Identification of Ions and Gases

Q2(c)/41/M/J/16

1 (c) (i) A small amount of magnesium ribbon is added to a test-tube containing dilute hydrochloric acid. A gas is produced.

Name the gas. Give a test and observation to identify the gas.

name .....

test and observation .....
[2]

(ii) Construct the equation for the reaction.

.....[1]

Q8/41/M/J/16

2 **L** is a compound which contains two ions.
Complete the table by adding the observations in tests **(a)**, **(b)** and **(c)** and both the test and observation for test **(d)**.

test	observations	conclusions
(a) **L** is dissolved in water and the resulting solution is divided into three parts for tests **(b)**, **(c)** and **(d)**.		**L** is not a compound of a transition metal.
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		Al^{3+}, Zn^{2+} or Ca^{2+} ions present.
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		Al^{3+} ions or Zn^{2+} ions present.
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.		Al^{3+} or Zn^{2+} ions present.
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.		Al^{3+} ions present.
(d)		**L** contains I^- ions.

[1] [2] [2] [3]

(e) Conclusion: the formula of **L** is ..... . [1]

(f) Referring to test **(c)(ii)**, what change in the observations is seen if Zn^{2+} ions are present instead of Al^{3+} ions?

.....[1]

[Total: 10]

Q2(a)/42/M/J/16

3 **(a)** Give a test and observation to identify the presence of the nitrate ion, $NO_3^-(aq)$.

test .....

.....

observation .....

.....[4]

Q8/42/M/J/16

4 **M** is a compound which contains two ions.
Complete the table by adding the observation in test **(a)**, the conclusions in tests **(b)** and **(c)** and both the test and observation for test **(d)**.

test	observations	conclusions
(a) **M** is dissolved in water and the resulting solution is divided into three parts for tests **(b)**, **(c)** and **(d)**.		**M** is not a compound of a transition metal.
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.	A white precipitate forms.	
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.	The precipitate dissolves.	
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.	A white precipitate forms.	
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.	The precipitate is insoluble.	
(d)		**M** contains Cl^- ions.

[1] [1] [1] [3]

(e) Conclusion: the formula of **M** is ..... [1]

[Total: 7]

Q8/41/O/N/16

5 The table shows the tests a student does on compound **L**.

L contains three different ions.

Complete the table by adding the conclusion for **(a)**, the observations for **(b) (i)**, **(ii)** and **(iii)**, the conclusions for **(c)(i)** and **(ii)** and both the test and observation which lead to the conclusion for test **(d)**. Any gases produced should be identified by test, result and name.

test	observations	conclusion	
(a) **L** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A coloured solution is formed.		[1]
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		**L** contains Fe^{2+} ions.	
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**L** contains Fe^{2+} ions.	
(iii) This mixture is then heated.		**L** contains NH_4^+ ions.	[4]
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.	A green precipitate forms.		
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.	The precipitate is insoluble in excess.		[1]
(d)		**L** contains SO_4^{2-} ions.	[3]

(e) The green precipitate that forms in test **(c)** turns brown at the surface after a few minutes. Suggest why.

.....

..... [2]

[Total: 11]

Q9/42/O/N/16

6 The following table shows the tests a student does on a mixture **L**, which contains two compounds.

L contains three different ions.

Complete the table by adding the conclusion for **(a)**, the observations for **(b) (i)**, **(ii)** and **(iii)**, the conclusions for tests **(c) (i)** and **(ii)**, and both the test and observation which lead to the conclusion for test **(d)**. Any gases produced should be identified by test, result and name.

test	observation	conclusion	
(a) **L** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is formed.		[1]
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		**L** contains Al^{3+}, Zn^{2+} or Ca^{2+} ions.	[4]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**L** contains Al^{3+} or Zn^{2+} ions.	
(iii) This mixture is then heated.		**L** contains NH_4^+ ions.	
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.	A white precipitate forms.		[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.	The precipitate is insoluble in excess.		
(d)		**L** contains SO_4^{2-} ions.	[3]

(e) Give the formulae of the two compounds which are present in mixture **L**.

..... and ..... [2]

[Total: 11]

Q2/41/M/J/18

7 Solid **L** is a mixture of two compounds. The compounds contain the same positive ion but different negative ions.

The table shows the tests a student does on **L**.

Complete the table by adding the observations for each of tests **(a)** and **(c)** and the conclusion for test **(b)**.

Any gases formed should be named and identified by a suitable test and observation.

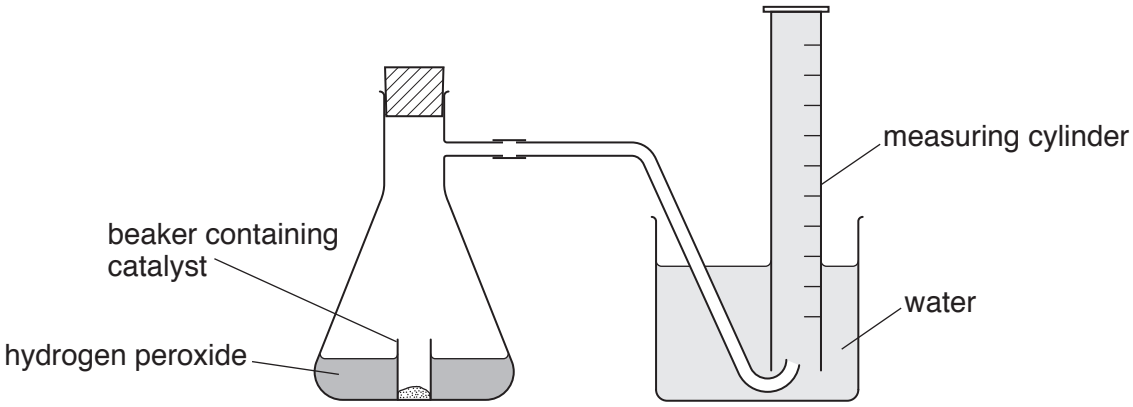
test	observations	conclusions	
(a) To a portion of **L** in a boiling tube, dilute hydrochloric acid is added until all the solid has dissolved. The resulting solution is used in tests **(b)** and **(c)**.		**L** contains CO_3^{2-} ions.	[2]
(b) To a portion of the solution from **(a)** in a test-tube, dilute nitric acid is added, followed by aqueous barium nitrate.	A white precipitate is formed.		[1]
(c)(i) To a portion of the solution from **(a)** in a test-tube, aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.		**L** contains Cu^{2+} ions.	[3]

