General Certificate of Secondary Education
Foundation Tier
June 2015

Additional Science
Unit Chemistry C2

Chemistry
Unit Chemistry C2

Thursday 14 May 2015  9.00 am to 10.00 am

For this paper you must have:
- a ruler
- the Chemistry Data Sheet (enclosed).
You may use a calculator.

Time allowed
- 1 hour

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 6(c) should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.
This question is about carbon and gases in the air.

1 (a) Carbon atoms have protons, neutrons and electrons.

Complete Table 1 by writing the relative mass of a neutron and an electron. \[2 \text{ marks}\]

<table>
<thead>
<tr>
<th>Name of particle</th>
<th>Relative mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>proton</td>
<td>1</td>
</tr>
<tr>
<td>neutron</td>
<td></td>
</tr>
<tr>
<td>electron</td>
<td></td>
</tr>
</tbody>
</table>

1 (b) What is the total number of protons and neutrons in an atom called? \[1 \text{ mark}\]

Tick (✓) one box.

- The atomic number
- The mass number
- One mole of the atom

1 (c) An atom of carbon has six electrons.

Which structure, A, B or C, represents the electronic structure of the carbon atom? \[1 \text{ mark}\]

The carbon atom is structure C.
1 (d) Carbon reacts with oxygen to produce carbon dioxide (CO₂).

1 (d) (i) How many different elements are in one molecule of carbon dioxide? [1 mark]

............................................................

1 (d) (ii) What is the total number of atoms in one molecule of carbon dioxide? [1 mark]

............................................................

1 (e) Sometimes carbon reacts with oxygen to produce carbon monoxide (CO).

1 (e) (i) Calculate the relative formula mass ($M_r$) of carbon monoxide.

Relative atomic masses ($A_r$): C = 12; O = 16 [1 mark]

............................................................................................................................................
............................................................................................................................................

$M_r$ of carbon monoxide = ......................

1 (e) (ii) Calculate the percentage by mass of carbon in carbon monoxide. [1 mark]

............................................................................................................................................
............................................................................................................................................

Percentage by mass of carbon in carbon monoxide = .........................%
1 (f) Carbon dioxide is one of the gases in the air.

1 (f) (i) Figure 1 shows the percentage of argon and the percentage of carbon dioxide in the air.

### Figure 1

<table>
<thead>
<tr>
<th>Percentage of gas in the air (%)</th>
<th>Argon</th>
<th>Carbon dioxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the percentage of argon in the air?  

[1 mark]

Percentage of argon = ........................................ %

1 (f) (ii) An instrumental method is used to measure the amount of carbon dioxide in the air.

Give one reason for using an instrumental method.  

[1 mark]

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
This question is about salts.

Salt (sodium chloride) is added to many types of food.

Sodium chloride is produced by reacting sodium with chlorine.

\[ \text{sodium} + \text{chlorine} \rightarrow \text{sodium chloride} \]

**Figure 2** shows what happens to atoms of sodium and chlorine in this reaction.

The dots (\(\cdot\)) and crosses (\(\times\)) represent electrons.

Only the outer electrons are shown.

**Figure 2**

\[ \text{Na} + \text{Cl} \rightarrow [\text{Na}]^+ + [\text{Cl}]^- \]

Describe, in terms of electrons, what happens when a sodium atom reacts with a chlorine atom to produce sodium chloride.

[3 marks]

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................

**Question 2 continues on the next page**
2 (b) Lack of iodine can affect the learning ability of children. One idea is that salt (sodium chloride) should have iodine added.

2 (b) (i) Iodine consists of simple molecules. What is a property of substances that have simple molecules? [1 mark]

Tick (✓) one box.

- Have no overall electric charge
- Have high boiling points
- Have giant covalent structures

2 (b) (ii) Which one of the following questions cannot be answered by science alone? [2 marks]

Tick (✓) one box.

- How much sodium chloride is in food?
- What harm does a lack of iodine do?
- Should iodine be added to salt in food?

Give one reason why this question cannot be answered by science alone.

............................................................................................................................................
............................................................................................................................................

2 (c) A student produced the salt ammonium nitrate by adding an acid to ammonia solution.

