

Questions

Q1.

Qualitative tests are carried out on ionic substances to identify the ions present in the substances.

The test for a given ion must be unique to that ion.

(i) Explain why the test for a given ion must be unique to that ion.

(2)

.....

.....

.....

.....

(ii) In the test for the carbonate ion, CO_3^{2-} , dilute hydrochloric acid is added to the solid being tested.

State the name of the gas produced in the test if carbonate ions are present.

(1)

.....

(iii) Tests for three ions are described.

Draw one straight line from the test for each ion to the observation that shows that ion to be present.

Each observation may be correct for one test, more than one test, or for none of the tests.

(3)

description of test	observation
test for chloride ion: add dilute nitric acid followed by silver nitrate solution	green precipitate
test for iodide ion: add dilute nitric acid followed by silver nitrate solution	red precipitate
test for sulfate ion: add dilute hydrochloric acid followed by barium chloride solution	white precipitate
	yellow precipitate

(Total for question = 6 marks)

Q2.

Qualitative tests are used to identify ions in compounds.

Instrumental methods are often used for analysis.

Give a reason why instrumental analysis may be better than other methods of analysis.

(1)

.....

.....

(Total for question = 1 mark)

Q3.

Some questions must be answered with a cross in a box (☐). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☐).

A precipitate is produced when an alkaline solution is added to a solution containing some metal ions.

(i) Which of these is evidence of a precipitate being produced?

(1)

- ☐ A fizzing
- ☐ B solid forms in the solution
- ☐ C the solution turns purple
- ☐ D the solution gets hot

(ii) You are given two solutions, one containing Ca^{2+} ions and the other containing Al^{3+} ions.

Devise a plan to identify which solution is which.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q4.

Two tests were carried out on copper sulfate solution.

(i) Sodium hydroxide solution was added to a small amount of copper sulfate solution.
A blue precipitate of copper hydroxide formed.

Complete the word equation for the reaction.

Include state symbols.

copper sulfate (aq) + sodium hydroxide (aq) → (.....) + (.....) (2)

(ii) Dilute hydrochloric acid was added to a different sample of copper sulfate solution.
Barium chloride solution was then added.

State what would be seen.

(1)

.....

(Total for question = 3 marks)

Q5.

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

Complete the ionic equation for this reaction.

(1)

$\text{Fe}^{3+} + 3\text{OH}^- \rightarrow \dots\dots\dots$

(Total for question = 1 mark)

Q6.

* A scientist carries out some tests on solid V and on a solution of V.

The tests and results are shown in Figure 11.

test	result
appearance of V	white solid
see whether solid V conducts electricity	the solid does not conduct electricity
see whether a solution of V conducts electricity	the solution conducts electricity
heat solid V to 400 °C	the solid does not melt
add some sodium hydroxide solution to solid V and warm	a pungent gas, W, is released which turns damp litmus paper blue
add some dilute nitric acid, followed by drops of silver nitrate solution, to a solution of V	a cream precipitate, X, is produced

Figure 11

Use the data in Figure 11 to deduce information about V, W and X, explaining your deductions.

(6)

(Total for question = 6 marks)

Q7.

Qualitative tests can be used to identify ions in substances.

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)

.....

.....

.....

.....

(Total for question = 2 marks)

Q8.

Tests are carried out to identify the ions in two solids, P and Q.

A flame test is used to identify the metal ions in each of these solids.

(i) Describe how to do a flame test.

(2)

.....

.....

.....

.....

.....

.....

(ii) Different metal ions produce different coloured flames.

Draw one straight line from each metal ion to its flame colour.

(2)

metal ion	flame colour
	● green
calcium ●	● yellow
	● lilac
potassium ●	● orange-red
	● blue-green

(Total for question = 4 marks)

Q9.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Compounds are tested to see if they contain chloride, bromide or iodide ions.

Figure 5 shows a flow chart of this test.

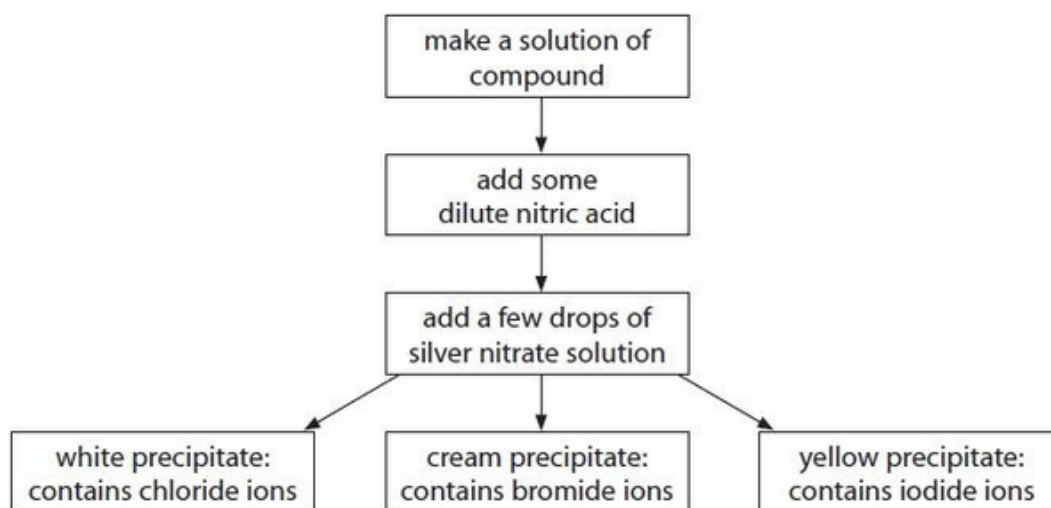


Figure 5

(i) Describe how to make a solution from a solid in a test tube.