[Total: 6]

Q5/41/M/J/18

8 In the presence of a catalyst, hydrogen peroxide, H_2O_2, decomposes into water and oxygen.

A student uses the apparatus shown to investigate the rate of decomposition of samples of hydrogen peroxide at two different temperatures.



The experiment starts when the flask is tipped so that the catalyst comes into contact with the hydrogen peroxide.

(a) The oxygen gas is collected in the measuring cylinder.

(i) What property of oxygen gas allows it to be collected by this method?

.....[1]

(ii) Name an alternative piece of apparatus that could be used to collect and measure the volume of oxygen gas.

.....[1]

(iii) Give a test and observation to identify oxygen.

test .....

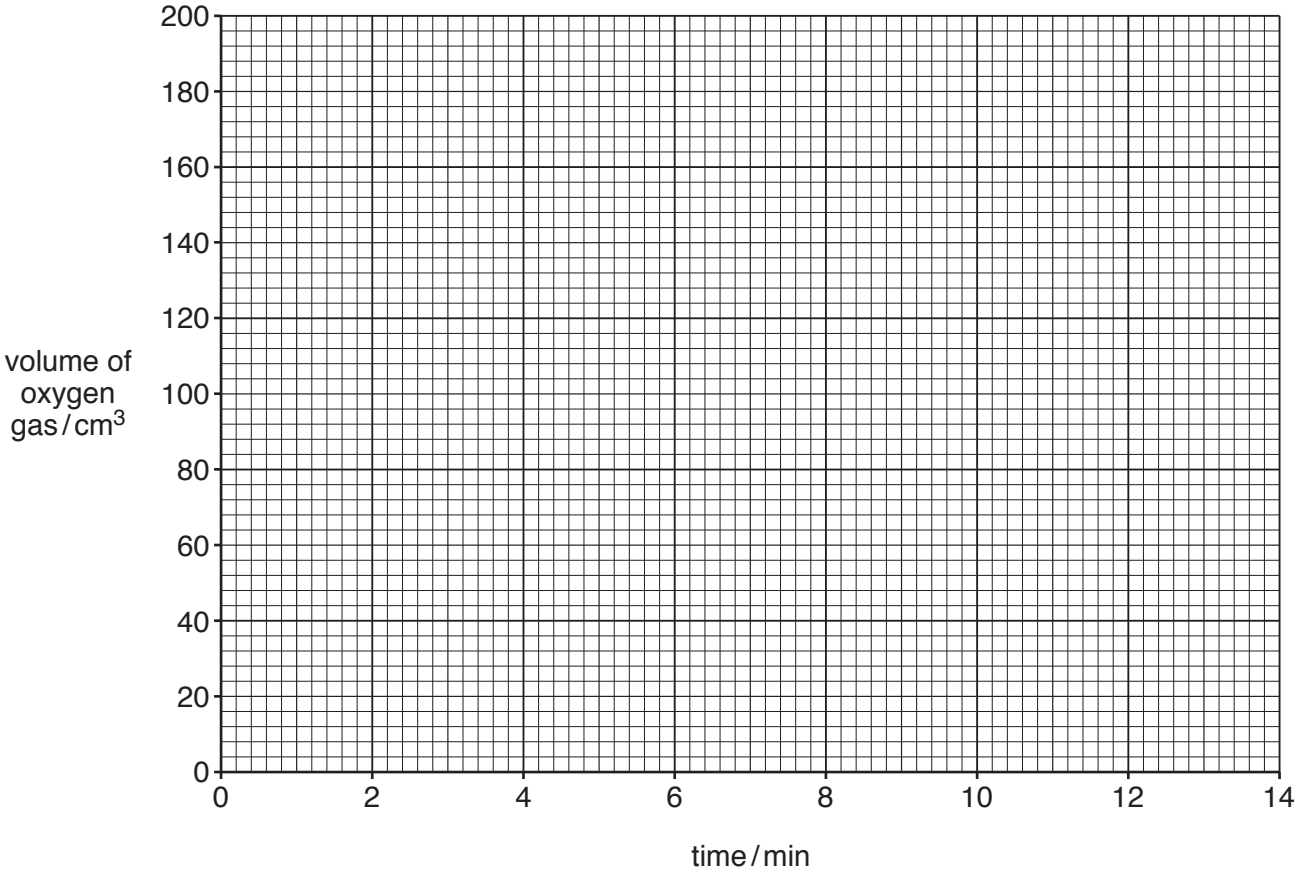
observation.....

[2]

(b) The results obtained for the first experiment, at 25 °C, are shown.

time / min	0	2	4	6	8	10	12	14
volume of oxygen gas / cm^3	0	40	50	91	97	99	100	100

(i) Plot the results on the grid.



[2]

(ii) Draw a circle around the anomalous point on the graph. [1]

(iii) Use the points to draw a curve of best fit. [1]

(iv) The student repeats the experiment at 50 °C. All other variables are kept constant.

Draw a second curve on the grid to represent the results that are obtained at this higher temperature.

Explain your answer.

.....

.....

.....

.....

