

GCSE Chemistry (9 – 1)

Chromatography

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/5
2	/11
3	/9
4	/9
5	/6
6	/12
Total	/52
%	
Grade	

Information

- The maximum mark for this paper is 52 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.

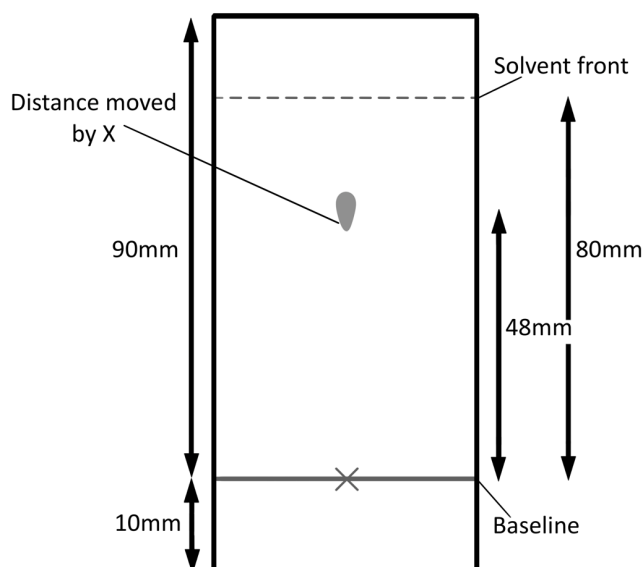


1. Chromatography is a technique used to separate mixtures of soluble substances, such as dyes in ink, so that we can identify their individual components.

Circle the letter of the correct answer for each of the following questions.

- a) The diagram below shows the measurements taken from a chromatography experiment involving a dye, identified as substance X. The diagram is not drawn to scale.

What is the R_f value for substance X.



A
0.48

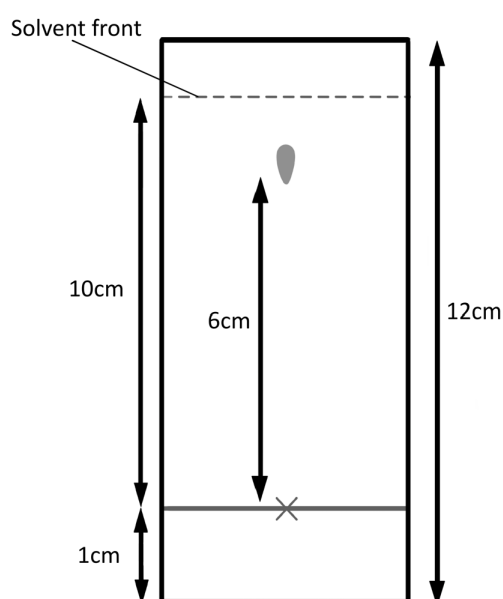
B
0.60

C
1.67

D
0.52

(1 mark)

- b) Another chromatogram for a similar unknown dye is shown below.



A
0.68

B
0.65

C
0.60

D
0.62

(1 mark)

c) Why is the starting line or baseline on a chromatogram always drawn in pencil rather than ink?

- A Pencil lead is cheaper than ink
- B The graphite in the pencil is insoluble and will not spread up the paper.
- C The pencil line stops the solvent from travelling too fast.
- D Ink is too thick and prevents the substances from moving.

(1 mark)

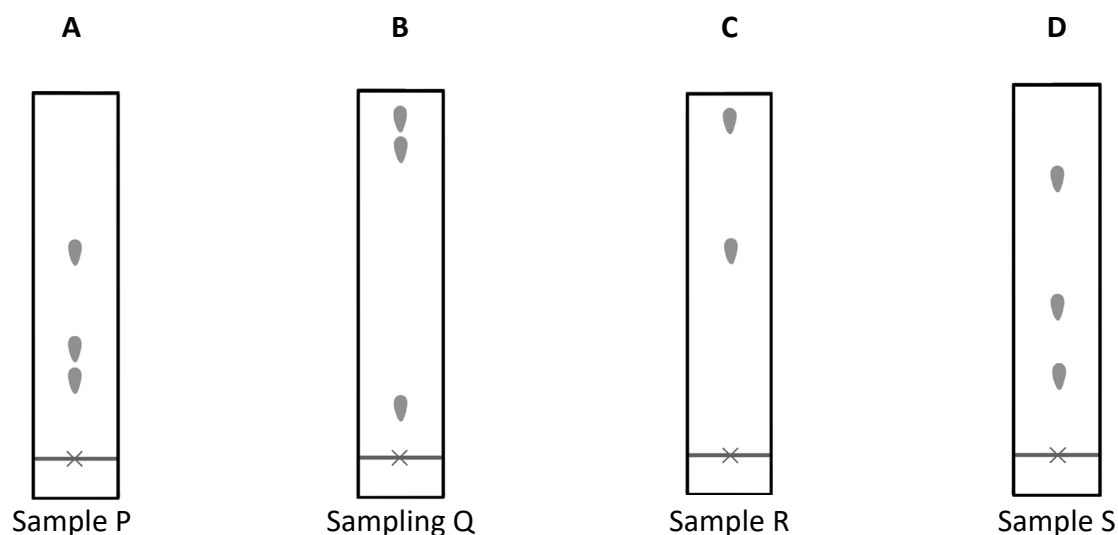
d) In a paper chromatography experiment using water as the solvent, what are the stationary phase and the mobile phase?