(2)

.....
 (ii)

Give the name of the apparatus that should be used to add a few drops of silver nitrate solution to the test tube.

(1)

.....

(iii) When an equation is written for this reaction, which state symbol is used for the silver nitrate solution?

(1)

- ☒ A aq
☒ B g
☒ C l
☒ D s

(Total for question = 4 marks)

Q10.

A sample of potassium carbonate is contaminated with a small amount of sodium carbonate. When a flame test is carried out on the sample, a bright yellow flame is seen.

Describe how you could show that potassium and sodium ions are present in this sample.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q11.

* A student was given a container of ammonium iron(II) sulfate, $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$. The student was also given a dilute solution of sodium hydroxide and access to other laboratory reagents.

Describe the tests the student should carry out to identify the ions in the ammonium iron(II) sulfate, including appropriate equations for the reactions involved.

(6)

(Total for question = 6 marks)

Q12.

A white solid is known to be a chloride in which the metal ion is sodium, potassium, calcium or aluminium.

A chemist was told to carry out a test for each metal ion that could be present in this white solid.

Describe tests to show the presence of each of these metal ions.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q13.

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)

.....

.....

.....

.....

(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)

.....

.....

.....

.....

(Total for question = 4 marks)

Q14.

Tests are carried out to identify the ions in two solids, P and Q.

P and Q dissolve in water to form colourless solutions.

Figure 7 shows the results of tests on these solutions.

test	results	
	solution of P	solution of Q
dilute hydrochloric acid added, then barium chloride solution	a white precipitate	remains colourless
dilute nitric acid added, then silver nitrate solution	remains colourless	a yellow precipitate

Figure 7

(i) The anions in solutions of P and Q can be identified from the results of the tests shown in Figure 7.

Draw one straight line from each solution to the anion present.

(2)

solution	anion
	● bromide
solution of P ●	● carbonate
	● chloride
solution of Q ●	● iodide
	● sulfate

(ii) The formula of barium chloride is BaCl_2 .

Give the total number of ions in the formula BaCl_2 .

(1)

.....

(Total for question = 3 marks)

Q15.

A teacher conducts a flame test to identify the metal ions in some unknown solids.

step 1 dip a flame test wire into hydrochloric acid

step 2 dip the flame test wire into the unknown solid

step 3 hold the flame test wire above a Bunsen burner flame

(i) This method did not work well.

Explain an improvement that needs to be made to step 3 to enable a bright flame colour to be produced.

(2)

.....

.....

.....

(ii) Figure 18 shows the results of the flame tests on three compounds, P, Q and R.

compound	flame colour
P	red
Q	lilac
R	blue-green

Figure 18

Use Figure 18 to identify the metal ions in compounds P, Q and R.

(3)

P

Q

R

(Total for question = 5 marks)

Q16.

Some acids are used in tests for ions.

A bottle of one acid is shown in Figure 17.

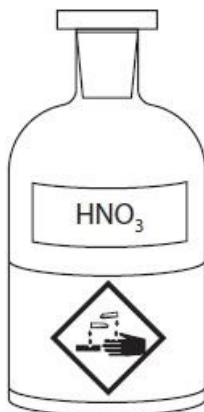


Figure 17

(i) The acid in Figure 17 can be used in the test for carbonate ions.

Explain, giving the name of the hazard symbol shown, what safety precautions should be taken when using this acid.

(2)

.....

.....

.....

.....

(ii) Give the name of the acid shown in Figure 17.

(1)

.....

(iii) State a property of glass that makes it a suitable material to make the container for an acid.

(1)

.....

.....

(Total for question = 4 marks)

Q17.

The student tested an unknown solution for sulfate ions by

1. adding a few drops of dilute sulfuric acid to the unknown solution
2. then adding a few drops of barium chloride solution.

A white precipitate was formed.

The student cannot conclude from this result that the unknown solution contains sulfate ions.

Explain what the student should change to obtain a valid result.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q18.

A student tests solutions of three ionic substances, K, L and M.

The student carries out the same two tests on each of the three solutions.

Test 1 add dilute nitric acid and then silver nitrate solution.

Test 2 add a few drops of sodium hydroxide solution and warm the mixture.

Figure 7 shows the results of the tests and the student's conclusions about the identity of each substance.

ionic substance	test 1	test 2	student's conclusion
K	white precipitate	colourless solution	ammonium chloride
L	white precipitate	white precipitate	aluminium chloride
M	no precipitate	green precipitate	iron(II) sulfate

Figure 7

None of the student's conclusions are fully justified.

Explain which part of each conclusion is justified and what further work can be carried out to fully justify each conclusion.

[illegible]

(Total for question = 6 marks)

Q19.

Qualitative tests are used to identify ions.

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)

.....

.....

.....

.....

(Total for question = 2 marks)

Q20.

A student carried out some tests on copper sulfate.

A solution of the copper sulfate was tested in a flame photometer.

(i) Give an advantage of using a flame photometer, rather than a flame test, to test for copper ions.

(1)

(ii) Figure 7 shows some values obtained when producing a calibration graph for copper ions in a flame photometer.

Draw a line of best fit through the points.

