

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE**

A172/02

**TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A/ADDITIONAL SCIENCE A**

Modules C4 C5 C6 (Higher Tier)

WEDNESDAY 15 JUNE 2016: Afternoon

**DURATION: 1 hour
plus your additional time allowance**

MODIFIED ENLARGED

| | | | |
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| Candidate forename | | Candidate surname | |
|-------------------------------|--|------------------------------|--|

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| Centre number | | | | | | Candidate number | | | | |
|--------------------------|--|--|--|--|--|-----------------------------|--|--|--|--|

**Candidates answer on the Question Paper.
A calculator may be used for this paper.**

OCR SUPPLIED MATERIALS:

**A copy of the Periodic Table
Loose Sheet for Question 6**

OTHER MATERIALS REQUIRED:

**Pencil
Ruler (cm/mm)**

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

The quality of written communication is assessed in questions marked with a pencil ().

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 60.

Any blank pages are indicated.

A list of qualitative tests for ions is printed on pages 4–5.

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TWENTY FIRST CENTURY SCIENCE DATA SHEET

QUALITATIVE ANALYSIS

Tests for ions with a positive charge

| ION | TEST | OBSERVATION |
|-------------------------------|-----------------------------|--|
| calcium Ca^{2+} | add dilute sodium hydroxide | a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| copper Cu^{2+} | add dilute sodium hydroxide | a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| iron(II) Fe^{2+} | add dilute sodium hydroxide | a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| iron(III) Fe^{3+} | add dilute sodium hydroxide | a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| zinc Zn^{2+} | add dilute sodium hydroxide | a white precipitate forms; the precipitate dissolves in excess sodium hydroxide |

Tests for ions with a negative charge

| ION | TEST | OBSERVATION |
|---------------------------------|--|--|
| carbonate CO_3^{2-} | add dilute acid | the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky) |
| chloride Cl^- | add dilute nitric acid, then add silver nitrate | a white precipitate forms |
| bromide Br^- | add dilute nitric acid, then add silver nitrate | a cream precipitate forms |
| iodide I^- | add dilute nitric acid, then add silver nitrate | a yellow precipitate forms |
| sulfate SO_4^{2-} | add dilute acid, then add barium chloride or barium nitrate | a white precipitate forms |

Answer ALL the questions.

- 1 In 1864, a chemist called John Newlands had an idea of arranging the elements in order, depending on their chemical properties.**

He called his idea the ‘Law of Octaves’.

- (a) Newlands put elements with similar properties together.**

He put lithium, sodium and potassium together.

Give TWO ways that the properties of lithium, sodium and potassium are similar.

[2]

- (b) The table shows Newlands' arrangement of some of the elements.

He put elements with similar properties into the same row of his table.

| Row | | | |
|-----|------------------|------------------|--------------------|
| 1 | ^1H | ^{19}F | $^{35.5}\text{Cl}$ |
| 2 | ^7Li | ^{23}Na | ^{39}K |
| 3 | ^9Gl | ^{24}Mg | ^{40}Ca |
| 4 | ^{11}Bo | ^{27}Al | ^{52}Cr |
| 5 | ^{12}C | ^{28}Si | ^{48}Ti |
| 6 | ^{14}N | ^{31}P | ^{55}Mn |
| 7 | ^{16}O | ^{32}S | ^{56}Fe |

- (i) The symbols that Newlands used for some of the elements are different to those on the Periodic Table today.

The numbers shown with each symbol give the atomic mass of each element.

What symbols do we use today for the elements ^9Gl and ^{11}Bo in Newlands' table?

^9Gl _____

^{11}Bo _____

[2]

(ii) Nina and Marty discuss Newlands' table.

Nina says, 'All of the elements in row 2 are in Group 1 of the Periodic Table.

I think the rows in Newlands' table match up with groups in the Periodic Table.'

Marty says, 'That is only partly true. For example row 5 of Newlands' table only partly matches a group in the Periodic Table.'

Explain why Marty is right. Use elements in row 5 to support your answer.

[2]

(iii) Newlands' table does not include any elements from one of the groups in the Periodic Table.

Identify the missing group and suggest why Newlands could not include these elements in his table.

