

GCSE Chemistry (9 – 1)

Separating mixtures

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	/4
2	/11
3	/13
4	/9
5	/5
6	/15
Total	/57
%	
Grade	

Information

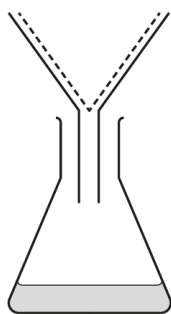
- The maximum mark for this paper is 57 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. From obtaining pure salt from rock salt to separating the different coloured dyes in an ink, understanding how to separate mixtures is a fundamental chemical skill that relies on exploiting the different physical properties of the substances involved.

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

- a) Name the separation method that uses the equipment in the figure below.



- | | | | |
|-----------------|-----------------|------------|-------------|
| A | B | C | D |
| Distillation | Crystallisation | Filtration | Evaporation |
| (1 mark) | | | |

- b) What equipment is used to perform a distillation?

- A** Condenser, round-bottomed flask, thermometer.
- B** Condenser, funnel, thermometer.
- C** Thermometer, measuring cylinder, filter paper.
- D** Thermometer, beaker, pH probe.

(1 mark)

- c) A scientist uses paper chromatography to analyse the dyes in a green food colouring. A spot of the colouring is placed on a pencil line on a piece of filter paper. The paper is then placed into a beaker containing ethanol, which soaks up the paper and separates the dyes.

What is the **stationary phase** in this experiment?

- A** The ethanol.
- B** The filter paper.
- C** The green food colouring.
- D** The beaker.

(1 mark)

- d) Which statement best describes what happens during crystallisation?

- A** An insoluble solid is separated from a liquid by pouring it through filter paper.
- B** A soluble solid is recovered from a solution by forming solid crystals.
- C** A liquid is separated from a dissolved solid by boiling it off.
- D** Two liquids are separated based on their different boiling points.

(1 mark)

(Total for Question 1 is 4 marks)

2. There are many different ways to separate the substances in a mixture.

a) Draw one straight line from each separation technique to the diagram showing the correct equipment.

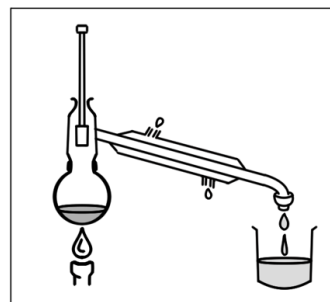
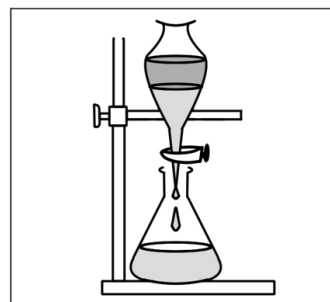
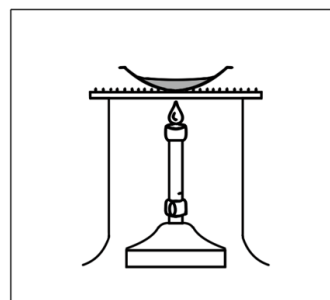
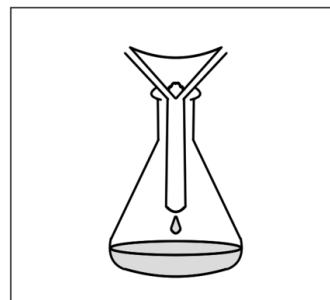
Separation Process

Apparatus Used

Filtration

Distillation

Crystallisation



(3 marks)

b) In the process of distillation, two changes of state occur.

Name the change of state happening in the flask and the change of state happening in the condenser.

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(2 marks)

- c) A student has a mixture of iron filings and sulfur powder.

Describe a simple, non-chemical method to separate the iron filings from the sulfur powder.

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(2 marks)

- d) When the mixture of iron and sulfur is heated, it reacts to form iron sulfide.

Describe **two** observations that show a chemical reaction has taken place.

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(2 marks)

- e) In a similar experiment, a student finds that 7.0 g of iron filings reacts completely with 4.0 g of sulfur powder.

Calculate the mass of iron sulfide formed.

