Surnname ________________________________
Other Names ________________________________
Centre Number ________________________________
Candidate Number ________________________________
Candidate Signature ________________________________

GCSE
CHEMISTRY
Foundation Tier Paper 1
8462/1F

Thursday 17 May 2018 Morning
Time allowed: 1 hour 45 minutes

For this paper you must have:
• a ruler
• a scientific calculator
• the periodic table (enclosed).

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]
INSTRUCTIONS

• Use black ink or black ball-point pen.
• Answer ALL questions in the spaces provided.
• Do all rough work in this book. Cross through any work you do not want to be marked.
• In all calculations, show clearly how you work out your answer.

INFORMATION

• There are 100 marks available on this paper.
• The marks for questions are shown in brackets.
• You are expected to use a calculator where appropriate.
• You are reminded of the need for good English and clear presentation in your answers.

DO NOT TURN OVER UNTIL TOLD TO DO SO
This question is about mixtures.

Substances are separated from a mixture using different methods.

Draw ONE line from each substance and mixture to the best method of separation. [3 marks]

<table>
<thead>
<tr>
<th>Substance and mixture</th>
<th>Method of separation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol from ethanol and water</td>
<td>Chromatography</td>
</tr>
<tr>
<td>Salt from sea water</td>
<td>Crystallisation</td>
</tr>
<tr>
<td>The different colours in black ink</td>
<td>Electrolysis</td>
</tr>
<tr>
<td></td>
<td>Filtration</td>
</tr>
<tr>
<td></td>
<td>Fractional distillation</td>
</tr>
</tbody>
</table>
A student filters a mixture.

FIGURE 1 shows the apparatus.

FIGURE 1

Suggest ONE improvement to the apparatus. [1 mark]

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

[Turn over]
Complete the sentences.

Choose answers from the list below. [2 marks]

- condense
- evaporate
- freeze
- melt
- solidify

In simple distillation, the mixture is heated to _________________.

make the liquid ________________.

The vapour is then cooled to make it _________________.

______________________________.
FIGURE 2 shows the arrangement of atoms in a pure metal and in a mixture of metals.

FIGURE 2

Pure metal

Mixture of metals

Metal A

Metal A

Metal B

01.4 Calculate the percentage of metal B atoms in the mixture of metals shown in FIGURE 2. [2 marks]

Percentage of metal B atoms = ____________ %
What is a mixture of metals called? [1 mark]

Tick ONE box.

- An alloy
- A compound
- A molecule
- A polymer
Why is the mixture of metals in FIGURE 2 harder than the pure metal? [1 mark]

Tick ONE box.

- The atoms in the mixture are different shapes.
- The layers in the mixture are distorted.
- The layers in the mixture slide more easily.
- The mixture has a giant structure.
A nanoparticle of pure metal A is a cube. Each side of the cube has a length of 20 nm. FIGURE 3 shows the cube.
What is the volume of the nanoparticle? [1 mark]

Tick ONE box.

- 20 nm$^3$
- 60 nm$^3$
- 400 nm$^3$
- 8000 nm$^3$

[Turn over]
The halogens are elements in Group 7.

Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom. [1 mark]

Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide? [1 mark]

Tick ONE box.

- Giant covalent
- Ionic lattice
- Metallic structure
- Small molecule
What is the formula for fluorine gas? [1 mark]

Tick ONE box.

2F  F2  F2  F
A student mixes solutions of halogens with solutions of their salts.

TABLE 1 shows the student’s observations.

TABLE 1

<table>
<thead>
<tr>
<th></th>
<th>Potassium chloride (colourless)</th>
<th>Potassium bromide (colourless)</th>
<th>Potassium iodide (colourless)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine (colourless)</td>
<td>Solution turns orange</td>
<td>Solution turns orange</td>
<td>Solution turns brown</td>
</tr>
<tr>
<td>Bromine (orange)</td>
<td>No change</td>
<td>Solution turns brown</td>
<td>Solution turns brown</td>
</tr>
<tr>
<td>Iodine (brown)</td>
<td>No change</td>
<td>No change</td>
<td>No change</td>
</tr>
</tbody>
</table>
Explain how the reactivity of the halogens changes going down Group 7.