(1)

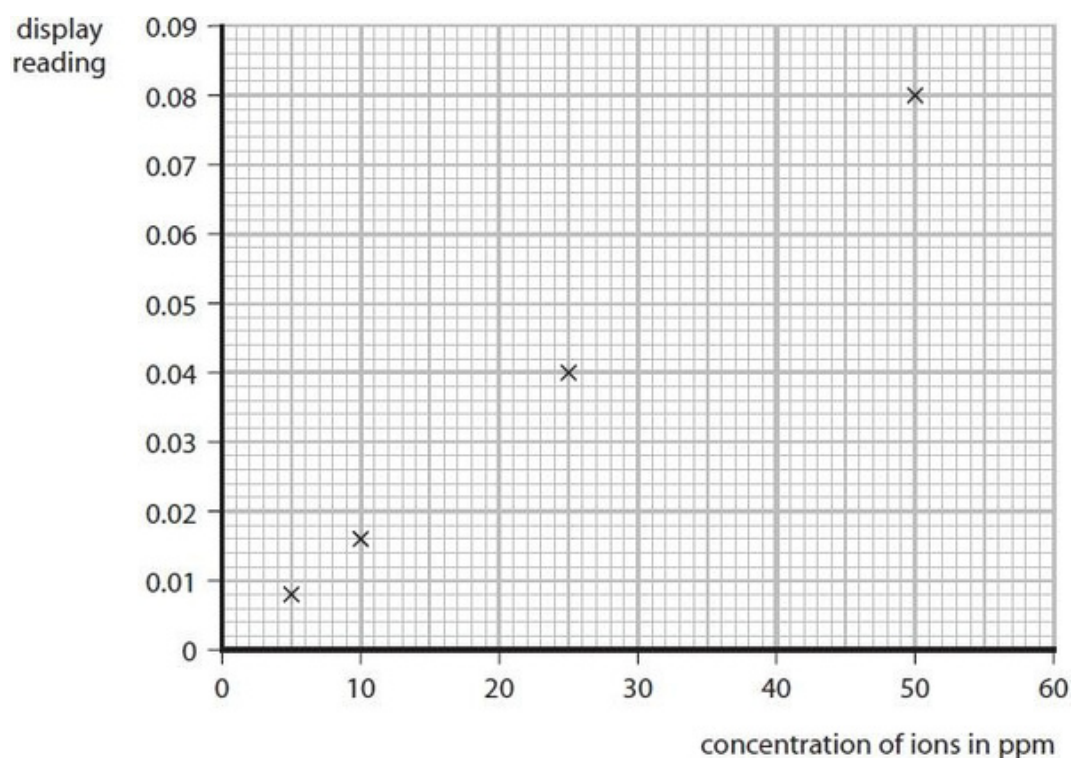


Figure 7

(iii) A solution containing copper ions gave a display reading of 0.030.

Use the calibration graph in Figure 7 to find the concentration of copper ions in this solution.

(1)

concentration of copper ions = ppm

(Total for question = 3 marks)

Q21.

Some polymerisation reactions produce ammonia as a waste product.

A student is given a sample of pure, dry ammonia gas.

The student suggests the following method to test for ammonia gas.

- step 1 take some dry, blue litmus paper
- step 2 place the dry litmus paper into the dry gas
- step 3 observe any change in colour of the litmus paper

This test for ammonia will not work.

Give two changes that should be made to this test for it to work.

(2)

change 1

.....

change 2

.....

(Total for question = 2 marks)

Q22.

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

.....

(Total for question = 2 marks)

Q23.

Figure 3 shows two tests carried out on a white solid and the results of the tests.

	test	results
test 1	flame test carried out	a yellow flame
test 2	dilute hydrochloric acid added	effervescence occurs
	gas given off passed into limewater	the limewater goes milky

Figure 3

(i) State the name of the gas given off in test 2.

(1)

..... (ii)

State the name of the ion shown to be present in the white solid by the result of test 2.

(1)

.....

(Total for question = 2 marks)

Q24.

Figure 3 shows two tests carried out on a white solid and the results of the tests.

	test	results
test 1	flame test carried out	a yellow flame
test 2	dilute hydrochloric acid added	effervescence occurs
	gas given off passed into limewater	the limewater goes milky

Figure 3

Which ion is shown to be present by the result of test 1?

(1)

- ☐ A lithium
- ☐ B sodium
- ☐ C potassium
- ☐ D calcium

(Total for question = 1 mark)

Q25.

Figure 3 shows two tests carried out on a white solid and the results of the tests.

	test	results
test 1	flame test carried out	a yellow flame
test 2	dilute hydrochloric acid added gas given off passed into limewater	effervescence occurs the limewater goes milky

Figure 3

A flame photometer can be used to measure the concentration of potassium ions in a solution.

Figure 4 shows the photometer readings for three different concentrations of potassium ions in solutions.