[4]

[Total: 12]

Q4(b,c,d)/42/M/J/18

9 **(b)** Two samples of a solution of **L** are put into separate test-tubes.

- Aqueous sodium hydroxide is added to the first test-tube and the mixture is warmed. A gas is produced which turns damp red litmus paper blue.
- Dilute nitric acid and aqueous barium nitrate are added to the second test-tube. A white precipitate is formed.

Name both ions present in **L**.

..... and ..... [2]

(c) **(i)** A sample of the insoluble solid, **M**, is put into another test tube.

Dilute hydrochloric acid is added to this test-tube. Carbon dioxide gas is produced.

Give a test and observation to identify carbon dioxide gas.

.....

..... [2]

(ii) Name the negative ion in **M**.

..... [1]

(d) Solid **M** reacts with dilute hydrochloric acid to form a solution.

Describe a test and observations to show that this solution contains calcium ions.

test .....

.....

observations .....

.....

[3]

Q6/42/M/J/18

10 **X** is a colourless solution of an oxidising agent.

Y is a colourless solution of a reducing agent.

Z is a metal between iron and calcium in the reactivity series.

(a) Tests are carried out on substances **X**, **Y** and **Z**. Complete the table.

substance	test	observation
X	To 1 cm depth of aqueous potassium iodide in a test-tube, **X** is added until no further change occurs.	
Y	To 1 cm depth of acidified potassium manganate(VII) in a test-tube, **Y** is added until no further change occurs.	
Z	A piece of **Z** is added to an excess of dilute hydrochloric acid in a test-tube.	

[5]

(b) **(i)** Name the gas produced by the reaction of **Z** with dilute hydrochloric acid.

..... [1]

(ii) Give a test and observation to identify this gas.

.....

..... [2]

Q3(e,f)/41/O/N/18

11 **(e)** At the end of the experiment, sulfur dioxide gas is still being produced by the reaction.

Give a test and observation to identify sulfur dioxide gas.

test .....

observation .....
[2]

(f) Another student suggested that the sulfur dioxide produced in the reaction would dissolve in the water and produce an aqueous solution containing sulfite ions, SO_3^{2-}.

Give a test and result to show the presence of sulfite ions, SO_3^{2-}, in the aqueous solution.

(You do **not** need to state how you would identify any gases evolved in the test.)

test .....

result .....
[2]

Q5/41/O/N/18

12 A student is provided with three bottles; one contains dilute hydrochloric acid, another contains aqueous sodium sulfate and the third contains ethanol.

The student is also provided with magnesium ribbon, acidified aqueous potassium manganate(VII) and aqueous barium nitrate (acidified with nitric acid). The student has access to all the apparatus normally found in a laboratory **but no other chemicals**.

For each of the three bottles, give a test with a positive result which identifies its contents. Chemical equations are not required.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

Q6/41/O/N/18

13 Solid **L** is a mixture of two compounds. The two compounds contain the same cation but different anions.

(a) An excess of dilute hydrochloric acid is added to **L**. Bubbles of carbon dioxide gas are given off and the solid dissolves completely, forming a colourless solution.

(i) What conclusion can be made from the fact that the solution is colourless?

.....[1]

(ii) Give a test and observation to identify carbon dioxide gas.

test .....

observation .....[2]

(iii) Identify the anion which reacts with hydrochloric acid to produce carbon dioxide gas.

.....[1]

The colourless solution formed in **(a)** is divided into two parts for tests **(b)** and **(c)**. Complete the table.

	test	observation	conclusion
(b) **(i)**	To the first part, in a test-tube, aqueous sodium hydroxide is added until a change is seen.	white precipitate	
(ii)	An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.	insoluble in excess	
(c)			**L** contains NO_3^- ions.

[1]

[4]

[Total: 9]

Q2(b)/42/O/N/18

14 (b) Give a test and observation to identify chlorine gas.

test .....

observation .....

[2]

Q4/42/O/N/18

15 A student is provided with three bottles: one contains dilute hydrochloric acid, another contains aqueous sodium sulfite and the third contains aqueous sodium sulfate.

The student is provided with magnesium ribbon, aqueous barium nitrate and dilute nitric acid **but no other chemicals**. The student has access to all the apparatus normally found in a school laboratory.

For each of the three bottles, describe a test and its positive result to identify the contents of the bottle. Chemical equations are not required.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[3]

Q6/42/O/N/18

16 Solid **L** is a mixture of two compounds. The compounds each contain a different cation but the same anion.

Complete the table.

Any gases given off should be named and identified by a suitable test and observation.

test	observation	conclusion	
(a) **L** is dissolved in water. The solution is divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is formed.		[1]
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**. **(iii)** The mixture from **(ii)** is warmed.		**L** may contain Al^{3+}, Ca^{2+} or Zn^{2+} ions. **L** contains Al^{3+} or Zn^{2+} ions. **L** contains NH_4^+ ions.	[4]
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.		**L** may contain Al^{3+} or Zn^{2+} ions. **L** contains Zn^{2+} ions.	[2]
(d)		**L** contains Cl^- ions.	[3]

