Identifying ions

Answers, marking points and revision notes | AQA GCSE Chemistry 8462 only (not Combined Science)

GCSE science required practicals

This practical online

Answers

1 Explain why the wire loop is dipped in hydrochloric acid and held in the flame before each flame test. (2 marks)

It cleans the loop by removing traces of the previous sample. Otherwise, metal ions left on the wire would add their own colour to the flame and give a wrong result.

Marking points

- Cleans the wire / removes earlier sample
- Prevents contamination giving a false flame colour

2 Give two things Hassan should do to make sure each test is fair and his results can be trusted. (2 marks)

Use clean test tubes and a clean loop for each sample, and add the same volume of sample and the same number of drops of reagent each time.

Marking points

- Clean equipment for each sample (no contamination)
- Same volume of sample / same amount of reagent each time

3 Barium chloride solution is toxic. Describe how Hassan should reduce the risk when he uses it. (2 marks)

Use only a few drops from a dropping pipette and wear goggles. Wash his hands after the practical and never eat or drink in the laboratory.

Marking points

- Small amounts, dropping pipette, goggles
- Wash hands / no eating or drinking

4 Name the compound in sample S. Explain how the results show this. (2 marks)

Potassium bromide. The lilac flame shows potassium ions, and the cream precipitate with silver nitrate shows bromide ions.

Marking points

- Lilac flame = potassium
- Cream precipitate = bromide, so potassium bromide

5 Name the compounds in samples P, Q and R. (3 marks)

P: lithium carbonate. Q: copper(II) chloride. R: iron(II) sulfate.

Marking points

- P: lithium carbonate
- Q: copper(II) chloride
- R: iron(II) sulfate

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6 Sample T gave a white precipitate with sodium hydroxide. This could be calcium, magnesium or aluminium ions. Explain how the results show it is calcium, and describe a further test that would rule out aluminium. (2 marks)

The orange-red flame shows calcium ions. To rule out aluminium, add more sodium hydroxide: an aluminium hydroxide precipitate would dissolve in excess, but calcium hydroxide stays.

Marking points

- Orange-red flame shows calcium
- Add excess sodium hydroxide: precipitate stays (aluminium hydroxide would dissolve)

7 Explain why dilute hydrochloric acid is added before barium chloride in the sulfate test. (2 marks)

The acid reacts with any carbonate ions and removes them as carbon dioxide. Carbonate ions would also form a white precipitate with barium ions and give a false positive result.

Marking points

- Removes carbonate ions
- Carbonates would also give a white precipitate (false positive)

8 The white precipitate in the halide test on sample Q is silver chloride, AgCl. Calculate its relative formula mass (M_r). Relative atomic masses: Ag = 108, Cl = 35.5. (2 marks)

143.5

$M_r \text{ of } AgCl = 108 + 35.5$

$M_r \text{ of } AgCl = 143.5$

Marking points

- 108 + 35.5
- 143.5

9 The white precipitate from sample U with barium chloride is barium sulfate, $BaSO_4$. Calculate its M_r. Relative atomic masses: Ba = 137, S = 32, O = 16. (2 marks)

233

$M_r \text{ of } BaSO_4 = 137 + 32 + (4 \times 16)$

$M_r = 137 + 32 + 64$

$M_r = 233$

Marking points

- 137 + 32 + (4 x 16)
- 233

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10 **Higher tier**

Hassan filtered, dried and weighed the barium sulfate from a sample of U. He got 0.466 g. Use your answer to question 9 to calculate the number of moles of barium sulfate. Give your answer in standard form. Show your working.

(3 marks)

2.00×10^{-3} mol

Moles = mass / M_r

Moles = 0.466 / 233

Moles = 0.00200

Moles = 2.00×10^{-3} mol

Marking points

- Moles = mass / M_r
- 0.466 / 233 = 0.00200
- 2.00×10^{-3} mol

11 **Higher tier**

Write a balanced ionic equation, with state symbols, for the formation of the blue precipitate in sample Q.

(2 marks)

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

Marking points

- Correct ions and formula of copper(II) hydroxide, balanced
- State symbols: (aq), (aq), (s)

12 Hassan's partner used hydrochloric acid instead of nitric acid before adding silver nitrate to sample U. She got a white precipitate and decided U was a chloride. Explain her mistake.

(2 marks)

Hydrochloric acid contains chloride ions, so these reacted with the silver nitrate and made white silver chloride. The precipitate came from the acid, not from the sample, so it was a false positive.

Marking points

- Hydrochloric acid adds chloride ions
- So a white precipitate forms whatever the sample is (false positive)

13 A sample contains a mixture of sodium and potassium ions. Explain why a flame test cannot easily identify both, and suggest an instrumental method that would.

(3 marks)

The strong yellow flame from sodium hides the lilac colour from potassium, so only sodium is seen. Flame emission spectroscopy would work: it splits the light into a line spectrum, and each metal ion has its own pattern of lines, so both can be identified even in a mixture.

