C7
ORGANIC CHEMISTRY
TEST 1

GCSE
CHEMISTRY
AQA - COMBINED SCIENCE

Materials
For this paper you must have:
- Ruler
- Pencil, Rubber, Protractor and Compass
- Scientific calculator, which you are expected to use when appropriate

Instructions
- Answer all questions
- Answer questions in the space provided
- All working must be shown
- Do all rough work in this book. Cross out any rough work you don’t want to be marked

Information
- The marks for the questions are shown in brackets
Diesel oil is obtained from crude oil. It can be used as a fuel for car engines. The diagram below represents a compound found in diesel oil.

![Diagram of a compound](image)

(a) What is the formula of this compound?

___________________________________________________________________

(1)

(b) Each of the lines on the diagram above represents a covalent bond.

What is a covalent bond?

___________________________________________________________________

___________________________________________________________________

(2)

(Total 3 marks)

Crude oil is a mixture of many saturated hydrocarbons. They can be separated into fractions by the process of fractional distillation.

State what is meant by:

(i) hydrocarbon. _______________________________________________________

___________________________________________________________________

(2)

(ii) saturated. _________________________________________________________

___________________________________________________________________

(1)

(iii) fraction. _________________________________________________________

___________________________________________________________________

(1)

(Total 4 marks)
There are several different forms of carbon and many different carbon compounds.

(a) Figure 1 shows a 3D model of a molecule of methane (CH₄).

![Figure 1](image)

Draw the 2D structure of a methane molecule.

(b) Different forms of carbon have different bonding and structure.

Draw one line from the form of carbon to the bonding and structure.

<table>
<thead>
<tr>
<th>Form of carbon</th>
<th>Bonding and structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Form 1" /></td>
<td>Each carbon atom is bonded to three other carbon atoms in a single layer</td>
</tr>
<tr>
<td><img src="image" alt="Form 2" /></td>
<td>Each carbon atom is bonded to four other carbon atoms</td>
</tr>
<tr>
<td><img src="image" alt="Form 3" /></td>
<td>Layers of carbon atoms with no covalent bonds between the layers</td>
</tr>
<tr>
<td><img src="image" alt="Form 4" /></td>
<td>Carbon ions held together by strong electrostatic forces</td>
</tr>
<tr>
<td><img src="image" alt="Form 5" /></td>
<td>Pairs of carbon atoms with no covalent bonds between the molecules</td>
</tr>
</tbody>
</table>
Crude oil is a mixture of many different carbon compounds.

Crude oil can be separated into useful fractions by fractional distillation.

**Figure 2** shows a column used to separate crude oil.

Complete the sentences.

Use words from the box.

<table>
<thead>
<tr>
<th>condense</th>
<th>evaporate</th>
<th>freeze</th>
</tr>
</thead>
</table>

Crude oil is heated so that most of the compounds ________________

At different temperatures the compounds cool and ________________
(d) Which fraction is the most **viscous**?

Tick **one** box.

- Engine oil
- Diesel oil
- Kerosene
- Petrol

(1)

(e) Which fraction is the most **flammable**?

Tick **one** box.

- Diesel oil
- Kerosene
- Petrol
- Refinery gas

(1)

(f) Why does kerosene separate out of the mixture before diesel oil?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(1)

(Total 9 marks)
Crude oil is a fossil fuel.

(a) To make crude oil more useful it is separated into fractions.

Use the correct word from the box to complete each sentence.

<table>
<thead>
<tr>
<th>boiling</th>
<th>compound</th>
<th>decomposition</th>
<th>distillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>filtration</td>
<td>mixture</td>
<td>molecule</td>
<td></td>
</tr>
</tbody>
</table>

(i) Crude oil is a _________________________ of different substances.

(ii) The substances in crude oil have different _________________________ points.

(iii) Crude oil is separated by fractional _________________________.

(b) Petrol is one of the fractions produced from crude oil.

Car engines use a mixture of petrol and air.

The diagram shows some of the gases produced.

(i) What type of reaction happens to petrol in a car engine?

Tick (✓) one box.

- combustion
- decomposition
- neutralisation

(1)
(ii) Petrol contains octane (C₈H₁₈).
Complete the word equation for the reaction of octane with oxygen.
\[ \text{octane} + \text{___________} \rightarrow \text{___________} + \text{___________} \] (2)

(iii) Cars use sulfur-free petrol as a fuel.
Describe why sulfur should be removed from petrol.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
(2)

(c) Some fractions from crude oil contain large hydrocarbon molecules.
These molecules can be cracked to produce smaller, more useful molecules.
An equation for cracking decane is:
\[ \text{C}_{10}\text{H}_{22} \rightarrow \text{C}_3\text{H}_8 + \text{C}_2\text{H}_4 + \text{C}_5\text{H}_{10} \]

(i) Why is propane useful?

Tick (✓) one box.

- Propane is a polymer. 
- Propane is an alloy.
- Propane is a fuel.

(1)

(ii) Draw bonds to complete the displayed structure of ethene.

\[ \text{H} \quad \text{H} \]
\[ \text{C} \quad \text{C} \]
\[ \text{H} \quad \text{H} \]
(iii) What is the colour change when bromine water reacts with ethene?

Tick (✓) one box.