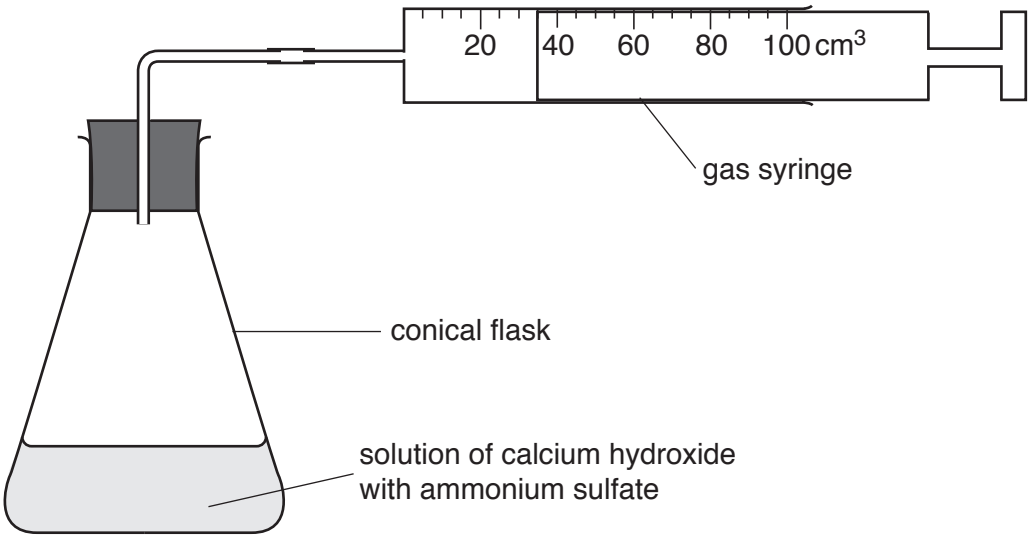
[Total: 10]

Q1(d)/41/M/J/19

17 (d) Calcium hydroxide is used to neutralise soil acidity. It reacts with ammonium sulfate fertiliser in the soil.

The student investigates the reaction between these two compounds.

She uses the apparatus shown.



(i) What volume of gas is in the gas syringe?

.....cm^3 [1]

(ii) After the gas has been collected, a piece of damp blue litmus paper and a piece of damp red litmus paper are put in the gas.

What happens to the colour of:

- the damp blue litmus paper .....
- the damp red litmus paper? .....

[1]

Q4/41/M/J/19

18 A sample of river water is tested for pollutants.

Complete the table to show the tests, observations and pollutant ions present in the sample.

test	observations	pollutant ions present in sample
	White precipitate, soluble in excess giving a colourless solution.	Al^{3+}
Acidify with dilute nitric acid, then add aqueous silver nitrate.		Cl^{-}
Add aqueous ammonia.	Light blue precipitate, soluble in excess, giving a dark blue solution.	
		SO_4^{2-}

[5]

Q6/42/M/J/19

19 The mineral alstonite contains two different cations but only one anion.

The table shows the tests a student does on a sample of alstonite.

Complete the table. Any gases formed should be named.

test	observations	conclusions
(a) To a portion of alstonite in a boiling tube, add dilute hydrochloric acid until all the solid has dissolved. Use the resulting solution in tests **(b)**, **(c)** and **(d)**.	The solid dissolves. Effervescence is observed and the gas formed turns limewater milky.	
(b) To a portion of the solution from **(a)** in a test-tube, add dilute sulfuric acid.		Alstonite contains Ba^{2+} ions.
(c) To a portion of the solution from **(a)** in a test-tube, add aqueous sodium hydroxide until in excess.		Alstonite may contain Ca^{2+} ions.
(d) To a portion of the solution from **(a)** in a test-tube, add aqueous ammonia.		Alstonite contains Ca^{2+} ions.

[2]

[1]

[2]

[1]

[Total: 6]

Q1(b)/41/O/N/19

20 **(b)** Give a test and observation to identify oxygen gas.

test .....

observation .....

[2]

Q4/41/O/N/19

21 A student is provided with three solutions:

- aqueous zinc sulfate
- aqueous copper(II) sulfate
- aqueous calcium nitrate.

The student tests the three aqueous solutions by adding each reagent shown in the table.

Record the observations in the table.

Write 'no reaction' where appropriate.

	reagents			
solutions	aqueous sodium hydroxide	aqueous sodium hydroxide in excess	aqueous barium nitrate and dilute nitric acid	aluminium and aqueous sodium hydroxide + heat
aqueous zinc sulfate				
aqueous copper(II) sulfate				
aqueous calcium nitrate				name of gas ..... test for gas ..... result of test .....

[10]

Q4/42/O/N/19

22 A student is provided with solutions of:

- aqueous chromium(III) nitrate
- aqueous iron(II) chloride
- aqueous iron(III) chloride.

The student tests the three aqueous solutions by adding each reagent shown in the table.

Record the observations in the table.

Write 'no reaction' where appropriate.

	reagents			
solutions	aqueous sodium hydroxide	aqueous sodium hydroxide in excess	aqueous silver nitrate and dilute nitric acid	aluminium and aqueous sodium hydroxide + heat
aqueous chromium(III) nitrate				name of gas ..... test for gas ..... result of test .....
aqueous iron(II) chloride				
aqueous iron(III) chloride				

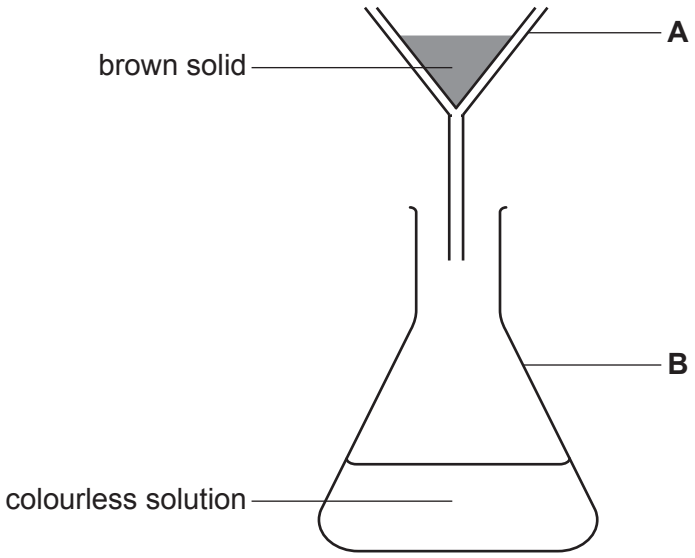
[10]

Q1/41/M/J/20

23 A student investigates a sample of rock salt.

The student:

- grinds the rock salt into a powder
- places the powder into a beaker and adds water to it
- stirs the mixture
- pours the mixture through the apparatus shown.



