PEARSON EDEXCEL GCSE COMBINED SCIENCE (HIGHER) · 1SC0

CHEMISTRY



EXAM QUESTION PACK

TOPIC 2: STATES OF MATTER AND MIXTURES: METHODS OF SEPARATING AND PURIFYING SUBSTANCES (PAPER 1)

SCORE	PERCENTAGE
/134	%

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Q1.

Water treatment is needed to make most sources of water suitable for drinking.

A student was asked to distil a sample of tap water.

Figure 4 shows the apparatus the student used.

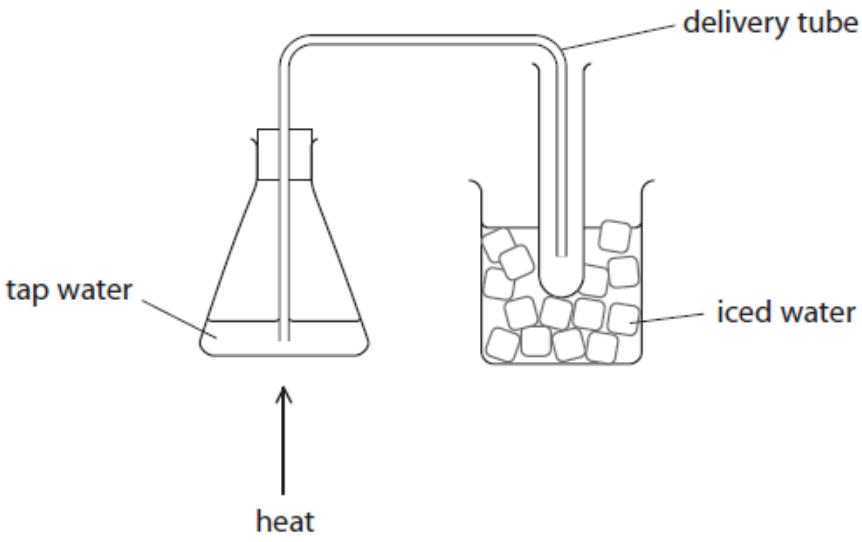


Figure 4

(i) The student made an error when setting up the apparatus in Figure 4.

This error meant that pure water could **not** be collected in the test tube.

Explain what the student needs to change so that pure water can be collected in the test tube.

(2)

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(ii) State what the student should use to heat the water.

(1)

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(Total for question = 3 marks)

Q2.

Nitrogen, N_2 , oxygen, O_2 and fluorine F_2 are all gases.

Fluorine has a boiling point of −188 °C.

(i) Explain why fluorine has a low boiling point.

(3)

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Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

(ii) A mixture of nitrogen and oxygen becomes a liquid when cooled to −200 °C.

Which row shows the changes in energy and movement of the molecules as they are cooled from room temperature to −200 °C?

(1)

		movement of molecules	energy of molecules
☒	**A**	less	more
☒	**B**	more	less
☒	**C**	less	less
☒	**D**	more	more

(iii) The mixture of liquid nitrogen and liquid oxygen can be separated.

Which process could be used to separate a mixture of liquid nitrogen and liquid oxygen?

(1)

☒ **A** paper chromatography

☒ **B** fractional distillation

☒ **C** filtration

☒ **D** crystallisation

(Total for question = 5 marks)

(**QU03b 1SC0/1CH, June 2025**)

Q3.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

In an experiment, paper chromatography was used to separate the coloured dyes in four different inks, **W**, **X**, **Y** and **Z**.

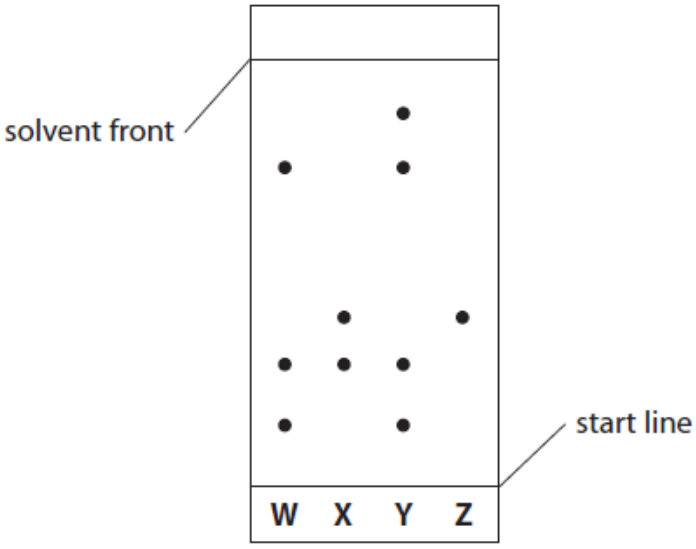


Figure 1

Figure 1 shows the chromatogram at the end of the experiment.

(i) The chromatogram shows that only one of the inks contains a single dye.

Which ink contains a single dye?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(ii) Which ink contains the greatest number of dyes?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(iii) The R_f value of a dye can be calculated using the equation

$$R_f = \frac{\text{distance moved by the dye}}{\text{distance moved by solvent front}}$$

At the end of the chromatography one dye had moved 3.60 cm and the solvent front had moved 9.20 cm.

Calculate the R_f value for this dye.

Give your answer to 2 decimal places.

(2)

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R_f = ...

(Total for question = 4 marks)

(**Q01a 1SC0/1CF, June 2023**)

Q4.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Water treatment is needed to make most sources of water suitable for drinking.

Some tap water contains chloride ions.

(i) Explain, in terms of electrons, how a chlorine atom, Cl, forms a chloride ion, Cl^-.

(2)

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.....

(ii) Why is chlorine added to water during water treatment?

(1)

☒ **A** to clean the water

☒ **B** to dissolve insoluble substances in the water

☒ **C** to increase the pH of the water to 11

☒ **D** to kill any bacteria in the water

(iii) State why tap water is not suitable for use in chemical analysis.

