



Percentage	
Grade	

# Organic Chemistry

Duration: 1 hour

Total Marks: 58

### Information for Candidates:

- Use black or blue ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional paper is used, the question number(s) must be clearly shown
- The number of marks is given in brackets [ ] at the end of each question or part question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

*Do not write in this table*

[illegible]

- 2** A mixture of petrol and air is burned in a car engine.  
Petrol is a mixture of alkanes. Air is a mixture of gases.

The tables give information about the composition of petrol and the composition of air.

Petrol	
Alkane	Formula
hexane	$C_6H_{14}$
heptane	
octane	$C_8H_{18}$
nonane	$C_9H_{20}$
decane	$C_{10}H_{22}$

Air	
Gas	Percentage (%)
nitrogen	78
oxygen	21
carbon dioxide	0.035
Small amounts of other gases and water vapour	

- 2 (a)** Use the information above to answer these questions.

- 2 (a) (i)** Give the formula for heptane.

.....  
(1 mark)

- 2 (a) (ii)** Complete the general formula of alkanes.  
n = number of carbon atoms



(1 mark)

- 2 (b)** Alkanes in petrol burn in air.  
The equations represent two reactions of hexane burning in air.



**Reaction 2** produces a different carbon compound to **Reaction 1**.

- 2 (b) (i)** Name the carbon compound produced in **Reaction 2**.

.....  
(1 mark)

- 2 (b) (ii)** Give a reason why the carbon compounds produced are different.

.....  
.....  
(1 mark)

Question 2 continues on the next page

Turn over ►



- 2 (c)** The table shows the percentages of some gases in the exhaust from a petrol engine.

Name of gas	Percentage (%)
nitrogen	68
carbon dioxide	15
carbon monoxide	1.0
oxygen	0.75
nitrogen oxides	0.24
hydrocarbons	0.005
sulfur dioxide	0.005
other gases	

- 2 (c) (i)** What is the percentage of the other gases in the table?

.....  
(1 mark)

- 2 (c) (ii)** What is the name of the compound that makes up most of the other gases?

.....  
(1 mark)

- 2 (c) (iii)** Give a reason why sulfur dioxide is produced in a petrol engine.

.....  
.....  
(1 mark)

- 2 (c) (iv)** State how nitrogen oxides are produced in a petrol engine.

.....  
.....  
.....  
.....  
(2 marks)



- 2 (d)** Many scientists are concerned about the carbon dioxide released from burning fossil fuels such as petrol.

Explain why.

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.....

(2 marks)

11

**Turn over for the next question**

**Turn over ►**

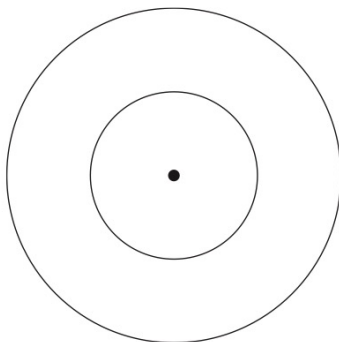


0 7

**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 \_\_\_\_\_

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

What does the term hydrocarbon mean?

**[1 mark]**

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**Turn over ►**



2 (c) Alkanes and alkenes are hydrocarbons.

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

Table 2

Alkanes

Name	Formula	Boiling point in °C
Ethane	C <sub>2</sub> H <sub>6</sub>	-88
Propane	C <sub>3</sub> H <sub>8</sub>	-42
Butane	C <sub>4</sub> H <sub>10</sub>	0
Pentane	C <sub>5</sub> H <sub>12</sub>	+36
Hexane	C <sub>6</sub> H <sub>14</sub>	+69

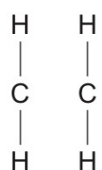
Alkenes

Name	Formula	Boiling point in °C
Ethene	C <sub>2</sub> H <sub>4</sub>	-104
Propene	C <sub>3</sub> H <sub>6</sub>	-48
Butene	C <sub>4</sub> H <sub>8</sub>	-6
Pentene	C <sub>5</sub> H <sub>10</sub>	+30
Hexene	C <sub>6</sub> H <sub>12</sub>	+64

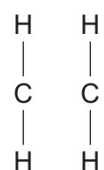
2 (c) (i) Complete the displayed structure of ethane and the displayed structure of ethene.

