1 Mixtures of coloured substances can be separated by paper chromatography.

(a) Paper chromatography was used to separate a mixture of blue and red inks.
A spot of the mixture was placed on chromatography paper as shown in Figure 1.

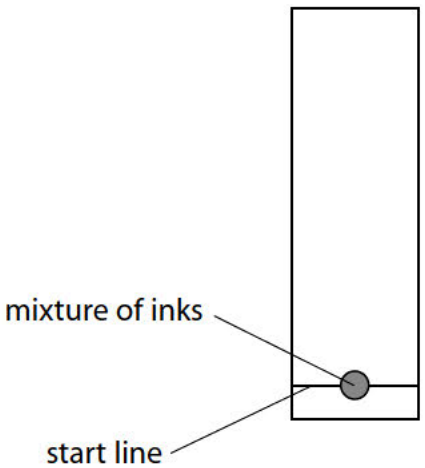


Figure 1

(i) Give a reason why the start line is drawn in pencil rather than in ink.

(1)

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.....

(ii) The chromatography paper, with the spot of mixture on it, was placed in a beaker with the bottom of the paper in water.

On Figure 2, complete the diagram showing the position of the chromatography paper with the spot of mixture at the start of the experiment.

(1)

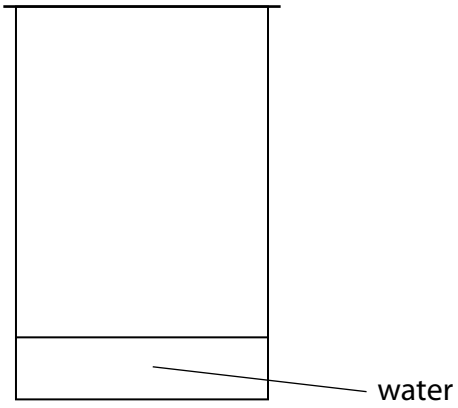


Figure 2

(iii) The chromatography was carried out and the result is shown in Figure 3.

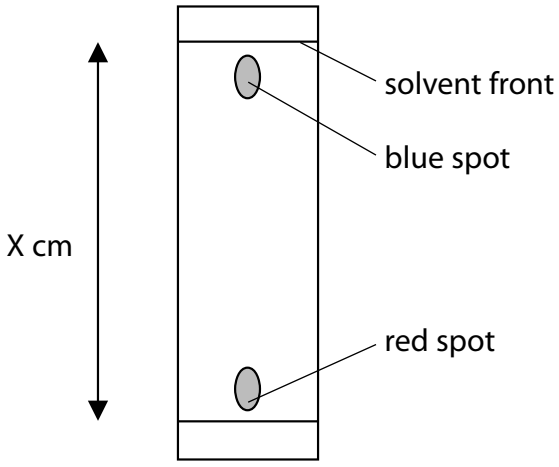


Figure 3

The blue spot had moved 14.5 cm and the solvent front had moved 15.3 cm.

Calculate the R_f value of the substance in the blue spot, giving your answer to 2 significant figures.

$$R_f \text{ value} = \frac{\text{distance travelled by a dye}}{\text{distance travelled by solvent front}}$$

(2)

(b) **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.

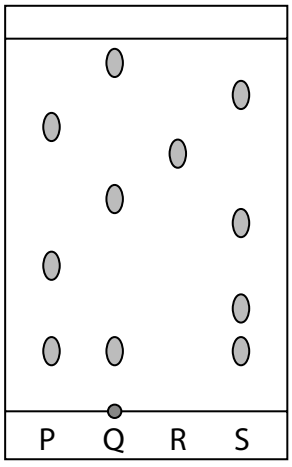


Figure 4

(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)

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.....

(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 1 = 8 marks)

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

A mixture of two immiscible liquids can be separated by using

(1)

☒ **A** fractional distillation

☒ **B** a separating funnel

☒ **C** evaporation

☒ **D** filtration

(b) Oxygen is a simple molecular, covalent substance.

(i) The electronic configuration of oxygen is 2.6.

Draw a dot and cross diagram for a molecule of oxygen, O_2.

Show the outer electrons only.

(3)

(ii) The boiling point of oxygen is –183 °C.

Explain, in terms of the forces between the molecules, why oxygen has a very low boiling point.

(2)

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(c) Describe how oxygen and nitrogen are obtained from liquid air by fractional distillation.