Use the Periodic Table to help you.

[2]

- (c) Newlands' arrangement was based on putting the elements in order of their relative atomic masses.

Mendeleev improved Newlands' arrangement.
Mendeleev reversed the order of some elements and left gaps.

His arrangement worked for more elements.

- (i) Why did reversing the order of some elements and leaving gaps make the arrangement work for more elements?

[2]

- (ii) What decides the order of elements in the Periodic Table today?

Put a tick (✓) in the box next to the correct answer.

the number of neutrons in the atom

☐

the proton number

☐

the type of bonds the elements form

☐

the relative atomic mass

☐




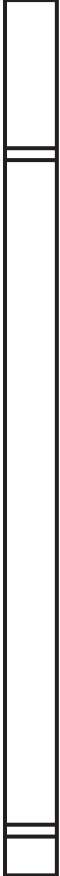
[1]

[TOTAL: 11]

2 Joe collects some samples of a mineral.


He thinks the mineral contains Group 1 elements.

He looks up the flame colours and the emission spectra for some Group 1 elements shown below.

| ELEMENT | FLAME COLOUR | EMISSION SPECTRUM |
|-----------|---------------------------|--|
| lithium | red |  |
| sodium | very strong yellow-orange |  |
| potassium | pale purple |  |
| rubidium | purple |  |

He does a flame test and records the emission spectrum produced by the mineral.

These are his results.

| | FLAME COLOUR | EMISSION SPECTRUM |
|---------|---------------|--|
| mineral | yellow-orange |  |

What conclusions can you make about which elements the mineral DOES and DOES NOT contain? Give your reasons and explain why neither the flame test nor the emission spectra data can be used to identify ALL of the elements in the mineral. [6]



The quality of written communication will be assessed in your answer.

[TOTAL: 6]

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3 The table gives some information about the elements in Group 7.

(a) Complete the table by filling in the missing information.

| ELEMENT | NORMAL STATE AT ROOM TEMPERATURE | COLOUR AT ROOM TEMPERATURE |
|-----------------|---|---|
| fluorine | gas | pale yellow |
| chlorine | | |
| bromine | | |
| iodine | | grey |

[2]

(b) Which statements about the atoms of the elements in Group 7 are true?

Put ticks (✓) in the boxes next to the two correct answers.

They all have the same number of electron shells.

☐

They all have the same number of outer shell electrons.

☐

They all form ions with the same charge.

☐

They all have the same charge on the nucleus.

☐

They all form ions by losing electrons.

☐

[2]

**(c) Group 7 elements are diatomic.
What does this mean?**

_____ **[2]**

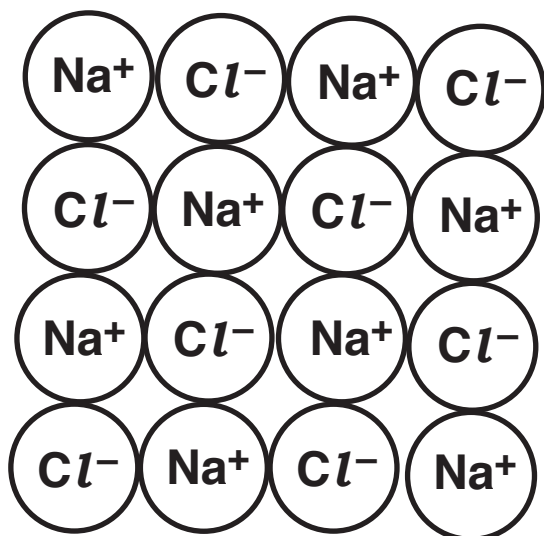
[TOTAL: 6]

