Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Tests for ions and gases

Time allowed: 2 hours 15 minutes

Subject code **0620**

Chemistry

Questions from Paper 4 and Paper 6

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 90

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 90 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 A student tests two substances: solid **R** and solid **S**.

Tests on solid R

Table 3.1 shows the tests and the student's observations for solid **R**.

Table 3.1

tests	observations
test 1 Gently heat about half of solid **R** in a boiling tube.	the white solid forms a colourless liquid steam comes out from the boiling tube and condensation forms at the top of the boiling tube
test 2 The remaining solid **R** is dissolved in distilled water to form solution **R**. Solution **R** is divided into four portions. To the first portion of solution **R**, add aqueous sodium hydroxide dropwise and then in excess.	white precipitate forms the white precipitate dissolves in excess aqueous sodium hydroxide
test 3 To the second portion of solution **R**, add aqueous ammonia dropwise and then in excess.	white precipitate forms the white precipitate remains in excess aqueous ammonia
test 4 To the third portion of solution **R**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	no change
test 5 To the fourth portion of solution **R**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	cream precipitate forms

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(a) State the conclusion that can be made from the observations in **test 1**.

..... [1]

(b) Identify solid **R**.

.....

..... [2]

Tests on solid S

Solid **S** is sodium sulfite.

Record the expected observations.

(c) The student carries out a flame test on solid **S**.

observations ..... [1]

The student dissolves the remaining solid **S** in distilled water to form solution **S**.
The student divides solution **S** into two portions.

(d) To the first portion of solution **S**, the student adds about 2 cm^3 of aqueous sodium hydroxide.

observations ..... [1]

(e) To the second portion of solution **S**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations ..... [1]

[Total: 6]

Tests for ions and gases Click for more variations

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1(a)	(**R** is) hydrated / has water of crystallisation	**1**
1(b)	**M1** aluminium / Al^{3+} **M2** bromide / Br^-	**2**
1(c)	yellow (flame)	**1**
1(d)	no change / no reaction / remains colourless	**1**
1(e)	becomes colourless / (pink / purple) is decolourised	**1**

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2 A student tests two solids: solid **E** and solid **F**.

Tests on solid E

Solid **E** is ammonium sulfate.

Record the expected observations.

The student dissolves solid **E** in distilled water to form solution **E**. The student divides solution **E** into three approximately equal portions.

(a) (i) To the first portion of solution **E**, the student adds about $2\,cm^3$ of aqueous sodium hydroxide. The student warms the mixture gently and tests any gas produced.

observations .....

..... [1]

(ii) Identify the gas given off in **(a)(i)**.

..... [1]

(b) To the second portion of solution **E**, the student adds about $1\,cm^3$ of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations .....

..... [1]

(c) To the third portion of solution **E**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations .....

..... [1]

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Tests on solid F

Table 3.1 shows the tests and the student's observations for solid **F**.

Table 3.1

tests	observations
test 1 Carry out a flame test on solid **F**.	yellow flame
test 2 Dissolve the remaining solid **F** in distilled water to form solution **F**. Divide solution **F** into three portions. To the first portion of solution **F**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	yellow precipitate forms
test 3 To the second portion of solution **F**, add aqueous sodium hydroxide dropwise until in excess.	white precipitate forms the precipitate dissolves in excess aqueous sodium hydroxide to form a colourless solution
test 4 To the third portion of solution **F**, add aqueous ammonia dropwise until in excess.	white precipitate forms the precipitate dissolves in excess aqueous ammonia to form a colourless solution

(d) Identify the **three** ions in solid **F**.

.....

.....

..... [3]

[Total: 7]

Tests for ions and gases Click for more variations

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2(a)(i)	(damp red) litmus (paper) turns blue	1
2(a)(ii)	ammonia / NH_3	1
2(b)	white precipitate	1
2(c)	(solution) becomes pink	1
2(d)	**M1** sodium / Na^+ **M2** zinc / Zn^{2+} **M3** iodide / I^-	3

3 This question is about ions and ionic compounds.

(a) Choose from the following list of ions to answer the questions.

Br^-	Ca^{2+}	Cl^-	Cr^{3+}	Cu^{2+}
K^+	Li^+	Na^+	SO_3^{2-}	SO_4^{2-}

Each ion may be used once, more than once or not at all.

State which ion:

(i) gives a lilac colour in a flame test ..... [1]

(ii) forms a grey-green precipitate with aqueous ammonia ..... [1]

(iii) forms a white precipitate with aqueous sodium hydroxide ..... [1]

(iv) forms a cream precipitate with acidified aqueous silver nitrate ..... [1]

(v) forms a white precipitate with acidified aqueous barium nitrate. ..... [1]

(b) Describe how to do a flame test on a sample of a salt.