[2 marks]

Ethane



Ethene



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]

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- 2 (c) (iii) Use the information in **Table 2** to compare the boiling points of alkanes with the boiling points of alkenes.

[2 marks]

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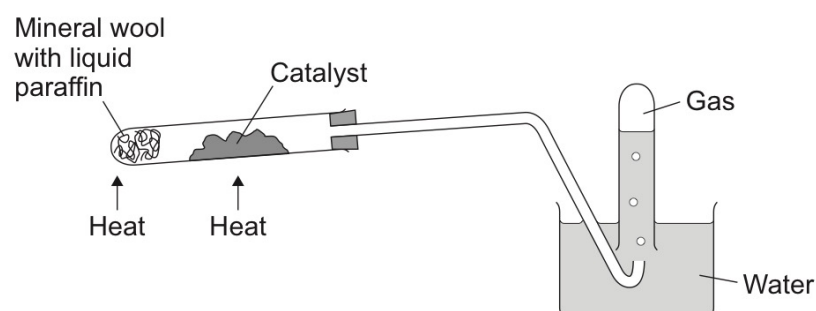
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- 2 (d) A student used the apparatus in **Figure 3** to investigate what happens when liquid paraffin is heated to a high temperature.

**Figure 3**



Liquid paraffin contains alkanes.

Describe what happens to the alkane molecules in this investigation.

[3 marks]

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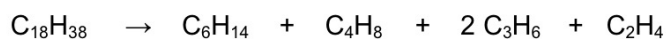


**0 1**

This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon,  $C_{18}H_{38}$

**0 1 . 1**

Which product of the reaction shown is an alkane?

**[1 mark]**

Tick **one** box.

 $C_2H_4$ ☐ $C_3H_6$ ☐ $C_4H_8$ ☐ $C_6H_{14}$ ☐**0 1 . 2**

**Table 1** shows the boiling point, flammability and viscosity of  $C_{18}H_{38}$  compared with the other hydrocarbons shown in the equation.

**Table 1**

	Boiling point	Flammability	Viscosity
<b>A</b>	highest	lowest	highest
<b>B</b>	highest	lowest	lowest
<b>C</b>	lowest	highest	highest
<b>D</b>	lowest	highest	lowest

Which letter, **A**, **B**, **C** or **D**, shows how the properties of  $C_{18}H_{38}$  compare with the properties of  $C_2H_4$ ,  $C_3H_6$ ,  $C_4H_8$  and  $C_6H_{14}$ ?

**[1 mark]**



Tick **one** box.

- A** ☐
- B** ☐
- C** ☐
- D** ☐

**0 1 . 3** The hydrocarbon  $C_4H_8$  was burnt in air.

Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?

[1 mark]

- A**  $C_4H_8 + 4O \rightarrow 4CO + 4H_2$
- B**  $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$
- C**  $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$
- D**  $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

Tick **one** box.

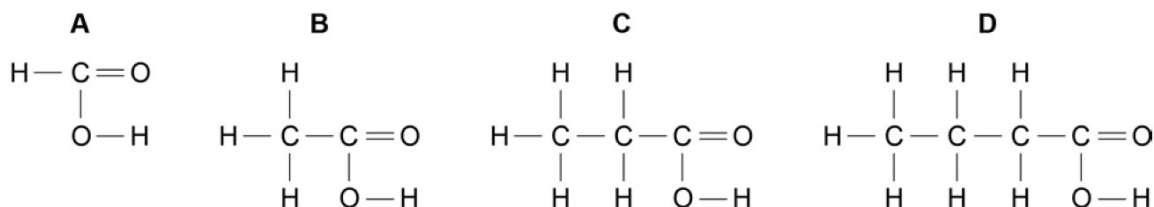
- A** ☐
- B** ☐
- C** ☐
- D** ☐

Question 1 continues on the next page

**0 1** . **4** Propanoic acid is a carboxylic acid.

Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?

[1 mark]



Tick **one** box.