(1)

.....

.....

(Total for question = 4 marks)

(**Q02b 1SC0/1CF, June 2024**)

Q5.

Bonding and separation techniques

(a) The diagram shows the structure of diamond.



(i) Describe what each ● represents.

(2)

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.....

(ii) State the type of bonding in the diamond structure.

(1)

.....

(b) Give the name of the process used to obtain oxygen from liquid air.

(2)

.....

.....

(c) A colouring in some sweets was analysed using paper chromatography.

One of the dyes in the colouring moved 2 cm up the paper while the solvent moved 8 cm.

What is the R_f value of this dye?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** 0.25

☒ **B** 2

☒ **C** 4

☒ **D** 6

*(d) Here is some information about magnesium, oxygen and magnesium oxide.

The electronic configuration of magnesium atoms is 2.8.2
The electronic configuration of oxygen atoms is 2.6
Magnesium oxide is an ionic compound.

When magnesium ribbon is heated, it reacts with oxygen from the air to form magnesium oxide, MgO.

Describe how the reaction can be carried out, including an explanation of what happens to the magnesium and oxygen atoms when they form magnesium oxide.

(6)

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(Total for question = 12 marks)

(**Q05 1SC0/1CF, June 2014**)

Q6.

Figure 5 shows the structure of a molecule of compound **S**.

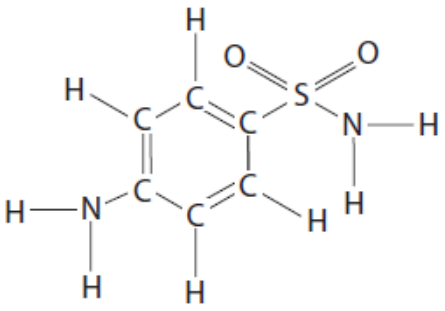


Figure 5

A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0.22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2.4 cm.

(2)

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.....

distance = ... cm

(Total for question = 2 marks)

(**QU06b 1SC0/1CH, June 2023**)

Q7.

Inks contain coloured dyes.
Samples of four inks, **W**, **X**, **Y** and **Z**, were separated using paper chromatography.
Figure 3 shows the chromatogram obtained.

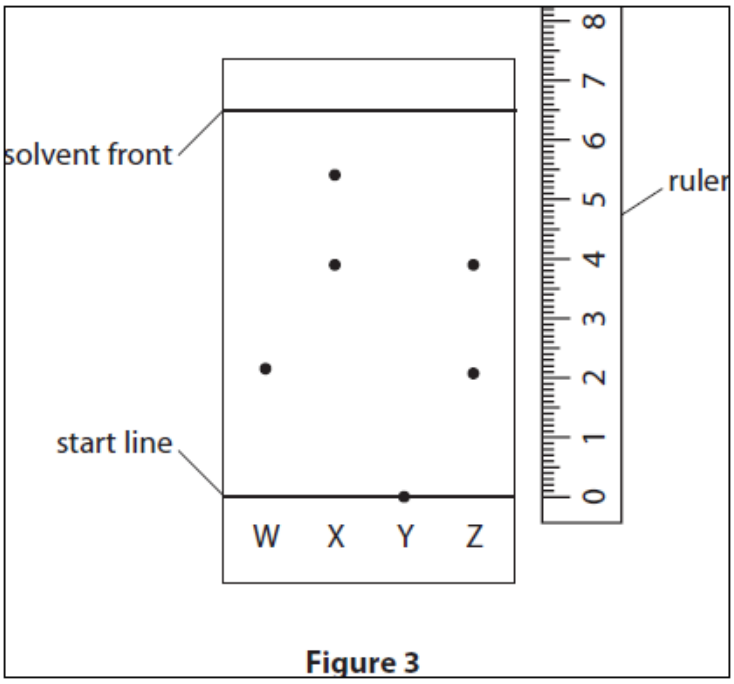


Figure 3

(i) In the experiment, the solvent front moved 6.5 cm.
Calculate the R_f value of the dye that is present in both inks **X** and **Z**.

(1)

.....

.....

R_f = ...

(ii) State what could be changed in the experiment to make the R_f value more accurate.

(1)

.....

.....

(iii) In this experiment, ink sample **Y** did not move from the start line.
Explain a change to the experiment that would be needed to separate the dyes in ink sample **Y**.

(2)

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(Total for question = 4 marks)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Potable water is water that is suitable for drinking.

River water can be treated to make it potable.
Chlorination, filtration and sedimentation are three of the processes involved in making the river water potable.

(i) Which row of the table shows these three processes in the order in which they are carried out?

(1)

		first	second	third
☒	**A**	chlorination	sedimentation	filtration
☒	**B**	chlorination	filtration	sedimentation
☒	**C**	sedimentation	filtration	chlorination
☒	**D**	sedimentation	chlorination	filtration

(ii) State the reason why chlorine is added during the water treatment.

(1)

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(iii) Describe how sedimentation is carried out.

(2)

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(iv) Figure 3 shows the results of an analysis of a sample of potable water.

ion	concentration in mg dm^{-3}
chloride	60.70
fluoride	0.24
nitrate	24.90
sulfate	71.40
copper	0.05
magnesium	9.10

Figure 3

Using this information, explain why this sample of potable water is not the same as pure water.

(2)

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(Total for question = 6 marks)

(**Q02a 1SC0/1CF, June 2022**)

Q9.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Waste water can be used to produce drinking water.
The processes used include sedimentation, filtration and chlorination.

(i) What is sedimentation?

(1)

☒ **A** the waste water is heated so the impurities evaporate

☒ **B** the waste water has an acid added to remove impurities

☒ **C** the impurities in the waste water settle to the bottom of their container

☒ **D** the impurities in the waste water are bleached

(ii) State why the waste water is filtered.

(1)

.....

.....

(iii) State the reason for chlorination.