4 Sodium chloride is the main compound in common salt.

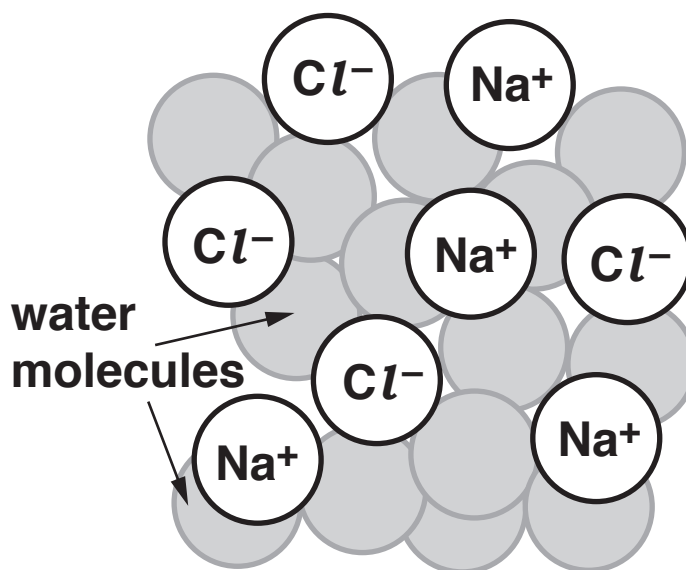
- (a) Solid salt has very different properties compared to salt dissolved in water.**

These diagrams show the structures of solid salt and salt dissolved in water (salt solution).

SOLID SALT



SALT SOLUTION



State and explain how the properties and structure of solid salt change when it dissolves in water, using ideas from the diagrams opposite to support your answer.



The quality of written communication will be assessed in your answer.

[6]

- (b) Salt is put on roads in winter because it lowers the freezing point of water.

Liz does some experiments to investigate whether salt can be used to stop water from freezing in extreme weather conditions.

She adds different masses of salt to 100 cm^3 of water and records the temperature when the water freezes.

Here are her results.

| Mass of salt added to 100 cm^3 water in g | Freezing point in $^{\circ}\text{C}$ |
|--|--------------------------------------|
| 0.0 | 0 |
| 5.0 | -3 |
| 10.0 | -6 |
| 15.0 | -9 |

Liz talks about her results.

Liz says, ‘My data shows that there is a relationship between the freezing point and the mass of salt added.

I can use this data to predict how much salt I need to add to water to stop it freezing at -30°C .’

- (i) What is the relationship shown in this data between the mass of salt added and the freezing point?**

[2]

- (ii) Use the relationship to predict how much salt would need to be added to 100 cm^3 of water to lower the freezing point to -30°C .**

Show your working.

[2]

- (c) Liz does some more experiments using two higher masses of salt.

These are her results.

| Mass of salt added to 100 cm ³ water in g | Freezing point in °C |
|---|----------------------|
| 25.0 | −15 |
| 35.0 | −5 |

- (i) Liz thinks that these results do not fully match predictions made based on the trend in the previous table on page 18.

Explain why she is right.

[3]

- (ii) Liz wants to investigate the relationship between mass of salt and the freezing point of water when she adds up to 50.0 g of salt.