(a) (i) Name apparatus **A**. ..... [1]

(ii) Name apparatus **B**. ..... [1]

(iii) A brown solid remains in apparatus **A**. A colourless solution is collected in apparatus **B**.

Name the process used to separate the solid from the colourless solution.

..... [1]

(b) The colourless solution contains two different cations. One cation is sodium.

The student adds dilute nitric acid and aqueous sodium sulfate to the colourless solution.

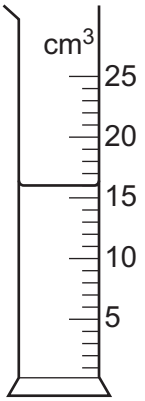
A white precipitate is formed.

Name the other cation in the colourless solution.

..... [1]

(c) A student investigates the effect of adding different masses of rock salt on the temperature of a mixture of ice and water.

The diagram shows the volume of water the student uses in the investigation.



State the volume of water the student uses. .....cm^3 [1]

(d) The student:

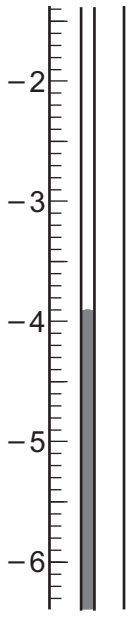
- places the water in a beaker
- adds ice
- stirs the mixture
- measures the lowest temperature of the mixture
- repeats the experiment four times.

In each of the repeated experiments a different mass of rock salt is added to the mixture.

(i) State a variable that needs to be kept constant in each experiment.

..... [1]

(ii) The diagram shows part of the thermometer the student uses to measure the lowest temperature reached when 1.0 g of rock salt is added.



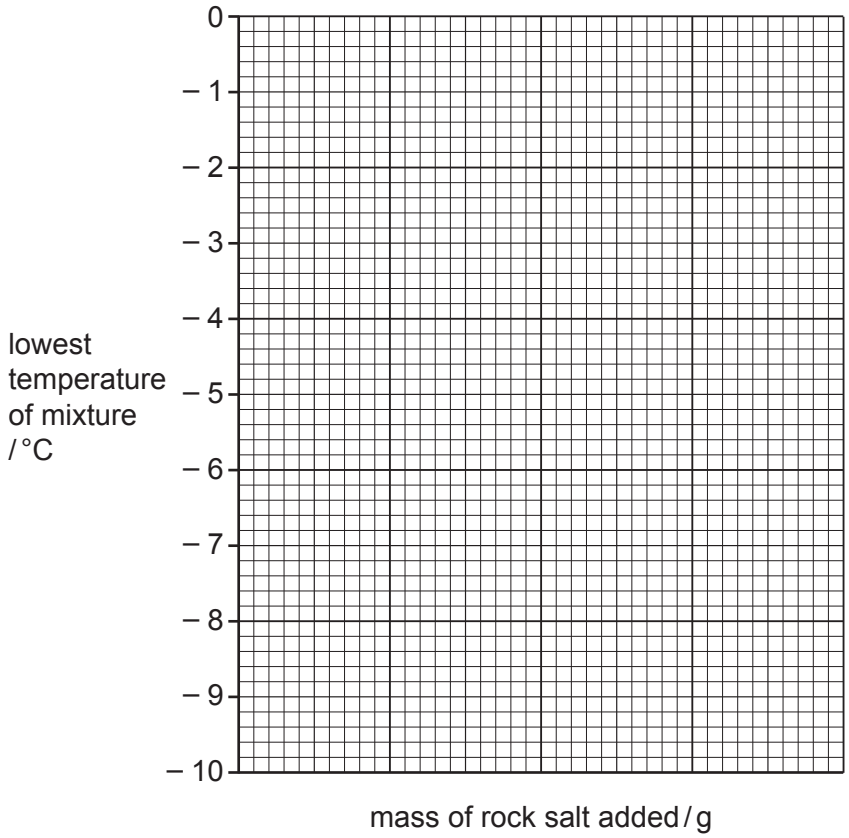
[1]

Record this temperature in the table of results.

mass of rock salt added / g	lowest temperature of ice and salt mixture / °C
0.0	0.0
0.5	–1.9
1.0	
1.5	–5.8
2.0	–7.8

(iii) Plot the results on the grid.
Include:

- a suitable scale for the *x*-axis
- a straight line of best fit.



[3]

(iv) Use your graph to find the lowest temperature when 1.4 g of rock salt is added.

.....°C [1]

(v) Deduce the relationship between the mass of rock salt added and the lowest temperature reached.

.....

..... [1]

[Total: 12]

Q4/41/M/J/20

24 Scientists analyse a sample of soil. They discover that the soil contains nitrate ions, carbonate ions and iron(III) ions.

(a) Complete the tables to show the observations of their tests.

Name any gases formed and state the tests used to identify them.

(i) Tests on a solid sample of soil.

ion	test	observations and conclusions
nitrate, NO_3^-	Add aqueous sodium hydroxide, then add aluminium foil and warm gently.	
carbonate, CO_3^{2-}	Add dilute hydrochloric acid.	

[6]

(ii) Tests on an aqueous solution made from soil.

ion	test	observations
iron(III), Fe^{3+}	Add aqueous sodium hydroxide.	
	Add excess aqueous sodium hydroxide.	

[2]

(b) The scientists also want to know the pH of the soil. They test the soil by shaking it with universal indicator solution then leaving it to stand.

