OCR GCSE GATEWAY CHEMISTRY A · J248

# CHEMISTRY



EXAM QUESTION PACK

## C4.1 PREDICTING CHEMICAL REACTIONS

| SCORE | PERCENTAGE |
| --- | --- |
| /121 | % |

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# Gateway Chemistry A (9-1)

## Predicting chemical reactions

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

**OCR supplied materials:**
Additional resources may be supplied with this paper.

**Other materials required:**
- Pencil
- Ruler (cm/mm)

**Duration:** Not set

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

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

## INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

## INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- 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 **121**.
- The total number of marks may take into account some 'either/or' question choices.

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1 A student reacts some metals with different salt solutions and records her results.

She places a tick (✓) in her results table if she sees a chemical change and a cross (x) if there is no reaction.

Some of the boxes are blanked out.

| | Magnesium chloride | Silver nitrate | Copper(II) sulfate | Iron(II) sulfate |
|---|---|---|---|---|
| **Magnesium** | | ✓ | ✓ | ✓ |
| **Silver** | x | | x | x |
| **Copper** | x | ✓ | | x |
| **Iron** | x | ✓ | ✓ | |

What is the order of reactivity (**most** reactive to **least** reactive) of these four metals?

A magnesium, copper, iron, silver
B magnesium, iron, copper, silver
C silver, copper, iron, magnesium
D iron, silver, magnesium, copper

Your answer ☐

**[1]**

2 Which statement is correct for a Group 1 element?

A It dissolves in water to form a bleach.
B It is a non-metal.
C It is an inert gas.
D It reacts with water to form hydrogen.

Your answer ☐

**[1]**

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3 The Group 7 elements are known as the halogens.

The halogens have similar chemical properties.

Their physical properties vary with increasing atomic number.

Look at the table of information about the halogens.

| Halogen | Atomic symbol | Atomic number | Molecular formula | Atomic radius in pm | Reaction of halogen with sodium iodide solution |
|---|---|---|---|---|---|
| fluorine | F | 9 | $F_2$ | 64 | Makes iodine and sodium fluoride |
| chlorine | C*l* | 17 | $Cl_2$ | 99 | Makes iodine and sodium chloride |
| bromine | Br | 35 | $Br_2$ | 114 | ..... ..... ..... |
| iodine | I | 53 | $I_2$ | 133 | No reaction |
| astatine | At | 85 | ..... | ..... | No reaction |

(i) Predict the molecular formula and atomic radius of astatine.

Put your answers in the table.

**[2]**

(ii) Predict the reaction of bromine with sodium iodide solution.

Put your answer in the table.

**[1]**

(iii) Explain your answer to **(ii)** in terms of the reactivity of the halogens.

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**[1]**

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4 Which statement is correct for a Group 1 element?

A It dissolves in water to form a bleach.
B It is a non-metal.
C It is an inert gas.
D It reacts with water to form hydrogen.

Your answer ☐

**[1]**

5 A student reacts some metals with different salt solutions and records her results.

She places a tick (✓) in her results table if she sees a chemical change and a cross (x) if there is no reaction.

Some of the boxes are blanked out.

| | Magnesium chloride | Silver nitrate | Copper(II) sulfate | Iron(II) sulfate |
|---|---|---|---|---|
| **Magnesium** | | ✓ | ✓ | ✓ |
| **Silver** | x | | x | x |
| **Copper** | x | ✓ | | x |
| **Iron** | x | ✓ | ✓ | |

Which metal has the **least** tendency to form a positive ion?

A copper
B iron
C magnesium
D silver

Your answer ☐

**[1]**



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6 The Group 7 elements are known as the halogens.

The halogens have similar chemical properties.

Their physical properties vary with increasing atomic number.

All halogens react with alkali metals to make a salt.

(i) All halogens have similar chemical reactions.

Explain why in terms of electronic structure.

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[1]

(ii) Sodium reacts with bromine to make sodium bromide, NaBr.

Construct the **balanced symbol** equation for this reaction.