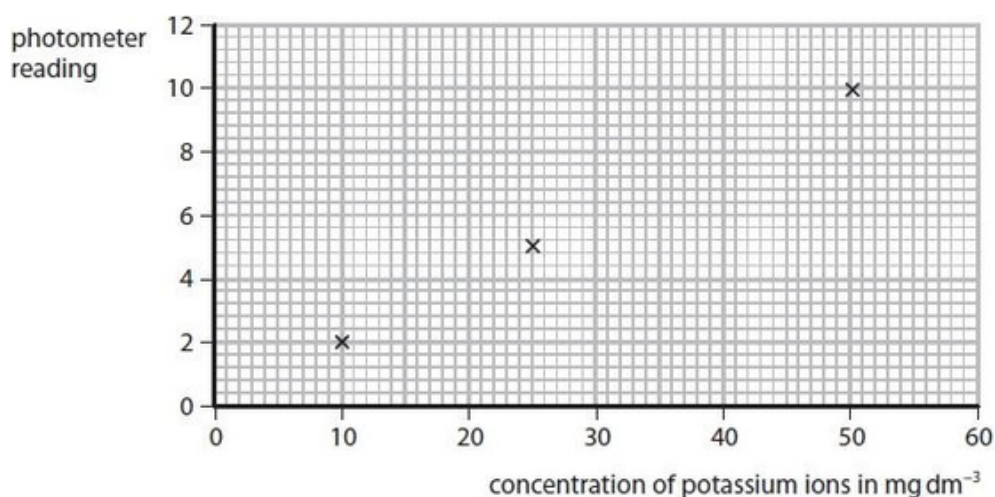


Figure 4

(i) A solution containing a concentration of potassium ions of 35 mg dm^{-3} is placed in the photometer.

The photometer reading is 7.0.

Plot this point on the graph and then draw the straight line of best fit.

(2)

(ii) Another solution of potassium ions gives a photometer reading of 9.0.

Use the graph to find the concentration of potassium ions in this solution.

(1)

concentration = mg dm^{-3}

(Total for question = 3 marks)

Q26.

A solution, X, is thought to contain chloride, bromide or iodide ions.

(i) The solution is tested to see whether it contains one of these ions.

In the test, a few drops of two different solutions are added to X.

Name the two solutions that are added in the test.

(2)

solution 1

.....

solution 2

.....

(ii) The student carrying out the test records the following result.

A precipitate forms in the test tube. The precipitate is a cream/yellow colour.

Explain why the anion in X cannot be known for certain.

(2)

.....
.....
.....
.....

(iii) The metal ions in X could be identified using a flame test.

There is a more sensitive and accurate instrumental method that can be used.

Give the name of an instrument that can be used to identify the metal ions in X.

(1)

.....

(Total for question = 5 marks)

Q27.

* A technician found some colourless crystals in an unlabelled beaker in a laboratory.

The technician knew that the substance was potassium chloride, potassium carbonate, sodium chloride or sodium iodide.

Plan a series of tests the technician could carry out to identify the colourless crystals.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q28.

Qualitative tests are used to identify ions in compounds.

Iron(II) sulfate solution reacts with sodium hydroxide solution to form a pale green precipitate of iron(II) hydroxide, $\text{Fe}(\text{OH})_2$.

(i) Write the ionic equation for this reaction.

(3)

.....

(ii) The green iron(II) hydroxide precipitate gradually turns brown when exposed to air.

Explain this observation.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q29.

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 few drops of sodium hydroxide solution are added to a solution of iron(II) sulfate.
Iron(II) hydroxide is formed.

(i) State what would be seen.

(2)

.....

.....

(ii) One other product is formed in this reaction.

What is the name of this other product?

(1)

- ☐ A iron(II) chloride
- ☐ B sodium chloride
- ☐ C sodium sulfate
- ☐ D water

(Total for question = 3 marks)

Q30.

Compounds are tested to see if they contain chloride, bromide or iodide ions.

Figure 5 shows a flow chart of this test.

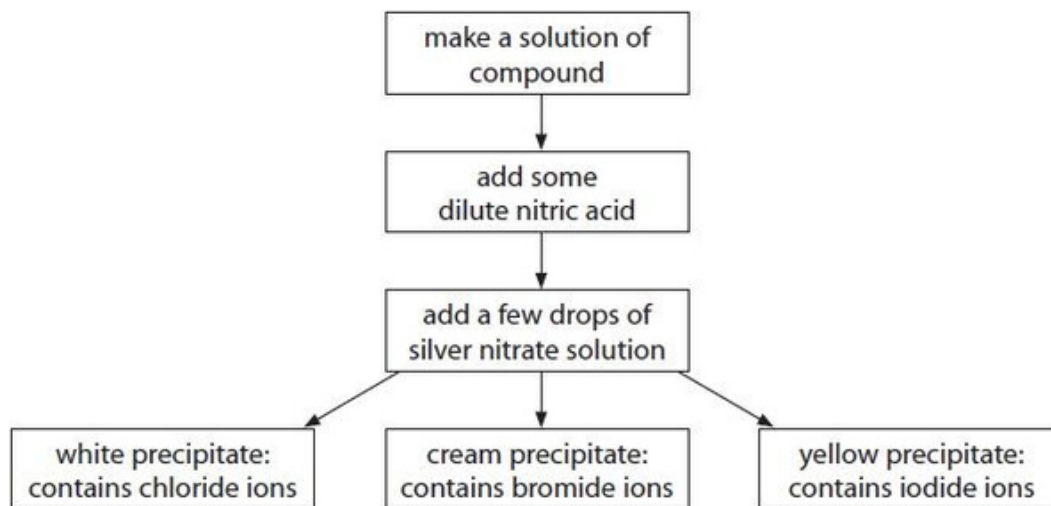


Figure 5

(i) When one compound is tested, a precipitate is seen.

State what you see when a precipitate forms.

(1)

.....

(ii) Using Figure 5, name the ion in the compound that causes a cream precipitate.

(1)

ion

(Total for question = 2 marks)

Q31.

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 student carried out some tests on copper sulfate.

A flame test was carried out on some copper sulfate crystals.

The student used the following method.

step 1 dip a wire in hydrochloric acid, then hold the wire in a roaring Bunsen burner flame

step 2 dip the wire in hydrochloric acid again, then dip the wire in the copper sulfate crystals

step 3 hold the wire with the copper sulfate in the roaring Bunsen burner flame.

