Thursday 19 May 2016  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 5(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.
1 There are eight elements in the second row (lithium to neon) of the periodic table.

1 (a) Figure 1 shows a lithium atom.

![Figure 1](image-url)

1 (a) (i) What is the mass number of the lithium atom in Figure 1?

Tick (✓) one box.

- 3
- 4
- 7

1 (a) (ii) What is the charge of an electron?

Tick (✓) one box.

- -1
- 0
- +1
1 (a) (iii) Protons are in the nucleus.

Which other sub-atomic particles are in the nucleus? [1 mark]

Tick (✓) one box.

ions

molecules

neutrons

1 (b) What is always different for atoms of different elements? [1 mark]

Tick (✓) one box.

number of neutrons

number of protons

number of shells

Question 1 continues on the next page
1 (c) **Figure 2** shows the electron arrangements of three different atoms, X, Y and Z. These atoms are from elements in the second row (lithium to neon) of the periodic table.

Which atom is from an element in Group 3 of the periodic table? [1 mark]

Tick (✓) one box.

Atom X
Atom Y
Atom Z

1 (d) **Figure 3** shows the electron arrangement of a different atom from an element in the second row of the periodic table.

1 (d) (i) Give the chemical symbol of this element. [1 mark]

_________________________________________

1 (d) (ii) Why is this element unreactive? [1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________
This question is about the Earth and its atmosphere.

2 (a) **Figure 4** shows the Earth and its atmosphere billions of years ago.

![Figure 4](image)

2 (a) (i) The boiling point of water is 100 °C.

Suggest one reason why there was no liquid water on the Earth’s surface billions of years ago.

[1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________

2 (a) (ii) Complete the sentence.

[1 mark]

On the Earth today, volcanic eruptions happen at the boundaries between tectonic ____________________ .

**Question 2 continues on the next page**
2 (b) The Earth’s atmosphere today contains nitrogen, oxygen, argon, carbon dioxide and other gases.

2 (b) (i) Draw one line from each substance to a description of the substance. [3 marks]

<table>
<thead>
<tr>
<th>Substance</th>
<th>Description of the substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>air</td>
<td>compound</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>compound</td>
</tr>
<tr>
<td>argon</td>
<td>element</td>
</tr>
<tr>
<td></td>
<td>hydrocarbon</td>
</tr>
<tr>
<td></td>
<td>metal</td>
</tr>
<tr>
<td></td>
<td>mixture</td>
</tr>
</tbody>
</table>

2 (b) (ii) Which gas in the Earth’s atmosphere is used when hydrocarbons burn? [1 mark]

Tick (✓) one box.
- carbon dioxide
- nitrogen
- oxygen

2 (b) (iii) What percentage of the Earth’s atmosphere is nitrogen? [1 mark]

Tick (✓) one box.
- about 40%
- about 60%
- about 80%
2 (c) Figure 5 shows the carbon dioxide percentage (%) in the Earth’s atmosphere since the year 1800.

![Graph showing carbon dioxide percentage (%) from 1800 to 2050]

2 (c) (i) What was the carbon dioxide percentage in 1900?  
[1 mark]

_________________________ %

2 (c) (ii) Describe, in detail, how the carbon dioxide percentage changed from 1900 to 2015.  
[2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

2 (c) (iii) Suggest two reasons for the change in the carbon dioxide percentage from 1900 to 2015.  
[2 marks]

1 ___________________________________________________________________________________
_____________________________________________________________________________________

2 ___________________________________________________________________________________
_____________________________________________________________________________________

Turn over
3 Metals are extracted from ores in the Earth’s crust.

3 (a) Why is copper used in the manufacture of computers? [1 mark]

Tick (✓) one box.

Because it has a high density. 
Because it does not react with water. 
Because it is a good conductor of electricity.

3 (b) Figure 6 shows the percentage (%) by mass of some metals in the Earth’s crust.

Figure 6
3 (b) (i) What is the percentage by mass of magnesium in the Earth’s crust? 

[1 mark]

------------- %

3 (b) (ii) On Figure 6 draw the bars for:

- calcium at 3.6% by mass
- iron at 5.0% by mass.