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[2]

(iii) What is the formula of the product of the reaction between astatine and potassium?

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[1]

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7(a) The Group 7 elements are known as the halogens.

The halogens have similar chemical properties.

Their physical properties vary with increasing atomic number.

Look at the table of information about the halogens.

| Halogen | Atomic symbol | Atomic number | Molecular formula | Atomic radius in pm | Reaction of halogen with sodium iodide solution |
|---|---|---|---|---|---|
| fluorine | F | 9 | $F_2$ | 64 | Makes iodine and sodium fluoride |
| chlorine | C*l* | 17 | $Cl_2$ | 99 | Makes iodine and sodium chloride |
| bromine | Br | 35 | $Br_2$ | 114 | ..... ..... ..... |
| iodine | I | 53 | $I_2$ | 133 | No reaction |
| astatine | At | 85 | ..... | ..... | No reaction |

(i) Predict the molecular formula and atomic radius of astatine.

Put your answers in the table.

**[2]**

(ii) Predict the reaction of bromine with sodium iodide solution.

Put your answer in the table.

**[1]**

(iii) Explain your answer to **(ii)** in terms of the reactivity of the halogens.

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**[1]**



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(b) All halogens react with alkali metals to make a salt.

(i) All halogens have similar chemical reactions.

Explain why in terms of electronic structure.

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[1]

(ii) Sodium reacts with bromine to make sodium bromide, NaBr.

Construct the **balanced symbol** equation for this reaction.

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[2]

(iii) What is the formula of the product of the reaction between astatine and potassium?

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[1]

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8 Colin investigates some displacement reactions.

He puts a small sample of metal powder into a salt solution.

Colin does five different experiments.

Look at his results.

| | | Colour of solution | |
|---|---|---|---|
| Metal | Salt solution | At start | At end |
| magnesium | iron(II) sulfate | green | colourless |
| iron | copper(II) sulfate | blue | green |
| copper | iron(II) sulfate | green | green |
| magnesium | copper(II) sulfate | blue | colourless |
| copper | silver nitrate | colourless | blue |

Predict the order of reactivity of the metals, copper, iron, magnesium and silver.

Put the most reactive metal first.

most reactive _____

_____

_____

least reactive _____

Explain your answer.

_____

_____

_____

_____ [3]

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9 Kate and Steve are testing some water samples.

They use lead nitrate solution and barium chloride solution.

They add each solution to different samples of water.

Look at the table. It shows their results.

| Water sample | Effect of adding lead nitrate solution | Effect of adding barium chloride solution |
|---|---|---|
| A | white precipitate | no reaction |
| B | yellow precipitate | white precipitate |
| C | no reaction | white precipitate |

Which negative ions are in each water sample?

Explain your answers.

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[4]

10(a) This question is about the Group 7 elements.

Chlorine and iodine are Group 7 elements.

What is the name given to the Group 7 elements?

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[1]

(b)

(i) Write down **two** uses of chlorine.

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---[2]

(ii) Write down **one** use of iodine.

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---[1]

11(a) This question is about two Group 1 elements, sodium and potassium.

Write down the name of **one other** Group 1 element.

---[1]

(b) Sodium reacts with water.

Describe what you would **see** when sodium reacts with water.

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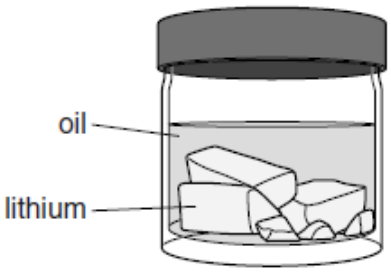
---[2]



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12 Lithium, Li, is in Group 1 of the Periodic Table.

Lithium is stored under oil in a sealed bottle.




Explain why lithium is stored under oil.

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[2]

13 Lithium, sodium and potassium all react with water.

In all three reactions the same gas is produced.

What is the name of the gas?