(i) State why in step 1 the wire is dipped in hydrochloric acid and held in a roaring Bunsen burner flame.

(1)

.....

(ii) State why in step 2 the wire is dipped in hydrochloric acid again before dipping it in the copper sulfate crystals.

(1)

.....

(iii) What colour should be seen when the flame test is carried out on copper sulfate?

(1)

- ☒ A blue-green
- ☒ B lilac
- ☒ C orange-red
- ☒ D yellow

(Total for question = 3 marks)

Q32.

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

(Total for question = 1 mark)

Q33.

Qualitative tests are used to identify ions in compounds.

Another solid, Y, also contains two ions.

A test was carried out on solid Y.

A few drops of sodium hydroxide solution were added to a solution of solid Y.

A white precipitate formed.

(i) Give the reason why this test does not identify the cation in solid Y.

(1)

.....

.....

.....

.....

(ii) Give the reason why this test does not identify the anion in solid Y.

(1)

.....

.....

.....

.....

(Total for question = 2 marks)

Q34.

In the test for chloride ions, silver nitrate solution is added to a solution containing chloride ions.

A white precipitate forms.

Write the ionic equation for this reaction.

(2)

.....

(Total for question = 2 marks)

Mark Scheme

Q1.

Question number	Answer	Mark
(i)	An explanation linking one of the following pairs - the test only detects that ion (1) - so no confusion with other ions (1) OR - if same result is given by more than one ion (1) - do not know which ion is present (1)	(2)

Question number	Answer	Additional guidance	Mark
(ii)	carbon dioxide	allow CO ₂ ignore CO ²⁻ / CO ₂ / C ₂ O ₂	(1)

Question number	Answer	Additional guidance	Mark
(iii)	(3)	chloride ion – white precipitate (1) iodide ion – yellow precipitate (1) sulfate ion – white precipitate (1) 1 mark for each line If more one line connects a left hand box to those on the right, do not award that mark	(3)

Q2.

Question Number	Answer	Additional guidance	Mark
	improve sensitivity / accuracy / speed (of tests)	ignore clearer/better/precise/efficient/reliable/valid results	(1) AO 1 1

Q3.

Question number	Answer	Mark
(i)	B solid forms in the solution is the only correct answer. A, C, and D are incorrect because a precipitate is a solid (of any colour)	(1) AO2 2

Question number	Answer	Additional guidance	Mark
(ii)	A plan including - add named alkaline solution / sodium hydroxide (solution) / potassium hydroxide (solution) (1) - white precipitate forms (in both) (1) - white precipitate dissolves with excess (alkali) indicates Al^{3+} (1) - white precipitate does not dissolve in excess (alkali) indicates Ca^{2+} (1)	accept correct formulae ignore 'alkaline solution' accept Al / Ca without charges mark independently as alternative tests allow - flame test - will show orange red / brick red for Ca^{2+} for max 2 marks or - sulfuric acid - white precipitate for calcium ions for max 2 marks	(4) AO1 2

Q4.

Question number	Answer	Additional guidance	Mark
(i)	(copper sulfate(aq) + sodium hydroxide(aq) →) copper hydroxide(s) + sodium sulfate(aq) - sodium sulfate identified as a product (1) (sodium sulfate)(aq) and copper hydroxide(s) both state symbols matched to the correct product (1)	allow Na_2SO_4 allow copper(II) hydroxide/ $\text{Cu}(\text{OH})_2$	(2)
Question number	Answer		Mark
(ii)	white precipitate/ppt/solid		(1)

Q5.

Question number	Answer	Mark
	$(\text{Fe}^{3+} + 3\text{OH}^-) \rightarrow \text{Fe}(\text{OH})_3$	(1)

Q6.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. V • does not contain transition metal • because it is white • has ionic bonding • because does not have low melting point, is soluble in water and only conducts when dissolved W • it is alkaline gas as litmus turned blue • pungent and alkaline so is ammonia X • X is insoluble • it contains bromide ions as a cream ppt formed • which is silver bromide Identity of V • V contains ammonium ions • V contains bromide ions • V is ammonium bromide	(6) A01 1 / A03 2

Level	Mark	Additional Guidance	General additional guidance – the decision between levels
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1-2	<u>Additional Guidance</u> Correctly identifies at least one of the three compounds OR Correctly deduces information about at least one of the three compounds	<u>Possible Candidate Responses</u> V is an ionic compound because it has a high melting point. W is ammonia X is (silver) bromide because a cream precipitate is formed on reaction with silver nitrate
Level 2	3-4	<u>Additional Guidance</u> Correctly identifies two of the three compounds and gives reasons for at least one of the three. OR Correctly identifies one of the three compounds and gives positive deductions for at least two of the three	<u>Possible Candidate Responses</u> W is ammonia because it turns red litmus paper blue. X is silver bromide. V does not contain a transition metal because it is a white solid. W is ammonia. X contains bromide ions because it forms a cream precipitate.
Level 3	5-6	<u>Additional Guidance</u> Correctly identifies V and W and gives positive deductions for at least 1 AND That X is (silver) bromide/the solution contains bromide ions	<u>Possible Candidate Responses</u> W is ammonia because it turns damp red litmus paper blue. X is silver bromide because a cream precipitate formed on reaction with silver nitrate. Therefore V must be ammonium bromide.

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	- Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	- Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	- Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q7.

Question number	Answer	Additional guidance	Mark
	An answer that provides a description by making reference to: - test gas with moist (red) litmus paper (1) - turns blue (1)	Allow universal indicator paper/pH paper (1) and yellow to blue/purple (1).	(2)

Q8.