- | | | |
|---|--|--|
| A | Stationary phase: Paper | Mobile phase: Water |
| B | Stationary phase: The spots | Mobile phase: The beaker |
| C | Stationary phase: Water | Mobile phase: Paper |
| D | Stationary phase: The pencil line | Mobile phase: The solvent front |

(1 mark)

e) Four different ink samples (P, Q, R, and S) were analysed using paper chromatography. The resulting chromatograms are shown below.

Which ink sample contains a substance that is insoluble in the mobile phase?

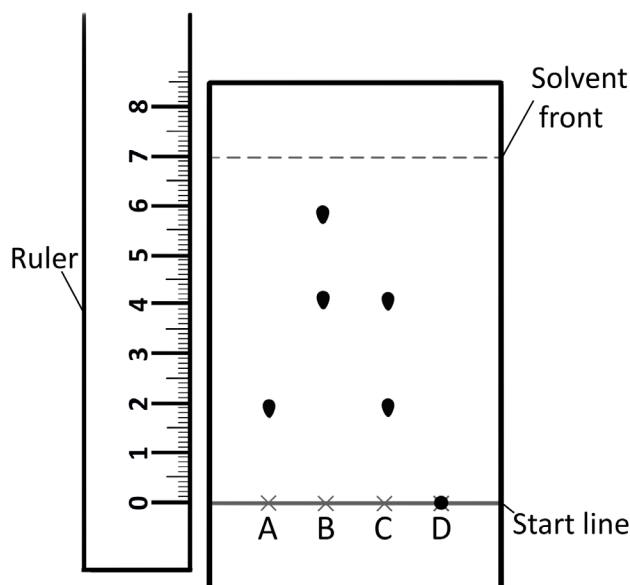


(1 mark)

(Total for Question 1 is 5 marks)

2. Inks which are used by commercial printers contain a mixture of dyes. These mixtures can be changed or altered to produce different coloured inks. A student conducts an experiment using four different samples of inks. These ink samples A, B, C and D, were separated using paper chromatography.

The figure below shows the chromatogram that the student produced from their experiment.



- a) In the student's experiment, ink sample D did not move up the paper from the baseline. Describe a change to the experiment that the student can make to separate the dyes in ink sample D.

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(2 marks)

- b) In the experiment, the solvent front moved 7.0 cm. Calculate the R_f value of the dye that is present in both inks B and C.

$R_f =$

(2 marks)

- c) Suggest **one** change to the method that would improve the accuracy of the measurements used to calculate the R_f value.

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3. A student conducts an experiment to analyse an red food colouring using paper chromatography. The investigation compares results between two different types of chromatography paper (type X and type Y). The food colouring itself has the following properties.