**A** Carbon dioxide
**B** Chlorine
**C** Hydrogen
**D** Oxygen

Your answer ☐ [1]

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14 The table shows the composition of the Earth's early atmosphere compared with the atmosphere today.

| | Nitrogen | Oxygen | Argon | Carbon dioxide |
|---|---|---|---|---|
| **Percentage of gas in the early atmosphere** | 4 | 0.5 | 0.5 | 95 |
| **Percentage of gas in the atmosphere today** | 78 | 21 | 0.9 | 0.04 |

Which gas has **changed by the largest percentage** from the early atmosphere to the atmosphere today?

**A** Nitrogen
**B** Oxygen
**C** Argon
**D** Carbon dioxide

Your answer ☐ **[1]**

15 Lithium, Li, is in Group 1 of the Periodic Table.

Laura's teacher adds a small piece of lithium to a bowl of water.



The lithium reacts with the water.

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The lithium moves about on the surface of the water.

Laura sees bubbles of hydrogen being made.

The piece of lithium gets smaller and smaller until it has completely reacted.

A solution of lithium hydroxide is made.

Caesium, Cs, is another element in Group 1.

Predict, including a word equation, how the reaction of **caesium** with water compares with the reaction of **lithium** with water.



*The quality of written communication will be assessed in your answer to this question.*

[6]

16 Which of these elements is a **transition metal**?

**A** Calcium
**B** Caesium
**C** Carbon
**D** Cobalt

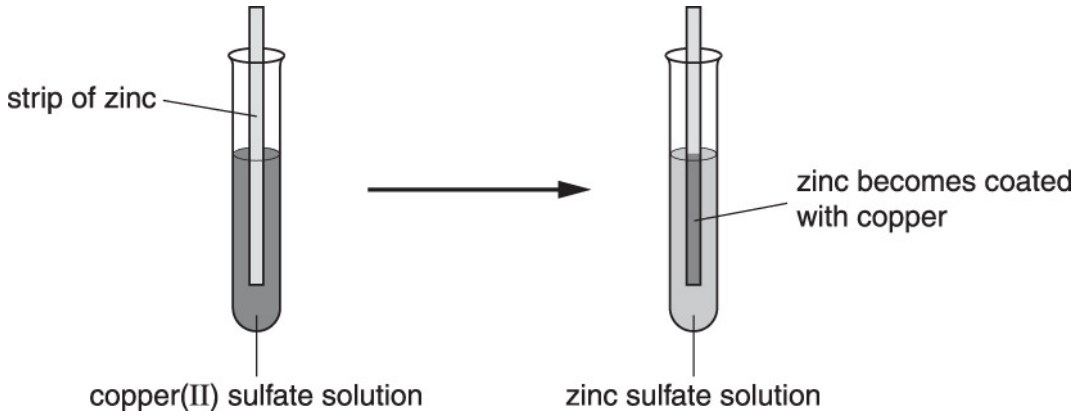
Your answer [1]



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17 Jill investigates the reactivity of some metals.

Look at the diagram. It shows what happens when she puts a strip of zinc into copper(II) sulfate solution.




Jill finds out that copper reacts with silver nitrate solution.

Predict what will happen if Jill puts a strip of **copper** into a solution of **silver nitrate**.

Explain your answer.

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[2]

18 Lithium, Li, is in Group 1 of the Periodic Table.

Laura's teacher adds a small piece of lithium to a bowl of water.



The lithium reacts with the water, $H_2O$.

The lithium moves about on the surface of the water.

Laura sees bubbles of hydrogen, $H_2$, being made.

The piece of lithium gets smaller and smaller until it has completely reacted.

A solution of lithium hydroxide, LiOH, is made.

Caesium, Cs, is another element in Group 1.

Predict, including a balanced symbol equation, how the reaction of **caesium** with water compares with the reaction of **lithium** with water.