2 (c) (i) Name the acid used. [1 mark]

............................................................................................................................................
2 (c) (ii) Use the correct answer from the box to complete the sentence. [1 mark]

an acid  an alkali  a salt

Ammonia solution (ammonium hydroxide) is ..................................

2 (c) (iii) The student added a few drops of a solution which changed colour when the reaction was complete.

Complete the sentence. [1 mark]

The solution added is an ............................................................. .

2 (d) Farmers buy solid ammonium nitrate in poly(ethene) sacks.

2 (d) (i) How is solid ammonium nitrate made from a solution of ammonium nitrate? [1 mark]

Tick (√) one box.

Crystallisation

Decomposition

Electrolysis

2 (d) (ii) Why do farmers use ammonium nitrate on their fields? [1 mark]

............................................................................................................................................

............................................................................................................................................

2 (d) (iii) The properties of poly(ethene) depend on the reaction conditions when it is made.

State one reaction condition that can be changed when making poly(ethene). [1 mark]

............................................................................................................................................

............................................................................................................................................
Lead iodide is an insoluble salt.

3 (a) What type of substance is lead iodide? [1 mark]

Tick (✓) one box.

- An element
- A mixture
- A compound

3 (b) A student produced lead iodide by a precipitation reaction.

Use the correct answers from the box to complete the word equation. [2 marks]

lead bromide  lead nitrate  potassium bromide  potassium iodide

...........................................  +  ...........................................  → lead iodide  +  potassium nitrate
3 (c) The student wanted to separate the precipitate of lead iodide from the solution by using filtration.

The student used the apparatus shown in Figure 3.

Figure 3

Filter funnel

Explain why the apparatus in Figure 3 would not separate the lead iodide from the mixture.

[2 marks]

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................

3 (d) The student expected to get 5 g of lead iodide but only got 3 g.

3 (d) (i) The student did this calculation.

\[ \frac{3}{5} \times 100 \]

Use the correct answer from the box to complete the sentence.

[1 mark]

mass of one mole  percentage yield  relative formula mass

The student calculated the ............................................................. .

3 (d) (ii) Give one reason why the mass the student got was less than expected.

[1 mark]

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
4 This question is about electrolysis.

4 (a) Metal spoons can be coated with silver. This is called electroplating.

Suggest one reason why spoons are electroplated. [1 mark]

............................................................................................................................................
............................................................................................................................................

4 (b) When sodium chloride solution is electrolysed the products are hydrogen and chlorine.

4 (b) (i) What is made from chlorine? [1 mark]

Tick (✓) one box.

Bleach

Fertiliser

Soap

4 (b) (ii) Sodium chloride solution contains two types of positive ions, hydrogen ions (H⁺) and sodium ions (Na⁺).

Why is hydrogen produced at the negative electrode and not sodium? [1 mark]

Tick (✓) one box.

Hydrogen is a gas.

Hydrogen is less reactive than sodium.

Hydrogen ions move faster than sodium ions.
4 (b) (iii) Hydrogen and chlorine can be used to produce hydrogen chloride.

The diagrams in Figure 4 show how the outer electrons are arranged in an atom of hydrogen and an atom of chlorine.

![Figure 4](image)

Complete Figure 5 to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

[1 mark]

![Figure 5](image)

4 (b) (iv) What is the type of bond in a molecule of hydrogen chloride?

Tick (✓) one box.

- Covalent
- Ionic
- Metallic

[1 mark]

Question 4 continues on the next page
4 (b) (v) Why is hydrogen chloride a gas at room temperature (20 °C)?

Tick (✓) two boxes.

- Hydrogen chloride has a low boiling point.
- Hydrogen chloride has a high melting point.
- Hydrogen chloride is made of simple molecules.
- Hydrogen chloride does not conduct electricity.
- Hydrogen chloride has a giant structure.

4 (c) Aluminium is produced by electrolysis of a molten mixture of aluminium oxide and cryolite. This is shown in Figure 6.

**Figure 6**

Molten cryolite containing aluminium oxide

Gas forms at the positive electrode

O^{2-} O^{2-} O^{2-} Al^{3+} Al^{3+}

Aluminium forms at the negative electrode

4 (c) (i) Name a gas produced at the positive electrode.