They discover that the pH is 6.

State the colour of the universal indicator at pH 6.

..... [1]

(c) The scientists believe that some fertiliser containing iodide ions has been added to the soil.

Describe how the scientists could test the solution made from the soil for the presence of iodide ions and the result of the test if iodide ions are present.

test:

.....

.....

.....

.....

result:

.....

.....

.....

.....

[3] [Total: 12]

Q2/42/M/J/20

25 (a) A solution contains one cation and two different anions.

The table shows the tests a student does on this solution.

Complete the table.

Name any gases formed.

test	observations	conclusions
(i) To a portion of the solution in a boiling tube, add aqueous sodium hydroxide.	....	The solution contains Fe^{2+} ions.
(ii) To a portion of the solution in a test-tube add dilute nitric acid until no further change is seen. Keep the solution for test **(iii)**.	A gas is evolved that turns limewater milky.	....
(iii) Add aqueous barium nitrate.	A white precipitate forms.	....

[1] [2] [1]

(b) Calcium ammonium nitrate, $CaNH_4(NO_3)_3$, is a water-soluble compound.

Describe a series of tests, and the observations, to identify the calcium, ammonium and nitrate ions in a sample of $CaNH_4(NO_3)_3$.

Your description will need to explain how to prevent ammonium ions interfering with the test for nitrate ions.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 10]

Q5/41/O/N/20

26 Compound **Q** contains two cations and one anion. The following table shows the tests a student does on compound **Q**.

Complete the table.

Identify any gases that are formed in the tests.

test	observation	conclusion
(a) **Q** is dissolved in water. The solution is divided into two portions for tests **(b)** and **(c)**.	A coloured solution is formed.	.... [1]
(b) **(i)** To the first portion, aqueous sodium hydroxide is added until a change is seen.	....	**Q** contains Cr^{3+} or Fe^{2+} ions. [1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(b)(i)**.	....	**Q** contains Fe^{2+} ions. [1]
(iii) The mixture from **(b)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	The gas turns damp red litmus paper blue.	.... [2]
(c)	....	**Q** contains SO_4^{2-} ions. [3]

[Total: 8]

Q5/42/O/N/20

27 A solid mixture **R** contains two cations and one anion. The table shows the tests that a student does on **R**.

Complete the table.

Identify any gases that are formed in the tests.

test	observation	conclusion	
(a) **R** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**.	A coloured solution is formed.	....	[1]
(b) **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(b)(i)**.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(c) **(i)** To a portion of the solution from **(a)**, aqueous sodium hydroxide is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.	....	**R** contains Cr^{3+} ions.	[2]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	The gas turns damp red litmus paper blue.	....	[2]
(d)	....	**R** contains SO_4^{2-} ions.	[3]

[Total: 11]

Q3/41/M/J/21

28 A student does a series of tests on a mixture of ionic compounds in aqueous solution.

Complete the table.

Name any gases formed and describe the tests used to identify these gases.

tests	observations	conclusions
(a) aqueous ammonia is added to the mixture	a green precipitate forms which is insoluble in excess aqueous ammonia	.....
(b) aqueous sodium hydroxide is added to the mixture	a green precipitate is formed which is soluble in excess aqueous sodium hydroxide	.....
the mixture is warmed	a gas is also produced which turns damp red litmus paper blue	....
(c) excess dilute nitric acid is added to the mixture	....	..... CO_3^{2-} ions are in the mixture
followed by aqueous silver nitrate	....	I^- ions are in the mixture
(d)	....	SO_4^{2-} ions are in the mixture

[1] [3] [4] [3]

[Total: 11]

Q2/42/M/J/21

29 (a) A solution contains two different cations and one anion.

Complete the table.

Name any gases formed and describe the tests used to identify these gases.

test	observations	conclusions
Add aqueous sodium hydroxide to the solution in a boiling tube.	a pale green precipitate forms	
(i) To the same boiling tube, continue adding aqueous sodium hydroxide until in excess. Keep the contents of the boiling tube for test **(ii)**.	a green precipitate dissolves to form a green solution a white precipitate remains	cation 1 is ..... cation 2 is .....
(ii)	....	..... anion is NO_3^-

[2]

[4]

(b) Ammonium sulfite, $(NH_4)_2SO_3$, is a water-soluble compound.

Aqueous ammonium sulfite is slowly oxidised by oxygen in air.

This means aqueous ammonium sulfite will also contain some sulfate ions, SO_4^{2-}.

Describe a series of tests, and the observations, to show the presence of ammonium ions, sulfite ions and sulfate ions in this solution.

It must be clear in your answer which ion is identified by each test.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 12]

Q3/41/O/N/21

30 A student is provided with three unlabelled bottles which each contain a solution.

The student knows that the bottles contain:

- dilute sulfuric acid
- aqueous calcium chloride
- aqueous zinc chloride.

The student is provided with:

- dilute nitric acid
- aqueous barium nitrate
- aqueous sodium hydroxide

but **no other chemicals or indicators**.

For each of the three unlabelled bottles, describe a **test** and give the **observations** to identify the contents of the bottle.

You must describe tests that give positive results to identify the contents of **each** bottle.

It must be clear in your answer which solution is identified by each positive result.

Chemical equations are **not** required.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [7]

Q5/41/O/N/21

31 A solid **R** contains two cations and one anion.

Complete the table.

Name any gases that are formed in the tests.

test	observation	conclusion	
(a) **R** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**.	A coloured solution forms.	....	[1]
(b) **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(b)(i)**.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(c) **(i)** To a portion of the solution from **(a)**, aqueous sodium hydroxide is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.	....	**R** contains Cr^{3+} ions.	[1]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	....	**R** contains NH_4^+.	[2]
(d)	A white precipitate forms	**R** contains Cl^-.	[2]

[Total: 9]

Q3/42/O/N/21

32 A student is provided with three unlabelled bottles which each contain a solution.

The student knows the bottles contain:

- dilute hydrochloric acid
- aqueous aluminium sulfate
- aqueous zinc sulfate.