(1)

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(Total for question = 3 marks)

(**Q06b 1SC0/1CF, Nov 2021**)

Q10.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Waste water can be used to produce drinking water.
The processes used include sedimentation, filtration and chlorination.

(i) What is sedimentation?

(1)

☒ **A** the waste water is heated so the impurities evaporate

☒ **B** the waste water has an acid added to remove impurities

☒ **C** the impurities in the waste water settle to the bottom of their container

☒

D the impurities in the waste water are bleached

(ii) State why the waste water is filtered.

(1)

.....

.....

(iii) State the reason for chlorination.

(1)

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.....

(Total for question = 3 marks)

(**Q02b 1SC0/1CH, Nov 2021**)

Q11.

A sample of rock salt contains a mixture of sodium chloride and some insoluble substances.

The rock salt is added to water and the mixture stirred.

The mixture is then filtered to obtain a filtrate of sodium chloride solution.

(i) Draw a labelled diagram of the apparatus used to filter the mixture and collect the sodium chloride solution.

(2)

(ii) Describe how a sample of pure, dry sodium chloride crystals can be obtained from the filtrate.

(3)

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(Total for question = 5 marks)

(**Q03a 1SC0/1CH, Nov 2020**)

Q12.

In a different method of obtaining nickel, the process produces a mixture of the liquids nickel tetracarbonyl and iron pentacarbonyl.

The boiling point of nickel tetracarbonyl is 43 °C.
The boiling point of iron pentacarbonyl is 103 °C.
These two liquids mix together completely.

Describe the process used to separate these two liquids.

(3)

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(Total for question = 3 marks)

(**Q03c 1SC0/1CH, June 2019**)

Q13.

* A sample of water was contaminated with a dissolved solid.

Devise a plan to separate pure water from this mixture, including a test to show that the water obtained is neutral.

You may use some or all of the apparatus shown in Figure 8 and any other laboratory apparatus.

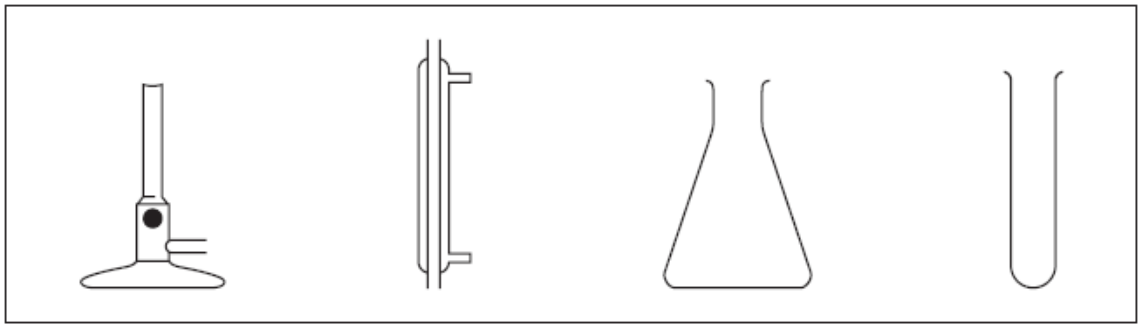


Figure 8

(6)

(Total for question = 6 marks)

(**Q06d 1SC0/1CF, Nov 2021**)

Q14.

A student set up the apparatus shown in Figure 4 to obtain pure water from sea water by distillation.

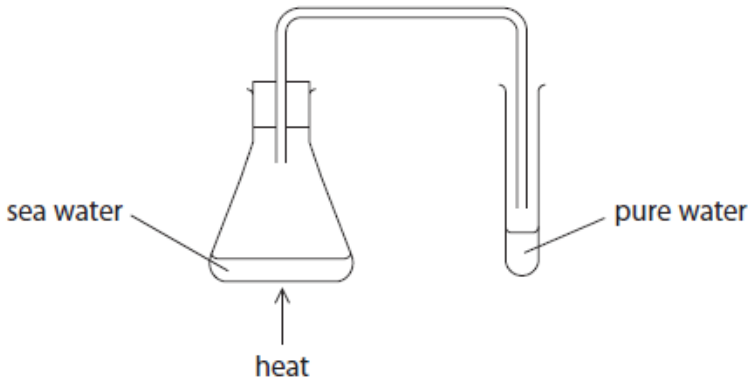


Figure 4

(i) Explain how the water in sea water separates to produce the pure water in this apparatus.

(2)

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(ii) Explain how the apparatus could be improved to increase the amount of pure water collected from the same volume of sea water.

(2)

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(Total for question = 4 marks)

(**Q09 1SC0/1CH, June 2018**)

Q15.

A student wanted to distil a sample of potable water. Figure 4 shows apparatus the student used.

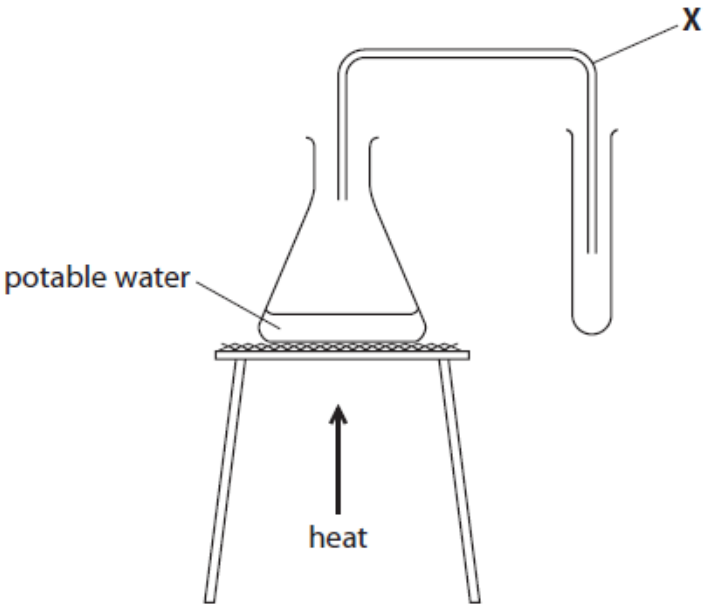


Figure 4

(i) Name the piece of equipment labelled **X** in Figure 4.