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(1 mark)

- f) The student started with 5.0 g of sulfur but only 4.0 g reacted.

What is the name given to the reactant that is not used up completely in a reaction?

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(1 mark)

(Total for Question 2 is 11 marks)

3. A student is given a beaker containing a mixture of sand, salt and water.
The student needs to separate this mixture to get pure samples of sand, pure water, and dry salt crystals.
- a) Describe the series of steps the student should take to separate all three substances.
You should name the techniques used and you **may** include labelled diagrams to support your answer.

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(6 marks)

- b) The student is now given a solution of ethanol and water. Ethanol has a boiling point of 78 °C and water has a boiling point of 100 °C.

The student attempts to separate the mixture using the simple distillation apparatus they would have used for salt water.

Explain why this method would fail to produce a pure sample of ethanol.

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(2 marks)

- c) Name and describe the piece of equipment that must be added to the distillation apparatus to successfully separate ethanol and water.

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(2 marks)

- d) Explain how this piece of equipment allows for a better separation of ethanol and water.

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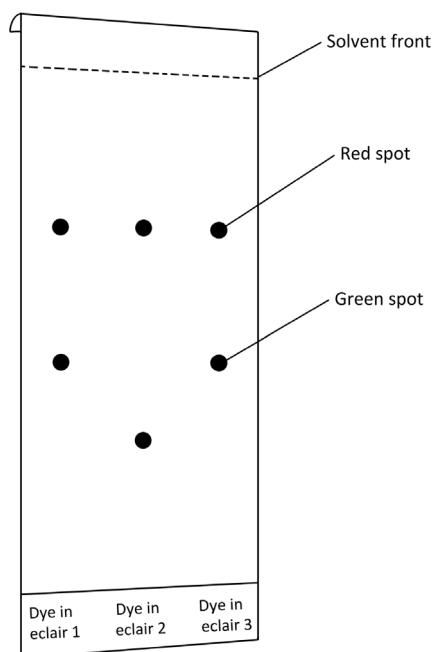
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(3 marks)

(Total for Question 3 is 13 marks)

4. A pastry chef makes large batches of chocolate éclairs.
 The chef notices that one batch, made with a new brand of brown food colouring, tastes slightly bitter.
 The chef thinks an impurity in the new food colouring is causing the bitter taste.
 To investigate, the chef uses chromatography to compare three different brown food colourings:
A – The chef's usual, trusted brand.
B – The new brand used in the bitter batch of éclairs.
C – Another potential replacement brand.

The chromatogram is shown below.



- a) Calculate the R_f value of the red spot in dye 3. Give your answer to 2 significant figures.

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(3 marks)

- b) Which of the chocolate éclairs would we expect to taste the same?
 Explain your answer using data from the chromatogram.

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(2 marks)

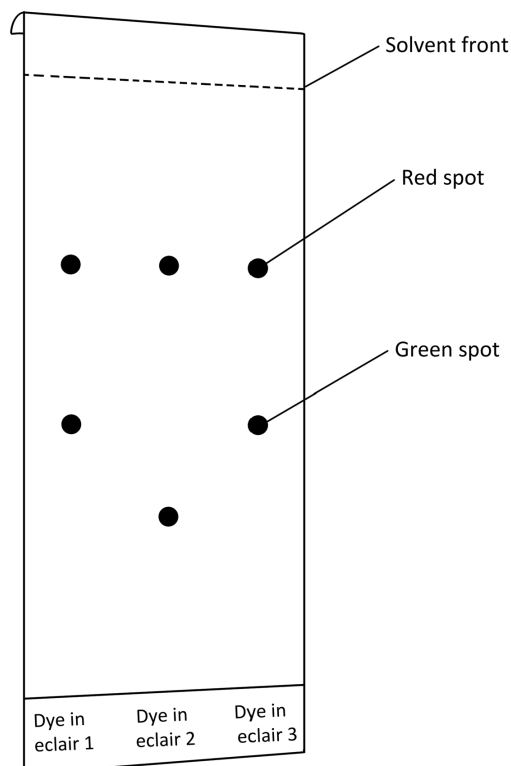
- c) The baker thinks the dyes are mixtures where the substances are combined in exact amounts.
What is the name given to this type of mixture?