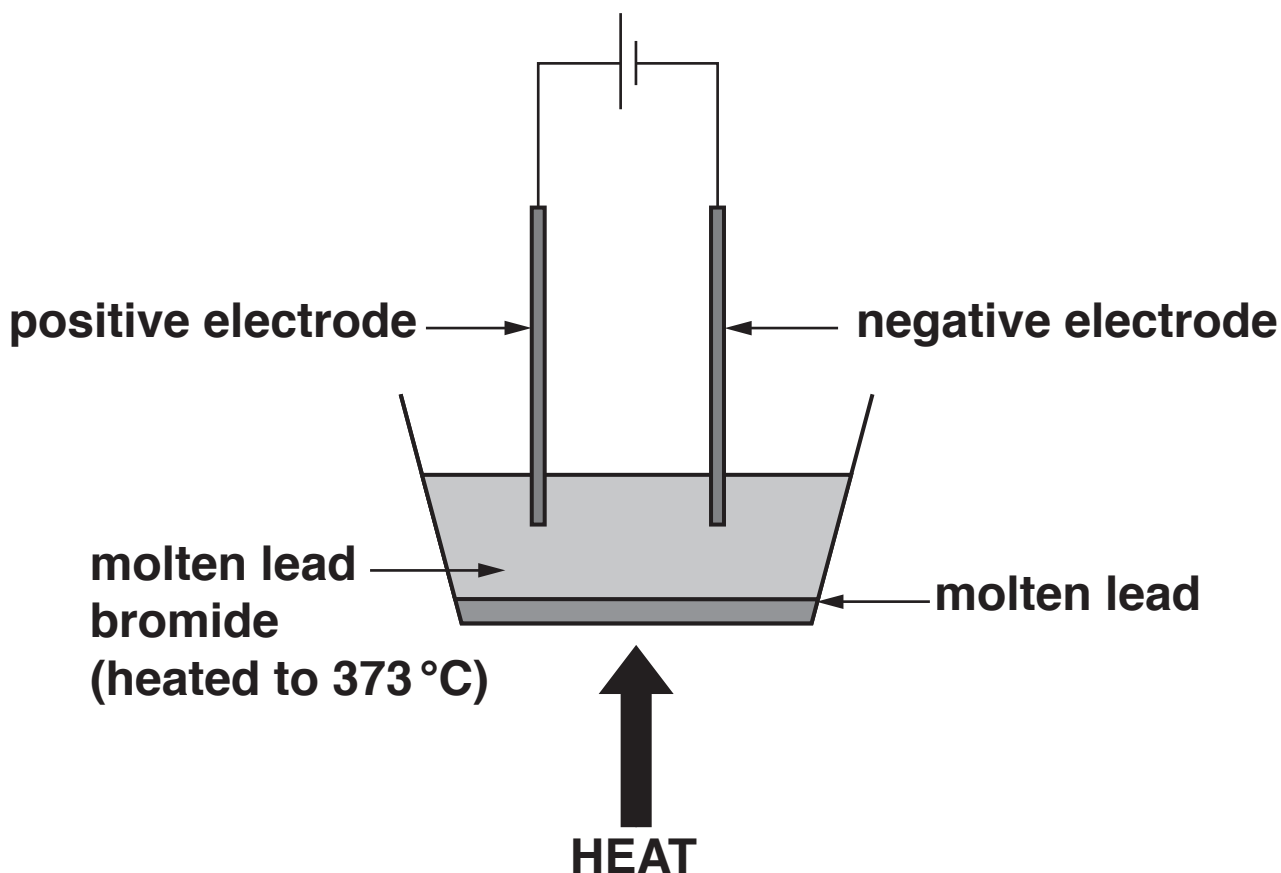
Describe what experiments she should do.

[3]

[TOTAL: 16]

5 The melting point of lead bromide is 373°C.

Molten lead bromide can be electrolysed using this apparatus.



- (a) During the electrolysis lead forms at one electrode.
The lead collects as a liquid at the bottom of the container.**

What does this tell you about the melting point of lead?

[1]

- (b) At which electrode would you expect lead to form?
Explain your reasoning.

[1]

- (c) The formula for lead bromide is PbBr_2 .

This is the half equation that shows what happens to the bromide ions during the electrolysis.



Write a half equation to show what happens to the lead ions during the electrolysis.

[2]

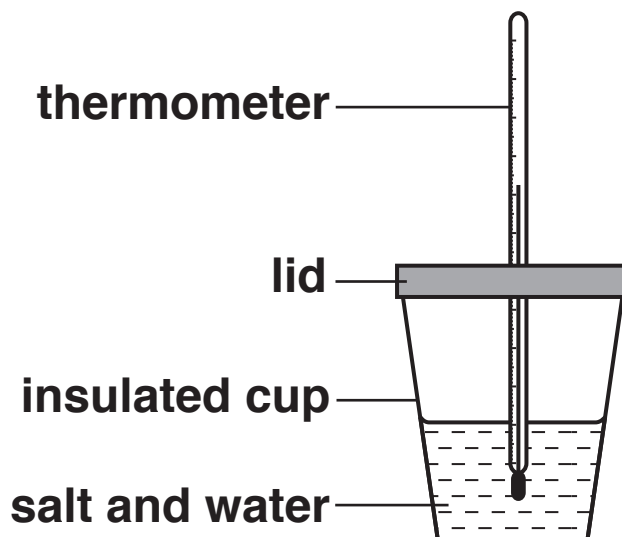
[TOTAL: 4]

