GCSE SCIENCE A CHEMISTRY
Higher Tier Unit Chemistry C1

Thursday 18 May 2017 Morning Time allowed: 1 hour

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

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 3 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.
There are no questions printed on this page
Answer all questions in the spaces provided.

1 Elements are made of atoms.

1 (a) Table 1 shows the atomic numbers and mass numbers of three atoms.

<table>
<thead>
<tr>
<th>Atom</th>
<th>Atomic number</th>
<th>Mass number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>26</td>
</tr>
</tbody>
</table>

1 (a) (i) Suggest, in terms of the number of subatomic particles, why the atomic numbers of the three atoms are the same.

[1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________

1 (a) (ii) Explain, in terms of the number of subatomic particles, why the mass numbers of the three atoms are different.

[2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

1 (b) When elements react, their atoms join with other atoms to form compounds.

Sulfuric acid, $\text{H}_2\text{SO}_4$, is a compound.

1 (b) (i) How many elements are in the formula $\text{H}_2\text{SO}_4$?

[1 mark]

_________________________________

1 (b) (ii) How many atoms are in the formula $\text{H}_2\text{SO}_4$?

[1 mark]

_________________________________
Sulfuric acid reacts with metal oxides.

\[
\text{CuO (copper oxide)} + \text{H}_2\text{SO}_4 (\text{sulfuric acid}) \rightarrow \text{CuSO}_4 (\text{copper sulfate}) + \text{H}_2\text{O (water)}
\]

In a reaction, 159 g of copper oxide reacts with 196 g of sulfuric acid.

What is the mass of the products?

Tick (✓) one box.

<table>
<thead>
<tr>
<th>Mass of copper sulfate in g</th>
<th>Mass of water in g</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>159</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>196</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>319</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
1 (d) **Figure 1** shows apparatus used to investigate the reaction of sulfuric acid with copper carbonate.

Describe and explain the changes seen during the reaction.  

[3 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

Turn over for the next question
2 This question is about compounds of carbon.

2 (a) Figure 2 shows an atom with two energy levels (shells).

![Figure 2]

2 (a) (i) A carbon atom has six electrons.

Complete Figure 2 to show the electronic structure of a carbon atom.

Use x to represent an electron.

[1 mark]

2 (a) (ii) Complete the following description about the central part of this carbon atom.

[3 marks]

The central part is made up of six neutrons that have no electrical charge and ______

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

2 (b) Crude oil is a mixture of compounds. These compounds are mainly hydrocarbons.

What does the term hydrocarbon mean?

[1 mark]

_____________________________________________________________________________________
Alkanes and alkenes are hydrocarbons.

Table 2 shows the boiling points of some alkanes and alkenes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Boiling point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethane</td>
<td>C₂H₆</td>
<td>−88</td>
</tr>
<tr>
<td>Propane</td>
<td>C₃H₈</td>
<td>−42</td>
</tr>
<tr>
<td>Butane</td>
<td>C₄H₁₀</td>
<td>0</td>
</tr>
<tr>
<td>Pentane</td>
<td>C₅H₁₂</td>
<td>+36</td>
</tr>
<tr>
<td>Hexane</td>
<td>C₆H₁₄</td>
<td>+69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Boiling point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethene</td>
<td>C₂H₄</td>
<td>−104</td>
</tr>
<tr>
<td>Propene</td>
<td>C₃H₆</td>
<td>−48</td>
</tr>
<tr>
<td>Butene</td>
<td>C₄H₈</td>
<td>−6</td>
</tr>
<tr>
<td>Pentene</td>
<td>C₅H₁₀</td>
<td>+30</td>
</tr>
<tr>
<td>Hexene</td>
<td>C₆H₁₂</td>
<td>+64</td>
</tr>
</tbody>
</table>

2 (c) (i) Complete the displayed structure of ethane and the displayed structure of ethene.

[2 marks]

2 (c) (ii) Describe the relationship between the number of carbon atoms in an alkane molecule and the boiling point of the alkane molecule.

[1 mark]
2 (c) (iii) Use the information in Table 2 to compare the boiling points of alkanes with the boiling points of alkenes.

[2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

2 (d) A student used the apparatus in Figure 3 to investigate what happens when liquid paraffin is heated to a high temperature.

Figure 3

Liquid paraffin contains alkanes.

Describe what happens to the alkane molecules in this investigation.

[3 marks]

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

Limestone is heated in a lime kiln to produce calcium oxide.

**Figure 4** shows the reactants used and the products made in a lime kiln.

**Figure 4**

Limestone from **quarrying** contains mostly calcium carbonate (CaCO₃)

Natural gas from **drilling** contains mostly methane (CH₄)

Air from the atmosphere contains mostly nitrogen (N₂) and oxygen (O₂)

**Thermal decomposition** of limestone in a lime kiln heated to 950 ºC.

Product: calcium oxide (CaO)

Waste products: carbon dioxide (CO₂), nitrogen (N₂), solid particles (particulates) and some sulfur dioxide (SO₂)

Use information from **Figure 4** to explain the potential environmental impacts of quarrying, drilling and the thermal decomposition of limestone used in the production of calcium oxide.