*The quality of written communication will be assessed in your answer to this question.*

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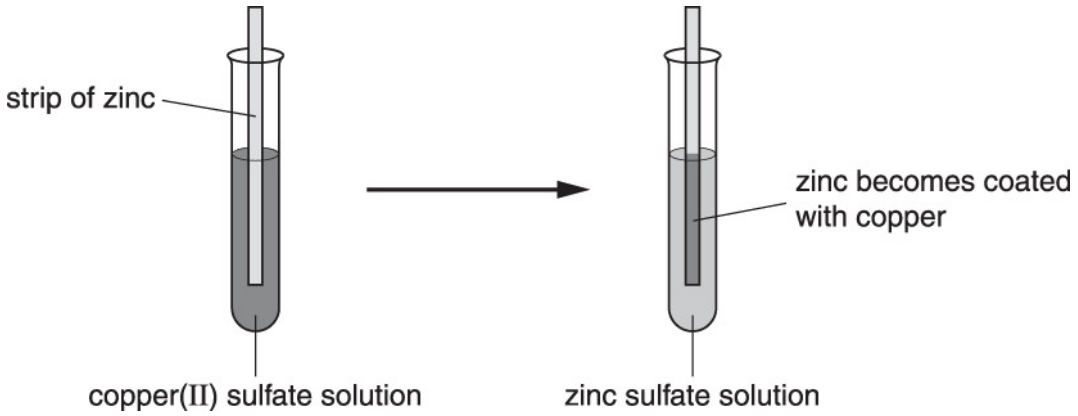
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[6]

19 Jill investigates the reactivity of some metals.

Look at the diagram. It shows what happens when she puts a strip of zinc into copper(II) sulfate solution.




Jill repeats the experiment with other metals and solutions.

Look at her table of results.

| Solution used | Metal being added | | | |
|---|---|---|---|---|
| | Iron | Copper | Magnesium | Zinc |
| Iron(II) sulfate | | ✗ | ✓ | ✓ |
| Copper(II) sulfate | ✓ | | ✓ | ✓ |
| Magnesium sulfate | ✗ | ✗ | | ✗ |
| Zinc sulfate | ✗ | ✗ | ✓ | |

✗ = no reaction

✓ = metal reacts

Write down the four metals, copper, iron, magnesium and zinc, in order of reactivity.

Use the table of results to help you. The first metal has been completed for you.

**most** reactive metal ..... magnesium .....

.....

.....

**least** reactive metal .....

[1]

20(a) Look at the table. It shows information about the Group 1 metals.

| Element | Symbol | Electronic structure | Melting point in °C | Boiling point in °C | Atomic radius in nm |
|---|---|---|---|---|---|
| lithium | Li | 2.1 | 181 | 1342 | 0.152 |
| sodium | Na | 2.8.1 | _____ | 883 | 0.185 |
| potassium | K | 2.8.8.1 | 64 | 760 | 0.227 |
| rubidium | Rb | 2.8.18.8.1 | 39 | 688 | _____ |

The Group 1 elements all react in a similar way.

Explain why.

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[1]

(b) Sodium reacts with water.

Sodium hydroxide, NaOH, and hydrogen, $H_2$, are made.

Write a **balanced symbol** equation for this reaction.

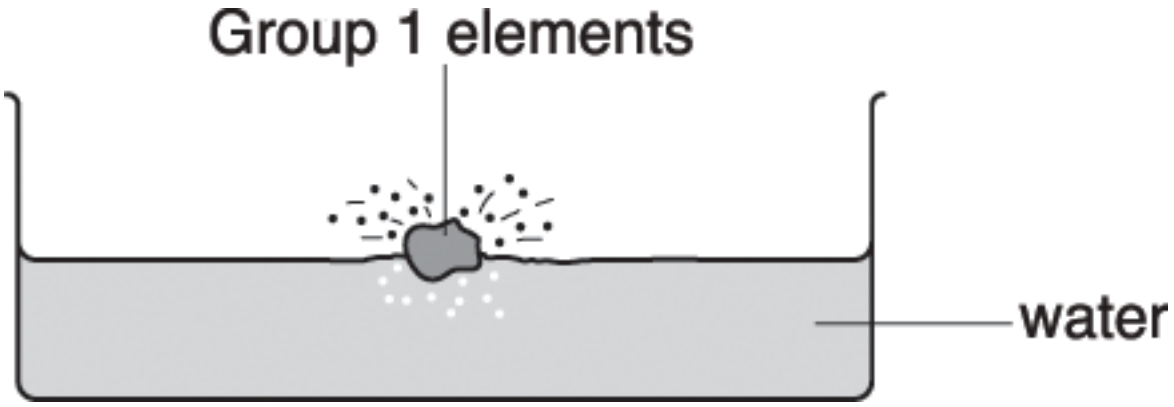
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[2]

21 This question is about the reaction of Group 1 elements with water.

Lithium, sodium and potassium are Group 1 elements.