Question number	Answer	Additional guidance	Mark
(i)	A description including - put (clean) wire into solid (1) - hold (wire) in (Bunsen) flame (1)	put (damp) splint into solid (1) hold splint in (Bunsen) flame (1) ignore: hold over flame reject use of yellow flame	(2)

Question number	Answer	Mark
(ii)	metal ion calcium potassium flame colour green yellow lilac orange-red blue-green Each line 1 mark Do not award mark if more than one line join the left hand boxes with those on the right	(2)

Q9.

Question number	Answer	Additional guidance	Mark
(i)	A description to include • add water (1) • shake/ stir (1)	allow: solvent / liquid Ignore: acid or alkali for MP1 but can score MP2 allow: mix; ignore dissolve MP2 depends on MP1 reject whole answer if referring to melting	(2) AO1 2

Question number	Answer	Mark
(ii)	pipette / dropper	(1) AO1 2

Question number	Answer	Mark
(iii)	A aq is the only correct answer B, C and D are incorrect as the substance is a solution in water	(1) AO2 2

Q10.

Question number	Answer	Additional guidance	Mark
	A description to include flame photometer (1) two (sets of) emissions / OWTTE (1)	allow flame emission spectroscopy / spectroscope ignore flame test allow compare emission to reference samples	(2)

Q11.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. - ions present – NH_4^+, Fe^{2+}, SO_4^{2-} - dissolve solid in (distilled / deionised) water - add drops of sodium hydroxide solution - green / grey-green / dirty green - precipitate shows Fe^{2+} ion - precipitate is iron(II) hydroxide $\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$ - warm mixture of salt solution and sodium hydroxide solution - hold damp (red litmus / universal / pH indicator) paper above mixture - indicator paper turns (blue / purple) - test shows ammonia gas formed - ammonia gas comes from NH_4^+ ions present $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$ - to second portion of salt solution add drops of dilute hydrochloric acid - add drops of barium chloride solution (or lead nitrate solution) - white - precipitate forms - precipitate is barium sulfate (or lead sulfate) $\text{Ba}^{2+}(\text{or } \text{Pb}^{2+}) + \text{SO}_4^{2-} \rightarrow \text{Ba}(\text{or } \text{Pb})\text{SO}_4$	(6) A01 A02

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> - names an ion present in the compound or - attempts test to identify an ion	<u>Possible candidate responses</u> - Ion present in compound NH_4^+ / Fe^{2+} / SO_4^{2-} - Adds compound to water (to make a solution) - Adds sodium hydroxide solution to solution of compound - Adds barium chloride solution to solution of compound
Level 2	3–4	<u>Additional guidance</u> - names at least two ions present And - describes at least one test to identify one of those ions – with positive result	<u>Possible candidate responses</u> - Adds sodium hydroxide solution to solution of compound - green ppt shows Fe^{2+} ion present - or - adds dilute hydrochloric acid and barium chloride solution to solution of compound - white ppt shows SO_4^{2-} ion present - or - adds sodium hydroxide solution to solution of compound and warms gently - pungent gas given which turns damp universal indicator purple shows presence of NH_4^+
Level 3	5–6	<u>Additional guidance</u> - Identifies all 3 ions And - Describes at least two tests for those ions – with positive results And - Suitable equations for at least two tests of ions	<u>Possible candidate responses</u> - adds sodium hydroxide solution to solution of compound - green ppt shows Fe^{2+} ion present $\text{Fe}^{2+} + 2 \text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$ - adds dilute hydrochloric acid and barium chloride solution to solution of compound - white ppt shows SO_4^{2-} ion present $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4$ - adds sodium hydroxide solution to solution of compound and warms gently - pungent gas given which turns damp universal indicator purple shows presence of NH_4^+ ions in compound $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Q12.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (3 marks) AO3 (3 marks) • sodium, potassium and calcium ions detected by flame test • clean flame test wire with hydrochloric acid • dip wire into solid • hold wire in flame • if flame is yellow – sodium • if flame is lilac – potassium • if flame is orange-red – calcium • if no flame colour – could be aluminium • calcium and aluminium ions detected using sodium hydroxide solution • dissolve white solid in water • add drops of sodium hydroxide solution • white ppt shows calcium or aluminium ions • no ppt shows sodium or potassium ions • add more drops sodium hydroxide solution • if white ppt dissolves to form colourless solution • is aluminium ions • if white ppt does not dissolve • is calcium ions	(6)

Level	Mark	Descriptor
	0	No awardable content
Level 1	1–2	- Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	- Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	- Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q13.

Question number	Answer	Additional guidance	Mark
	An answer that provides a description by making reference to: - test gas with moist (red) litmus paper (1) - turns blue (1)	Allow universal indicator paper/pH paper and yellow to blue/purple	(2)

Question number	Answer	Additional guidance	Mark
	An answer that provides a description by making reference to: - iron(II) – green/pale green/grey-green and precipitate /solid (1) - iron(III) – red-brown/brown and precipitate /solid (1)	Allow two correct colours (1)	(2)

Q14.