The student is provided with:

- dilute nitric acid
- aqueous silver nitrate
- aqueous ammonia

but **no other chemicals or indicators**.

For each of the three unlabelled bottles, describe a **test** and give the **observations** to identify the contents of the bottle.

You must describe tests that give positive results to identify the contents of **each** bottle.

It must be clear in your answer which solution is identified by each positive result.

Chemical equations are **not** required.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [7]

Q5/42/O/N/21

33 A solid **S** contains two cations and one anion.

Complete the table.

Name any gases that are formed in the tests.

test	observation	conclusion	
(a) **S** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**.	A coloured solution forms.	....	[1]
(b) **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen.	....	**S** contains Cu^{2+} ions.	[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(b)(i)**.	....	**S** contains Cu^{2+} ions.	[1]
(c) **(i)** To a portion of the solution from **(a)** aqueous sodium hydroxide is added until a change is seen.	....	**S** contains Cu^{2+} ions.	[1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.	....	**S** contains Cu^{2+} ions.	[1]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	....	**S** contains NH_4^+.	[2]
(d)	A white precipitate forms.	**S** contains SO_4^{2-}.	[2]

[Total: 9]

Q2/41/M/J/22

34 A student has a mixture of solid ionic compounds.

The student adds the mixture to a beaker with water and stirs the contents of the beaker.

The beaker contains a colourless solution and an insoluble black solid.

(a) Draw a diagram to show how the student separates the colourless solution from the black solid.

Label the apparatus, the black solid and the colourless solution in your diagram.

[3]

(b) The student tests the colourless solution as shown in the table.

(i) Complete the table.

Name any gas formed and describe the tests used to identify the gas.

	test	observations	conclusions
1	Add dilute hydrochloric acid followed by aqueous barium chloride.	....	.... The mixture contains sulfate ions and carbonate ions.
2	Add aqueous sodium hydroxide and warm the mixture.	....	.... The mixture contains ammonium ions.
3	Add dilute nitric acid followed by aqueous silver nitrate.	.... A pale yellow precipitate is formed.	....

[8]

(ii) Use the conclusions from tests 2 and 3 **only** to name an ionic compound in the mixture.

..... [1]

(c) The student tests the insoluble black solid as shown in the table.

Complete the table.

	test	observations	conclusions
1	Put the black solid into dilute sulfuric acid and warm the mixture.	The black solid dissolves and a blue solution is formed.	....
2	To some of the blue solution from test 1, add aqueous sodium hydroxide drop by drop until it is in excess.	A light blue precipitate is formed which is insoluble in excess.	....
3	To some of the blue solution from test 1, add aqueous ammonia drop by drop until it is in excess.	....	

[4]

[Total: 16]

Q2(a)/42/M/J/22

35 (a) A solution contains one cation and two different anions.

The table shows the tests a student does on this solution.

Complete the table.

Name any gases formed.

test	observations	conclusions
(i) To 1 cm depth of the solution in a test-tube, add a small volume of aqueous sodium hydroxide. Then add more aqueous sodium hydroxide until it is in excess.	....	The cation might be Al^{3+}. The cation could also be ..... .
(ii) To 1 cm depth of the solution in a boiling tube, add a small volume of aqueous ammonia. Then add more aqueous ammonia until it is in excess.	....	The cation is Al^{3+}.
(iii) To 1 cm depth of the solution in a test-tube add nitric acid and warm until no further change is seen.	A gas is evolved that decolourises acidified potassium manganate(VII) solution.	The gas is ..... . One of the anions is ..... .
(iv) To the solution from **(iii)** add aqueous silver nitrate.	A yellow precipitate forms.	The other anion is ..... .

[4]

[2]

[2]

[1]

Q6/41/O/N/22

36 A student is provided with aqueous copper(II) sulfate, aqueous aluminium sulfate and an aqueous solution labelled **X**.

The student tests the three solutions by adding each reagent shown in the table.

(a) Complete the table with the expected observations.

	aqueous solutions		
reagents	copper(II) sulfate	aluminium sulfate	**X**
aqueous sodium hydroxide	....	....	red-brown precipitate
aqueous sodium hydroxide in excess	....	....	precipitate remains
aqueous ammonia	....	....	red-brown precipitate
aqueous ammonia in excess	....	....	precipitate remains
aqueous silver nitrate and dilute nitric acid	....	....	white precipitate
aqueous barium nitrate and dilute nitric acid	....	....	no change

[7]

(b) Identify **X**.

..... [2]

[Total: 9]

Q3/41/M/J/23

37 A student investigates solution **W** and copper(II) carbonate.

(a) The tests the student does on **W** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

	tests on solution **W**	observations
1	Add aqueous sodium hydroxide to **W**.	solution remains colourless
2	Add dilute nitric acid, then add aqueous barium nitrate to **W**.	white precipitate
3	Add dilute hydrochloric acid, then add aqueous silver nitrate to **W**.	white precipitate
4	Flame test on **W**.	no colour is observed

(i) The student correctly concludes that ammonia is formed in test 1.

Describe what else the student must have done to reach this conclusion.

.....

.....

..... [3]

(ii) State why the student cannot identify the anion in **W** from the observation in test 3.

..... [1]

(iii) State how the tests and observations show that **W** does **not** contain sodium ions.

..... [1]

(iv) Identify the cation and anion in **W**.

cation ..... anion ..... [2]

(b) The student adds dilute hydrochloric acid to copper(II) carbonate.

A gas and a solution are produced.

(i) State the observation that confirms the production of a gas.

