

Organic Chemistry 4

Name: _____

Class: _____

Date: _____

Time: **71 minutes**

Marks: **65 marks**

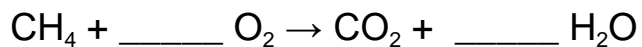
Comments:

1.

The combustion of fuels is a source of atmospheric pollutants.

(a) Methane is a fuel.

Balance the equation for the combustion of methane.



(1)

(b) Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

The table below shows properties of petrol and of diesel.

	Petrol	Diesel
Range of number of carbon atoms in a hydrocarbon molecule	4 to 12	12 to 20
Range of boiling points in °C	40 to 205	250 to 350

Compare the properties of petrol and diesel.

Use the table above.

(2)

(c) The gases released when a fuel is burned in car engines may include:

- oxides of nitrogen
- carbon monoxide
- water vapour.

Which chemical element do all these gases contain?

Tick (✓) **one** box.

Carbon

Hydrogen

Nitrogen

Oxygen

(1)

(d) When diesel burns in car engines, oxides of nitrogen are produced.

Where does the nitrogen come from?

(1)

(e) When diesel burns, particulates may be produced.

What environmental effect do particulates from burning diesel cause?

(1)

(f) Carbon monoxide may be produced when diesel burns.

Give **one** reason why carbon monoxide is difficult to detect.

(1)

(g) Explain why water vapour and **not** liquid water is produced when diesel burns.

(2)

(h) Sulfur is a common impurity in diesel.

Explain why this causes an environmental problem.

(3)

(Total 12 marks)

2.

Crude oil is a mixture of many different compounds.

(a) Give **two** reasons why crude oil is **not** a formulation.

1 _____

2 _____

(2)

(b) Describe how crude oil is separated into fractions.

(4)

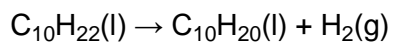
(c) The fractions from crude oil contain alkanes.

Explain why alkanes are cracked.

(2)

Cracking produces a mixture of products.

(d) An equation for cracking decane ($C_{10}H_{22}$) is:



Describe a test to identify the gas produced in the reaction.

Test _____

Result _____

(2)

(e) Alkenes are produced in cracking.

The general formula for the homologous series of alkenes is C_nH_{2n}

Which formula represents an alkene?

Tick (✓) **one** box.

C_2H_2

C_2H_4

C_2H_6

C_3H_8

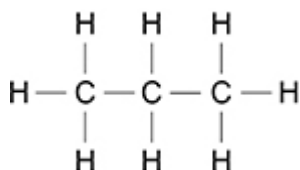
(1)

(Total 11 marks)

3.

This question is about hydrocarbons.

The diagram below shows a hydrocarbon.



(a) Complete the formula for the hydrocarbon shown in the figure above.

C _____ H _____

(1)

(b) What is the name of the hydrocarbon in the figure above?

(1)

(c) Which homologous series does the hydrocarbon in the figure above belong to?

(1)

- (d) 30 g of another hydrocarbon contains 24 g of carbon.

Which calculation gives the percentage of carbon in the hydrocarbon?

Tick (✓) **one** box.

$$\frac{24 \times 30}{100}$$

$$\frac{100 \times 30}{24}$$

$$\frac{24 \times 100}{30}$$

$$\frac{24}{30 \times 100}$$

(1)

- (e) **Table 1** shows boiling points of some hydrocarbons.

Table 1

Formula of hydrocarbon	Boiling point in °C
C ₂ H ₆	-89
C ₄ H ₁₀	0
C ₆ H ₁₄	69
C ₈ H ₁₈	125
C ₁₀ H ₂₂	174

Describe how the boiling points change as the number of carbon atoms in the hydrocarbon increases.

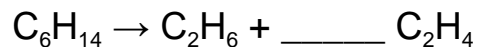
(1)

Hydrocarbons can be cracked.

(f) Give **one** condition used to crack hydrocarbons.

(1)

(g) Balance the equation for the cracking of C_6H_{14}



(1)

(h) Give **one** reason why hydrocarbons are cracked.