They all react with water.




Look at the table.

| Group 1 element | Time for 0.5 g of metal to react in seconds | Observations |
|---|---|---|
| sodium | 15 | melts<br>moves across surface of water<br>makes a gas which burns with a 'pop'<br>makes an alkaline solution |
| potassium | 7 | melts and catches fire<br>moves quickly across surface of water<br>makes a gas which burns with a 'pop'<br>makes an alkaline solution |
| lithium | 25 | moves slowly across surface of water<br>makes a gas which burns with a 'pop'<br>makes an alkaline solution |

Rubidium is another Group 1 element.

It is **below** potassium in Group 1 of the periodic table.

Predict the reaction time, and name the products, of the reaction between rubidium and water.

Include a **balanced symbol** equation for the reaction.

*The quality of written communication will be assessed in your answer to this question.*

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[6]

22(a) Look at the table.

It shows information about the Group 7 elements.

| Element | Appearance | Melting point in °C | Boiling point in °C | Order of reactivity |
|---|---|---|---|---|
| fluorine | yellow gas | – 220 | _____ | most reactive  least reactive |
| chlorine | green gas | – 101 | – 34 | |
| bromine | red / brown liquid | – 7 | 59 | |
| iodine | _____ | 114 | 184 | |
| astatine | black solid | _____ | 337 | |

Fluorine is more reactive than astatine.

Explain the trend in the reactivity of the Group 7 elements.

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[2]

(b) Complete the table. Use ideas about trends down a group.

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[3]

23 Jed is testing iron(III) chloride and some unknown compounds.

He does some tests.

These are the tests that Jed does on solutions of the compounds:

- adding sodium hydroxide solution
- adding silver nitrate solution.

Look at his results.

| Compound | Adding sodium hydroxide | Adding silver nitrate |
|---|---|---|



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| | solution | solution |
|---|---|---|
| iron(III) chloride | brown solid made | white solid made |
| **A** | blue solid made | white solid made |
| **B** | green solid made | cream solid made |

Iron(III) chloride, $FeC?_3$, reacts with silver nitrate, $AgNO_3$, to make silver chloride, $AgC?$, and iron(III) nitrate, $Fe(NO_3)_3$.

Write a **balanced symbol** equation for this reaction.

Identify the unknown compounds **A** and **B** and explain your answers.

*The quality of written communication will be assessed in your answer to this question.*

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[6]

24 Kate and Steve are testing some water samples.

They use lead nitrate solution and barium chloride solution.

They add each solution to different samples of water.

Look at the table. It shows their results.

| Water sample | Effect of adding lead nitrate solution | Effect of adding barium chloride solution |
|---|---|---|
| A | white precipitate | no reaction |
| B | yellow precipitate | white precipitate |
| C | no reaction | white precipitate |

Which negative ions are in each water sample?

Explain your answers.

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[3]

25 This question is about two Group 1 elements, sodium and potassium.

Potassium reacts with water.

One of the substances made is an alkali.

The other substance made burns with a 'pop'.

Complete the **word** equation for this reaction.

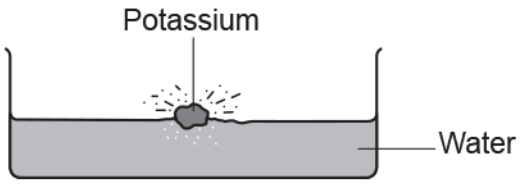
potassium + water → ..... + .....