..... [1]

(ii) Describe how to do a flame test to confirm the presence of copper(II) ions in the solution.

.....

.....

.....

..... [3]

(iii) Describe one **other** method the student could use to confirm that the solution contains copper(II) ions.

.....

.....

.....

..... [3]

[Total: 14]

Q3/42/M/J/23

38 A student investigates solution **W** and solid **X**.

(a) Solution **W** is green in colour and contains Fe^{2+} ions.

(i) Describe how **W** can be shown to contain Fe^{2+} ions.

.....

..... [2]

(ii) Excess **W** is added to acidified aqueous potassium manganate(VII).

Describe the colour change seen.

from ..... to ..... [2]

(iii) Describe the observations made when a few drops of aqueous ammonia and then an excess of aqueous ammonia are added to the mixture from **(ii)**.

a few drops .....

an excess .....
[2]

(b) Solid **X** is a shiny grey metal.

The tests the student does on **X** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

	tests on solid **X**	observations
1	Add excess dilute acid to **X** in a test-tube. The gas produced is tested.	solid disappears solution remains colourless and becomes warmer
2	Add dilute nitric acid, then add aqueous silver nitrate to some of the solution from test 1.	solution remains colourless
3	Add dilute nitric acid, then add aqueous barium nitrate to some of the solution from test 1.	white precipitate

(i) Predict the identity of the gas produced in test 1.

Describe how the student tests the gas to confirm its identity.

gas .....

test .....

observation to confirm gas .....

[3]

(ii) The observations for test 1 are incomplete.

State one **other** observation that the student makes for test 1.

..... [1]

(iii) State the conclusion you can make from test 2.

..... [1]

(iv) State the conclusion you can make from test 3.

..... [1]

(v) Identify the acid used in test 1.

..... [1]

(vi) Suggest the identity of metal **X**.

..... [1]

[Total: 14]

Q3/41/O/N/23

39 A student investigates solution **X** and solution **Y**. Both solutions are colourless.

(a) The student does some tests on **X**.

Table 3.1 shows the notes the student makes about these tests.

Table 3.1

	tests on solution **X**	observations
1	Add one drop of aqueous sodium hydroxide to **X** in a test-tube.	white precipitate which then dissolves
2	Add aqueous sodium hydroxide to **X** in a boiling tube. Warm the mixture and test the gas produced with damp litmus paper.	pungent smell of ammonia no change to the litmus paper
3	Add aqueous dilute nitric acid and aqueous barium nitrate to solution **X** in a test-tube.	white precipitate

(i) Part of the method for test 1 is missing.

Describe the missing part of the method that is needed to give the observations shown.

..... [1]

(ii) The observations for test 1 are incomplete.

State one **other** observation which is made for test 1.

..... [1]

(iii) Suggest why the ammonia produced in test 2 has no effect on the litmus paper.

..... [1]

(iv) Solution **X** contains two cations. Identify the cation in solution **X** which produces ammonia in test 2.

..... [1]

(v) Explain why the student cannot identify the second cation in solution **X** from the tests and observations in Table 3.1.

.....

..... [2]

(vi) Identify the anion in **X**.

..... [1]

(b) (i) The student adds universal indicator to solution **Y** in a test-tube.

The universal indicator turns red.

Identify the cation present in **Y**.

..... [1]

(ii) The student adds a piece of magnesium ribbon to **Y**.

Hydrogen is produced.

Suggest **two** observations the student makes.

1. .....

2. .....
[2]

(iii) Describe how the student tests the gas to show that it is hydrogen.

test .....

observation if hydrogen present .....
[2]

(c) The student adds dilute nitric acid and then adds aqueous silver nitrate to **Y**.

A white precipitate is observed.

(i) Identify the anion present in **Y**.

..... [1]

(ii) Identify **Y**.

..... [1]

[Total: 14]

Q3/42/O/N/23

40 A student investigates solid **Y** and solution **Z**.

(a) Solid **Y** is white and contains carbonate ions.

The tests the student does on **Y** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

	tests on solid **Y**	observations
1	Add excess dilute sulfuric acid to **Y** in a boiling tube.	effervescence solid disappears
2	Add aqueous sodium hydroxide to the solution from test 1 until a change is seen.	white precipitate
3	Add more aqueous sodium hydroxide to the mixture from test 2 until a further change is seen.	white precipitate dissolves

(i) Predict the identity of the gas produced in test 1.

Describe how the student tests the gas to confirm its identity.

gas .....

test and observation .....

.....

[2]

(ii) The solution produced in test 1 contains an anion.

Name a reagent that reacts with this anion to form a white precipitate when added to the solution produced in test 1 after the addition of dilute nitric acid.

..... [1]

(iii) The observations for test 3 are incomplete.

State **one** other observation the student makes in test 3.

..... [1]

(iv) Solid **Y** contains only one cation. The student cannot identify the cation from the observations in Table 3.1.

Use Table 3.1 to name the **two** cations which could be present in **Y**.

.....

..... [2]

(v) Describe an additional test the student does on the solution produced in test 1 to identify the cation in **Y**.

.....

.....

..... [2]

(b) Solution **Z** contains **one** cation and **one** anion. The cation contains two non-metals.

(i) The student adds aqueous sodium hydroxide to **Z** in a boiling tube.

Describe how the student completes this test to identify the cation in **Z**.

.....

.....

..... [3]

(ii) The student adds dilute nitric acid and then aqueous silver nitrate to **Z**.

A precipitate is formed. It is difficult to tell if the precipitate is white or cream in colour.

Describe how the student uses separate aqueous solutions of a chloride and a bromide to decide the colour of the precipitate.

.....

.....

..... [2]

(iii) The student adds dilute nitric acid and then aqueous barium nitrate to **Z**.

Predict the expected observation.

..... [1]

[Total: 14]