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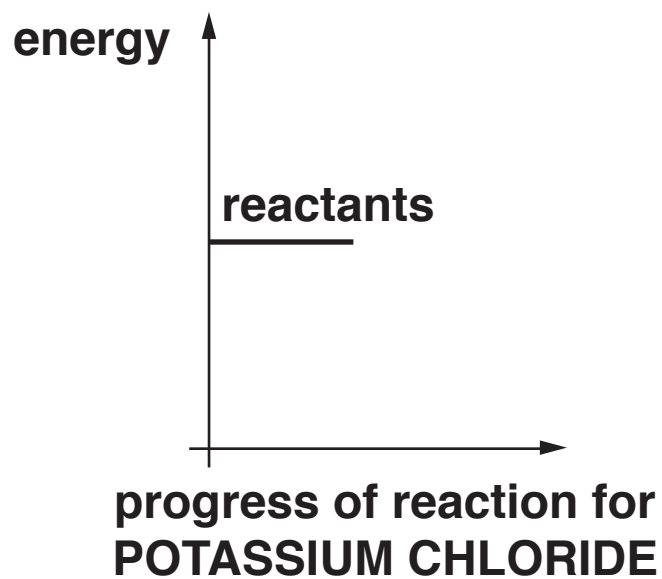
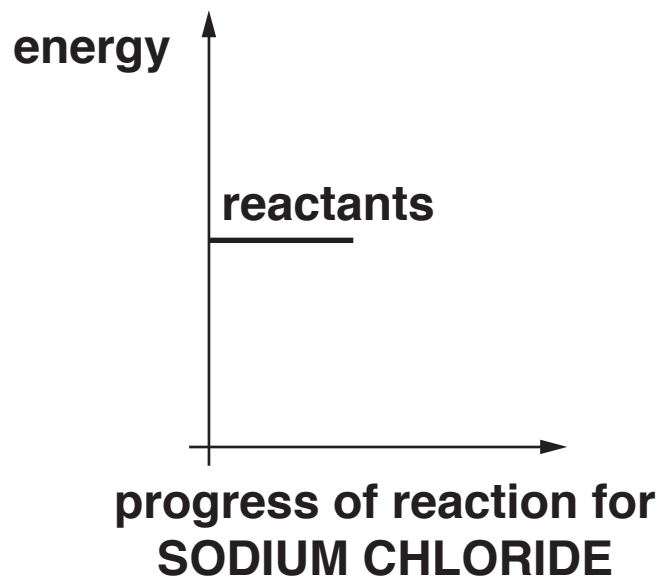
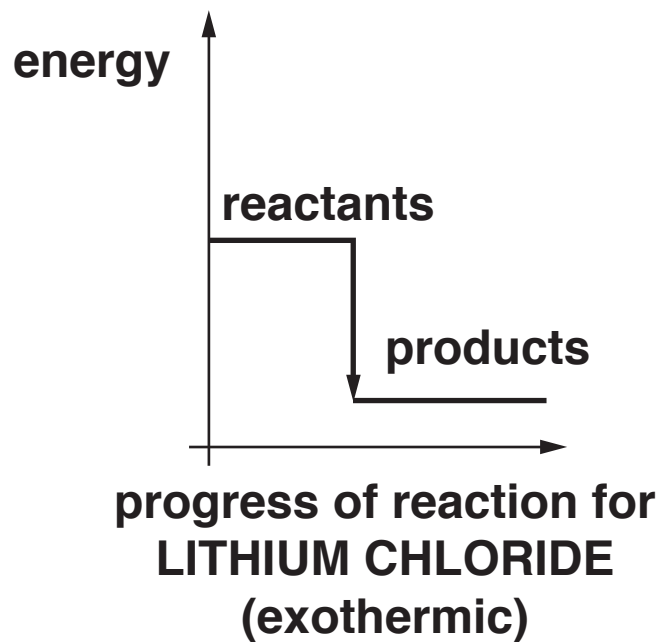
6 Rose investigates the energy changes when three salts dissolve in water.

She adds the same amount of each salt to the same amount of water.

She measures the maximum temperature change when each salt dissolves.



The table on the loose sheet shows her results.



Complete and label the energy level diagrams on page 27. Compare the changes in temperature and energy that happen when each salt dissolves.