[2]

26(a) This question is about the properties of elements in Groups 1, 7 and 0.

Lithium, sodium and potassium are all Group 1 elements.

A teacher adds a small piece of potassium to a trough of water, as shown in the diagram.




The potassium fizzes and a gas is produced.

Describe what else you would observe.

[2]

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(b) Reactivity **increases** going down Group 1 from lithium to potassium.

Explain this trend in reactivity.

Use ideas about the electronic configurations of the atoms in your answer.

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**[2]**

(c) Look at the table. It shows information about the Group 7 elements.

Complete the table.

| Element | Formula | Colour | State at room temperature |
|---|---|---|---|
| Fluorine | $F_2$ | pale yellow | gas |
| Chlorine | $Cl_2$ | ..... | ..... |
| Bromine | $Br_2$ | brown | liquid |
| Iodine | $I_2$ | grey | ..... |

**[3]**



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(d) The Group 7 elements exist as simple molecules.

Fluorine boils at –188 °C.

Explain why fluorine has a low boiling point.

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[2]

(e) The elements in Group 0 (the noble gases) are unreactive.

Explain why, in terms of their electronic configurations.

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[2]

27 Zinc, Zn, reacts with copper sulfate solution, $CuSO_4$.

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

What type of reaction is this?

**A** Combustion
**B** Displacement
**C** Neutralisation
**D** Thermal decomposition

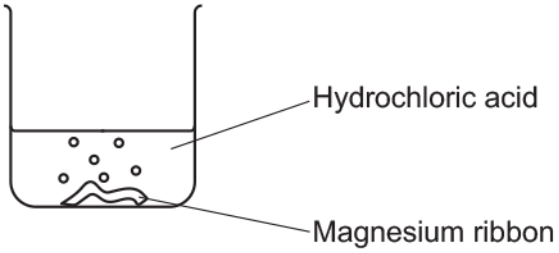
Your answer ☐ [1]



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28(a) A student investigates the reaction between magnesium and dilute hydrochloric acid, HC*l*.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.




Magnesium chloride, $MgCl_2$, and hydrogen gas are made.

Write the **balanced symbol** equation for this reaction.

[2]

(b) *The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

**"The smaller the volume of acid and the smaller the mass of magnesium, the shorter the reaction time."**

Look at the student's results.

| Experiment | Mass of magnesium used (g) | Volume of acid used ($cm^3$) | Concentration of acid (mol / $dm^3$) | Reaction time (s) |
|---|---|---|---|---|
| 1 | 0.05 | 25 | 1.0 | 30 |
| 2 | 0.05 | 50 | 1.0 | 30 |
| 3 | 0.05 | 50 | 2.0 | 15 |
| 4 | 0.10 | 25 | 1.0 | 30 |
| 5 | 0.10 | 50 | 2.0 | 15 |

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

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[6]

(c) The student repeats experiment **1**. This time he uses acid at a **lower** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

[3]

29(a) This question is about elements in the Periodic Table.

Look at the table. It shows some properties of Group 7 elements.

| Element | Molecular formula | State at room temperature | Radius of an atom (nm) | Order of reactivity |
|---|---|---|---|---|
| Fluorine | $F_2$ | ..... | 0.072 | most reactive  least reactive |
| Chlorine | $Cl_2$ | gas | 0.099 | |
| Bromine | $Br_2$ | liquid | 0.114 | |
| Iodine | $I_2$ | solid | 0.133 | |
| Astatine | $At_2$ | solid | ..... | |

Complete the table. Use ideas about trends down a Group to help you. **[2]**



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(b) In the table, the Group 7 elements are listed in order of reactivity.

The equations show a displacement reaction of Group 7 elements.

chlorine + sodium bromide → sodium chloride + bromine

$Cl_2$ + 2NaBr → 2NaCl + $Br_2$

(i) Complete the word equation.

bromine + sodium iodide → _____ + _____ [1]

(ii) There is no reaction between iodine and sodium bromide.

Explain why.