[2 marks]

3 (c) An ore of zinc contains zinc carbonate.

The equation for the reaction when zinc carbonate is heated is:

\[ \text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2 \]

3 (c) (i) What is the name of this type of reaction?

Tick (✓) one box.

- corrosion
- decomposition
- electrolysis

[1 mark]

3 (c) (ii) Which substance in the equation is a gas at room temperature (20 °C)?

Tick (✓) one box.

- zinc carbonate
- zinc oxide
- carbon dioxide

[1 mark]

Question 3 continues on the next page
3 (c) (iii) Complete Table 1 to show the number of atoms of carbon and oxygen in the formula of zinc carbonate.

Table 1

<table>
<thead>
<tr>
<th>Element</th>
<th>Number of atoms in the formula ZnCO₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>zinc, Zn</td>
<td>1</td>
</tr>
<tr>
<td>carbon, C</td>
<td></td>
</tr>
<tr>
<td>oxygen, O</td>
<td></td>
</tr>
</tbody>
</table>

3 (c) (iv) When 125 g zinc carbonate is heated, 81 g zinc oxide is produced.

Calculate the mass of carbon dioxide produced.

\[
\text{Mass of carbon dioxide} = \phantom{00000} \text{g}
\]

3 (d) Figure 7 shows a simple life cycle of a car body.

Figure 7

Quarry iron ore → Extract iron in a blast furnace → Convert iron into steel → Make a car body → Recycle the steel

Use the car
3 (d) (i) What is **one** reason why iron from the blast furnace is converted into steel? [1 mark]

Tick (✓) one box.

To make the iron pure. 

To make the iron more brittle. 

To make alloys for specific uses. 

3 (d) (ii) Apart from cost, give **three different** reasons why steel should be recycled. [3 marks]

1 

____________________________________________________________________________________

____________________________________________________________________________________

2 

____________________________________________________________________________________

____________________________________________________________________________________

3 

____________________________________________________________________________________

____________________________________________________________________________________

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Turn over for the next question
4 Figure 8 shows how ethanol is made from plants and from crude oil.

Figure 8

<table>
<thead>
<tr>
<th>Plants</th>
<th>Crude oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>Alkanes</td>
</tr>
<tr>
<td>Solution of sugar in water</td>
<td>Ethene gas at 300 °C</td>
</tr>
<tr>
<td>Add yeast</td>
<td>Add steam</td>
</tr>
<tr>
<td>Mixture of ethanol, water and yeast</td>
<td>Mixture of ethanol and water</td>
</tr>
</tbody>
</table>

4 (a) (i) What is the name of the reaction to produce ethanol from sugar? [1 mark]

Tick (✓) one box.

- fermentation
- polymerisation
- reduction

4 (a) (ii) What is the name of the reaction to produce ethanol from ethene? [1 mark]

Tick (✓) one box.

- bioleaching
- displacement
- hydration
4 (a) (iii) A lot of the ethanol produced is used as a fuel for cars.

What are two reasons why most of this ethanol is made from plants and not from crude oil?

Tick (✓) two boxes.

- Resources of crude oil are non-renewable.
- Ethanol from plants is more flammable.
- Producing ethanol from plants is not sustainable.
- Ethanol from plants has a different formula.
- Producing ethanol from plants uses less energy.

[2 marks]

Question 4 continues on the next page
4 (b) A student made ethanol from sugar.

Figure 9 shows the apparatus used.

![Figure 9](image)

4 (b) (i) What change is seen in the limewater?

Give a reason for your answer.

[2 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

4 (b) (ii) The student wanted to separate the solid yeast from the solution.

Figure 10 shows the apparatus used.

![Figure 10](image)

What is missing from the apparatus in Figure 10?

[1 mark]

_____________________________________________________________________________________

_____________________________________________________________________________________
4 (c) Vegetable oils are made from plants.

4 (c) (i) Which statement is correct? [1 mark]

Tick (✓) one box.

Vegetable oils have lower boiling points than water.

Vegetable oils cook foods at higher temperatures than boiling water.

Cooking in vegetable oils decreases the energy content of the food.

4 (c) (ii) A student puts different mixtures into two flasks, A and B. The student shakes the flasks.