The quality of written communication will be assessed in your answer.

[6]

[TOTAL: 6]

- 7 Matt finds out some information about the bonding in some compounds and the ions that they produce when they dissolve in water. He dissolves the compounds in water and tests their pH values.**

The table shows his results.

| COMPOUND | BONDING IN COMPOUND | WHEN DISSOLVED IN WATER | | |
|-------------------|---------------------|-------------------------|--------------|----|
| | | Positive ion | Negative ion | pH |
| sodium hydroxide | ionic | sodium | hydroxide | 14 |
| calcium bromide | ionic | calcium | bromide | 7 |
| ammonia | covalent | ammonium | hydroxide | 9 |
| hydrogen chloride | covalent | hydrogen | chloride | 1 |
| ethanoic acid | covalent | hydrogen | ethanoate | 3 |
| calcium hydroxide | ionic | calcium | hydroxide | 12 |
| citric acid | covalent | hydrogen | citrate | 3 |

- (a) Which compounds in the table are acidic?**
Put a tick (✓) in the boxes next to each correct answer.

sodium hydroxide

☐

calcium bromide

☐

ammonia

☐

hydrogen chloride

☐

ethanoic acid

☐

calcium hydroxide

☐

citric acid

☐

[1]

- (b) Matt looks at the information on page 28 and puts forward this idea.

I can identify the alkalis from their pH values.
I think all alkalis are ionic and one of the ions they produce is always the same.

Does the data support Matt's ideas?

Explain your reasoning.

[2]

- (c) Draw straight lines to show the state of pure ethanoic acid and pure citric acid at room temperature.

| |
|---------------|
| ethanoic acid |
| citric acid |

solid

liquid

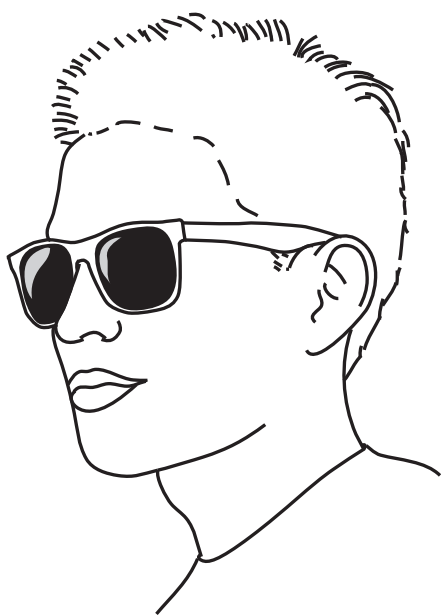
gas

[2]

[TOTAL: 5]

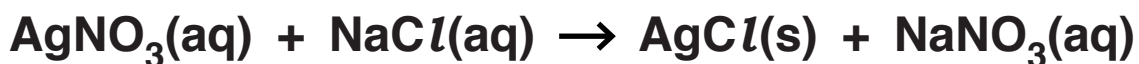
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- 8 Silver chloride is a salt that is used to make lenses that darken in bright light.**



- (a) Silver chloride can be made from silver nitrate in a precipitation reaction.**

This is the symbol equation for the reaction.



- (i) Explain how this equation shows that silver chloride forms as a precipitate.**

_____ **[1]**

(ii) Write a word equation for the reaction.

[1]

(b) When light shines on silver chloride, AgCl , a solid forms which makes the lenses go dark.

The solid is silver metal.

Suggest the name of the OTHER element that forms in the reaction.

_____ **[1]**

- (c) Silver chloride is made using precipitation.
Sodium chloride can be made using titration.
Sodium chloride is a soluble salt.

What techniques are needed to produce pure, dry samples of solid silver chloride and solid sodium chloride?

Put a tick (✓) in one box in each row.

| TECHNIQUE | NEEDED FOR SILVER CHLORIDE | NEEDED FOR SODIUM CHLORIDE | NEEDED FOR BOTH |
|--|----------------------------------|-------------------------------------|--------------------|
| filtration of reaction mixture | | | |
| heating strongly to evaporate water | | | |
| leaving in a warm oven | | | |

[3]

[TOTAL: 6]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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