GCSE CHEMISTRY
Foundation Tier Paper 1F

Specimen 2018 (set 2) Time allowed: 1 hour 45 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 100.
• 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.
Figure 1 shows the structure of five substances.

Figure 1

A B C D E

Which diagram shows a gas? [1 mark]

Tick one box.

A   B   C   D   E

Which diagram shows the structure of diamond? [1 mark]

Tick one box.

A   B   C   D   E

Which diagram shows a metallic structure? [1 mark]

Tick one box.

A   B   C   D   E
Which diagram shows a polymer? [1 mark]

Tick one box.

A   B   C   D   E

A chlorine atom has 7 electrons in the outer shell.

Two chlorine atoms covalently bond to form a chlorine molecule, Cl₂

Figure 2 is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram.

Show only the electrons in the outer shell. [1 mark]

Figure 2

Question 1 continues on the next page
01.6 What is the reason for chlorine’s low boiling point?

Tick one box.

- Strong covalent bonds
- Strong forces between molecules
- Weak covalent bonds
- Weak forces between molecules

[1 mark]

Figure 3 represents the structure of manganese oxide.

Manganese oxide is an ionic compound.

Figure 3

Key
- $\text{Mn}^{2+}$
- $\text{O}^{2-}$

01.7 Determine the empirical formula of manganese oxide.

Use Figure 3.

[1 mark]

Empirical formula = _________________________
Why does manganese oxide conduct electricity as a liquid? [1 mark]

Tick one box.

- Atoms move around in the liquid
- Electrons move around in the liquid
- Ions move around in the liquid
- Molecules move around in the liquid

Turn over for the next question
This question is about atomic structure.

**Figure 4** represents the structure of a lithium atom.

**Figure 4**

---

**02.1** Name the particle in the atom that has a positive charge.

[1 mark]

---

**02.2** Name the particle in the atom that has the smallest mass.

[1 mark]

---

**02.3** Complete the sentences.

Choose the answers from the box.

[2 marks]

- The mass number of the lithium atom is ____________.
- The number of neutrons in the lithium atom is ____________.
What are lithium atoms with different numbers of neutrons called? [1 mark]

Tick one box.

- Compounds
- Ions
- Isotopes
- Molecules

Name the particle in the atom discovered by James Chadwick. [1 mark]

______________________________

Question 2 continues on the next page
An element has two isotopes.

Table 1 shows information about the isotopes.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mass number</th>
<th>Percentage (%) abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isotope 1</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Isotope 2</td>
<td>11</td>
<td>80</td>
</tr>
</tbody>
</table>

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

Use the equation:

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

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass ($A_r$) = ______________________
The radius of an atom is 0.2 nm.

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

Calculate the radius of the nucleus.

Give your answer in standard form.

[2 marks]

Radius = \( \underline{\underline{\phantom{0000}}} \) nm
A student investigated the energy change occurring in the endothermic reaction between potassium hydrogen carbonate and hydrochloric acid.

**Figure 5** shows the apparatus used.

This is the method used.

1. Measure 50 cm$^3$ hydrochloric acid into a glass beaker.
2. Measure 1.0 g of potassium hydrogen carbonate.
3. Add the potassium hydrogen carbonate to the hydrochloric acid.
4. Stir until all the potassium hydrogen carbonate has reacted.
5. Record the lowest temperature reached.
6. Repeat steps 1–5 two more times.
7. Repeat steps 1–6 with different masses of potassium hydrogen carbonate.
03.1 Which is the most suitable apparatus to use to measure 50 cm³ of hydrochloric acid?

Tick one box.

- Balance
- Conical flask
- Gas syringe
- Measuring cylinder

03.2 The student used a glass beaker for the reaction.

Suggest one change to the apparatus that would improve the accuracy of the results.

Give a reason for your answer.

[2 marks]

Question 3 continues on the next page
Which two variables should the student keep the same to make this a fair test? [2 marks]

Tick two boxes.

- Mass of potassium hydrogen carbonate
- Same balance
- Same thermometer
- Starting temperature of hydrochloric acid
- Volume of hydrochloric acid

Figure 6 shows part of the thermometer used to measure the temperature.

