Thursday 17 May 2018  Morning  Time allowed: 1 hour 15 minutes

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

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• 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
• The maximum mark for this paper is 70.
• 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.
This question is about structure and bonding.

**Figure 1** shows part of the structure of calcium oxide (CaO).

What type of bonding is present in calcium oxide? [1 mark]

Tick **one** box.

- Covalent
- Ionic
- Macromolecular
- Metallic
Figure 2 shows a particle of methane (CH₄).

Figure 2

What type of particle is present in Figure 2?

Tick one box.

- An ion
- A lattice
- A molecule
- A polymer

Figure 3 shows the structure of C₆₀.

Figure 3

Complete the sentence.

Choose the answer from the box.

[1 mark]

diatomic  giant ionic  a fullerene  giant metallic

The structure of C₆₀ is ________________________________.
Figure 4 shows the structure of graphite.

What type of bond is labelled A in Figure 4? [1 mark]

Tick one box.
- covalent
- double
- ionic
- metallic

In graphite, each carbon atom forms bonds with other carbon atoms as shown in Figure 4.

How many electrons does one carbon atom use to form one bond? [1 mark]

Tick one box.
- 1
- 2
- 3
- 4
An electric current is passed through copper.

**Figure 5** shows the apparatus used.

**Figure 5**

Complete the sentence. Choose the answer from the box.

[1 mark]

| gas | liquid | solid | solution |

**Figure 5** shows that copper conducts electricity as a ____________________ .

Complete the sentence. Choose the answer from the box.

[1 mark]

| atoms | electrons | ions | molecules |

Copper conducts electricity because of the movement of delocalised ____________ .
Figure 6 shows the apparatus used to investigate the effect of electricity on sodium chloride solution.

**Figure 6**

Choose the answer from the box.

[1 mark]

**dissolved** **gaseous** **molten**

**Figure 6** shows that sodium chloride conducts electricity when ________________.
Sodium chloride is made up of ions.

**Figure 7** shows the apparatus used to investigate the effect of electricity on solid sodium chloride and molten sodium chloride.

**Figure 7**

![Diagram of the apparatus](image)

**Table 1** shows the results.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Solid sodium chloride</th>
<th>Molten sodium chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>The filament bulb does not light up</td>
<td>Does not conduct electricity</td>
<td>Does conduct electricity</td>
</tr>
</tbody>
</table>

**Deduction**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid sodium chloride does not conduct electricity.</td>
<td>The ions are fixed.</td>
</tr>
<tr>
<td>Molten sodium chloride conducts electricity.</td>
<td>The ions are mobile.</td>
</tr>
</tbody>
</table>
| The ions are neutral. | The ions are vibrating.
This question is about the halogens.

Which group in the periodic table is known as the halogens? [1 mark]

Tick one box.

Group 1
Group 2
Group 7
Group 0

A fluorine atom has 7 electrons in the outer shell.

Figure 8 shows part of a dot and cross diagram to represent a molecule of fluorine \((F_2)\).

Complete the dot and cross diagram.

You should show only the electrons in the outer shells. [2 marks]

Figure 8

Chlorine reacts with potassium bromide solution.

Complete the word equation. [2 marks]

chlorine + bromide → _______________ + _______________
02.4 What type of reaction happens when chlorine reacts with potassium bromide solution? [1 mark]
Tick one box.
- decomposition
- displacement
- neutralisation
- precipitation

02.5 Complete the sentence.
Choose the answer from the box. [1 mark]

Chlorine is more reactive than bromine.
This is because chlorine gains ________________ more easily.

02.6 How does the size of a chlorine atom compare with the size of a bromine atom?
Complete the sentence.
Choose the answer from the box. [1 mark]

A chlorine atom is ________________ a bromine atom.
02.7 Give a reason for your answer to question 02.6 [1 mark]

Reason ____________________________________________

02.8 Fluorine reacts with chlorine to produce ClF₃

Balance the chemical equation for the reaction. [1 mark]

\[ \text{Cl}_2 + ____ \text{F}_2 \rightarrow 2 \text{ClF}_3 \]

02.9 Explain why fluorine is a gas at room temperature.

Use the following words in your answer: energy forces molecules weak [3 marks]

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________
This question is about acids and bases.

Which ion is found in all acids?

Tick one box.

Cl\(^-\)  H\(^+\)  Na\(^+\)  OH\(^-\)

Zinc nitrate can be produced by reacting an acid and a metal oxide.

Name the acid and the metal oxide used to produce zinc nitrate.

Acid ________________________________

Metal oxide ________________________________

In an equation, zinc nitrate is written as Zn(NO\(_3\))\(_2\)(aq).

What does (aq) mean?

Tick one box.

Dissolved in water

Insoluble

Not all reacted

Reactant

The pH of a solution is 8

Some hydrochloric acid is added to the solution.

Suggest the pH of the solution after mixing.

pH = ________________________________
Table 2 shows the solubility of three solids in water at room temperature.

<table>
<thead>
<tr>
<th>Solid</th>
<th>The mass of the solid that dissolves in 100 cm³ of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus oxide</td>
<td>50 g</td>
</tr>
<tr>
<td>Silicon dioxide</td>
<td>0 g</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>100 g</td>
</tr>
</tbody>
</table>

A teacher labelled these three solids A, B and C.

She gave a student the information shown in Table 3

<table>
<thead>
<tr>
<th>Solid</th>
<th>Observation when added to water</th>
<th>pH of the solid in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>colourless solution</td>
<td>14</td>
</tr>
<tr>
<td>B</td>
<td>colourless solution</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>solid does not dissolve</td>
<td>7</td>
</tr>
</tbody>
</table>

Describe a method that could be used to identify each of the three solids A, B and C.