Use the results in TABLE 1 on page 14.
[3 marks]

[Turn over]
A company uses chlorine to produce titanium chloride from titanium dioxide.

0.5 mark What is the relative formula mass \( (M_r) \) of titanium dioxide, \( \text{TiO}_2 \) ?

Relative atomic masses \( (A_r) \): \( \text{O} = 16 \) \( \text{Ti} = 48 \) [1 mark]

Tick ONE box.

- 64
- 80
- 128
- 768
The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield. [2 marks]

Percentage yield = _________________ %
This question is about the structure of the atom.

Complete the sentences.

Choose answers from the list below.

Each word may be used once, more than once, or not at all. [5 marks]

- electron
- ion
- neutron
- nucleus
- proton

The centre of the atom is the ________________________________.

The two types of particle in the centre of the atom are the proton and the ________________________________.

James Chadwick proved the existence of the ________________________________.
Niels Bohr suggested particles orbit the centre of the atom. This type of particle is the ____________________________.

The two types of particle with the same mass are the neutron and the ____________________________.

[Turn over]
TABLE 2 shows information about two isotopes of element X.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mass number</th>
<th>Percentage (%) abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isotope 1</td>
<td>63</td>
<td>70</td>
</tr>
<tr>
<td>Isotope 2</td>
<td>65</td>
<td>30</td>
</tr>
</tbody>
</table>
Calculate the relative atomic mass \((A_r)\) of element X using the equation:

\[
A_r = \frac{(\text{mass number } \times \text{percentage}) \text{ of isotope } 1 + (\text{mass number } \times \text{percentage}) \text{ of isotope } 2}{100}
\]

Use TABLE 2 on page 20.

Give your answer to 1 decimal place. [2 marks]
Suggest the identity of element X.

Use the periodic table. [1 mark]

Element X is ________________________________

The radius of an atom of element X is

\[1.2 \times 10^{-10} \text{ m}\]

The radius of the centre of the atom is \(\frac{1}{10000}\) the radius of the atom.

Calculate the radius of the centre of an atom of element X.

Give your answer in standard form. [2 marks]

\[
\text{Radius} = \frac{1}{10000} \times 1.2 \times 10^{-10} \text{ m}
\]

\[
\text{Radius} = 1.2 \times 10^{-12} \text{ m}
\]
A student investigated the electrolysis of sodium chloride solution.

FIGURE 4 shows the apparatus.

FIGURE 4

The student measured the volume of gas collected in each measuring cylinder every minute for 20 minutes.
FIGURE 5 shows the volume of hydrogen gas collected in the measuring cylinder after 8 minutes.

FIGURE 5

What is the volume of hydrogen gas collected? [1 mark]

Volume = ____________________________ cm$^3$

[Turn over]
FIGURE 6 shows the results of the investigation.

FIGURE 6

Volume of gas collected in cm³

Time in minutes

Hydrogen

Chlorine
Which of the lines on FIGURE 6, on page 26, show that the volume of gas collected is directly proportional to the time? [1 mark]

Tick ONE box.

- Both lines
- Chlorine line only
- Hydrogen line only
- Neither line

[Turn over]
Repeat of FIGURE 6

Volume of gas collected in cm$^3$

<table>
<thead>
<tr>
<th>Time in minutes</th>
<th>Hydrogen</th>
<th>Chlorine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>
Which of the lines on FIGURE 6, on page 28, show a positive correlation between the volume of gas collected and time? [1 mark]

Tick ONE box.

- Both lines
- Chlorine line only
- Hydrogen line only
- Neither line

[Turn over]
A teacher demonstrates the electrolysis of different substances using graphite electrodes.

FIGURE 7 shows the apparatus used.

FIGURE 7
Why can graphite conduct electricity? [1 mark]

Tick ONE box.

☐ Graphite exists in layers of atoms.

☐ Graphite has a giant structure.

☐ Graphite has a high melting point.

☐ Graphite has delocalised electrons.
The teacher demonstrates the electrolysis of:

- molten zinc chloride
- potassium bromide solution.

Complete TABLE 3 on page 33 to predict the products.