Orange to colourless

Orange to green

Orange to red

(1)

(iv) Complete the sentence.

Pentene is useful because many pentene molecules can join together

to form ________________________ .

(1)

(Total 12 marks)

Alkanes are hydrocarbons found in crude oil.

(a) (i) Complete the sentence.

Hydrocarbons contain the elements _____________ and _____________ only.

(1)

(ii) Ethane is an alkane with the formula C₂H₆

Draw a ring around the correct answer to complete the sentence.

Alkanes are hydrocarbons with the general formula

\[
C_nH_n \\
C_nH_{2n} \\
C_nH_{2n+2}
\]

(1)
(b) Crude oil is separated into useful fractions by fractional distillation.

Describe and explain how crude oil is separated into fractions by fractional distillation.

Use the diagram to help you answer the question.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

___________________________________________________________________

(c) Dodecane \((C_{12}H_{26})\) from crude oil is cracked to produce ethene \((C_2H_4)\).

(i) Complete the equation for this reaction.

\[ C_{12}H_{26} \rightarrow 2 \text{C}_2\text{H}_4 + \text{______________} \]  

(ii) Give two conditions needed for cracking.

1. ____________________________________________________________

2. ____________________________________________________________

(Total 9 marks)
Hot air balloons burn hydrocarbons to heat the air.

(a) The hot air contains these gases: nitrogen, N\textsubscript{2}, oxygen, O\textsubscript{2}, argon, Ar, carbon dioxide, CO\textsubscript{2}, water vapour, H\textsubscript{2}O

(i) Argon is an element.

What is an element?

________________________________________________________________________________________

________________________________________________________________________________________

(1)

(ii) Name one other gas in the hot air that is also an element.

________________________________________________________________________________________

(1)

(b) Propane, C\textsubscript{3}H\textsubscript{8}, can be represented as:

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

Use the correct words from the box to complete the sentences.

\[
\begin{array}{cccccc}
\text{bond} & \text{carbon} & \text{compound} & \text{element} & \text{mixture} \\
\end{array}
\]

(i) Propane is a ________________ and is made up of atoms of hydrogen and ________________

(2)
This question is about hydrocarbons.

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

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

The equation shows the cracking of dodecane.

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

Give two conditions used to crack large alkane molecules.

1. ____________________________

2. ____________________________

(b) The products hexene and ethene are alkenes.

Complete the sentence.

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

(c) Butane (C\textsubscript{4}H\textsubscript{10}) is an alkane.

Complete the displayed structure of butane.
A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

The diagram below shows the apparatus used.

![Diagram of apparatus](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, C(<em>6)H(</em>{14})</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, C(<em>8)H(</em>{18})</td>
<td>1.10</td>
<td>54</td>
<td>22.68</td>
<td>20.62</td>
<td>some smoke</td>
</tr>
<tr>
<td>Decane, C(<em>{10})H(</em>{22})</td>
<td>1.20</td>
<td>58</td>
<td>24.36</td>
<td></td>
<td>smoky</td>
</tr>
<tr>
<td>Dodecane, C(<em>{12})H(</em>{26})</td>
<td>1.41</td>
<td>67</td>
<td>28.14</td>
<td>19.96</td>
<td>very smoky</td>
</tr>
</tbody>
</table>

(i) Calculate the energy released by 1.0 g of decane in kJ.

\[
\text{Energy released} = \frac{28.14}{1.41} \text{ kJ}
\]

(ii) Calculate the energy released by 1.0 g of decane in kJ.
(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)

(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)

(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.

1. __________________________________________________________
______________________________________________________________

2. __________________________________________________________
______________________________________________________________

(2)
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)  
(Total 18 marks)

Crude oil is a mixture of a large number of compounds most of which are hydrocarbons such as the molecule shown below.

```
H     H     H     H     H
|     |     |     |     |
H—C—C—C—C—C—C—H
|     |     |     |     |
H     H     H     H     H
```
(a) What is a hydrocarbon?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(1)

(b) What is the chemical formula of the molecule shown above?

___________________________________________________________________
___________________________________________________________________

(1)

(c) The cracking of large molecules obtained from crude oil is one of the important processes in an oil refinery. Cracking involves the thermal decomposition of large molecules. The diagram below shows an apparatus that can be used to demonstrate cracking in the laboratory. The porous pot acts as a catalyst in the reaction.

(i) What happens during thermal decomposition?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(ii) What effect does the porous pot catalyst have on the reaction?

___________________________________________________________________
___________________________________________________________________

(1)

(iii) Complete the equation below for the cracking of the molecule. \( \text{C}_{20}\text{H}_{42} \).

\[ \text{C}_{20}\text{H}_{42} \rightarrow \text{C}_{12}\text{H}_{26} + \text{__________________________} \]

(1)

(Total 6 marks)
Crude oil is a complex mixture of hydrocarbons, mainly alkanes. The number of carbon atoms in the molecules ranges from 1 to over 100.

(a) How does the boiling point change as the number of carbon atoms in the molecules increases?

___________________________________________________________________
___________________________________________________________________

(b) Name the method used to separate petroleum into fractions.

___________________________________________________________________

(c) The simplest hydrocarbon is methane, CH₄. Its structure can be represented:

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

Draw the structure of ethane, C₂H₆.

(1)
(Total 3 marks)