(1)

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(ii) The student made an error when setting up the equipment in Figure 4.

This error meant no water could be collected in the test tube.

Explain what the student needs to do so water can be collected.

(2)

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(Total for question = 3 marks)

(**Q02b 1SC0/1CF, June 2022**)

Q16.

Calcium nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker.
The solid calcium carbonate is added until some remains at the bottom of the beaker.

(i) The mixture in the beaker is filtered to remove the excess solid calcium carbonate.

Draw a diagram to show the apparatus used to filter the mixture and to collect the filtrate.

(2)

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

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(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

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(Total for question = 7 marks)

(**Q05a 1SC0/1CF, SAM**)

Q17.

* A solution of sodium chloride in water needs to be separated to obtain a sample of pure, dry sodium chloride and a sample of pure water.

Figure 7 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 7

Explain this difference in boiling points in terms of the structure and bonding of sodium chloride and water and how this difference is used to choose a method to separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6)

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(Total for question = 6 marks)

(**QU06c 1SC0/1CH, June 2023**)

Q18.

Figure 1 shows a label from a bottle of drinking water.

Pure drinking water	
Mass of dissolved solids in mg per 1000 cm^3	
calcium ions	60
sodium ions	2
hydrogencarbonate ions	200
pH of water	
pH	7

Figure 1

(i) Explain why this drinking water should not be described as pure water.

(2)

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.....

(ii) State the information from Figure 1 that shows that the drinking water is neutral.

(1)

.....

(iii) Calculate the mass of calcium ions in 250 cm^3 of this drinking water.

(2)

.....

.....

mass = ... mg

(Total for question = 5 marks)

(**Q01b 1SC0/1CF, Nov 2021**)

Q19.

Nitrogen and oxygen are present in the air.

(a) In industry, nitrogen and oxygen are obtained from air.

(i) Give the name of the process used.

(1)

.....

(ii) State why the air is cooled before the start of the process.

(1)

.....

.....

(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

Oxygen has a low boiling point because there are

(1)

☒ **A** weak covalent bonds between the oxygen atoms

☒ **B** weak covalent bonds between the oxygen molecules

☒ **C** weak forces of attraction between the oxygen atoms

☒ **D** weak forces of attraction between the oxygen molecules

(c) Another gas present in air is carbon dioxide, CO_2.
There are covalent bonds between the atoms in a molecule of carbon dioxide.

(i) Describe what is meant by a**covalent bond.**

(2)

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.....

(ii) The electronic configuration of oxygen (atomic number 8) is 2.6.

Give the electronic configuration of carbon (atomic number 6).

(1)

.....

(iii) Draw a dot and cross diagram of a molecule of carbon dioxide.

Show outer electrons only.

(2)

(Total for Question = 8 marks)

(**Q12 1SC0/1CH, June 2013**)

Q20.

Figure 3 shows the apparatus that a student set up to obtain pure water from ink.

There are three mistakes in the way the apparatus has been set up.

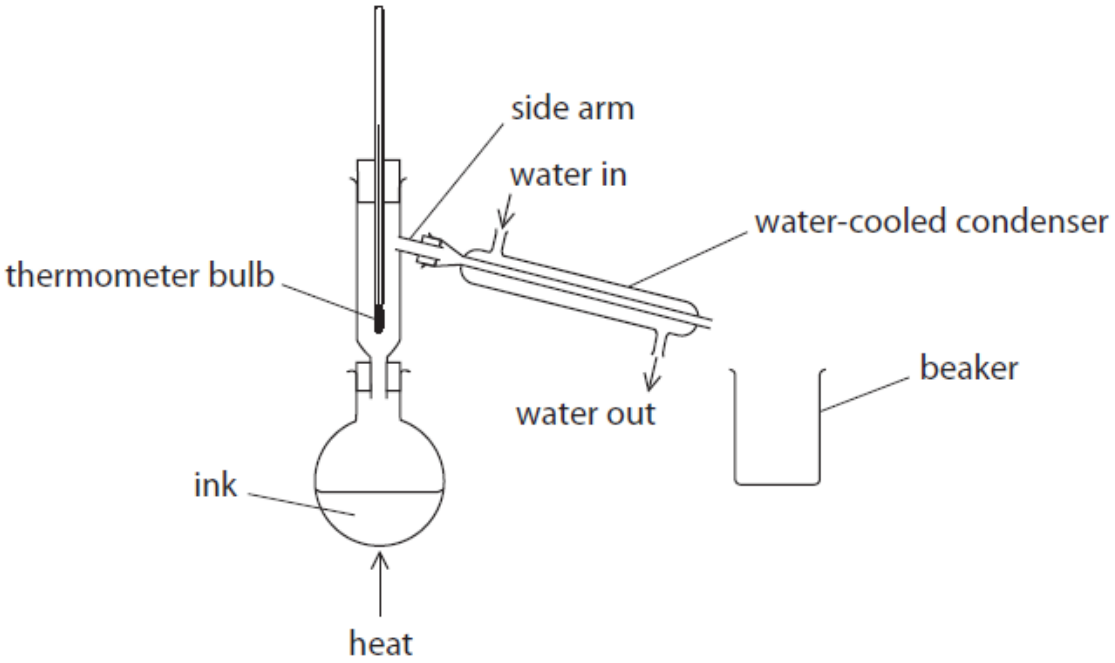


Figure 3

(i) One mistake is that the bulb of the thermometer is too low.

The bulb of the thermometer should be level with the side arm.

Give a reason why the bulb of the thermometer should be level with the side arm.

(1)

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.....

.....

(ii) State **one** other mistake in Figure 3.

(1)

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.....

(Total for question = 2 marks)

(**Q02b 1SC0/1CF, June 2019**)

Q21.