Question number	Answer	Mark
(i)	solution anion bromide solution of P solution of Q carbonate chloride iodide sulfate Each line 1 mark Do not award mark if more than one line join the left hand boxes with those on the right	(2)

Question number	Answer	Mark
(ii)	3 / three	(1)

Q15.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking - Hold the wire in the flame / at the tip of the (blue) cone (1) (as) it is hotter (1)	if the wire has been placed <u>in the flame</u> then any colour of flame is allowed. if the wire has not been placed in the flame then allow use of a blue/roaring flame/open air hole, but NOT any other specified colours of roaring flame.	(2) AO1 2

Question number	Answer	Additional guidance	Mark
(ii)	P: lithium / Li (1) Q: potassium / K (1) R: copper / Cu (1)	for P allow strontium / Sr ignore any charges, even if incorrect (e.g. allow Li ⁺ , Li ²⁺) do not penalise incorrect capital/small letters (e.g. allow CU, li)	(3) AO1 2

Q16.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking - corrosive (1) - so wear gloves/ (safety) goggles (1)	allow safety glasses/ safety spectacles / eye protection ignore glasses and any other precautions mark independently	(2) A03 3a

Question number	Answer	Mark
(ii)	nitric acid	(1) AO1 1

Question number	Answer	Additional guidance	Mark
(iii)	inert/ unreactive/ does not corrode	reject 'is not corrosive' allow acid will not dissolve/ react with glass ignore 'acid won't burn through' ignore references to clear / strong	(1) AO2 1

Q17.

Question number	Answer	Additional guidance	Mark
	An explanation linking use hydrochloric acid (rather than sulfuric acid) (1) (as) sulfuric acid contains sulfate ions (1)	Allow nitric acid allow use a different acid	(2) A03

Q18.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (3 marks) AO3 (3 marks) - the chloride ion is justified as it produces a white precipitate with nitric acid and silver nitrate solution in K and L Fe^{2+} ion is justified because it forms green precipitate with sodium hydroxide solution in M - in K ammonium ion is justified by adding more sodium hydroxide solution and heating - gas evolved turns damp red litmus paper blue - in L aluminium ion is justified by adding more sodium hydroxide solution until in excess - precipitate dissolves - to give colourless solution - in M sulfate ion is justified by adding dilute hydrochloric acid and barium (chloride / nitrate) solution - white precipitate	(6)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Two or more statements as to which ions are justified by the students conclusions (1) OR A full explanation of one of the students conclusions (2)	<u>Possible candidate responses</u> In K and L chloride ion is justified (1) in K chloride is justified, ammonium is not justified (1) in K chloride is justified, in M iron is justified (1) In K and L chloride ion is justified as test 1 shows a white precipitate. (2) In K chloride ion is justified as test 1 shows a white precipitate, for ammonium ion is justified as warm and test gas with damp litmus which turns blue (2)
Level 2	3–4	<u>Additional guidance</u> a partial explanation of the further work required to justify two of the ions and why chlorine or iron are justified (3) OR A full explanation of two of the students conclusions (4)	<u>Possible candidate responses</u> In L chloride ion is justified as test 1 shows a white precipitate but aluminium is not justified by test 2, add more sodium hydroxide which should dissolve the white precipitate. In M iron is justified by green precipitate (3) In K chloride ion is justified as test 1 shows a white precipitate, In L chloride ion is justified as test 1 shows a white precipitate, In M iron ion is justified as test 2 shows a green precipitate (3) In M sulfate is not justified by any test, add barium chloride white precipitate is formed, iron is justified by green precipitate in test 2. In K chloride ion is justified as test 1 shows a white precipitate, warm and test gas with damp litmus which turns blue to test for ammonium ion (4)
Level	5–6	<u>Additional guidance</u> An explanation of the further work required to justify three of the ions and a reason why at least and why chlorine or iron are justified (5) OR A full explanation of three of the students conclusions (6)	<u>Possible candidate responses</u> In K chloride ion is justified as test 1 shows a white precipitate, to test for the ammonium ion warm and test gas with damp litmus which turns blue. In L chloride ion is justified as test 1 shows a white precipitate but aluminium is not justified by test 2, add more sodium hydroxide which should dissolve the white precipitate. In M, the sulfate ion can be justified by adding dilute hydrochloric acid and barium chloride solution to get a white precipitate. (5) In K chloride ion is justified as test 1 shows a white precipitate, warm and test gas with damp litmus which turns blue to justify ammonium ion. In L chloride ion is justified as test 1 shows a white precipitate but aluminium is not justified by test 2, add more sodium hydroxide which should dissolve the white precipitate. In M, iron ion is justified because it forms green precipitate in test 2. The sulfate ion can be justified by adding dilute hydrochloric acid and barium chloride solution to get a white precipitate. (6)

Q19.

Question number	Answer	Mark
	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): - the flame test only confirms the presence of lithium ions/Li⁺ (1) - but another test is needed to confirm the identity of the anion/negative ion/CO₃²⁻ (1) OR - the red flame test shows the presence of calcium ions Ca²⁺ and not lithium ions/Li⁺ (1) - the student did not test for carbonate ions (1)	(2)

Q20.

Question number	Answer	Additional guidance	Mark
(i)	more {accurate / sensitive / reliable}	requires no judgement / can be quantitative	(1) A01

Question number	Answer	Mark
(ii)	single straight line of best fit through points	(1) A03

Question number	Answer	Mark
(iii)	value consistent with candidate's line of best fit	(1) A03

Q21.

Question number	Indicative content	Mark
	An answer to include, in either order • use red litmus paper (1) • make litmus paper damp (1)	(2)

Q22.

Question number	Answer		Mark
	• name: sodium sulfate (1) • formula: Na₂SO₄ (1)	Allow formula consequential on incorrect name	(2)

Q23.

Question Number	Answer	Additional Guidance	Mark
(i)	carbon dioxide	Allow CO ₂ Reject carbon monoxide/ CO	(1) AO 1 1

Question Number	Answer	Mark
(ii)	carbonate / CO ₃ ²⁻	(1) AO 1 1

Q24.