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(1 mark)

Another student sets up a chromatography experiment but makes a mistake.
Instead of using a pencil, they draw the baseline using a **black ink pen**.



- d) Describe what would be **seen** on the chromatogram as a result of this mistake and explain why it would make the results invalid.

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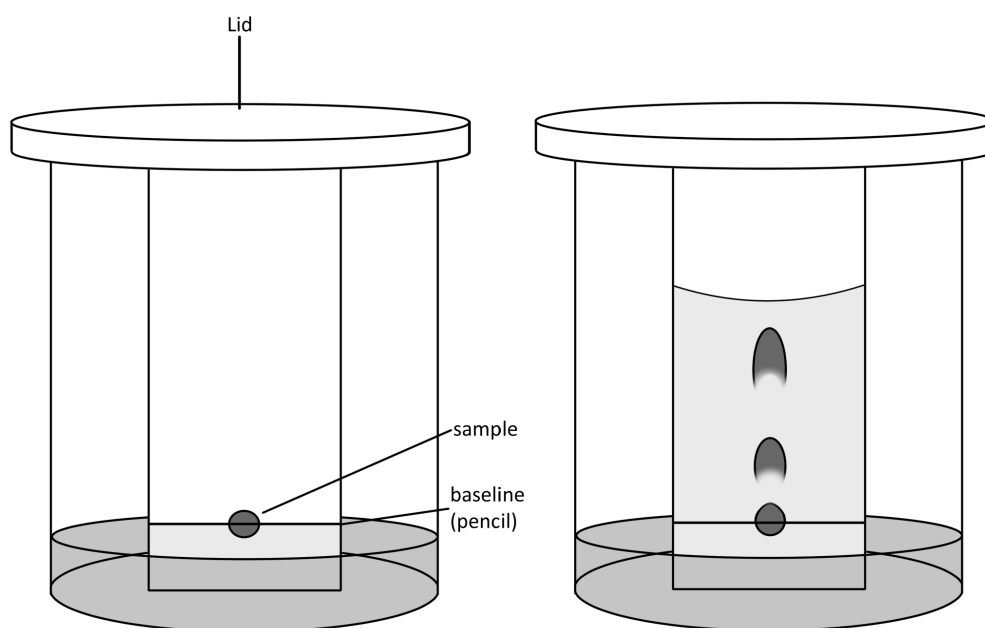
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(3 marks)

(Total for Question 4 is 9 marks)

5. A student used paper chromatography to investigate the food dyes in a purple sweet.

The student spotted the dissolved purple sweet onto a pencil line on a piece of chromatography paper. The paper was then placed in a beaker containing a small amount of solvent, as shown in the figure.



The chromatogram showed that the purple sweet contained two different dyes:

- a red dye
- and a blue dye.

The R_f value of the red dye was calculated to be 0.75.

The distance moved by the solvent front from the pencil line was 8.0 cm.

- a) Calculate the distance moved by the red dye.
Give your answer in millimetres (mm).

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(3 marks)

- b) Give **two** reasons why the starting line must be drawn in pencil.

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(2 marks)

(Total for Question 5 is 5 marks)

6. Substances can be classified as elements, compounds or mixtures.

a) What is meant by the term **compound**?