Figure 6

What is the temperature reading on the thermometer? [1 mark]

Temperature = ______________ °C
Table 2 shows a set of results.

**Table 2**

<table>
<thead>
<tr>
<th>Lowest temperature in °C</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16.1</td>
<td>15.8</td>
<td>15.9</td>
</tr>
</tbody>
</table>

What is the range of the lowest temperature?  
[1 mark]  
From __________ °C to __________ °C

Calculate the mean lowest temperature.  
Use Table 2.  
[2 marks]  
Mean lowest temperature = ______________ °C

How do the results show that the reaction is endothermic?  
[1 mark]  
__________________________________________________________  
__________________________________________________________  

Question 3 continues on the next page
Figure 7 shows the student's results.

**Figure 7**

0 3.8 Draw **two** straight lines of best fit on Figure 7.

[2 marks]
Describe how the lowest temperature changes as the mass of potassium hydrogen carbonate added increases. [3 marks]

Turn over for the next question
A student investigated the voltage produced by simple cells.

**Figure 8** shows the apparatus used.

**Table 3** shows the voltage produced with different metal electrodes.

<table>
<thead>
<tr>
<th>Electrode A</th>
<th>Electrode B</th>
<th>Voltage in V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>Copper</td>
<td>0.00</td>
</tr>
<tr>
<td>Copper</td>
<td>Iron</td>
<td>0.78</td>
</tr>
<tr>
<td>Copper</td>
<td>Magnesium</td>
<td>2.71</td>
</tr>
<tr>
<td>Copper</td>
<td>Tin</td>
<td>0.48</td>
</tr>
<tr>
<td>Copper</td>
<td>Zinc</td>
<td>1.10</td>
</tr>
</tbody>
</table>

List the metals in **Table 3** in order of reactivity.

**Most reactive**

**Least reactive** Copper
**04.2** Batteries consist of cells.

Describe how a 6.0 V battery can be made from cells of voltage 1.5 V

[2 marks]

---

**04.3** Why do non-rechargeable cells stop producing electricity?

[2 marks]

---

**04.4** Complete the word equation for the reaction in a hydrogen fuel cell.

[1 mark]

\[
\text{hydrogen} \quad + \quad \text{______________} \quad \rightarrow \quad \text{water}
\]

---

**04.5** Give **two** reasons why using a hydrogen fuel cell is seen as non-polluting.

Use the equation in Question 04.4

[2 marks]

1 \___________________________

2 \___________________________
This question is about metal oxides.

When sodium is heated in oxygen, sodium oxide is produced.

Balance the equation for the reaction. \[ \text{[1 mark]} \]

\[
\underline{\text{Na}} + \text{O}_2 \rightarrow 2 \text{Na}_2\text{O}
\]

Why is this an oxidation reaction? \[ \text{[1 mark]} \]

Sodium oxide is added to water and shaken.

Universal indicator is added.

The pH of the solution is 14

What is the colour of the universal indicator? \[ \text{[1 mark]} \]

Tick one box.

Green
Purple
Red
Yellow
Aluminium oxide reacts with hydrochloric acid to produce a salt.

What is the name of the salt produced?

Tick one box.

- Aluminium chloride
- Aluminium nitrate
- Aluminium sulfate
- Aluminium sulfide

[1 mark]
A student investigates the solubility of four metal oxides and four non-metal oxides in water.

The student tests the pH of the solutions formed.

Table 4 shows the student’s results.

### Table 4

<table>
<thead>
<tr>
<th>Type of oxide</th>
<th>Oxide</th>
<th>Solubility in water</th>
<th>pH of solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metal oxides</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium oxide</td>
<td>Soluble</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Calcium oxide</td>
<td>Soluble</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Magnesium oxide</td>
<td>Slightly soluble</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>Insoluble</td>
<td></td>
<td>No solution formed</td>
</tr>
<tr>
<td><strong>Non-metal oxides</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>Soluble</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>Soluble</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Phosphorus oxide</td>
<td>Soluble</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Silicon dioxide</td>
<td>Insoluble</td>
<td></td>
<td>No solution formed</td>
</tr>
</tbody>
</table>

The student makes two conclusions.