Question Number	Answer	Mark
	B sodium The only correct answer is B <i>A is not correct because lithium gives red flame</i> <i>C is not correct because potassium gives lilac flame</i> <i>D is not correct because calcium gives red-orange flame</i>	(1) AO 1 1

Q25.

Question Number	Answer	Additional guidance	Mark
(i)	- point plotted correctly (1) - line of best fit (1)	Point must be on correct line (35 mg dm⁻³), +/- half a square, i.e. between 6.8-7.2 inclusive Line of best fit must be one single ruler-drawn line that goes through 3 printed points (allow within +/- half a square of every point). Ignore any extrapolation below first printed point or above last printed point	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	value taken from candidate's graph	Examiner to read value from candidates' line of best fit (whether correct line or not) and allow +/- 1 mg dm⁻³ If no best fit line at all, or if best fit line does not reach 9, then no marks scored.	(1) AO 2 1

Q26.

Question number	Answer	Mark
(i)	in either order: silver nitrate / AgNO_3 (1) nitric acid / HNO_3 (1)	(2)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation to include any two from • bromides give a cream (precipitate) (1) • iodides give a yellow (precipitate) (1) • other ions also may give these colours (1)	allow 'bromine' for bromide allow 'iodine' for iodide allow there are {2 colours/ mix of colours} so there is more than one ion (1) allow it could be bromide or iodide (1)	(2)

Question number	Answer	Additional guidance	Mark
(iii)	flame photometer (1)	allow any suitable method except flame test	(1)

Q27.

Question number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. A03 (6 marks) Any logical description of tests which result in identification of all four substances. Plans may include: • flame test • description of carrying out a flame test • if the flame is yellow/not lilac, sodium ions present • if the flame is lilac/not yellow, potassium ions present • add dilute {hydrochloric/nitric} acid to the solid • if bubbles of gas form then carbonate ions present • bubble gas through limewater • if limewater turns milky/cloudy, carbon dioxide present • make a solution of the crystals in water • add dilute nitric acid • (if no reaction with acid) add silver nitrate solution • if there is a white precipitate, chloride ions present • if there is a yellow precipitate, iodide ions present. Alternative test for halide ions: • make a solution of the crystals in water • add chlorine water • then cyclohexane • if the cyclohexane/top layer turns purple, iodide ions present.

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• Analyses the scientific information but understanding and connections are flawed. (A03) • An incomplete plan that provides limited synthesis of understanding. (A03)
Level 2	3–4	• Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (A03) • A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (A03)
Level 3	5–6	• Analyses the scientific information and provide logical connections between scientific concepts throughout. (A03) • A well-developed plan that synthesises relevant understanding coherently. (A03)

Q28.

Question Number	Answer	Additional guidance	Mark
(i)	$\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$ left hand side (1) right hand side (1) balancing of correct species (1)	allow multiples ignore incorrect state symbols	(3) AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking {iron(II) hydroxide / iron(II) ions / Fe^{2+}} oxidised (by air) (1) (it goes brown due to formation of) {iron(III) hydroxide / iron(III) ions / Fe^{3+}} (1)	'it' = iron(II) hydroxide 'precipitate' = iron(II) hydroxide Fe^{2+} is oxidised to Fe^{3+} OR Iron(II) is oxidised to iron(III) both score 2 $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$ scores 1 mark for MP2 ignore rusting	(2) AO 3 2a AO 3 2b

Q29.

Question number	Answer	Additional Guidance	Mark
(i)	- green (1) - precipitate / (insoluble) solid (1)	allow any shades of green e.g. light green, grey green, blue green but no other colours (1)	(2)

Question number	Answer	Mark
(ii)	C sodium sulfate A,B and D are incorrect because they are not products of the reaction	(1)

Q30.

Question number	Answer	Additional guidance	Mark
(i)	solid/ goes cloudy	allow forms of solid e.g. powder/ sediment / goes milky ignore substance ignore any colours/ colour change reject answers involving fixing/ bubbles/ effervescence	(1) AO1 2

Question number	Answer	Additional guidance	Mark
(ii)	bromide	reject bromine allow Br ⁻ (allow br ⁻ , BR ⁻ , bR ⁻)	(1) AO3 2

Q31.

Question number	Answer	Mark
(i)	to clean the wire / to prevent contamination of sample	(1) AO1

Question number	Answer	Mark
(ii)	so that the solid vaporises more easily / so that the solid sticks onto the wire	(1) AO1

Question number	Answer	Mark
(iii)	A blue-green B is incorrect as potassium gives a lilac flame C is incorrect as calcium gives an orange-red flame D is incorrect as sodium gives a yellow flame	(1) AO2

Q32.

Question number	Answer	Mark
	C	(1)

Q33.

Question Number	Answer	Additional guidance	Mark
(i)	more than one cation gives white precipitate	allow answers referring to specified cations that give a white precipitate (aluminium, calcium, magnesium, zinc, lead). Ignore incorrect ionic charges. reject incorrect cations	(1) AO 1 2

Question Number	Answer	Additional guidance	Mark
(ii)	(sodium hydroxide) is not used to test for anions	allow (sodium hydroxide) (only) tests for cations	(1) AO 1 2

Q34.

Question number	Answer	Additional guidance	Mark
	$\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$ (2)	$\text{Ag}^+ + \text{Cl}^- \rightarrow$ (1) $\rightarrow \text{AgCl}$ (1) allow (1) max for equation with no ionic charges	(2) AO2