**Figure 11** shows the two flasks after they have been shaken and left to stand for one minute.

**Figure 11**

Flask A

Vegetable oil

Water

Flask B

Mixture of vegetable oil, water and an emulsifier

Complete the sentences. [2 marks]

The mixture in flask A separates because ____________________________________________

_____________________________________________________________________________________

The mixture in flask B does not separate because ____________________________________________

_____________________________________________________________________________________
There are no questions printed on this page
5 This question is about hydrocarbons.

5 (a) Most of the hydrocarbons in crude oil are alkanes.

5 (a) (i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.

\[ \text{C}_ {12}\text{H}_{26} \rightarrow \text{C}_ {4}\text{H}_{10} + \text{C}_ {6}\text{H}_{12} + \text{C}_ {2}\text{H}_{4} \]

dodecane butane hexene ethene

Give two conditions used to crack large alkane molecules. [2 marks]

1. 
2. 

5 (a) (ii) The products hexene and ethene are alkenes.

Complete the sentence. [1 mark]

When alkenes react with bromine water the colour changes from orange to ______________________________ .

5 (a) (iii) Butane \((\text{C}_ {4}\text{H}_{10})\) is an alkane.

Complete the displayed structure of butane. [1 mark]

\[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H}\text{C}\text{C} \\
\text{H} \text{H}
\end{array}
\]

Question 5 continues on the next page
5 (b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

Figure 12 shows the apparatus used.

Each hydrocarbon fuel was burned for two minutes.

Table 2 shows the students’ results.

<table>
<thead>
<tr>
<th>Name and formula of hydrocarbon fuel</th>
<th>Mass of fuel used in g</th>
<th>Temperature increase of water in °C</th>
<th>Energy released by fuel in kJ</th>
<th>Energy released by 1.0 g of fuel in kJ</th>
<th>Relative amount of smoke in the flame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexane, C₆H₁₄</td>
<td>0.81</td>
<td>40</td>
<td>16.80</td>
<td>20.74</td>
<td>very little smoke</td>
</tr>
<tr>
<td>Octane, C₈H₁₈</td>
<td>1.10</td>
<td>54</td>
<td>22.68</td>
<td>20.62</td>
<td>some smoke</td>
</tr>
<tr>
<td>Decane, C₁₀H₂₂</td>
<td>1.20</td>
<td>58</td>
<td>24.36</td>
<td>20.96</td>
<td>smoky</td>
</tr>
<tr>
<td>Dodecane, C₁₂H₂₆</td>
<td>1.41</td>
<td>67</td>
<td>28.14</td>
<td>19.96</td>
<td>very smoky</td>
</tr>
</tbody>
</table>
5 (b) (i) Calculate the energy released by 1.0 g of decane in kJ. [2 marks]

__________________________________________________

__________________________________________________

Energy released = ________________ kJ

5 (b) (ii) Suggest one improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement. [2 marks]

__________________________________________________

__________________________________________________

__________________________________________________

5 (b) (iii) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

Name this black substance.

Suggest why it is produced. [2 marks]

__________________________________________________

__________________________________________________

__________________________________________________

__________________________________________________

5 (b) (iv) A student concluded that hexane is the best of the four fuels.

Give two reasons why the results in Table 2 support this conclusion. [2 marks]

1  ___________________________________________________________________________________

__________________________________________________

2  ___________________________________________________________________________________

Question 5 continues on the next page
In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Most car engines use petrol as a fuel.
- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.
- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

Table 3 shows information about petrol and hydrogen.

<table>
<thead>
<tr>
<th></th>
<th>Petrol</th>
<th>Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of fuel at room temperature</td>
<td>Liquid</td>
<td>Gas</td>
</tr>
<tr>
<td>Word equation for combustion of the fuel</td>
<td>petrol + oxygen → carbon dioxide + water</td>
<td>hydrogen + oxygen → water</td>
</tr>
<tr>
<td>Energy released from combustion of 1 g of the fuel</td>
<td>47 kJ</td>
<td>142 kJ</td>
</tr>
</tbody>
</table>

Describe the advantages and disadvantages of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

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

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ANSWER IN THE SPACES PROVIDED
There are no questions printed on this page