and putting it in water, with no logical order or comparison.

Revision notes: the method

Aim: To separate the coloured substances in inks or food colourings by paper chromatography, and to identify them by calculating R_f values.

Equipment

- chromatography paper
- pencil and ruler
- capillary tubes or fine glass rods
- food colouring samples, known and unknown
- beaker (250 cm^3)
- water as the solvent
- glass rod or split cork to hang the paper
- lid or watch glass to cover the beaker
- safety goggles

Method

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

1. Draw a straight line in pencil about 2 cm from the bottom of the chromatography paper. This is the start line.
2. Mark small pencil crosses along the line, about 1.5 cm apart, one for each sample.
3. Use a capillary tube to put a small, concentrated spot of each sample on its cross. Let it dry and add another drop on the same spot.
4. Pour water into the beaker to a depth of about 1 cm, so the start line will be above the water.
5. Hang the paper in the beaker so the bottom edge dips into the water but the spots do not, and put a lid on.
6. Leave the water to soak up the paper. Take the paper out when the solvent is near the top, and mark the solvent front with pencil straight away.
7. Let the paper dry, then measure from the start line to the centre of each spot and to the solvent front.
8. Calculate R_f = distance moved by spot / distance moved by solvent for each spot, and compare the unknown with the known samples.

Variables

- **Independent:** The sample being tested (different food colourings).
- **Dependent:** The distance moved by each spot, used to calculate its R_f value (measured with a ruler in cm).
- **Control:** The solvent used; The type of paper; The temperature, and a lid on the beaker; The size of each spot and the height of the start line

Hazards

Hazard	What could happen	How to reduce the risk
Organic solvents if used instead of water (e.g. ethanol)	Flammable vapour that could catch fire	Keep away from flames and use a lid; water is the safer solvent for food colourings
Glass capillary tubes	Can snap and cut the fingers	Handle gently and put broken glass in the glass bin, not by hand

Key points

- Draw the start line in pencil, not pen: ink would dissolve and run up the paper.
- The start line must be above the solvent level, otherwise the spots dissolve into the solvent in the beaker.
- R_f = distance moved by spot / distance moved by solvent; it has no unit and is always less than 1.
- A pure substance gives one spot; a mixture gives two or more spots.
- The same substance has the same R_f in the same solvent, so matching R_f values identify substances.
- Measure to the centre of each spot, and mark the solvent front as soon as the paper is removed.

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.