.....

.....

.....

..... [2]

(c) Magnesium phosphate contains magnesium ions, Mg^{2+}, and phosphate ions, PO_4^{3-}.

Deduce the formula of magnesium phosphate.

..... [1]

[Total: 8]

Tests for ions and gases Click for more variations

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3(a)(i)	K^+	1
3(a)(ii)	Cr^{3+}	1
3(a)(iii)	Ca^{2+}	1
3(a)(iv)	Br^-	1
3(a)(v)	SO_4^{2-}	1
3(b)	(compound / salt) on wooden splint **or** (nichrome / platinum) wire (1) into (roaring) Bunsen flame (1)	2
3(c)	$Mg_3(PO_4)_2$	1

4 Two solids, solid **L** and solid **M**, were analysed. Solid **L** was chromium(III) chloride.
Tests were done on each solid.

tests on solid L

Complete the expected observations.

Solid **L** was dissolved in distilled water to produce solution **L**. Solution **L** was divided into four portions in three test-tubes and a boiling tube.

(a) To the first portion of solution **L** in the boiling tube, about 1 cm depth of dilute hydrochloric acid was added. The boiling tube was warmed gently.

A strip of filter paper was dipped in acidified potassium manganate(VII) solution and held at the mouth of the boiling tube.

observations ..... [1]

(b) To the second portion of solution **L** aqueous sodium hydroxide was added slowly until it was in excess and no further changes were seen.

observations .....

.....

..... [2]

(c) To the third portion of solution **L** aqueous ammonia was added slowly until it was in excess and no further changes were seen.

observations .....

.....

..... [2]

(d) To the fourth portion of solution **L** about 1 cm depth of dilute nitric acid was added followed by about 1 cm depth of aqueous silver nitrate.

observations .....

..... [1]

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tests on solid M

Tests were done and the following observations made.

tests on solid **M**	observations
test 1 Flame test	yellow flame seen
test 2 About 10 cm^3 of dilute nitric acid was added to solid **M**. Any gas produced was tested.	effervescence limewater turned milky
test 3 About 1 cm depth of aqueous barium nitrate was added to the solution formed by adding dilute nitric acid to solid **M** in **test 2**.	no change

(e) Identify solid **M**.

..... [2]

[Total: 8]

Tests for ions and gases Click for more variations

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4	**Tests on solution L**	
4(a)	stays purple **or** no change	1
4(b)	green ppt	1
	(dissolves / soluble) producing a green solution	1
4(c)	grey-green precipitate	1
	remains in excess / does not dissolve	1
4(d)	white precipitate	1

	Tests on solid M	
4(e)	sodium / Na^+	1
	carbonate / CO_3^{2-}	1

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5 Two substances, solid **A** and solid **B**, were analysed. Solid **A** was zinc nitrate.
Tests were done on the substances.

tests on solid A

Complete the expected observations.

Solid **A** was added to distilled water and the mixture shaken to dissolve solid **A** and produce solution **A**. Solution **A** was divided into three equal portions in three test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution **A**.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to this mixture.

observations ..... [1]

(b) (i) A few drops of aqueous ammonia were added to the second portion of solution **A**.

observations ..... [1]

(ii) An excess of aqueous ammonia was then added to this mixture.

observations ..... [1]

(c) Aluminium foil and aqueous sodium hydroxide were added to the third portion of solution **A**. The mixture was heated and the gas produced was tested with litmus paper.

observations .....

..... [2]

tests on solid B

Some of the tests and observations are shown.

tests on solid **B**	observations
test 1 A flame test was done on solid **B**.	red flame
test 2 Solid **B** was dissolved in water. Dilute nitric acid and aqueous silver nitrate were added to the solution.	yellow precipitate formed

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(d) Identify solid **B**.

..... [2]

[Total: 9]

Tests for ions and gases Click for more variations

5(a)(i)	white	1
	precipitate	1
5(a)(ii)	clears / dissolves / colourless solution	1
5(b)(i)	white precipitate	1
5(b)(ii)	clears / dissolves / colourless solution	1
5(c)	bubbles / effervescence	1
	litmus turns blue	1

5(d)	lithium	1
	iodide	1

6 Two solids, solid **C** and solid **D**, were analysed.
Tests were done on each solid.

tests on solid C

Tests were carried out and the following observations were made.

tests	observations
test 1 A flame test was carried out on solid **C**.	a red flame was seen
Solid **C** was dissolved in distilled water to produce solution **C**. **test 2** About 5 cm^3 of aqueous sodium hydroxide was added to solution **C**.	no change
test 3 A piece of aluminium foil was added to the mixture formed in **test 2**.The mixture was warmed gently and any gas produced was tested.	effervescence was seen; damp red litmus paper turned blue

(a) Name the gas that turned the damp red litmus paper blue in **test 3**.