Choose answers from the list below. [4 marks]

- chlorine
- bromine
- hydrogen
- oxygen
- potassium
- zinc
### TABLE 3

<table>
<thead>
<tr>
<th>Substance electrolysed</th>
<th>Product at cathode (negative electrode)</th>
<th>Product at anode (positive electrode)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molten zinc chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium bromide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Turn over]
A student investigated the mass of copper oxide produced by heating copper carbonate.

This is the method used.

1. Weigh an empty test tube.

2. Weigh 2.00 g of copper carbonate into the test tube.

3. Heat the copper carbonate until there appears to be no further change.

4. Re-weigh the test tube and copper oxide produced.

5. Subtract the mass of the empty tube to find the mass of copper oxide.

6. Repeat steps 1–5 twice.

7. Repeat steps 1–6 with different masses of copper carbonate.

TABLE 4, on page 35, shows the student’s results.
### TABLE 4

<table>
<thead>
<tr>
<th>Mass of copper carbonate in g</th>
<th>Mass of copper oxide in g</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 3</td>
<td>Mean</td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td>1.29</td>
<td>1.27</td>
<td>1.31</td>
<td>1.29</td>
</tr>
<tr>
<td>4.00</td>
<td></td>
<td>2.89</td>
<td>2.57</td>
<td>2.59</td>
<td>2.58</td>
</tr>
<tr>
<td>6.00</td>
<td></td>
<td>3.85</td>
<td>3.90</td>
<td>3.87</td>
<td>3.87</td>
</tr>
<tr>
<td>8.00</td>
<td></td>
<td>5.12</td>
<td>5.15</td>
<td>5.09</td>
<td>X</td>
</tr>
<tr>
<td>10.00</td>
<td></td>
<td>6.42</td>
<td>6.45</td>
<td>6.45</td>
<td>6.44</td>
</tr>
</tbody>
</table>

The equation for the reaction is:

\[ \text{CuCO}_3(s) \rightarrow \text{CuO(s)} + \text{CO}_2(g) \]

Complete the sentence. [1 mark]

The state symbol shows carbon dioxide is a

\[ \text{_____________________________} \].

[Turn over]
Repeat of TABLE 4

<table>
<thead>
<tr>
<th>Mass of copper carbonate in g</th>
<th>Mass of copper oxide in g</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 3</td>
<td>Mean</td>
</tr>
<tr>
<td>2.00</td>
<td>1.29</td>
<td>1.27</td>
<td>1.31</td>
<td>1.29</td>
</tr>
<tr>
<td>4.00</td>
<td>2.89</td>
<td>2.57</td>
<td>2.59</td>
<td>2.58</td>
</tr>
<tr>
<td>6.00</td>
<td>3.85</td>
<td>3.90</td>
<td>3.87</td>
<td>3.87</td>
</tr>
<tr>
<td>8.00</td>
<td>5.12</td>
<td>5.15</td>
<td>5.09</td>
<td>X</td>
</tr>
<tr>
<td>10.00</td>
<td>6.42</td>
<td>6.45</td>
<td>6.45</td>
<td>6.44</td>
</tr>
</tbody>
</table>
5.2 Why do the contents of the test tube lose mass in the investigation? [1 mark]

5.3 Calculate the mean mass \( X \) in TABLE 4 on page 36. [1 mark]

\[ X = \text{__________________________} \text{ g} \]

5.4 One of the results in TABLE 4, on page 36, is anomalous.

Which result is anomalous? [1 mark]

Mass of copper carbonate \( \text{______________} \text{ g} \)

Trial \( \text{______________} \)

[Turn over]
Suggest how the investigation could be improved to make sure the reaction is complete. [2 marks]

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Another student repeated the investigation using magnesium carbonate instead of copper carbonate.

The word equation for the reaction is:

magnesium carbonate → magnesium oxide + carbon dioxide

FIGURE 8, on page 40, shows the results of the investigation.

[Turn over]
FIGURE 8

Mass of magnesium oxide in g

Mass of magnesium carbonate in g
Draw a line of best fit on FIGURE 8 on page 40. [1 mark]

Determine the mass of magnesium oxide produced by 8.4 g of magnesium carbonate.