Substances can be pure or they can be mixtures.

Which of these is a mixture?

(1)

☒ **A** chlorine

☒ **B** sodium

☒ **C** sodium chloride

☒ **D** sodium chloride solution

(Total for question = 1 mark)

(**Q05a 1SC0/1CF, SAM 2016**)

Q22.

(i) Which type of water is potable water?

(1)

☒ **A** tap water

☒ **B** sea water

☒ **C** waste water

☒ **D** ground water

(ii) When sea water is distilled a white solid and a colourless liquid are obtained.

Give the name of the main substance present in

(2)

the white solid

.....

the colourless liquid

.....

(Total for question = 3 marks)

(**Q03a 1SC0/1CF, SAM**)

Q23.

Water treatment is needed to make most sources of water suitable for drinking.

Water treatment includes the processes of **chlorination**, **filtration** and **sedimentation**.

Place these processes in the order that they take place during water treatment.

(2)

first		last

(Total for question = 2 marks)

(**Q02a 1SC0/1CF, June 2024**)

Q24.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Mixtures of substances can be separated using different techniques.

Which of the following is a mixture of substances?

(1)

☒ **A** air

☒ **B** carbon dioxide

☒ **C** gold

☒ **D** titanium

(Total for question = 1 mark)

(**Q02a 1SC0/1CF, June 2019**)

Q25.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A sample of potable water contains impurities.

Why is this sample of water potable even though it contains impurities?

(1)

☒ **A** the impurities have no smell

☒ **B** the impurities are colourless

☒ **C** the impurities are harmless

☒ **D** the impurities are soluble

(Total for question = 1 mark)

(**Q06a 1SC0/1CF, Nov 2021**)

Q26.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A sample of potable water contains impurities.

Why is this sample of water potable even though it contains impurities?

(1)

☒ **A** the impurities have no smell

☒ **B** the impurities are colourless

☒ **C** the impurities are harmless

☒ **D** the impurities are soluble

(Total for question = 1 mark)

(**Q02a 1SC0/1CH, Nov 2021**)

Q27.

P, Q, R and S are mixtures of food colourings.

They are investigated using paper chromatography.

Figure 13 shows the chromatogram at the end of the experiment.

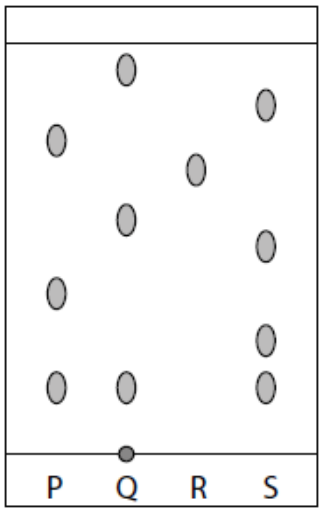


Figure 13

(i) Which mixture contains an insoluble food colouring?

(1)

☒ **A** mixture **P**

☒ **B** mixture **Q**

☒ **C** mixture **R**

☒ **D** mixture **S**

(ii) Give a change that could be made to the experiment to obtain an R_f value for the insoluble colouring.

(1)

.....

.....

(iii) Explain, by referring to Figure 13, which mixture is separated into the greatest number of soluble food colourings by this chromatography experiment.

(2)

.....

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.....

.....

(Total for question = 4 marks)

(**Q05d 1SC0/1CF, SAM 2016**)

Q28.

P, **Q**, **R** and **S** are mixtures of food colourings.
They are investigated using paper chromatography.
Figure 4 shows the chromatogram at the end of the experiment.

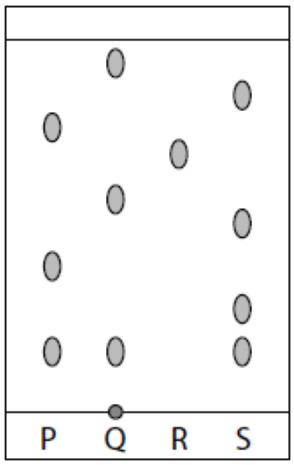


Figure 4

(i) Which mixture contains an insoluble food colouring?

(1)

☒ **A** mixture **P**

☒ **B** mixture **Q**

☒ **C** mixture **R**

☒ **D** mixture **S**

(ii) Give a change that could be made to the experiment to obtain an R_f value for the insoluble colouring.

(1)

.....

.....

(iii) Explain, by referring to Figure 4, which mixture is separated into the greatest

number of soluble food colourings by this chromatography experiment.

(2)

.....

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.....

.....

(Total for question = 4 marks)

(**Q01b 1SC0/1CH, SAM 2016**)

Q29.

A student is investigating the maximum mass of sodium chloride that can be dissolved in 100 cm^3 water at room temperature.

The student has been given 1.0 g samples of solid sodium chloride to dissolve in the water.

The method the student uses is

step **1** fill a 100 cm^3 beaker with tap water

step **2** add 1.0 g sodium chloride and see if it dissolves

step **3** keep adding 1.0 g portions of sodium chloride until a portion of solid does not dissolve completely

In step **3**, some sodium chloride remains undissolved.

(i) State what would you **see** in the beaker when this step is complete.

(1)

.....

.....

.....

(ii) State the name of the method that could be used to separate the undissolved sodium chloride from the mixture.

(1)

.....

(Total for question = 2 marks)

(Q01d 1SC0/1CF, SAM)

Q30.

Paper chromatography is used to separate the substances in five different food colourings, **P**, **Q**, **R**, **S** and **T**.

Figure 4 shows the chromatogram at the end of the experiment.

