

## 4-8 Chemical Analysis – Chemistry

1.0 This question is about pure substances and mixtures.

1.1 Which **two** substances are mixtures?

**[2 marks]**

Tick **two** boxes.

Air

Copper oxide

Diamond

Stainless steel

Water vapour

1.2 Draw **one** line from each context to the correct meaning.

**[2 marks]**

### Context

### Meaning

A substance that has had nothing added to it

Pure substance in chemistry

A single element or a single compound

A complex mixture with specific properties

Pure substance in everyday life

A substance that can be separated by distillation

A substance that can be separated by filtration

2.0 This question is about chemical analysis and chromatography.

2.1 What is the test for chlorine gas?

[1 mark]

Tick **one** box.

A glowing splint relights

A lighted splint gives a pop

Damp litmus paper turns white

Limewater turns milky

A student added sodium hydroxide solution to four different solutions labelled A, B, C and D. The student added 5 drops of sodium hydroxide. The student then added excess sodium hydroxide.

The student's results are shown in **Table 1**.

**Table 1**

Sample	Effect of sodium hydroxide addition	
	5 drops	excess
A	White precipitate formed	No further change
B	Blue precipitate formed	No further change
C	Green precipitate formed	No further change
D	White precipitate formed	Precipitate dissolves

2.2 Which sample from **Table 1** contains copper ions?

[1 mark]

Tick **one** box.

A

B

C

**D**

**2.3** Which sample from **Table 1** contains iron(II) ions?

**[1 mark]**Tick **one** box.**A****B****C****D**

**2.4** Complete the sentence to show the reagents the student could add to show if a sample contains sulfate ions.

**[3 marks]**

The reagents are barium \_\_\_\_\_ and dilute \_\_\_\_\_ acid.

If sulfate ions are present, a \_\_\_\_\_ precipitate is seen.

**2.5** Chromatography was used to compare three colours used as food colourings.



What do these results tell you about these three colours?

**[3 marks]**

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**2.6** State two advantages of using instrumental methods compared to chemical tests.

**[2 marks]**

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**3.0** This question is about identifying metal ions in ionic compounds.

A student did a flame test on a white powder **A**.

**3.1** Describe how to carry out a flame test.

**[2 marks]**

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**3.2** The flame turned crimson.

Name the metal ion in the white powder **A**.

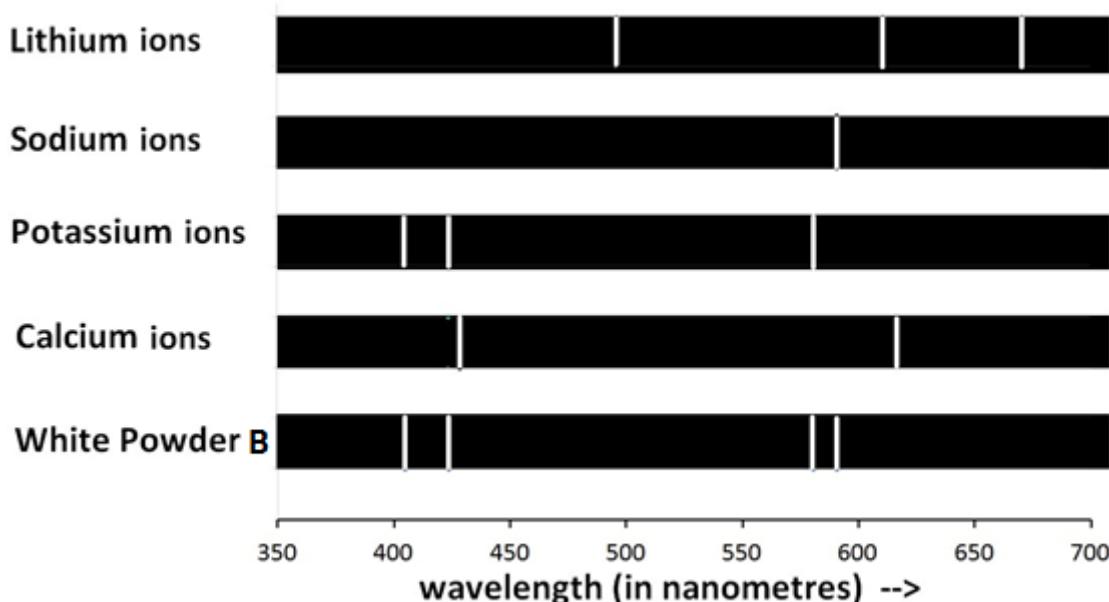
**[1 mark]**

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**3.3** Metal ions can also be identified using flame emission spectroscopy.