Use FIGURE 8 on page 40. [1 mark]

Mass = __________________________ g

Calculate the mass of magnesium oxide produced when 168 g of magnesium carbonate is heated.

Use your answer to Question 05.7 [2 marks]

Mass of magnesium oxide produced = __________________________ g
A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

This is the method used.

1. Measure 50 cm³ of the copper sulfate solution into a polystyrene cup.

2. Record the starting temperature of the copper sulfate solution.

3. Add the metal and stir the solution.

4. Record the highest temperature the mixture reaches.

5. Calculate the temperature increase for the reaction.

6. Repeat steps 1–5 with different metals.
Draw ONE line from each type of variable to the name of the variable in the investigation. [2 marks]

<table>
<thead>
<tr>
<th>Type of variable</th>
<th>Name of variable in the investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable</td>
<td>Concentration of solution</td>
</tr>
<tr>
<td></td>
<td>Particle size of solid</td>
</tr>
<tr>
<td></td>
<td>Temperature change</td>
</tr>
<tr>
<td>Independent variable</td>
<td>Type of metal</td>
</tr>
<tr>
<td></td>
<td>Volume of solution</td>
</tr>
</tbody>
</table>
06.2 The student used a polystyrene cup and NOT a glass beaker.

Why did this make the investigation more accurate? [1 mark]

Tick ONE box.

- Glass is breakable
- Glass is transparent
- Polystyrene is a better insulator
- Polystyrene is less dense
TABLE 5 shows the student’s results.

**TABLE 5**

<table>
<thead>
<tr>
<th>Metal</th>
<th>Temperature increase in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium</td>
<td>38</td>
</tr>
<tr>
<td>Nickel</td>
<td>8</td>
</tr>
<tr>
<td>Zinc</td>
<td>16</td>
</tr>
</tbody>
</table>
Complete FIGURE 9.

Use data from TABLE 5 on page 46. [2 marks]

FIGURE 9

Temperature increase in °C

Magnesium

Metal
The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give ONE reason why this conclusion is NOT correct. [1 mark]

The temperature increase depends on the reactivity of the metal.

Write the metals magnesium, nickel and zinc in order of reactivity.

Use TABLE 5 on page 46. [1 mark]

Most reactive

Least reactive
Y is an unknown metal.

Describe a method to find the position of Y in the reactivity series in Question 06.5 [3 marks]

___________________________________________________________________________

___________________________________________________________________________

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___________________________________________________________________________

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___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

[Turn over]
FIGURE 10 shows the reaction profile for the reaction between zinc and copper sulfate solution.

FIGURE 10
Which letter represents the products of the reaction? [1 mark]

Tick ONE box.

A
B
C
D
E

[Turn over]
Repeat of FIGURE 10

Energy

Progress of reaction

A B C D E
Which letter represents the activation energy? [1 mark]

Tick ONE box.

A
B
C
D
E

[Turn over]
This question is about elements in Group 1.

A teacher burns sodium in oxygen.

Complete the word equation for the reaction.

[1 mark]

\[ \text{sodium} + \text{oxygen} \rightarrow \text{________________________} \]

What is the name of this type of reaction?

[1 mark]

Tick ONE box.

- Decomposition
- Electrolysis
- Oxidation
- Precipitation
The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution? [1 mark]

Tick ONE box.

1
4
7
13

The solution contains a substance with the formula NaOH

Give the name of the substance. [1 mark]

[Turn over]
All alkalis contain the same ion.

What is the formula of this ion? [1 mark]

Tick ONE box.

- H⁺
- Na⁺
- OH⁻
- O²⁻
A solution of NaOH had a concentration of 40 g/dm$^3$

What mass of NaOH would there be in 250 cm$^3$ of the solution? [2 marks]

Mass = ___________________________ g
The melting points of the elements in Group 1 show a trend.

TABLE 6 shows the atomic numbers and melting points of the Group 1 elements.