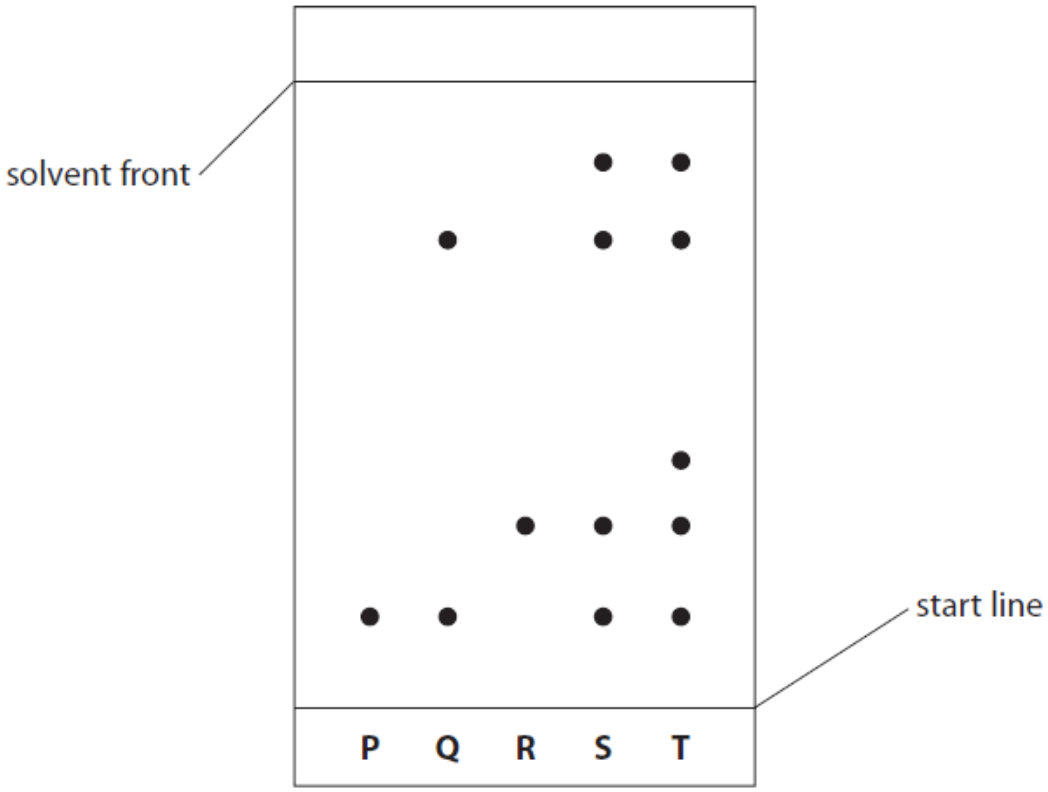


Figure 4

(i) The steps needed to carry out the chromatography experiment are listed below.

They are not in the correct order.

1 leave the solvent to rise up the paper
2 put solvent in the beaker
3 draw a start line on the piece of paper
4 place the paper in the beaker
5 remove the paper when the solvent is near the top
6 put small spots of the food colourings on the start line

List the steps in the correct order.

The first two steps have been done for you.

(2)

2	3				

(ii) Explain, using Figure 4, which food colouring contains the greatest number of coloured substances.

(2)

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(iii) During chromatography of the food colourings, the solvent front moved

8.00 cm and the food colouring **R** moved 2.30 cm.

Calculate the R_f value for food colouring **R**.
Give your answer to two significant figures.

(2)

.....

.....

.....

.....

R_f value = ...

(Total for question = 6 marks)

(**Q02c 1SC0/1CF, June 2019**)

Q31.

Figure 4 shows the apparatus that can be used to separate a mixture of ethanol and water by fractional distillation.

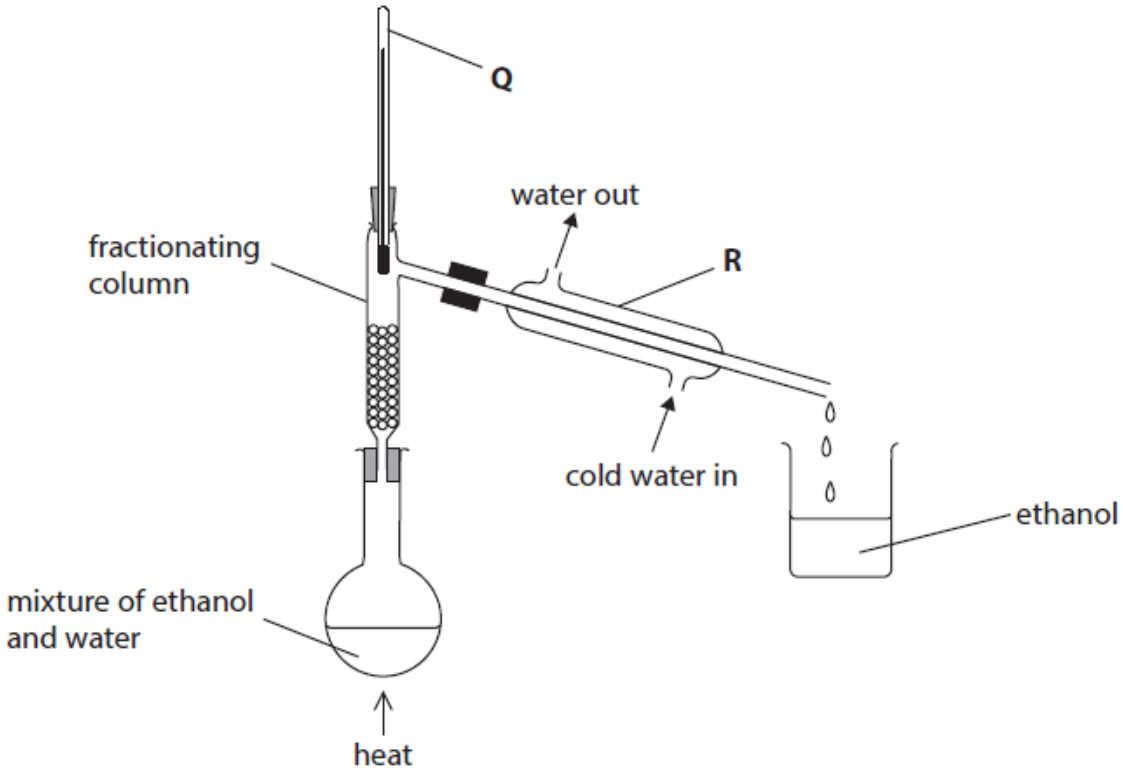


Figure 4

(i) Name the piece of apparatus labelled **R** in Figure 4 used to record the temperature.