The student then used flame emission spectroscopy to analyse a different white powder **B**.

**Figure 2** shows the spectra of compounds containing four metal ions, and the spectrum of the white powder **B**.



Use **Figure 2** to identify the **two** metal ions in the white powder B.

[2 marks]

Metal 1: \_\_\_\_\_

Metal 2: \_\_\_\_\_

### 3.4 An ionic compound can be analysed using

- a flame-test
- flame emission spectroscopy

Compare the advantages and disadvantages of these two methods

[6 marks]

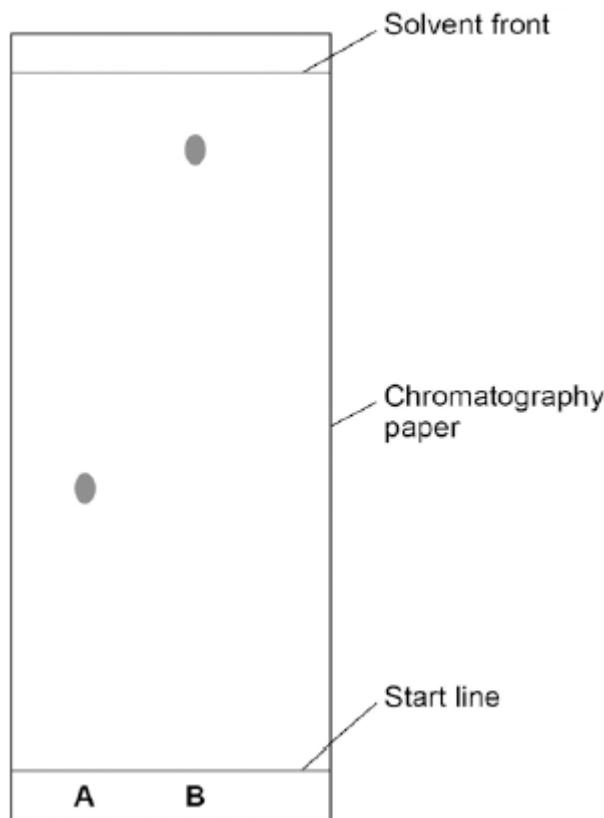


**4.0** A farmer has had his prize goat kidnapped! A ransom note, written in marker pen, has been left. The police arrest two suspects and search their houses. They find a marker pen at each house which could have been used to write the note. They decide to use paper chromatography to see whether the ink in the marker pens match the ransom note.

**4.1** Describe how you would use chromatography to test whether the ink in the felt tip pens matches the ink on the note.

[4 marks]

4.2 The chromatogram shown below was taken from the suspects' marker pens.



Calculate the R<sub>f</sub> value for ink spot A. Give your answer to 3 significant figures.

**[3 marks]**

R<sub>f</sub> value for ink spot A \_\_\_\_\_

4.3 Explain why inks A and B move by different amounts during paper chromatography.

You should refer to the stationary and mobile phases in your answer.

**[4 marks]**

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4.4 The Ink on the ransom note had an  $R_f$  value of 4.10.

Was the ink taken from the ransom note the same as the ink taken from marker pen A?

Explain your answer.

**[3 marks]**

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5.0 Two students investigated a white salt, **Z**.

5.1 The students dissolved **Z** in water. They then added a few drops of sodium hydroxide solution to a fresh solution of **Z**. A white precipitate was formed. The students then added dilute nitric acid and silver nitrate solution to the solution of **Z**. A cream precipitate was formed.

Student A concluded that compound Z was zinc sulfate.

Student B concluded that compound Z was copper bromide.

Which student, if any, was correct?

Explain your reasoning.

[4 marks]

**5.2** Name **two** other metal ions that would also give a white precipitate when a few drops of sodium hydroxide solution are added.