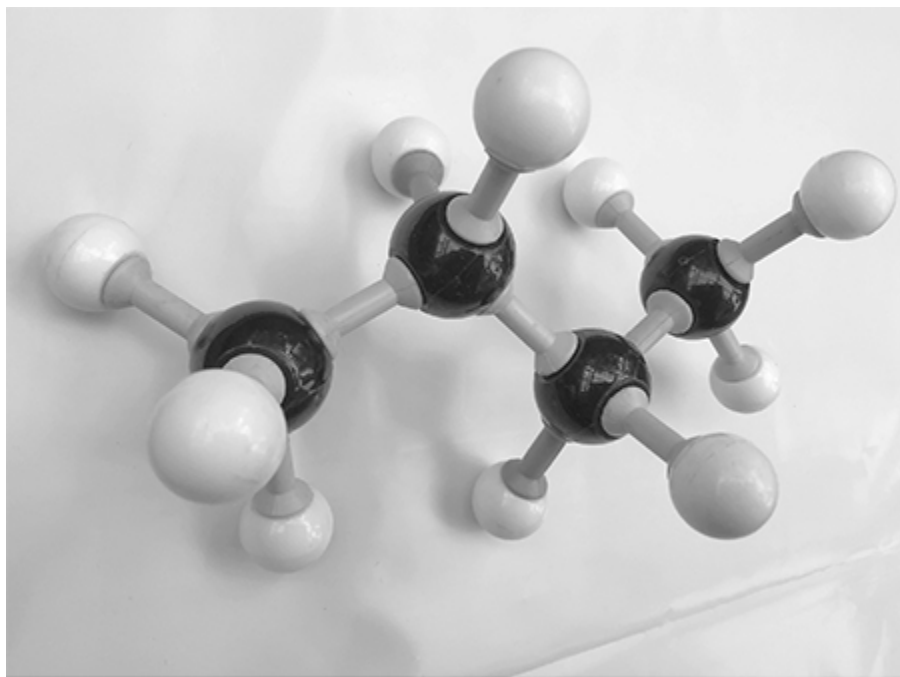
(1)

(Total 8 marks)

4.

This question is about hydrocarbons and the uses of hydrocarbons.

(a) The figure below shows a model of an alkane.



What is the name of the alkane in the figure above?

(1)

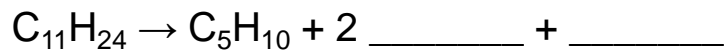
(b) What is a hydrocarbon?

(1)

Large hydrocarbon molecules are cracked.

(c) When $C_{11}H_{24}$ is cracked, three products are formed.

Complete the equation for the reaction.



(2)

(d) Explain why **one** of the products of cracking is in high demand.

(2)

5.

Crude oil is a resource found in rocks.

Most of the compounds in crude oil are hydrocarbons.

(a) Complete the sentence.

Crude oil is formed by the decomposition of _____.

(1)

(b) Alkanes are hydrocarbons.

Give the name of the alkane molecule that has three carbon atoms.

(1)

(e) C₂H₄ is an alkene.

What is the test for alkenes?

Give the result of the test if an alkene is present.

Test _____

Result _____

(2)

(Total 11 marks)

6.

Crude oil is a mixture of hydrocarbons.

(a) Complete the sentences.

Choose answers from the box.

air	enzymes	mud	plankton	trees
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Crude oil is the remains of _____.

Millions of years ago biomass was buried under _____.

(2)

(b) There are three stages, **A**, **B** and **C**, in separating hydrocarbons from crude oil.

Stage **A** Hydrocarbons evaporate

Stage **B** Crude oil is heated

Stage **C** Vapours condense

Give the correct order for stages **A**, **B** and **C**.

First stage _____

Second stage _____

Third stage _____

(1)

(c) What is the name of the process used in separating hydrocarbons from crude oil?

Tick (✓) **one** box.