[1 mark]
4 (c) (ii) Aluminium ions move to the negative electrode. Explain why. [2 marks]

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................

4 (c) (iii) At the negative electrode, the aluminium ions gain electrons to produce aluminium. What is this type of reaction called? [1 mark]

Tick (✓) one box.

Combustion

Oxidation

Reduction

4 (c) (iv) Aluminium has layers of atoms, as shown in Figure 7.

Figure 7

[Aluminium atom]

Complete the sentence. [1 mark]

Metals can be bent and shaped because the layers of atoms can ....................................

Question 4 continues on the next page
4 (d) Electrodes used in the production of aluminium are made from graphite.

4 (d) (i) Which diagram, A, B or C, shows the structure of graphite? [1 mark]

A  

B  

C  

The structure of graphite is shown in diagram □.

4 (d) (ii) The temperature for the electrolysis is 950 °C.

Use the correct answer from the box to complete the sentence. [1 mark]

cross links  a giant ionic lattice  strong covalent bonds

The graphite does not melt at 950 °C because

graphite has .......................................................... .
A student investigated the rate of reaction between calcium carbonate (marble chips) and hydrochloric acid.

The student used the apparatus shown in Figure 8.

The student:
- recorded the volume of gas collected every 5 seconds
- repeated the experiment using hydrochloric acid at different temperatures.

The equation for the reaction is:

\[ \text{CaCO}_3(s) + 2 \text{HCl(aq)} \rightarrow \text{CaCl}_2(aq) + \text{H}_2\text{O(l)} + \text{CO}_2(g) \]
The student plotted results for the hydrochloric acid at 20 °C and 40 °C on a graph. Figure 9 shows the student’s graph.

Figure 9

Use information from Figure 9 to answer these questions.

5 (a) (i) State one conclusion the student could make about the effect of temperature on the rate of the reaction. [1 mark]

................................................................................................................................................
................................................................................................................................................

5 (a) (ii) Give one reason why the student could make this conclusion. [1 mark]

................................................................................................................................................
................................................................................................................................................

5 (a) (iii) For the hydrochloric acid at 60 °C the student had collected 30 cm³ after 15 seconds. Calculate the average rate of reaction from 0 to 15 seconds. [1 mark]

................................................................................................................................................
................................................................................................................................................

Rate of reaction = ……………………………. cm³ per second
5 (b) The student then investigated how the surface area of marble chips affected the rate of reaction.

5 (b) (i) Which two variables should the student keep constant? [2 marks]

Tick (☑) two boxes.

- Amount of water in the trough
- Concentration of acid
- Mass of marble chips
- Size of marble chips
- Volume of measuring cylinder

5 (b) (ii) Explain, in terms of particles and collisions, the effect that increasing the surface area of the marble chips has on the rate of reaction. [2 marks]

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................

5 (c) Calcium carbonate is a catalyst for the industrial production of biodiesel.

Give one reason why using a catalyst reduces costs. [1 mark]

............................................................................................................................................
............................................................................................................................................
A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

The student used the apparatus shown in Figure 10.

![Figure 10]

The student:
- measured 50 cm$^3$ copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:

$$\text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{Cu(s)} + \text{ZnSO}_4(\text{aq})$$

The thermometer reading changes during the reaction.

Give one other change the student could see during the reaction.

[1 mark]

............................................................................................................................................
............................................................................................................................................

Question 6 continues on the next page
6 (b) Suggest one improvement the student could make to the apparatus in Figure 10.

Give a reason why this improves the investigation.

[2 marks]

Improvement ..........................................................................................................................................
...........................................................................................................................................................

Reason ..................................................................................................................................................
............................................................................................................................................................

6 (c) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The student's results are shown in Table 2.

<table>
<thead>
<tr>
<th>Experiment number</th>
<th>Concentration of copper sulfate in moles per dm³</th>
<th>Increase in temperature in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>0.3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>0.4</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>0.5</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>0.6</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>0.7</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td>9</td>
<td>0.9</td>
<td>35</td>
</tr>
<tr>
<td>10</td>
<td>1.0</td>
<td>35</td>
</tr>
</tbody>
</table>
Describe and explain the trends shown in the student’s results. [6 marks]
There are no questions printed on this page