(3)

(Total for Question 2 = 9 marks)

3 (a) Which of the following pairs of substances contains one substance that is soluble in water and one that is insoluble in water?

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

(1)

- ☐ **A** aluminium nitrate and lead sulfate
- ☐ **B** ammonium chloride and copper sulfate
- ☐ **C** copper hydroxide and lead sulfate
- ☐ **D** sodium hydroxide and potassium nitrate

(b) Barium chloride is an ionic compound and has a high melting point.

Explain why barium chloride has a high melting point.

(2)

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(c) Barium chloride solution is used to test for the presence of sulfate ions in a solution.

When sulfate ions are present, insoluble barium sulfate is formed.

(i) Describe the appearance of barium sulfate.

(1)

.....

(ii) Complete the balanced equation for the reaction between barium chloride and potassium sulfate.

(2)

$BaCl_2 + K_2SO_4 \rightarrow$ .....

(d) Compound **X** is a metal carbonate.

(i) A flame test was carried out on compound **X**.
A lilac flame was seen.

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

(1)

The formula of the metal ion in compound **X** is

☐ **A** Ca^{2+}

☐ **B** Cu^{2+}

☐ **C** K^{+}

☐ **D** Na^{+}

(ii) Lead carbonate is an insoluble salt.

Describe how a pure, dry sample of solid lead carbonate can be obtained from sodium carbonate solution and lead nitrate solution.

(3)

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(Total for Question 3 = 10 marks)

4 The method used to prepare a salt depends on its solubility in water.

(a) Complete Figure 9 by placing one tick in each row to show whether the salt is soluble or insoluble.

(2)

salt	soluble	insoluble
ammonium chloride		
lithium sulfate		
magnesium carbonate		

Figure 9

(b) Lead nitrate solution mixed with sodium sulfate solution forms lead sulfate as a precipitate.

$$Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$$

The theoretical yield of lead sulfate for this reaction was 2.85 g.
The actual yield of lead sulfate obtained was 2.53 g.

Calculate the percentage yield of lead sulfate in this experiment.

Give your answer to two significant figures.

(3)

percentage yield = ... %

(c) The method used to make the lead sulfate is:

- pour 100 cm^3 lead nitrate solution into a beaker
- add drops of sodium sulfate solution until a precipitate is seen
- allow the precipitate to settle to the bottom of the beaker
- pour off the liquid
- use a spatula to transfer the solid lead sulfate onto a filter paper

Explain **two** ways of improving this experimental method to increase the amount and quality of lead sulfate obtained from the same volume of lead nitrate solution.

(4)

(d) Ammonium nitrate is produced from ammonia and nitric acid on a large scale in industry.

Ammonium nitrate can also be made in the laboratory by titrating ammonia solution with dilute nitric acid.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

Ammonium nitrate crystals can then be obtained by evaporating off some of the water from the solution.

Give **two** reasons why this laboratory method is not suitable for use on a large scale in industry.

(2)

(Total for Question 4 = 11 marks)

5 The table shows some properties of six compounds.

compound	melting point / °C	boiling point / °C	solubility in water	electrical conductivity of solution
copper sulfate	200	decomposes	soluble	high
hexane	–95	69	insoluble	does not dissolve
hydrogen chloride	–112	–85	soluble	high
octane	–57	126	insoluble	does not dissolve
silicon(IV) oxide	1610	2230	insoluble	does not dissolve
sodium chloride	801	1413	soluble	high

(a) Which of the following lists of compounds from the table contains only ionic compounds?

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

(1)

☐ **A** copper sulfate, octane and sodium chloride

☐ **B** silicon(IV) oxide and sodium chloride

☐ **C** copper sulfate and sodium chloride

☐ **D** copper sulfate and silicon(IV) oxide

(b) Two of the compounds in the table produce a colour in a flame test.

Give the name of **one** of these compounds and the colour it produces in the flame test.

(2)

compound .....

colour .....

(c) Hexane is a covalent compound containing simple molecules.
It has a low boiling point.

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

(2)

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(ii) Hexane and water are immiscible.

Describe how separate samples of hexane and water can be obtained from a mixture of hexane and water.

(2)

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(d) Draw a dot and cross diagram of a molecule of hydrogen chloride.

Show outer electrons only.

(2)

(Total for Question 5 = 9 marks)