Chromatography

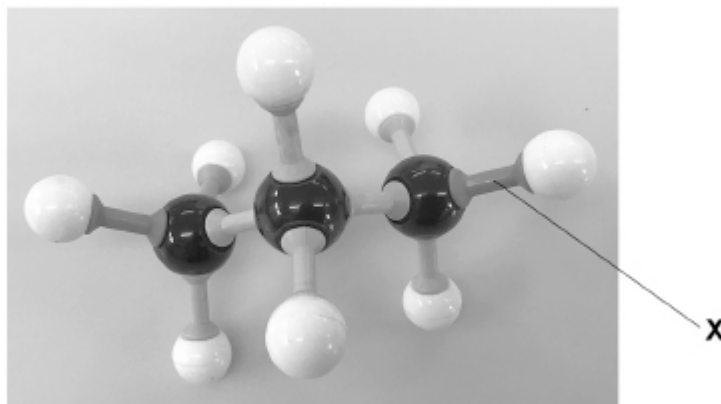
Filtration

Fractional distillation

(1)

(d) Alkanes are hydrocarbons.

The image below represents an alkane.



What is the formula of the alkane in the above image?

C___ H___

(1)

(e) What does **X** represent in the above image?

Tick (✓) **one** box.

Covalent bond

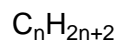
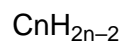
Ionic bond

Metallic bond

(1)

(f) What is the general formula for alkanes?

Tick (✓) **one** box.



(1)

(g) Hydrocarbons are used to make polymers. Polymers are used to make plastic bags.

In one year 8.0 billion plastic bags were used.

The next year there was a charge for plastic bags and only 1.3 billion plastic bags were used.

Calculate the decrease in the number of plastic bags used.

Decrease = _____ billion

(1)

(Total 8 marks)

Mark schemes

1. (a) $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$ 1
- (b) hydrocarbon molecules in petrol have fewer carbon atoms than those in diesel 1
- petrol has a lower boiling point (range) than diesel 1
- allow converse throughout*
- allow petrol is more flammable than diesel*
- allow petrol is less viscous than diesel*
- (c) oxygen 1
- (d) air 1
- allow the atmosphere*
- allow from volcanoes*
- (e) global dimming 1
- (f) (carbon monoxide is) colourless
or
(carbon monoxide is) odourless
ignore clear 1
- (g) (diesel) burns at a high temperature
or
(diesel) burns at a temperature greater than 100 °C 1
- (which is) above the boiling point of water 1

- (h) sulfur dioxide (is produced when diesel is burnt) 1
- (which causes) acid rain 1
- (which results in)
- any **one** from:
- damage to buildings / statues / bridges
 - damage to trees / plants
 - damage to aquatic life
 - acidification of lakes / rivers / soil
 - respiratory problems
- allow (which affects) asthma*

1
[12]

2.

- (a) (crude oil is a mixture but) not a useful product 1
- allow (crude oil is) not designed for a specific purpose*
- (and) not mixed in carefully measured quantities 1
- allow not the same composition all the time*
- (b) (crude oil) is heated to vaporise (the hydrocarbons) 1
- allow (crude oil) is heated to evaporate the hydrocarbons*
- temperature (of column) decreases from bottom to top 1
- allow the column gets cooler going up*
- (so) the fractions / hydrocarbons condense at different heights (in the column) 1
- (because) the fractions / hydrocarbons have different boiling points 1
- (c) (to make) smaller (hydrocarbon) molecules 1
- any **one** from: (which are)
- more useful molecules
- allow (which are) in higher demand*
- useful as fuels
 - starting materials
- allow (which are) alkenes for the production of other chemicals*

1

(d) (test)
burning / lit splint
allow flame
do not accept glowing splint

1

(result)
burns with a (squeaky) pop sound
allow pops

MP2 is dependent upon MP1 being awarded

1

(e) C₂H₄

1

[11]

3.