..... [1]

(b) Identify solid **C**.

.....

..... [2]

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tests on solid D

Solid **D** was aluminium sulfate.

Complete the expected observations.

Solid **D** was dissolved in water to form solution **D**. Solution **D** was divided into four approximately equal portions in four test-tubes.

(c) Aqueous sodium hydroxide was added dropwise and then in excess to the first portion of solution **D**.

observations .....

..... [2]

(d) Aqueous ammonia was added dropwise and then in excess to the second portion of solution **D**.

observations .....

..... [2]

(e) About 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the third portion of solution **D**.

observations ..... [1]

(f) About 1 cm^3 of dilute nitric acid and a few drops of aqueous barium nitrate were added to the fourth portion of solution **D**.

observations ..... [1]

[Total: 9]

Tests for ions and gases Click for more variations

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6(a)	ammonia / NH_3	**1**
6(b)	lithium nitrate lithium (ions) / Li^+	**1**
	nitrate / NO_3^-	**1**
6(c)	white precipitate	**1**
	dissolves / disappears / forms colourless solution	**1**
6(d)	white precipitate	**1**
	remains / does not dissolve / no further change / white precipitate / nothing happens	**1**
6(e)	no change	**1**
6(f)	white precipitate	**1**

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7 A student tests two substances: solution **F** and solid **G**.

Tests on solution F

Table 3.1 shows the tests and the student's observations for solution **F**. The student divides solution **F** into three portions.

Table 3.1

tests	observations
test 1 Do a flame test on the first portion of solution **F**.	light green colour
test 2 To the second portion of solution **F**, add a 1 cm depth of aqueous sodium hydroxide and a piece of aluminium foil. Warm the mixture gently and test any gas produced.	effervescence was seen; the gas turned damp red litmus paper blue
test 3 To the third portion of solution **F**, add a 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.	no change

(a) Describe how to do the flame test used in **test 1**.

.....

.....

..... [2]

(b) Identify the gas given off in **test 2**.

..... [1]

(c) Identify solution **F**.

.....

..... [2]

(d) State what would be observed if the student adds dilute sulfuric acid to another portion of solution **F**.

observations .....

..... [1]

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Tests on solid G

Solid **G** is iron(II) carbonate.

(e) About 10 cm^3 of dilute sulfuric acid is added to solid **G**.
Any gas given off is tested.

observations .....

.....

..... [2]

(f) To the product from **(e)**, aqueous sodium hydroxide is added dropwise until in excess.

observations adding dropwise .....

observations in excess .....
[2]

[Total: 10]

Tests for ions and gases Click for more variations

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7(a)	**M1** use of a wire / splint to get substance into a flame	**1**
	M2 putting sample **I**NTO flame **and** identifying (Bunsen) flame as roaring / blue / non-luminous / hot	**1**
7(b)	ammonia / NH_3	**1**

7(c)	**M1** barium / Ba^{2+}	**1**
	M2 nitrate / NO_3^-	**1**
7(d)	white precipitate	**1**
7(e)	**M1** fizzing / bubbles / effervescence	**1**
	M2 limewater becomes milky	**1**
7(f)	**M1** green precipitate	**1**
	M2 remains in excess / does not dissolve / green precipitate	**1**

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8 Two aqueous solutions, **M** and **N**, were analysed. Solution **N** was aqueous sodium hydroxide. The tests on **M** and **N**, and some of the observations are in the following table. Complete the observations in the table.

tests	observations
<u>tests on solution **M**</u> Solution **M** was divided into four equal portions in separate test-tubes. **(a)** Appearance of solution **M**. The pH of the first portion of **M** was tested.	 colourless liquid pH 1
(b) Calcium carbonate was added to the second portion of **M**. The gas given off was tested with a splint.	effervescence lighted splint extinguished
(c) Magnesium ribbon was added to the third portion of **M**. The gas given off was tested with a splint.	effervescence lighted splint popped
(d) A few drops of dilute nitric acid and aqueous silver nitrate were added to the fourth portion of **M**.	white precipitate

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tests	observations
<u>tests on solution **N**</u> Solution **N** was divided into three equal portions in separate test-tubes. **(e)** Appearance of solution **N**. The pH of the first portion of solution **N** was tested.	..... [1] pH = [1]
(f) Drops of aqueous zinc sulfate were added to the second portion of **N** and the mixture was shaken. Excess aqueous zinc sulfate was then added to the mixture and the mixture was shaken.	..... [1] ..... [2]
(g) Ammonium chloride was added to the third portion of **N**. The mixture was warmed and the gas tested with damp red litmus paper.	.... [2]

(h) **(i)** Identify the gas given off in test **(c)**.