<b>A</b>	<input type="checkbox"/>
<b>B</b>	<input type="checkbox"/>
<b>C</b>	<input type="checkbox"/>
<b>D</b>	<input type="checkbox"/>

**0 1** . **5** Propanoic acid is formed by the oxidation of which organic compound?

[1 mark]

Tick **one** box.

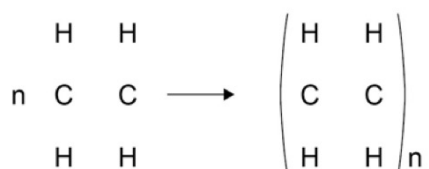
Propane	<input type="checkbox"/>
Propene	<input type="checkbox"/>
Propanol	<input type="checkbox"/>
Polyester	<input type="checkbox"/>

**0 6**

Ethene is used to produce poly(ethene).

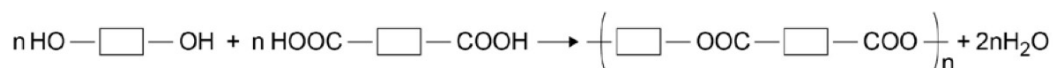
**0 6**. **1**

Draw the bonds to complete the displayed formulae of ethene and poly(ethene) in the equation.

**[2 marks]****0 6**. **2**

Polyesters are made by a different method of polymerisation.

The equation for the reaction to produce a polyester can be represented as:



Compare the polymerisation reaction used to produce poly(ethene) with the polymerisation reaction used to produce a polyester.

**[4 marks]**


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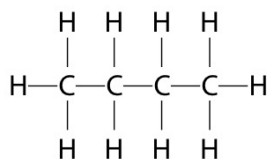
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## 4 Alkanes and alkenes are hydrocarbons.

The structure of a molecule of butane is shown.



(a) Which of the following is the empirical formula for butane?

(1)

- ☐ A CH
- ☐ B CH<sub>2</sub>
- ☐ C C<sub>2</sub>H<sub>5</sub>
- ☐ D C<sub>4</sub>H<sub>10</sub>

(b) Figure 5 shows some information about the alkenes, ethene and propene.

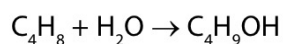
Complete the table. The structure of propene must show all covalent bonds.

(2)

name of alkene	molecular formula	structure
ethene		$  \begin{array}{ccc}  \text{H} & & \text{H} \\  & \diagdown \quad \diagup & \\  & \text{C}=\text{C} & \\  & \diagup \quad \diagdown & \\  \text{H} & & \text{H}  \end{array}  $
propene	C <sub>3</sub> H <sub>6</sub>	

Figure 5

(c) Butene reacts with steam to produce butanol.



- (i) Calculate the maximum mass of butanol,  $\text{C}_4\text{H}_9\text{OH}$ , that can be produced when 1.4 kg of butene,  $\text{C}_4\text{H}_8$ , reacts with excess steam.

(relative atomic masses:  $\text{H} = 1$ ,  $\text{C} = 12$ ,  $\text{O} = 16$ )

relative molecular mass of butene,  $\text{C}_4\text{H}_8 = 56$ )

(3)

mass of butanol = ..... kg

- (ii) What type of reaction takes place between butene and steam?

(1)

- ☐ **A** addition
- ☐ **B** dehydration
- ☐ **C** neutralisation
- ☐ **D** substitution

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- (d) A sample of each of three hydrocarbons, **X**, **Y** and **Z**, was shaken with bromine water. Bromine water is orange coloured.

The results are:

- X** orange mixture becomes colourless  
**Y** orange mixture becomes colourless  
**Z** mixture remains orange

Using the results, comment on the structures of the hydrocarbons **X**, **Y** and **Z**.