**Conclusion 1**: ‘All metal oxides produce alkaline solutions.’

**Conclusion 2**: ‘All non-metal oxides produce acidic solutions.’
Explain why the student’s conclusions are only **partly** correct. Use information from **Table 4**. [4 marks]

Give an improved conclusion for metal oxides. Use **Table 4**. [2 marks]
This question is about metal compounds.

Lithium reacts with chlorine to produce lithium chloride.

When lithium atoms and chlorine atoms react to produce lithium chloride, lithium ions and chloride ions are formed.

Figure 9 shows the electronic structures of the atoms and ions.

The symbols o and x are used to represent electrons.

**Figure 9**

[Lithium atom](#) [Chlorine atom](#)

[Lithium ion](#) [Chloride ion](#)
Describe what happens when a lithium atom reacts with a chlorine atom.

Answer in terms of electrons.

[4 marks]

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Question 6 continues on the next page
Zinc sulfate can be made by two methods.

The equations for the two methods are:

**Method 1:** \( \text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O} \)

**Method 2:** \( \text{ZnCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \)

Calculate the percentage atom economy for making zinc sulfate in **Method 1**.

Use the equation:

\[
\text{percentage atom economy} = \frac{\text{relative formula mass of ZnSO}_4}{\text{relative formula mass of ZnO} + \text{relative formula mass of H}_2\text{SO}_4} \times 100
\]

Give your answer to 3 significant figures.

Relative formula masses \((M_r)\):

- \( \text{ZnO} = 81 \)
- \( \text{H}_2\text{SO}_4 = 98 \)
- \( \text{ZnSO}_4 = 161 \)

\[
\text{Percentage atom economy} = \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ %
\]

**Method 1** gives a higher percentage atom economy for making zinc sulfate than **Method 2**.

Give a reason why it is important to use a reaction with a high atom economy.

[1 mark]
A student uses 50 cm$^3$ of a zinc sulfate solution of 80 g/dm$^3$. What mass of zinc sulfate is dissolved in 50 cm$^3$ of this zinc sulfate solution? [2 marks]

Mass = ________________ g

Turn over for the next question
Sodium hydroxide reacts with hydrochloric acid.

Figure 10 shows apparatus that can be used to find the volume of sodium hydroxide reacting with 25.0 cm$^3$ hydrochloric acid.

Describe a method to find the exact volume of sodium hydroxide that reacts with 25.0 cm$^3$ of hydrochloric acid.

[6 marks]
The reaction produces a solution of sodium chloride.

A student wants to obtain sodium chloride crystals from the sodium chloride solution.

This is the method used.
1. Add solid charcoal to the sodium chloride solution to remove the indicator colour.
2. Remove the solid charcoal.
3. Evaporate the solution to dryness over a Bunsen burner.

Charcoal is not soluble in water.
Suggest a method the student could use to remove the solid charcoal in Step 2. [1 mark]

The student obtains a powdery white solid.
Suggest how the student could improve Step 3 of the method to obtain larger crystals instead of powder. [1 mark]
Figure 11 shows an outline of the modern periodic table.

Figure 11

J, L, M, Q and R represent elements in the periodic table.

0 8.1 Which element has four electrons in its outer shell?

[1 mark]

Tick one box.

J   L   M   Q   R

0 8.2 Which two elements in Figure 11 are in the same period?

[1 mark]

_________ and __________

0 8.3 Which element reacts with potassium to form an ionic compound?

[1 mark]

Tick one box.

J   L   M   Q   R
Which element forms ions with different charges? [1 mark]

Tick one box.

J L M Q R

Which element has three electron shells? [1 mark]

Tick one box.

J L M Q R

Question 8 continues on the next page
In the 1860s scientists were trying to organise elements.

**Figure 12** shows the table published by John Newlands in 1865.

The elements are arranged in order of their atomic weights.