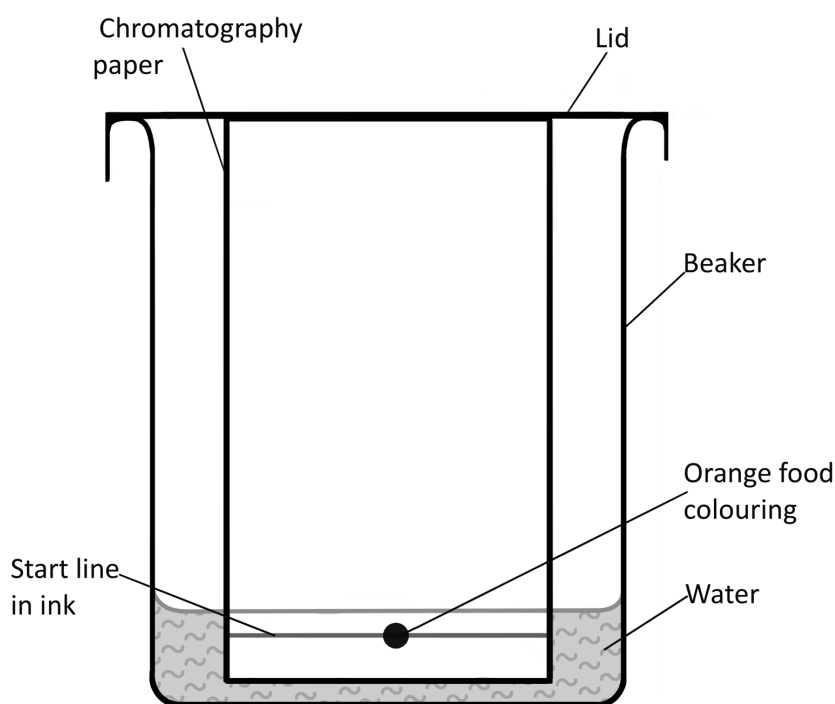
Composition: A mixture of red and yellow dyes.

Solubility: Fully soluble in water.

Experimental method the student followed this procedure:

- Mark a start line using ink on a sheet of type X chromatography paper.
- Place a single spot of the red food colouring onto this line.
- Place the paper upright in a beaker containing water (the solvent).
- Allow time for the water to travel up the paper.
- Measure the vertical distance travelled by the water (solvent front) and the individual green and yellow dyes.
- Repeat steps 1 through 5 using type Y chromatography paper.

The diagram below shows how the student set up their apparatus.



- a) The student has made two errors when setting up the apparatus. Identify the two errors the student made.

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(2 marks)

- b) The student wants to repeat the experiment to get valid results.

Describe two changes the student should make to the apparatus to correct the mistakes identified in part (a).

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(2 marks)

The student then set up the apparatus correctly and redid the experiment.

The table below shows their results.

	Type X chromatography paper		Type Y chromatography paper	
	Red dye	Yellow dye	Red dye	Yellow dye
Distance moved by dye in cm	3.60	7.20	4.20	
Distance moved by water in cm	12.0	12.0	12.0	12.0
Rf value	0.30	0.60	0.35	0.75

- c) Calculate the distance moved by the yellow dye for the type Y chromatography paper using the values from the table above.

distance moved by the yellow dye = ...

(2 marks)

The student used water as the solvent for both experiments.

- d) Explain, using data from the table above, why the red dye moved a different distance on Type X paper compared to Type Y paper.

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(3 marks)

(Total for Question 3 is 9 marks)

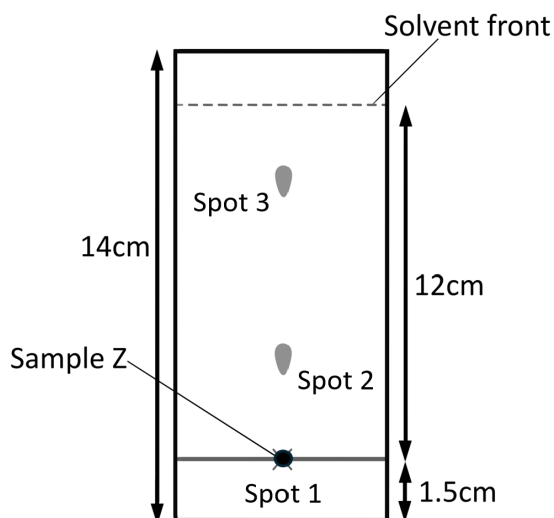
4. A scientist is analysing the additives in a sample of a fizzy drink, sample Z.

She runs a chromatogram using water as the solvent.

The setup is as follows:

- The start line is drawn 1.5 cm from the bottom edge of the paper.
- The solvent front travels 12.0 cm from the start line.
- Sample Z separates into three distinct spots: Spot 1, Spot 2, and Spot 3.

The figure below shows the chromatogram that the scientist obtains from her experiment.



The table below shows known R_f values of common additives that are soluble in water.

Additive	R_f Value
Caffeine	0.65
Citric Acid	0.00
Yellow number 5	0.85
Red number 40	0.45
Blue number 1	0.92

a) Spot 2 moved 5.4 cm through the chromatography paper.