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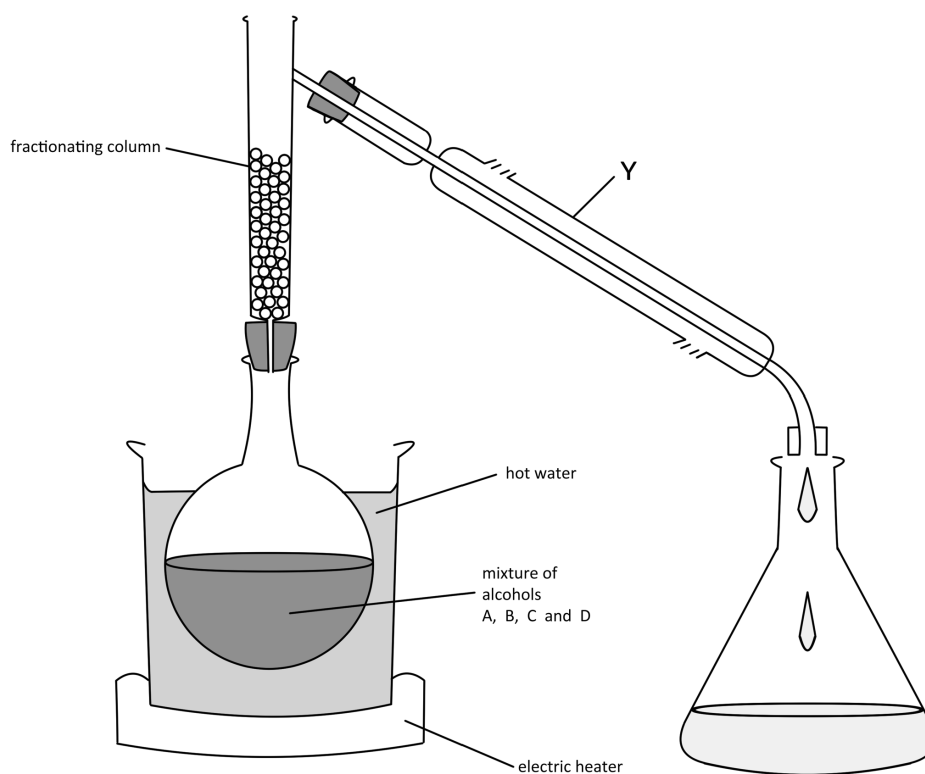
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(2 marks)

b) A student suggested that the apparatus shown below could be used to separate the mixture of alcohols.



b) The water vapour is cooled and turned back into a liquid in apparatus Y.

i. Name apparatus Y.

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(1 mark)

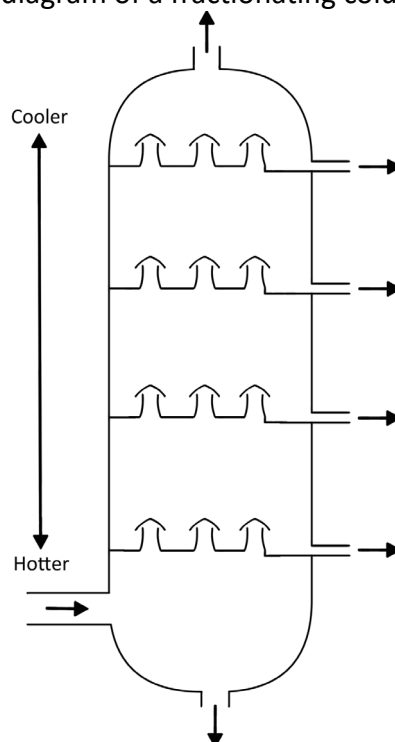
ii. The student must connect a supply of cold water to apparatus Y.

Complete the figure above by drawing **one** arrow to show the path of cold water into the apparatus.

(1 mark)

Crude oil is a complex mixture of hydrocarbons. It is separated into more useful substances, called fractions, by fractional distillation in a fractionating column.

The figure below shows a simplified diagram of a fractionating column.



The crude oil is heated before it enters the column.

- c) Describe the change in the state of the hydrocarbons when the crude oil is heated.

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(1 mark)

The table below shows information about some of the fractions obtained from crude oil.

Fraction	Number of carbon atoms in molecules	Boiling point range (°C)
Naphtha	7 – 14	70 – 200
Kerosene	11 – 16	180 – 260
Diesel	15 – 20	260 – 340
Bitumen	> 70	> 350

- d) Explain the relationship between the number of carbon atoms in a hydrocarbon molecule and its boiling point. Refer to intermolecular forces in your answer.

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(3 marks)

- e) Explain how the mixture of hydrocarbon vapours is separated into different fractions within the column.

In your answer you should refer to the temperature gradient in the column and the properties of the different hydrocarbon molecules.

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(4 marks)

- f) Kerosene is collected from a tray at a height where the temperature is 220 °C.

The temperature controller for the top of the column malfunctions, causing the temperature at the very top to increase from 40 °C to 150 °C.

Explain how this fault would affect the naphtha fraction collected.

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(3 marks)

(Total for Question 6 is 15 marks)