[6 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
4 A polymer is used to make supermarket carrier bags.

4 (a) Table 3 shows data about polymer bags used by customers of UK supermarkets.

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bags used in millions</td>
<td>12 419</td>
<td>11 346</td>
<td>9004</td>
<td>7570</td>
<td>7974</td>
<td>8392</td>
<td>8487</td>
<td>8759</td>
<td>8959</td>
</tr>
<tr>
<td>Mass of bags used in thousands of tonnes</td>
<td>109.8</td>
<td>104.7</td>
<td>83.4</td>
<td>65.6</td>
<td>68.3</td>
<td>72.3</td>
<td>70.4</td>
<td>67.3</td>
<td>66.1</td>
</tr>
</tbody>
</table>

4 (a) (i) Describe what happens in a polymerisation reaction. 

[1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________

4 (a) (ii) Describe the trend in the number of bags used per year between 2006 and 2014. 

[2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

4 (a) (iii) The trend in the number of bags used does not match the trend of the mass of bags used between 2012 and 2014.

Suggest two reasons why. 

[2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

There has been an increase in the amount of recycled polymer used to make supermarket carrier bags. This reduces the amount of polymer put into landfill.

4 (b) (i) Give two reasons why the amount of polymer put into landfill **should** be reduced. [2 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

4 (b) (ii) Apart from reducing the use of landfill, give two reasons why more recycled polymer, instead of newly manufactured polymer, should be used to make supermarket carrier bags. [2 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

Turn over for the next question
This question is about the Earth’s atmosphere.

The Earth’s early atmosphere was a mixture of gases. One theory is that the Earth’s early atmosphere had the composition shown in Table 4.

Table 4

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage in Earth’s early atmosphere (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>96</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>3.5</td>
</tr>
<tr>
<td>Oxygen</td>
<td>a trace</td>
</tr>
<tr>
<td>Other gases including methane, ammonia, hydrogen and water vapour</td>
<td>0.5</td>
</tr>
</tbody>
</table>

(a) (i) Amino acids are at the basis of all life processes. The simplest amino acid is glycine, $\text{NH}_2\text{CH}_2\text{COOH}$

Two scientists, Miller and Urey, showed that they could produce glycine from a mixture of methane, ammonia, hydrogen and water. Miller and Urey concluded that this is how life was formed on Earth.

Suggest one reason why this conclusion may not be correct.

[1 mark]

_____________________________________________________________________________________

_____________________________________________________________________________________

(b) (ii) Give three reasons why the percentage of carbon dioxide in the Earth’s atmosphere today is less than the percentage of carbon dioxide in the Earth’s early atmosphere.

[3 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________
5 (b) Table 5 shows the boiling points of some gases in the air.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Boiling point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>–196</td>
</tr>
<tr>
<td>Oxygen</td>
<td>–183</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>–79*</td>
</tr>
<tr>
<td>Helium</td>
<td>–269</td>
</tr>
<tr>
<td>Neon</td>
<td>–246</td>
</tr>
<tr>
<td>Argon</td>
<td>–186</td>
</tr>
</tbody>
</table>

*freezes at this temperature

Oxygen from the air is separated by fractional distillation. To do this separation the air is cooled to –200 °C. Most of the gases condense.

5 (b) (i) Name the two gases that would not condense at –200 °C. [1 mark]

_______________________________________ and _________________________________________

5 (b) (ii) Suggest why carbon dioxide is removed before the air is cooled. [1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________

5 (b) (iii) The liquid at –200 °C is passed into a fractionating column.

Explain why one of the fractions is a mixture of oxygen and one other gas. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Turn over ➤
5 (c) Oxygen is used in the production of steel.

Cast iron from a blast furnace contains 96% iron and 4% carbon.

The stages for the production of steel from cast iron are:

**Stage 1** pass oxygen into molten cast iron

**Stage 2** add small amounts of other metals.

Explain why each stage is needed in the production of steel.

[4 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

[12 marks]
6 Oils from plants are used in the production of fuels and foods.

6 (a) Explain one advantage of using biodiesel made from plant oils compared with using fossil diesel made from crude oil. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

6 (b) Plant oils are used in emulsions to give a consistent texture to many foods.

Explain how an emulsion of water and oil is formed. [4 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

6 (c) Bromine water changes colour when shaken with some plant oils.

Describe the colour change. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________

Question 6 continues on the next page
6 (d) Describe and explain what happens to plant oils when they react with hydrogen in the presence of a nickel catalyst at about 60 °C.

[3 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

END OF QUESTIONS
There are no questions printed on this page.