(1)

.....

(ii) Explain the purpose of the piece of apparatus labelled **Q** in Figure 4.

(2)

.....

.....

.....

.....

(Total for question = 3 marks)

(**QU02b 1SC0/1CF, June 2025**)

Q32.

Nitrogen and oxygen are present in the air.

In industry, nitrogen and oxygen are obtained from air.

(i) Give the name of the process used.

(1)

.....

(ii) State why the air is cooled before the start of the process.

(1)

.....

.....

(**Q18 1SC0/1CH, June 2013**)

Q33.

An ink is a mixture of coloured substances dissolved in water.

The apparatus shown in Figure 9 can be used to separate water from ink.

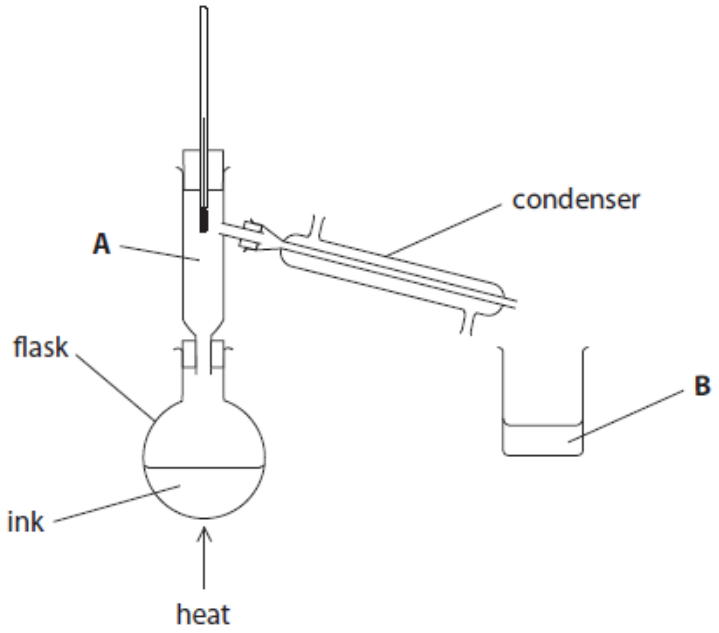


Figure 9

(i) Cold water flows through the condenser.

On Figure 9 use arrows to show where the water should flow in and where it should flow out.

(1)

(ii) Explain why a condenser is used.

(2)

.....

.....

.....

.....

(iii) The flask was heated with a Bunsen burner.

Give the name of an alternative piece of apparatus that could be used to heat the flask.

(1)

.....

.....

(Total for question = 4 marks)

(**Q15 1SC0/1CF, June 2018**)

Q34.

An ink is a mixture of coloured substances dissolved in water.

Which method is used to separate the coloured substances in the ink?

(1)

☒ **A** chromatography

☒ **B** crystallisation

☒ **C** filtration

☒ **D** fractional distillation

(Total for question = 1 mark)

(**Q14 1SC0/1CF, June 2018**)

Q35.

A gas was left to cool to form a liquid.

Figure 1 shows how the temperature of the substance changed with time.

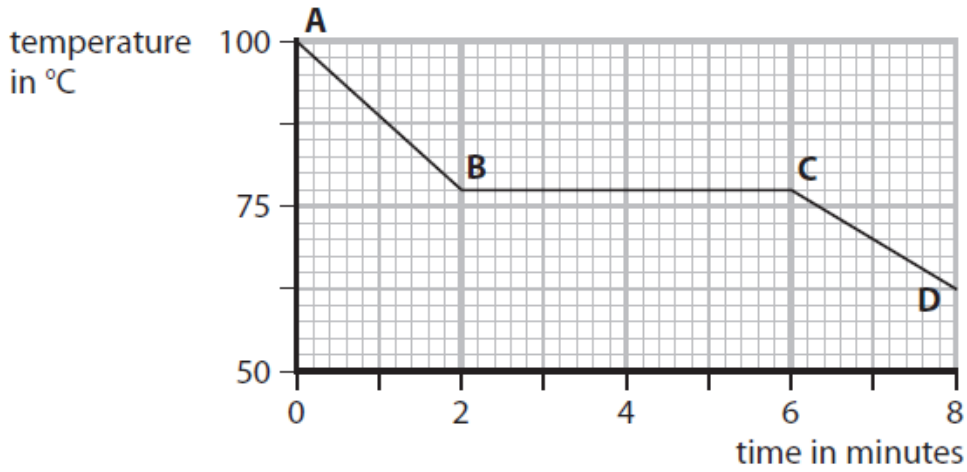


Figure 1

From **A** to **B** the substance is a gas.

From **C** to **D** the substance is a liquid.

(i) State the time when the gas first started to form a liquid.

(1)

..... minutes

(ii) Calculate the number of minutes it took from the gas first starting to form a liquid until the substance was completely liquid.

(1)

.....

..... minutes

(Total for question = 2 marks)

(**Q01b 1SC0/1CF, June 2019**)

Q36.

A student investigates the reaction that occurs when zinc carbonate is heated.

Figure 1 shows the apparatus the student uses.