Marking points

- Sodium's yellow colour masks potassium's lilac
- Flame emission spectroscopy
- Gives a line spectrum unique to each ion, so both can be identified (and it is more sensitive)

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14 A technician has three bottles that have lost their labels. She knows they are iron(III) chloride solution, magnesium sulfate solution and sodium iodide solution, but not which is which. Describe how you would use chemical tests to work out which bottle is which.

(6 marks)

Wear goggles. Put about 2 cm^3 of each solution into separate labelled test tubes and add a few drops of sodium hydroxide solution. Iron(III) chloride gives a brown precipitate. Magnesium sulfate gives a white precipitate that does not dissolve when more sodium hydroxide is added. Sodium iodide gives no precipitate. To confirm, take fresh samples. Add dilute nitric acid and then silver nitrate: iodide gives a yellow precipitate and chloride gives a white one. Add dilute hydrochloric acid and then barium chloride to a fresh sample of the third solution: a white precipitate shows sulfate. A flame test on sodium iodide would also give a yellow flame. Clean the equipment between samples so they do not contaminate each other.

Marking points (any 6, with the method in a logical order)

- Sodium hydroxide added to each sample
- Brown precipitate = iron(III)
- White precipitate (not dissolving in excess) = magnesium
- No precipitate = sodium compound
- Nitric acid then silver nitrate: yellow = iodide, white = chloride
- Hydrochloric acid then barium chloride: white precipitate = sulfate
- Flame test: yellow for sodium
- Fresh samples / clean equipment for each test; goggles worn

How it is marked

- 5-6 marks: clear tests that tell all three solutions apart, with the correct result for each, and a confirming test for the negative ions, set out logically.
- 3-4 marks: correct tests and results that identify at least two of the solutions, with some results or reagents missing.
- 1-2 marks: one or two correct tests or results, but not enough to tell the bottles apart.

Revision notes: the method

Aim: To identify the positive and negative ions in unknown ionic compounds using flame tests, sodium hydroxide, and tests for carbonate, halide and sulfate ions.

Equipment

- nichrome wire loop in a handle
- Bunsen burner and heatproof mat
- dilute hydrochloric acid (to clean the wire)
- test tubes and test tube rack
- dropping pipettes
- sodium hydroxide solution (dilute)
- dilute nitric acid and silver nitrate solution
- barium chloride solution
- limewater and a delivery tube
- safety goggles

Method

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1. Flame test: dip a clean nichrome wire loop in dilute hydrochloric acid, then into the solid sample, and hold it at the edge of a blue Bunsen flame. Record the flame colour. Clean the loop in acid between samples.
2. Metal hydroxides: add about 2 cm^3 of the sample solution to a test tube, then add a few drops of sodium hydroxide solution. Record the colour of any precipitate.
3. Carbonates: add dilute hydrochloric acid to a small amount of the sample. If it fizzes, bubble the gas through limewater; carbon dioxide turns it milky.
4. Halides: add dilute nitric acid to the sample solution, then a few drops of silver nitrate solution. Record the colour of any precipitate.
5. Sulfates: add dilute hydrochloric acid to the sample solution, then a few drops of barium chloride solution. A white precipitate shows sulfate ions.
6. Use fresh sample and a clean test tube for each test.
7. Put the results together in a table and name each compound from its positive and negative ions.

Variables

- **Independent:** The unknown compound being tested.
- **Dependent:** The observations: flame colour, precipitate colour, fizzing and limewater result.
- **Control:** Volume of sample solution in each test tube; Same reagents and number of drops for each test; Clean wire loop and clean test tubes for every sample; Same part of the flame used for every flame test

Hazards

Hazard	What could happen	How to reduce the risk
Sodium hydroxide solution	Irritant or corrosive to eyes and skin	Wear goggles and wash splashes off straight away
Silver nitrate solution	Stains and irritates the skin; harmful to the eyes	Use a dropping pipette, wear goggles and gloves if available
Barium chloride solution	Toxic if swallowed	Use small volumes, do not eat or drink, wash hands afterwards
Hot nichrome wire in the Bunsen flame	Burns	Hold the insulated handle and let the loop cool on a heatproof mat

Key points

- Flame colours: lithium crimson, sodium yellow, potassium lilac, calcium orange-red, copper green.
- Hydroxide precipitates: copper(II) blue, iron(II) green, iron(III) brown; aluminium, calcium and magnesium white, and only the aluminium one dissolves in excess sodium hydroxide.
- Halides with silver nitrate: chloride white, bromide cream, iodide yellow.
- Nitric acid goes in before silver nitrate, and hydrochloric acid before barium chloride, to remove carbonate ions that would also give a precipitate.
- Never use hydrochloric acid before silver nitrate: it adds chloride ions and gives a false white precipitate.
- A mixture of metal ions can hide flame colours (for example a strong yellow can hide others).

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