Using the information and the table above identify the chemicals in spot 1 and spot 2, showing your full working for spot 2.

Spot 1 = ...

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Spot 2 = ...

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(4 marks)

b) Calculate the distance that Spot 3 (Yellow number 5) travelled from the start line.

Distance for Spot 3 = ... cm
(2 marks)

In the experiment above, some of the original sample remained on the start line.

c) Explain why this substance did not move **and** suggest **one** change to the method that would allow the scientist to calculate an R_f value for this substance.

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(3 marks)

(Total for Question 4 is 9 marks)

5. A forensic scientist analyses a white solid found at a crime scene.

She suspects the solid is pure ibuprofen.

She conducts a paper chromatography experiment using ethanol as the solvent.

- The chromatogram shows only one spot.
- The R_f value of the spot is 0.72, which matches the value for ibuprofen in a data book.

Discuss whether the scientist is correct. In your answer, you should:

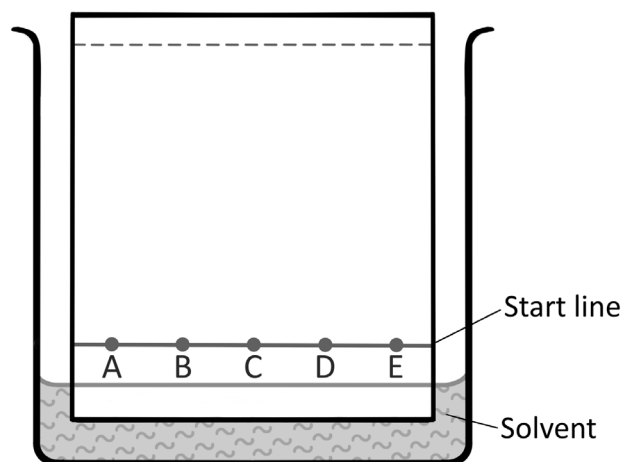
- Explain how the mobile and stationary phases separate substances.
- Explain why the result does not prove the sample is pure.
- Describe one other method (chemical or physical) to test if the solid is pure.

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(6 marks)

(Total for Question 5 is 6 marks)

6. Many inks are mixtures of different soluble dyes. These mixtures can be analysed and separated using a technique called paper chromatography. A student investigated the composition of five different ink samples, labelled A, B, C, D, and E. The figure below shows the arrangement of the ink spots on the chromatography paper before the experiment began. The paper was suspended in a beaker containing a small amount of solvent.



- a) Name the component in this experiment that acts as the stationary phase.

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(1 mark)

- b) Explain why the level of the solvent in the beaker must be lower than the ink spots on the start line.

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(2 marks)

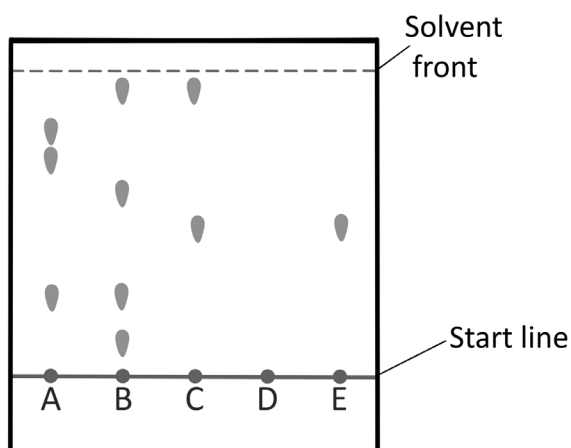
- c) Suggest why the start line was drawn in pencil rather than in ink.

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(1 mark)

- d) State the reason why the spot for ink A did not move from the start line during the experiment.

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(2 marks)

- e) Using the figure of the student's results below, identify which ink is a mixture containing the greatest number of soluble dyes.



Give a reason for your answer.

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(2 marks)

The student compared the spots in the inks against a database of known dyes to identify the chemicals present. Table 1 shows the R_f values of four known dyes.

Name of Dye	R_f Value
Dye A	0.33
Dye B	0.45
Dye C	0.63
Dye D	0.81

A specific spot in ink C moved 5.4 cm. The solvent front moved 12.0 cm.

- f) Calculate the R_f value of this spot to 2 significant figures.
Use your answer to identify which dye from the table above is likely to be in ink C.

R_f value = ...

Identity of dye = ...

(4 marks)

(Total for Question 6 is 12 marks)