(2)

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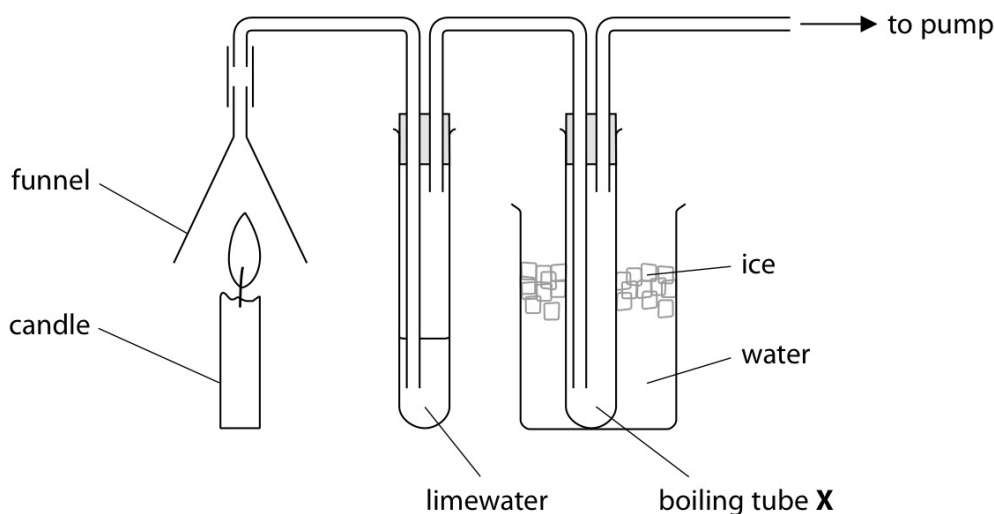
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**(Total for Question 4 = 9 marks)**

- 9 (a) A student carried out an experiment to prove that candle wax, a hydrocarbon, produces carbon dioxide and water vapour when it burns.

The equipment used is shown in Figure 11.



**Figure 11**

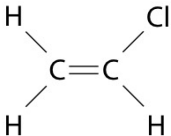
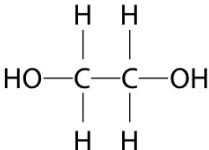
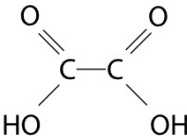
The gas produced from the burning candle is drawn through the apparatus. The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube X. The student claimed that this proved that burning candle wax produced water. The teacher said the apparatus had been set up incorrectly and therefore this conclusion about water was not valid.

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

Polymers can be formed by using the monomers shown in Figure 12.

monomer	structure
chloroethene	
ethane-1,2-diol	
ethanedioic acid	

**Figure 12**

Explain, using appropriate monomers from Figure 12, how different polymers can be formed.

(6)



(c) An alcohol **A**, with molecular formula  $\text{C}_2\text{H}_5\text{OH}$  is oxidised to a compound **B** with molecular formula  $\text{C}_2\text{H}_4\text{O}_2$ .

(i) Compound **B** is not an alcohol and is a member of another homologous series.

State the name of this homologous series.

(1)

(ii) Draw the structure of a molecule of compound **A** and a molecule of compound **B**, showing all covalent bonds.

(2)

Compound **A**

Compound **B**

(Total for Question 9 = 11 marks)

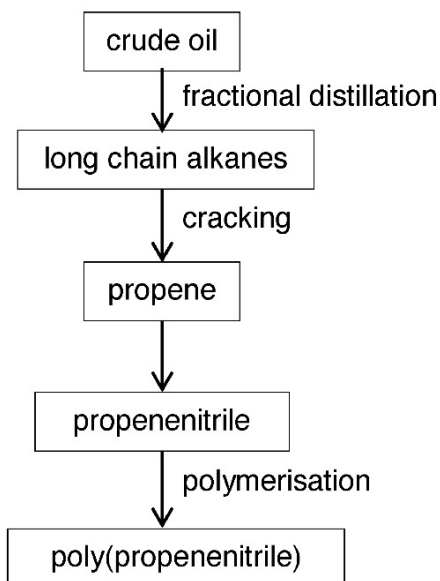
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20 Poly(propenenitrile) is an addition polymer.

Look at the flow chart. It shows how poly(propenenitrile) is made from crude oil.



(a) Crude oil is a mixture of hydrocarbons.

Fractional distillation separates the hydrocarbons in this mixture.

Explain how fractional distillation separates the hydrocarbons, in terms of intermolecular forces.

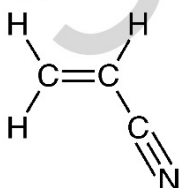
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..... [2]

(b) Look at the displayed formula for propenenitrile.



How can you tell from the displayed formula that propenenitrile is an unsaturated compound?

.....

..... [1]