..... [1]

(ii) Identify the gas given off in test **(g)**.

..... [1]

(i) Identify solution **M**.

..... [2]

[Total: 11]

Tests for ions and gases Click for more variations

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8 tests on solution **N**

(e) appearance colourless (1) [1]
pH 11–14 (1) [1]

(f) colourless / no change (1)
white (1)
precipitate (1) [3]

(g) litmus paper turns blue (1)
pungent smell (1) [2]

(h) **(i)** hydrogen / H_2 (1) [1]

(ii) ammonia (1) [1]

(i) hydrochloric acid (2) [2]
acid or chloride only, 1 mark.

9 Two solids, solid **G** and solid **H**, were analysed. Solid **G** was copper(II) carbonate.
Tests were done on each solid.

tests on solid G

Complete the expected observations.

(a) Solid **G** was placed in a boiling tube. An excess of dilute sulfuric acid was added to the boiling tube. Any gas produced was tested.

observations .....

.....

..... [3]

(b) Identify the gas produced in **(a)**.

..... [1]

(c) Aqueous ammonia was added slowly until in excess to the solution produced in **(a)**.

observations .....

.....

.....

..... [3]

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tests on solid H

Tests were done and the following observations were made.

tests on solid **H**	observations
test 1 Flame test	yellow flame
test 2 Some of solid **H** was placed in a boiling tube. The boiling tube was heated strongly.	condensation appeared near the mouth of the boiling tube
Solid **H** was dissolved in distilled water. The solution was divided into two equal portions. **test 3** About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the first portion of the solution.	the solution remained colourless
test 4 About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the second portion of the solution.	white precipitate

(d) What conclusion can be made from the result of **test 3**?

.....

..... [1]

(e) What conclusions can be made about solid **H** from the results of **test 1**, **test 2** and **test 4**?

.....

.....

..... [3]

[Total: 11]

Tests for ions and gases Click for more variations

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9	**Tests on solid G**	
9(a)	any **three** from: • bubble / fizz / effervescence • blue solution formed • (gas made turns) limewater • milky	**3**
9(b)	• carbon dioxide / CO_2	**1**

9(c)	blue	**1**
	precipitate	**1**
	dark(er) / royal blue and dissolves / solution	**1**
9(d)	not a halide	**1**
	tests on solid H	
9(e)	hydrated	**1**
	sodium / Na^+ sulfate / SO_4^{2-} sodium sulfate = 2 Na_2SO_4 = 2	**1**

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10 A student tests two substances: solid **H** and solution **I**.

Tests on solid H

Solid **H** is barium carbonate.

Complete the expected observations.

(a) (i) The student adds an excess of dilute nitric acid to the sample of solid **H** in a boiling tube and tests any gas produced.

observations .....

.....

..... [2]

(ii) Identify the gas made in **(a)(i)**.

..... [1]

The solution produced in **(a)(i)** is solution **J**. The student divides solution **J** into four approximately equal portions.

(b) The student carries out a flame test on the first portion of solution **J**.

observations ..... [1]

(c) To the second portion of solution **J**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations .....

..... [1]

(d) To the third portion of solution **J**, the student adds a few drops of dilute sulfuric acid.

observations .....

..... [1]

(e) To the fourth portion of solution **J**, the student adds about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations .....

..... [1]

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Tests on solution I

Table 3.1 shows the tests and the student's observations for solution **I**.

The student divides solution **I** into two portions.

Table 3.1

tests	observations
test 1 To the first portion of solution **I** in a boiling tube, add 2 cm^3 of aqueous sodium hydroxide and warm the mixture. Test any gas produced, using damp red litmus paper.	damp red litmus paper turns blue
test 2 To the second portion of solution **I** in a boiling tube, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	a white precipitate forms

(f) (i) Identify the gas produced in **test 1**.

..... [1]

(ii) State what is observed when the gas produced in **test 1** is tested using damp blue litmus paper.

..... [1]

(g) Identify solution **I**.

.....

..... [2]

[Total: 11]

Tests for ions and gases Click for more variations

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10(a)(i)	• limewater turns milky (when gas passed through it) and any **one** from • effervescence / fizzing / bubbles • solid disappears / dissolves	**2**
10(a)(ii)	carbon dioxide / CO_2	**1**
10(b)	(pale / light) green (flame)	**1**
10(c)	(solution becomes) pink / pale purple / lilac	**1**
10(d)	white precipitate	**1**

10(e)	no change	**1**
10(f)(i)	ammonia / NH_3	**1**
10(f)(ii)	no change / stays blue	**1**
10(g)	ammonium chloride / NH_4Cl **M1** ammonium / NH_4^+ **M2** chloride / Cl^-	**2**

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