**Figure 12**

<table>
<thead>
<tr>
<th>H</th>
<th>Li</th>
<th>Be</th>
<th>B</th>
<th>C</th>
<th>N</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Na</td>
<td>Mg</td>
<td>Al</td>
<td>Si</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>Cl</td>
<td>K</td>
<td>Ca</td>
<td>Cr</td>
<td>Ti</td>
<td>Mn</td>
<td>Fe</td>
</tr>
<tr>
<td>Co, Ni</td>
<td>Cu</td>
<td>Zn</td>
<td>Y</td>
<td>In</td>
<td>As</td>
<td>Se</td>
</tr>
<tr>
<td>Br</td>
<td>Rb</td>
<td>Sr</td>
<td>Ce, La</td>
<td>Zr</td>
<td>Di, Mo</td>
<td>Ro, Ru</td>
</tr>
<tr>
<td>Pd</td>
<td>Ag</td>
<td>Cd</td>
<td>U</td>
<td>Sn</td>
<td>Sb</td>
<td>Te</td>
</tr>
</tbody>
</table>

**Figure 13** shows the periodic table published by Dmitri Mendeleev in 1869.

**Figure 13**

<table>
<thead>
<tr>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
</tr>
<tr>
<td>Na</td>
</tr>
<tr>
<td>K</td>
</tr>
<tr>
<td>Rb</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Mendeleev’s table became accepted by other scientists whereas Newlands’ table was not.

Evaluate Newlands’ and Mendeleev’s tables.

You should include:

• a comparison of the tables
• reasons why Mendeleev’s table was more acceptable.

Use Figure 12 and Figure 13 and your own knowledge. [6 marks]
A student investigated the law of conservation of mass.

The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

1. Pour lead nitrate solution into a beaker labelled A.
2. Pour potassium chromate solution into a beaker labelled B.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker B into beaker A.
5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:

\[ \text{Pb(NO}_3\text{)}_2(\text{aq}) + \text{K}_2\text{CrO}_4(\text{aq}) \rightarrow \text{PbCrO}_4(\text{s}) + 2\text{KNO}_3(\text{aq}) \]

What would the student see when the reaction takes place?

[1 mark]
Table 5 shows the student’s results.

<table>
<thead>
<tr>
<th>Mass in g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaker A and contents before mixing</td>
</tr>
<tr>
<td>Beaker B and contents before mixing</td>
</tr>
<tr>
<td>Beaker A and contents after mixing</td>
</tr>
<tr>
<td>Beaker B after mixing</td>
</tr>
</tbody>
</table>

Show that the law of conservation of mass is true.
Use the data from **Table 5**.

[2 marks]

What is the resolution of the balance used to obtain the results in **Table 5**?

Tick one box.

0.01 g  
0.1 g  
1 g  
100 g  

[1 mark]

Question 9 continues on the next page
Calculate the relative formula mass \( (M_r) \) of lead nitrate \( \text{Pb(NO}_3\text{)}_2 \) \[2 \text{ marks}\]

Relative atomic masses \( (A_r) \): \( \text{N} = 14 \quad \text{O} = 16 \quad \text{Pb} = 207 \)

Relative formula mass = 

The formula of potassium chromate is \( \text{K}_2\text{CrO}_4 \)

The charge on the potassium ion is +1

What is the formula of the chromate ion? \[1 \text{ mark}\]

Tick one box.

\begin{itemize}
  \item \( \text{CrO}_4^{+} \)
  \item \( \text{CrO}_4^{2+} \)
  \item \( \text{CrO}_4^{-} \)
  \item \( \text{CrO}_4^{2-} \)
\end{itemize}
Another student also tests the law of conservation of mass using the same method. The student uses a different reaction. This is the equation for the reaction.

\[ \text{Na}_2\text{CO}_3(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \]

Explain why this student’s results would not appear to support the law of conservation of mass.

[3 marks]

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________


Turn over for the next question
A student makes a hypothesis:

‘When different salt solutions are electrolysed with inert electrodes, the product at the negative electrode is always a metal’.

Describe how you would test this hypothesis in the laboratory.

You should:

• draw a labelled diagram of the apparatus
• give the independent variable
• describe what you would see at the negative electrode if the hypothesis is true.

Diagram

Independent variable

Observation
The student’s hypothesis is only partially correct.

Explain why the product at the negative electrode is not always a metal. [2 marks]

Predict the product at the positive electrode in the electrolysis of:
- sodium chloride solution
- copper sulfate solution. [2 marks]

END OF QUESTIONS
There are no questions printed on this page