_____

_____ [1]

(iii) Chlorine reacts with sodium iodide. Sodium chloride and iodine are made.

Write the **balanced symbol** equation for this reaction.

_____ [2]

(c) Group 1 is a group of elements in the Periodic Table.

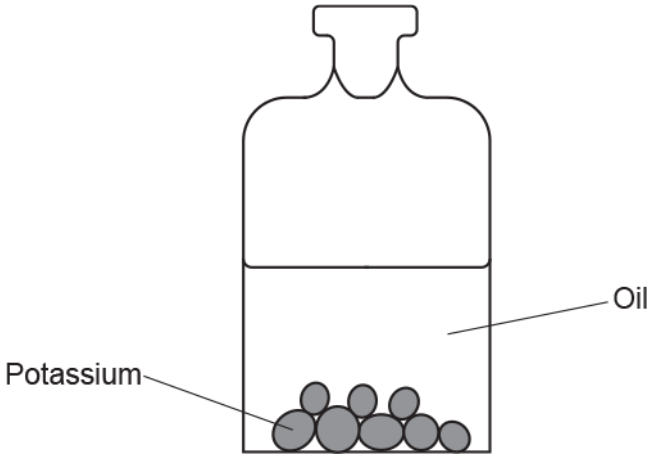
(i) Potassium is a Group 1 metal.

Potassium is stored under oil because it is very reactive.

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What does the oil stop the potassium reacting with?

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[1]

(ii) Sodium is another Group 1 metal.

Sodium reacts in a similar way to potassium.

Explain why.

Use ideas about atomic structure in your answer.

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[1]

30 A student reacts some metals with different salt solutions.

**Table 17.2** shows her results.

| | Magnesium | Zinc | Iron | Copper |
|---|---|---|---|---|
| Copper sulfate | blue solution becomes colourless | blue solution becomes colourless | blue solution becomes green | no reaction |
| | green solution | green solution | no reaction | no reaction |

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| | | | | |
|---|---|---|---|---|
| **Iron sulfate** | becomes colourless | becomes colourless | | |
| **Magnesium sulfate** | no reaction | no reaction | no reaction | no reaction |
| **Zinc sulfate** | black coating on magnesium | no reaction | no reaction | no reaction |

Table 17.2

(i) What colour is **iron sulfate** solution?

[1]

(ii) Write down the order of reactivity of the four metals copper, iron, magnesium and zinc.
Use **Table 17.2** to help you.

..... **most reactive**

.....

.....

..... **least reactive** [2]

(iii) Magnesium reacts with copper sulfate, $CuSO_4$.

Magnesium sulfate, $MgSO_4$, and copper are made.

Write the **balanced symbol** equation for this reaction.

[1]

31(a) Sodium is in Group 1 of the Periodic Table.

Sodium reacts with water to make sodium hydroxide, NaOH, and hydrogen.

Write the **balanced symbol** equation for the reaction between sodium and water.

[2]

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(b) Sodium ions, $Na^+$, are formed when sodium reacts with water.

Look at the equation. It shows how a sodium ion is formed from a sodium atom.

$Na - e^- \rightarrow Na^+$

The symbol $e^-$ means an electron.

The formation of a sodium ion from a sodium atom is an example of **oxidation**.

Explain why.

[1]

(c) Rubidium is another element in Group 1.

Rubidium reacts much faster than sodium does.

Explain why.

Use ideas about electrons in your answer.

[2]

32 A student investigates the reactivity of four metals, **A**, **B**, **C** and **D**.

He adds a small piece of each metal to cold water.

He then adds a small piece of each metal to dilute hydrochloric acid.

Look at his results.

"

| Metal | Observations in water | Observations in dilute hydrochloric acid |
|---|---|---|
| A | slow bubbling | very fast bubbling |
| B | no reaction | no reaction |
| C | fast bubbling | very fast bubbling |
| D | no change | slow bubbling |

Write down the order of reactivity of the four metals **A**, **B**, **C** and **D**.

..... **most reactive**

.....

.....

..... **least reactive** [2]

END OF QUESTION PAPER