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 2(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 an atom with two energy levels (shells).

**Figure 1**

1 (a) (i) Complete Figure 1 to show the electronic structure of a boron atom. [1 mark]

1 (a) (ii) What does the central part labelled Z represent in Figure 1? [1 mark]

1 (a) (iii) Name the sub-atomic particles in part Z of a boron atom. Give the relative charges of these sub-atomic particles. [3 marks]
1 (b) The electronic structure of a neon atom shown in Figure 2 is not correct.

Figure 2

Electron

Explain what is wrong with the electronic structure shown in Figure 2.

[3 marks]

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Turn over for the next question
2 This question is about hydrocarbons.

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

2 (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

2 (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 ______________________________ .

2 (a) (iii) Butane (C\textsubscript{4}H\textsubscript{10}) is an alkane.

Complete the displayed structure of butane. [1 mark]

\[
\begin{array}{cc}
\text{H} & \text{H} \\
\text{C} & \text{C} \\
\text{H} & \text{H}
\end{array}
\]

Question 2 continues on the next page
2 (b)  A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

Figure 3 shows the apparatus used.

![Figure 3](image)

Each hydrocarbon fuel was burned for two minutes.

Table 1 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>19.96</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>
2 (b) (i) Calculate the energy released by 1.0 g of decane in kJ. [2 marks]

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Energy released = ____________________ kJ

2 (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]

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2 (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]

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

Give two reasons why the results in Table 1 support this conclusion. [2 marks]

1 ___________________________________________________________________________________

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2 ___________________________________________________________________________________

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Question 2 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 2 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]
3 Metals are extracted from ores in the Earth’s crust.

Some ores contain metal carbonates and some ores contain metal oxides.

3 (a) (i) Name the type of reaction that happens when a metal carbonate is heated. [1 mark]

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3 (a) (ii) Which solid product is formed when copper carbonate is heated? [1 mark]

Tick (✓) one box.

- copper
- copper nitrate
- copper oxide
- copper sulfide

3 (b) A student investigated heating four metal carbonates.

Figure 4 shows the apparatus used.

Figure 4

10 g metal carbonate

Heat

Limewater
The student heated each metal carbonate for five minutes.

**Table 3** shows the results.

<table>
<thead>
<tr>
<th>Metal carbonate</th>
<th>Mass of metal carbonate at start in g</th>
<th>Mass of solid after heating for 5 minutes in g</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper carbonate</td>
<td>10.0</td>
<td>6.9</td>
<td>Limewater turns cloudy</td>
</tr>
<tr>
<td>Magnesium carbonate</td>
<td>10.0</td>
<td>9.1</td>
<td>Limewater turns cloudy</td>
</tr>
<tr>
<td>Potassium carbonate</td>
<td>10.0</td>
<td>10.0</td>
<td>Limewater does not turn cloudy</td>
</tr>
<tr>
<td>Zinc carbonate</td>
<td>10.0</td>
<td>8.3</td>
<td>Limewater turns cloudy</td>
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3 (b) (i) Explain the results for potassium carbonate.  

[3 marks]

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3 (b) (ii) Suggest how the reactivity series can be used to predict which metal carbonate reacts most easily when heated.  

[2 marks]

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Question 3 continues on the next page
3 (c) **Figure 5** shows a simple life cycle of a car body.

3 (c) (i) Complete the sentence.  

Iron ores must contain enough iron to ________________________________________________________________________________________  

[1 mark]

3 (c) (ii) Some iron ores contain iron oxide (Fe$_2$O$_3$).  

Complete and balance the equation for a reaction to produce iron from iron oxide.  

[2 marks]

$$\boxed{\text{____ Fe}_2\text{O}_3 + \text{____ C} \rightarrow \text{________} + \text{_____ CO}_2}$$

3 (c) (iii) Give **two** reasons why iron produced in a blast furnace is converted into steel.  

[2 marks]

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3 (c) (iv) When a car reaches the end of its useful life, the car body can be:

- recycled
- reused
- sent to landfill.

Give three reasons why a steel car body should be recycled and not reused or sent to landfill.

[3 marks]

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Turn over for the next question
Ethanol can be made from plants and from crude oil as shown in Figure 6.

Figure 6

Plants
Sugar
Solution of sugar in water
Mixture of ethanol and water

Crude oil
Alkanes
Ethene
Ethanol

4 (a) (i) Describe how the solution of sugar in water is used to produce the mixture of ethanol and water.

[2 marks]

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4 (a) (ii) Describe how ethanol is produced from ethene.

[2 marks]

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4 (b) Explain one advantage and one disadvantage of using crude oil to make ethanol instead of using plants.

[4 marks]

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4 (c) Ethanol has a boiling point of 78 °C. Water has a boiling point of 100 °C.

Describe how distillation is used to separate a mixture of ethanol and water.

[3 marks]

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Turn over for the next question
5 This question is about vegetable oils.

5 (a) Explain why using vegetable oils as biofuels does not increase global warming. [3 marks]

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5 (b) Describe how and explain why vegetable oils are hardened for use in foods. [5 marks]

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END OF QUESTIONS