1 Tests can be carried out on salts to identify the ions present in the salts.

(a) (i) A flame test on a salt produces an orange-red colour.

Which ion is responsible for the orange-red colour?

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

(1)

☐ **A** calcium ion, Ca^{2+}

☐ **B** copper ion, Cu^{2+}

☐ **C** potassium ion, K^{+}

☐ **D** sodium ion, Na^{+}

(ii) A solution of a chloride salt is acidified with dilute nitric acid.
Silver nitrate solution is added to the mixture.

Describe what is **seen** when the silver nitrate solution is added.

(2)

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(b) Which of these salts is insoluble in water?

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

(1)

☐ **A** sodium carbonate

☐ **B** lead chloride

☐ **C** magnesium nitrate

☐ **D** potassium sulfate

(c) Sodium sulfate solution and barium chloride solution are mixed.
A precipitate of barium sulfate is formed.
Another product is formed in solution.

(i) Complete the word equation for the reaction.

Include state symbols.

(2)

sodium sulfate (aq) + barium chloride (aq) ⟶ ..... (.....) + ... (.....)

(ii) Barium salts are toxic.
Before some X-rays, patients have to swallow a suspension of barium sulfate, known as a 'barium meal'.

Explain why it is safe for these patients to swallow the barium sulfate.

(2)

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(Total for Question 1 = 8 marks)

2 (a) A technician had two bottles containing solid salts.
One bottle contained a potassium salt and the other contained a sodium salt.
Unfortunately the labels had fallen off the bottles.
The technician tested the salts to find the ions present.

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

Both salts contained the same anion.

A solution of one salt was made and some dilute nitric acid was added.
Drops of silver nitrate solution were added.
A yellow precipitate formed.

This test shows the anion in the salt is

(1)

☐ **A** bromide, Br^-

☐ **B** chloride, Cl^-

☐ **C** iodide, I^-

☐ **D** sulfate, SO_4^{2-}

(ii) The technician wanted to find out which bottle contained the sodium salt and which bottle contained the potassium salt.

Explain how the technician should do this.

(2)

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(b) When sodium hydroxide solution is mixed with a solution containing copper ions, Cu^{2+}, copper hydroxide, $Cu(OH)_2$, is formed.

(i) Describe what you would **see** when these solutions are mixed.

(2)

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(ii) Write the ionic equation for this reaction.

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(3)

(Total for Question 2 = 8 marks)

3 (a) Three solids, **A**, **B**, and **C**, are analysed.

(i) Solid **A** is potassium iodide.

A small amount of solid **A** is dissolved in water to form a solution.

Describe the test to show that the solution of **A** contains iodide ions.

(2)

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(ii) Solid **B** is ammonium chloride.

Describe the test to show that solid **B** contains ammonium ions.

(3)

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(iii) Solid **C** is dissolved in water.

When sodium hydroxide solution is added to the solution of **C**, a red-brown precipitate is formed.

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

This test shows that the ion present in solid **C** is

(1)

☒ **A** copper, Cu^{2+}

☒ **B** iron(II), Fe^{2+}

☒ **C** iron(III), Fe^{3+}

☒ **D** sodium, Na^{+}

(b) Sodium hydroxide solution can be used to test for aluminium ions and for calcium ions in solution.

Describe the results of these tests for aluminium ions and for calcium ions, explaining how the results distinguish between the two ions.

(3)

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(Total for Question 3 = 9 marks)

4 Qualitative tests are used to identify ions.

(a) A student carries out a flame test on an unknown solid.
A red flame is seen.
The student concludes that the solid is lithium carbonate.

Explain why this conclusion is **not** justified.

(2)

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(b) The following tests were carried out on a substance containing two ions.

1. A flame test on the solid substance produced a yellow colour.

2. Dilute hydrochloric acid was added to a solution of the substance followed by a few drops of barium chloride solution.
A white precipitate formed.

Give the name and formula of the substance.

(2)

Name of substance .....

Formula of substance .....

(c) The test for chloride ions was carried out on a solution.
Dilute nitric acid was added to the solution, followed by a few drops of silver nitrate solution.
A white precipitate formed.

Why is it necessary to add dilute nitric acid in this test?

(1)

☒ **A** To neutralise the solution

☒ **B** Nitrate ions are needed for the test to work

☒ **C** To make sure that no carbonate ions are present

☒ **D** The test only works in alkaline conditions

(d) Sodium hydroxide solution is used to identify some cations present in compounds.

(i) Sodium hydroxide solution is warmed with a solution of ammonium ions. Ammonia gas is given off.

Describe the test to show the gas is ammonia.

(2)

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(ii) Sodium hydroxide solution is also used to distinguish between iron(II) ions, Fe^{2+} and iron(III) ions, Fe^{3+}, in solution.

You are given a solution containing iron(II) ions and another solution containing iron(III) ions.

Describe what is seen when sodium hydroxide solution is added to each of these solutions.

(2)

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(iii) Iron(III) ions, Fe^{3+}, react with hydroxide ions in solution to form iron(III) hydroxide.

Complete the ionic equation for this reaction.

(1)

$Fe^{3+} + 3OH^- \rightarrow$ .....

(Total for Question 4 = 10 marks)

5 Sodium carbonate and copper chloride are both ionic solids.

They are both soluble in water.

(a) Which row of the table shows the most likely melting points of these two salts?

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

(1)

	melting point / °C	
	sodium carbonate	**copper chloride**
A ☐	17	498
B ☐	851	9
C ☐	851	498
D ☐	9	17

(b) Copper chloride contains copper ions, Cu^{2+}, and chloride ions, Cl^-.
Give the formula of copper chloride.

(1)

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

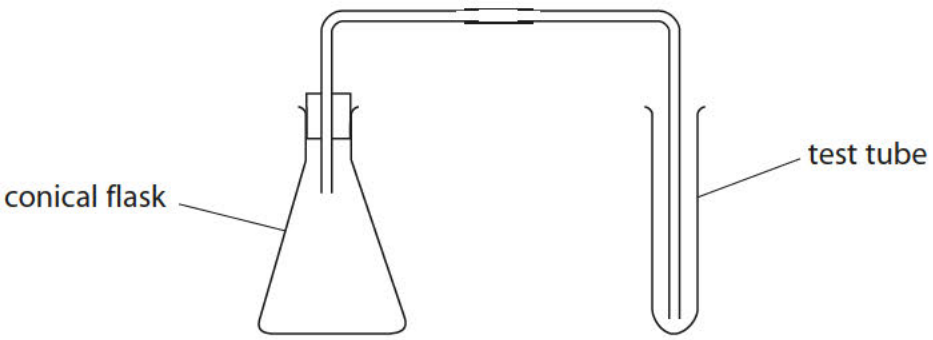
If a flame test is carried out on copper chloride, the colour in the flame is

(1)

- ☐ **A** red-brown
- ☐ **B** yellow
- ☐ **C** lilac
- ☐ **D** green-blue

(d) Describe how this apparatus can be used to show that sodium carbonate reacts with dilute acid to form carbon dioxide.

(3)



(e) Copper carbonate is an insoluble salt.

Describe how you would use sodium carbonate and copper chloride to produce a pure, dry sample of copper carbonate.

(3)

(Total for Question 5 = 9 marks)