(a) C₃H₈

1

(b) propane

1

(c) alkane(s)

1

(d) $\frac{24 \times 100}{30}$

1

(e) (as the number of carbon atoms increases the) boiling point increases

1

(f) any **one** from:

- high temperature
allow a temperature between 400 °C and 900 °C
ignore heat / hot

- steam
- high pressure
- low / no oxygen (atmosphere)
- catalyst

allow aluminium oxide

allow alumina

allow zeolites

allow porous pot

1

(g) C₆H₁₄ → C₂H₆ + 2 C₂H₄
allow multiples or halves

1

- (h) any **one** from:
- to make smaller molecules
 - to make more useful molecules
 - to produce fuels
 - more demand for smaller molecules
 - to make (starting materials for) polymers
- allow to make (starting materials for) other chemicals*
allow to make alkenes

1

[8]

4.

(a) butane

1

(b) (molecule) made up of carbon and hydrogen (atoms) only

1

(c) $C_{11}H_{24} \rightarrow C_5H_{10} + 2 C_2H_4 + C_2H_6$
allow 1 mark for 2 C₂H₄
allow 1 mark for C₂H₆

OR

$C_{11}H_{24} \rightarrow C_5H_{10} + 2 C_3H_6 + H_2$ (2)
allow 1 mark for 2 C₃H₆
allow 1 mark for H₂

OR

$C_{11}H_{24} \rightarrow C_5H_{10} + 2 C_2H_6 + C_2H_2$ (2)
allow 1 mark for 2 C₂H₆
allow 1 mark for C₂H₂

2

(d) C₂H₆ is useful as a fuel

allow smaller molecule so useful as a fuel

1

(because more) flammable (than larger molecules)

1

OR

C₂H₄ / C₃H₆ / C₅H₁₀ is used to make polymers (1)

allow C₂H₄ / C₃H₆ / C₅H₁₀ is used to make plastics

allow C₂H₄ / C₃H₆ / C₅H₁₀ is used to make other chemicals

(because more) reactive (than alkanes) (1)

if a named product is given, allow 1 mark for a correct use and 1 mark for a correct linked reason

(e) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons is given.

5-6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3-4

Level 1: Relevant points are made. They are not logically linked.

1-2

No relevant content

0

Indicative content

- production of plastic uses more hydrocarbons which are from non-renewable crude oil
- production of plastic produces more greenhouse gases in the atmosphere which contributes to global warming
- production of plastic produces more sulfur dioxide which causes acid rain
- production of plastic produces more oxides of nitrogen which cause acid rain and respiratory problems
- disposal of plastic produces more waste which increases landfill
- burning plastic produces fumes which are toxic so cause respiratory problems
- lifetime cost of plastic frames is less
- plastic frames have lower costs for maintaining
- the total energy consumption for plastic frames is greater than for wooden frames
- judgement

[12]

5.

(a) plankton

or

(ancient) biomass

allow microscopic plants / animals

1

(b) propane

allow C₃H₈

1

- (c) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.

4–6

Level 1: Relevant features are identified and differences noted. 1–3 AO1 AO2

1–3

No relevant content

0

Indicative content

- methane has 1 carbon atom, hexane has 6
- methane has 4 hydrogen atoms, hexane has 14
- both contain C – H bonds
- only hexane contains C – C bonds
- both are hydrocarbons

- hexane has a higher melting point than methane (or converse)
- hexane has a higher boiling point than methane (or converse)
- methane is a gas at room temperature
- hexane is a liquid at room temperature

- both are small molecules
- hexane has larger molecules than methane
- weak forces between molecules
- forces between hexane molecules stronger than between methane molecules

- hexane is more viscous than methane
- both are flammable
- methane is more flammable than hexane (or converse)
- possible products of combustion from both are: carbon, carbon monoxide, carbon dioxide, water
- neither conduct electricity

- (d) C₈H₁₈

1

- (e) bromine (water)

1

turns (from orange / brown) to colourless

MP2 is dependent on MP1 allow decolourises ignore clear

1

[11]

6.

- (a) plankton

must be in this order

1

mud

1

- (b) **B or** crude oil is heated
A or hydrocarbons evaporate
C or vapours condense
must be in this order
all correct for 1 mark

1

- (c) fractional distillation

1

- (d) C_3H_8

1

- (e) covalent bond

1

- (f) C_nH_{2n+2}

1

- (g) 6.7 (billion)

allow 6 700 000 000

1

[8]