You must use an indicator in the method.

Use information in Table 2 and Table 3

[4 marks]
This question is about the elements in Group 2 of the periodic table.

Figure 9 shows the positions of four elements, A, B, C, and D, in the periodic table.

Which element is in Group 2?

Tick one box.

A   B   C   D

[1 mark]

Question 4 continues on the next page
Group 2 metal carbonates break down when heated to produce a metal oxide and a gas.

\[
\text{metal carbonate} \rightarrow \text{metal oxide} + \text{gas}
\]

0 4. 2 Name the two products when calcium carbonate (CaCO₃) is heated. [2 marks]

_______________ and _______________

0 4. 3 What type of reaction happens when a compound breaks down? [1 mark]
Tick one box.

- burning
- decomposition
- neutralisation
- reduction

0 4. 4 The metal carbonate takes in energy from the surroundings to break down.
What type of reaction takes in energy from the surroundings? [1 mark]
Tick one box.

- combustion
- electrolysis
- endothermic
- exothermic
**04.5** Figure 10 shows the volume of gas produced when a Group 2 metal carbonate is heated.

![Figure 10](image)

Figure 10

The student collected 5.2 dm\(^3\) of gas.

What mass of the Group 2 metal carbonate is heated?

[1 mark]

\[
\text{Mass} = \text{__________} \text{ g}
\]

**04.6** Calculate the mass of the Group 2 carbonate needed to produce 24 dm\(^3\) of gas.

Use your answer from question **04.5** to help you.

[2 marks]

\[
\text{Mass} = \text{__________} \text{ g}
\]
A student heated different masses of a Group 2 carbonate. The student measured the volume of gas produced.

Figure 11 shows a graph of the student’s results.

The student calculates the gradient of the line in Figure 11.

The student makes two mistakes.

**Figure 11**

Correct formula for gradient = \[
\frac{\text{Increase in volume of gas}}{\text{Increase in mass of Group 2 metal carbonate heated}}
\]

Student’s calculation = \[
\frac{4}{750} = 0.00533 \text{ cm}^3 \text{ per g}
\]

Identify the two mistakes the student makes.

Calculate the correct gradient of the line.

[4 marks]

Mistake 1 ________________________________

Mistake 2 ________________________________

Calculation ________________________________

Gradient = ____________________________ cm\(^3\) per g
A student repeated the experiment with a different Group 2 metal carbonate (XCO₃).

The relative formula mass ($M_r$) of XCO₃ is 84.

Relative atomic masses ($A_r$): $C = 12$  $O = 16$

Calculate the relative atomic mass ($A_r$) of X.

Name metal X.

Use the periodic table.

[4 marks]

Relative atomic mass ($A_r$) = 

Metal X is 

Turn over for the next question
This question is about electrolysis.

A student investigates the mass of copper produced during electrolysis of copper chloride solution.

**Figure 12** shows the apparatus.

Which gas is produced at the positive electrode (anode)?

Tick one box.

- carbon dioxide
- chlorine
- hydrogen
- oxygen
Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper? [1 mark]

Tick one box.

- Copper is less reactive than hydrogen
- Copper is less reactive than oxygen
- Copper is more reactive than carbon
- Copper is more reactive than chlorine

Table 4 shows the student's results.

Table 4

<table>
<thead>
<tr>
<th>Time in mins</th>
<th>Experiment 1</th>
<th>Experiment 2</th>
<th>Experiment 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.60</td>
<td>0.58</td>
<td>0.62</td>
<td>0.60</td>
</tr>
<tr>
<td>2</td>
<td>1.17</td>
<td>1.22</td>
<td>1.21</td>
<td>1.20</td>
</tr>
<tr>
<td>4</td>
<td>2.40</td>
<td>2.41</td>
<td>2.39</td>
<td>2.40</td>
</tr>
<tr>
<td>5</td>
<td>3.02</td>
<td>X</td>
<td>3.01</td>
<td>3.06</td>
</tr>
</tbody>
</table>

Determine the mean mass of copper produced after 3 minutes. [1 mark]

\[
\text{Mass} = \underline{\text{}} \text{ mg}
\]

Question 5 continues on the next page
Calculate the mass $X$ of copper produced in Experiment 2 after 5 minutes.

Use Table 4 on page 19

$\text{Mass } X = \underline{\text{\hspace{1cm}}} \text{ mg}$

The copper chloride solution used in the investigation contained 300 grams per dm$^3$ of solid CuCl$_2$ dissolved in 1 dm$^3$ of water.

The students used 50 cm$^3$ of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

$\text{Mass } = \underline{\text{\hspace{1cm}}} \text{ g}$
This question is about sodium and chlorine.

Figure 13 shows the positions of sodium and chlorine in the periodic table.

**Figure 13**

State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

[2 marks]

**Difference**

**Similarity**

Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

[4 marks]
The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

**Figure 14**

Relative energy

Reactants

Progress of reaction

[2 marks]
A student plans a method to prepare pure crystals of copper sulfate.

The student’s method is:

1. Add one spatula of calcium carbonate to dilute hydrochloric acid in a beaker.
2. When the fizzing stops, heat the solution with a Bunsen burner until all the liquid is gone.

The method contains several errors and does not produce copper sulfate crystals.

Explain the improvements the student should make to the method so that pure crystals of copper sulfate are produced.

[6 marks]

END OF QUESTIONS
There are no questions printed on this page