TABLE 6

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic number</th>
<th>Melting point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>3</td>
<td>181</td>
</tr>
<tr>
<td>Sodium</td>
<td>11</td>
<td>98</td>
</tr>
<tr>
<td>Potassium</td>
<td>19</td>
<td>63</td>
</tr>
<tr>
<td>Rubidium</td>
<td>37</td>
<td>X</td>
</tr>
<tr>
<td>Caesium</td>
<td>55</td>
<td>29</td>
</tr>
</tbody>
</table>

Plot the data from TABLE 6 on FIGURE 11 on page 59. [2 marks]
Predict the melting point, X, of rubidium, atomic number 37

Use FIGURE 11 on page 59. [1 mark]

Melting point = _________________ °C
Soluble salts are formed by reacting metal oxides with acids.

Give ONE other type of substance that can react with an acid to form a soluble salt. [1 mark]

Calcium nitrate contains the ions Ca\(^{2+}\) and NO\(_3^-\). Give the formula of calcium nitrate. [1 mark]
Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid. [6 marks]
This question is about metals and metal compounds.

Iron pyrites is an ionic compound.

FIGURE 12 shows a structure for iron pyrites.

**FIGURE 12**

![Diagram of iron pyrites structure]

**KEY**

- **Fe**
- **S**

Determine the formula of iron pyrites.

**Use FIGURE 12. [1 mark]**

__________________________________________________________

__________________________________________________________
An atom of iron is represented as $^{56}_{26}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron. [3 marks]

Number of protons

Number of neutrons

Number of electrons

Iron is a transition metal.

Sodium is a Group 1 metal.

Give TWO differences between the properties of iron and sodium. [2 marks]

1

2

[Turn over]
Nickel is extracted from nickel oxide by reduction with carbon.

Explain why carbon can be used to extract nickel from nickel oxide. [2 marks]
An equation for the reaction is:

\[ \text{NiO} + \text{C} \rightarrow \text{Ni} + \text{CO} \]

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses \((A_r)\):
\[
\begin{align*}
\text{C} &= 12 \\
\text{Ni} &= 59
\end{align*}
\]

Relative formula mass \((M_r)\):
\[
\text{NiO} = 75
\]

Give your answer to 3 significant figures. [3 marks]

\[
\text{Percentage atom economy} = \frac{\text{Ni}}{\text{NiO}} \times 100 \%
\]

[Turn over]
Chemical reactions can produce electricity.

FIGURE 13 shows a simple cell.
Which of these combinations would NOT give a zero reading on the voltmeter in FIGURE 13? [1 mark]

Tick ONE box.

<table>
<thead>
<tr>
<th>Electrode A</th>
<th>Electrode B</th>
<th>Electrolyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>Copper</td>
<td>Sodium chloride solution</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zinc</td>
<td>Water</td>
</tr>
<tr>
<td>Copper</td>
<td>Zinc</td>
<td>Sodium chloride solution</td>
</tr>
<tr>
<td>Copper</td>
<td>Zinc</td>
<td>Water</td>
</tr>
</tbody>
</table>

[Turn over]
Alkaline batteries are non-rechargeable.

**10.2** Why do alkaline batteries eventually stop working? [1 mark]

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

**10.3** Why can alkaline batteries NOT be recharged? [1 mark]

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________
Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

10.4 Complete the balanced equation for the overall reaction in a hydrogen fuel cell. [2 marks]

\[ \text{_______ H}_2 + \text{_______} \rightarrow \text{_______ H}_2\text{O} \]

[Turn over]
TABLE 7 shows data about different ways to power electric cars.

<table>
<thead>
<tr>
<th></th>
<th>Hydrogen fuel cell</th>
<th>Rechargeable lithium-ion battery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time taken to refuel or recharge</strong></td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>in minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Distance travelled before</strong></td>
<td>Up to 415</td>
<td>Up to 240</td>
</tr>
<tr>
<td><strong>refuelling or recharging in miles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Distance travelled per unit of</strong></td>
<td>22</td>
<td>66</td>
</tr>
<tr>
<td><strong>energy in km</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost of refuelling or recharging</strong></td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td><strong>in £</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum cost of car in £</strong></td>
<td>60 000</td>
<td>18 000</td>
</tr>
</tbody>
</table>
Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use TABLE 7 and your own knowledge.

[6 marks]
There are no questions printed on this page