[2 marks]

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**MARK SCHEME**

Qu No.		Extra Information	Marks
1.1	Air Stainless steel		1 1
1.2	(substance in chemistry) A single element or a single compound (substance in everyday life) A substance that has had nothing added to it		1 1

Qu No.		Extra Information	Marks
2.1	Damp litmus paper turns white		1
2.2	B		1
2.3	C		1
2.4	(barium) chloride Hydrochloric (acid) white (precipitate)	Allow (barium) nitrate	1 1 1
2.5	<ul style="list-style-type: none"> <li>colours 1 and 2 contain only one colour / dye</li> <li>colour 3 contains two colours / dyes</li> <li>colour 3 is a mixture of colour 2 <b>and</b> a different dye (that is not colour 1)</li> </ul>		1 1 1
2.6	Any <b>two</b> from: <ul style="list-style-type: none"> <li>More accurate</li> <li>More sensitive</li> <li>Rapid/faster</li> <li>Can be used to analyse very small samples</li> </ul>		2

Qu No.		Extra Information	Marks
3.1	Any <b>two</b> from: <ul style="list-style-type: none"> <li>method of introducing sample into flame e.g. wire</li> <li>clean wire in concentrated acid</li> <li>blue / roaring flame</li> </ul>	Allow colourless flame	1 1
3.2	Lithium (ion)	Allow $\text{Li}^+$	1
3.3	Sodium (ions) Potassium (ions)	Allow $\text{Na}^+$ Allow $\text{K}^+$	1 1
3.4			
<b>Level 3:</b>	A detailed and coherent comparison is given, which demonstrates a broad knowledge and understanding of the key scientific ideas. The response makes logical links between the points raised.		5-6
<b>Level 2:</b>	A description is given which demonstrates a reasonable knowledge and understanding of the key scientific ideas. Comparisons are made but may not be fully articulated and / or precise.		3-4
<b>Level 1:</b>	Simple statements are made which demonstrate a basic knowledge of some of the relevant ideas. The response may fail to make comparisons between the points raised.		1-2
<b>Indicative content</b>			
<b>Advantages of flame test:</b> <ul style="list-style-type: none"> <li>Simple equipment</li> <li>Quick result</li> <li>Very small amount of sample required</li> </ul> <b>Disadvantages of flame test:</b> <ul style="list-style-type: none"> <li>Difficult to analyse mixtures</li> <li>One colour may mask others</li> <li>Subjective</li> </ul> <b>Advantages of flame emission spectroscopy:</b> <ul style="list-style-type: none"> <li>Can analyse mixtures</li> <li>Can be used to determine percentages of different ions in a mixture</li> <li>Objective</li> <li>Very small amount of sample required</li> </ul> <b>Disadvantages of flame emission spectroscopy</b> <ul style="list-style-type: none"> <li>Specialist equipment</li> <li>Equipment requires calibration</li> <li>More time consuming to set up</li> </ul>			

Qu No.		Extra Information	Marks
4.1	<p>Any <b>four</b> from:</p> <ul style="list-style-type: none"> <li>use chromatography paper</li> <li>draw pencil line on paper</li> <li>add a drop of ink from each marker pen to the line</li> <li>place in solvent</li> <li>solvent level to be below pencil line</li> <li>leave to run</li> <li>compare with ink from ransom note</li> </ul>		4
4.2	<p>(distance moved by A) 3.7cm and 9.2 cm (distance moved by solvent)</p> <p>3.7 9.2 0.402</p>	<p>allow values in range 3.6 – 3.8 cm and 9.1 – 9.3 cm distances must be verified on print out from school.</p> <p>accept 0.402 without working shown for 3 marks allow ecf from incorrect measurement to final answer for max of 2 marks if given to 3 significant figures.</p>	1 1 1
4.3	<ul style="list-style-type: none"> <li>Separation depends on the amount of time substances spend in the mobile and stationary phase</li> <li>Ink that travels further has a greater attraction to the mobile phase/solvent</li> <li>Ink that travels less has a greater attraction to the stationary phase/paper</li> <li>So <b>A</b> has a greater attraction to the mobile phase / solvent <b>or</b> so <b>C</b> has a greater attraction to the stationary phase / paper</li> </ul>		1 1 1 1
4.4	<p>(Yes/No)</p> <ul style="list-style-type: none"> <li>Rf value is close</li> <li>But not the same</li> <li>If yes: Difference likely due to small errors in measurement If no: Rf values should be the same for the same substance</li> </ul>	<p>(no mark awarded)</p> <p>distances must be verified on print out from school</p>	1 1 1
Qu No.		Extra Information	Marks
5.1	<p>Neither student was correct Zinc ions would give white precipitate with sodium hydroxide But cream precipitate indicates presence of bromide ions However, copper ions would give blue precipitate with hydroxide ions</p>	<p>Allow salt was zinc bromide</p> <p>Allow copper salts not white</p>	1 1 1 1
5.2	<p>Any <b>two</b> from: Aluminium ions Magnesium ions Calcium ions</p>	<p>allow <math>\text{Al}^{3+}</math> allow <math>\text{Mg}^{2+}</math> allow <math>\text{Ca}^{2+}</math></p>	Up to 2