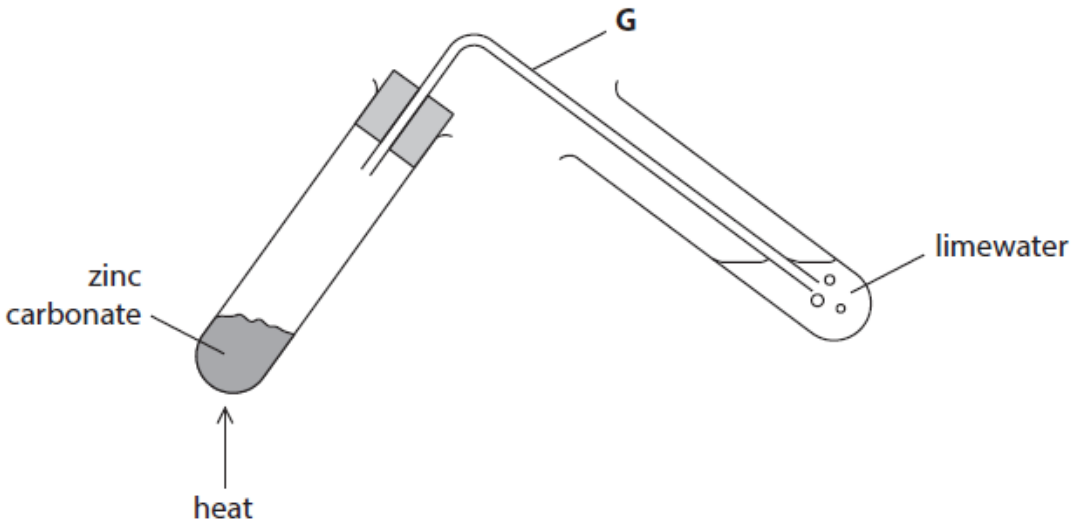


Figure 1

State what apparatus should be used to heat the zinc carbonate in Figure 1.

(1)

.....

(Total for question = 1 mark)

(**QU01b 1SC0/1CF, June 2025**)

Q37.

A student investigates the food dyes used to make the colours **W**, **X**, **Y** and **Z** in four different sweets.

Figure 5 shows the chromatogram produced.

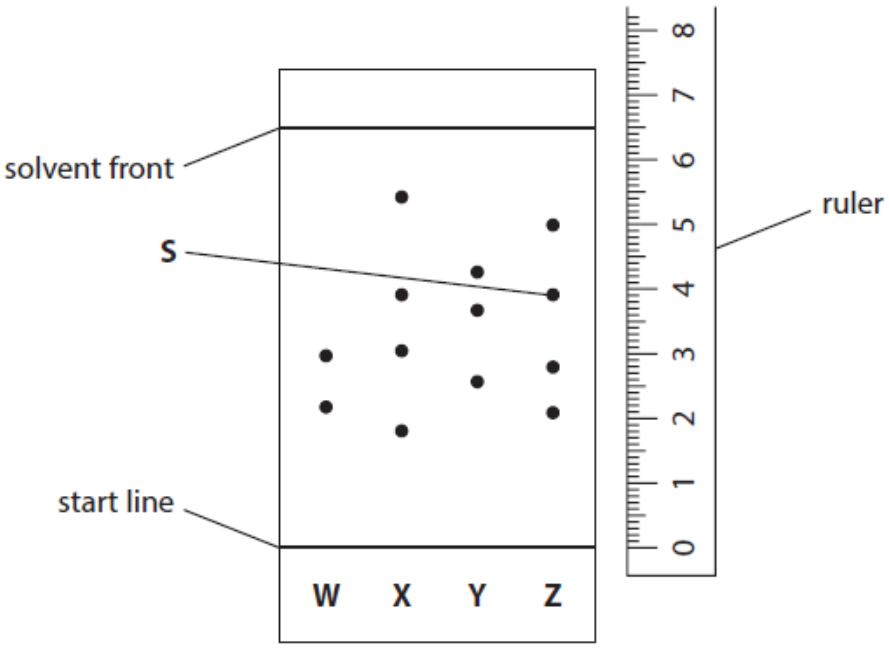


Figure 5

The solvent front shows how far the solvent moves during the investigation.

(i) Using the information in Figure 5, state which colour is made of only two food dyes.

(1)

.....

(ii) The R_f value of a spot on the chromatogram can be calculated using the equation

$$R_f = \frac{\text{distance moved by the food dye}}{\text{distance moved by solvent front}}$$

Using the information in Figure 5, calculate the R_f value of the food dye labelled **S**.

Give your answer to 2 decimal places.

(3)

.....

.....

.....

.....

R_f value of food dye **S** = ...

(Total for question = 4 marks)

Q38.

Figure 5 shows the structure of a molecule of compound **S**.

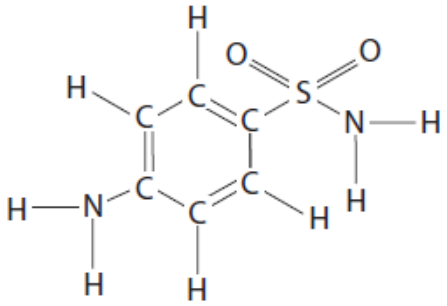


Figure 5

(i) Use Figure 5 to deduce the empirical formula of compound **S**.

(1)

.....

(ii) The melting points of three samples of **S** are shown in Figure 6.

sample	melting point in °C
A	160–164
B	166
C	163–165

Figure 6

State whether each of these samples, **A**, **B** and **C**, is pure or impure and justify your answers using the information in Figure 6.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

(**QU06a 1SC0/1CH, June 2023**)

Q39.

After this reaction, there is a mixture of the solids magnesium, titanium and magnesium chloride.

Titanium does not react with dilute hydrochloric acid.

Suggest a simple method to separate titanium from the mixture.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 2 marks)

(**Q05e 1SC0/1CH, Nov 2021**)

Q40.

Titanium is extracted from its ore in several stages.

In the first stage, titanium chloride is formed as a gas.

The gas is cooled to form liquid titanium chloride containing **dissolved** impurities.

Suggest how pure titanium chloride could be separated from the impurities.

(1)

.....

(Total for question = 1 mark)

(**Q05c 1SC0/1CH, Nov 2021**)