

Name: _____

Organic Chemistry part 2 AQA Triple Chemistry

Class: _____

Date: _____

Time: **70 minutes**

Marks: **66 marks**

Comments:

1.

This question is about glass and polymers.

Beakers can be made from borosilicate glass or poly(propene).

Table 1 shows information about materials used to make beakers.

Table 1

	Material used to make beakers	
	borosilicate glass	poly(propene)
Temperature at which melting begins in °C	850	160
Flammability	does not burn	burns
Resistance to impact	shatters	tough
Cost of 100 cm ³ beaker in £	1.50	2.00

- (a) Suggest **two** reasons why a Bunsen burner should **not** be used to heat a liquid in a poly(propene) beaker.

Use **Table 1**.

1 _____

2 _____

(2)

- (b) Poly(propene) beakers are more expensive than borosilicate glass beakers.

Suggest **one** reason why using poly(propene) beakers instead of borosilicate glass beakers could save money.

Use **Table 1**.

(1)

(c) Which is a raw material used to make borosilicate glass?

Tick (✓) **one** box.

Boron trioxide

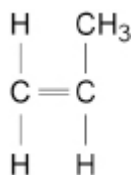
Clay

Limestone

(1)

Poly(propene) is produced from propene.

The displayed structural formula of propene is:



(d) **Table 2** shows some information about the elements in one molecule of propene.

Table 2

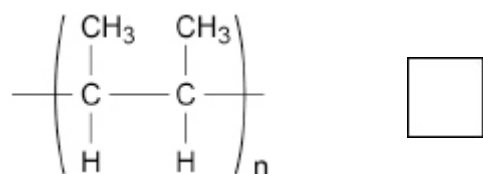
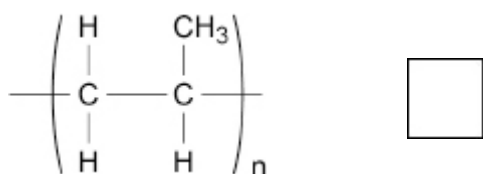
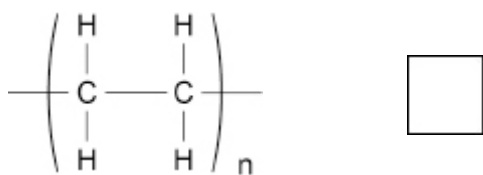
Symbol for element	Name of element	Number of atoms of element in one molecule of propene
C		
H		

Complete **Table 2**.

(2)

(e) Which structure is the repeating unit of poly(propene)?

Tick (✓) **one** box.



(1)

(f) Poly(propene) is produced in three stages:

- **Stage 1:** separating large alkane molecules from crude oil
- **Stage 2:** producing propene molecules from large alkane molecules
- **Stage 3:** joining many propene molecules together.

Name **Stage 1**, **Stage 2** and **Stage 3**.

Choose answers from the box.

cracking	fermentation	fractional distillation
polymerisation	reverse osmosis	

Stage 1 is _____.

Stage 2 is _____.

Stage 3 is _____.

(3)

(g) A molecule of hexene contains a double carbon–carbon bond.

Many hexene molecules join together to form poly(hexene).

Which **two** words describe a hexene molecule in this process?

Tick (✓) **two** boxes.

Alkene

Catalyst

Composite

Element

Monomer

(2)
(Total 12 marks)

2.

This question is about alcohols and carboxylic acids.

Alcohols are used as fuels.

A student burned 1.00 g of six alcohols and determined the energy released from each.

The table below shows the results.

Alcohol	Formula of one molecule of the alcohol	Energy released in kJ/g
Ethanol	C_2H_5OH	29.6
Propanol	C_3H_7OH	33.6
Butanol	C_4H_9OH	36.1
Pentanol	$C_5H_{11}OH$	37.7
Hexanol	$C_6H_{13}OH$	38.9
Heptanol	$C_7H_{15}OH$	39.8

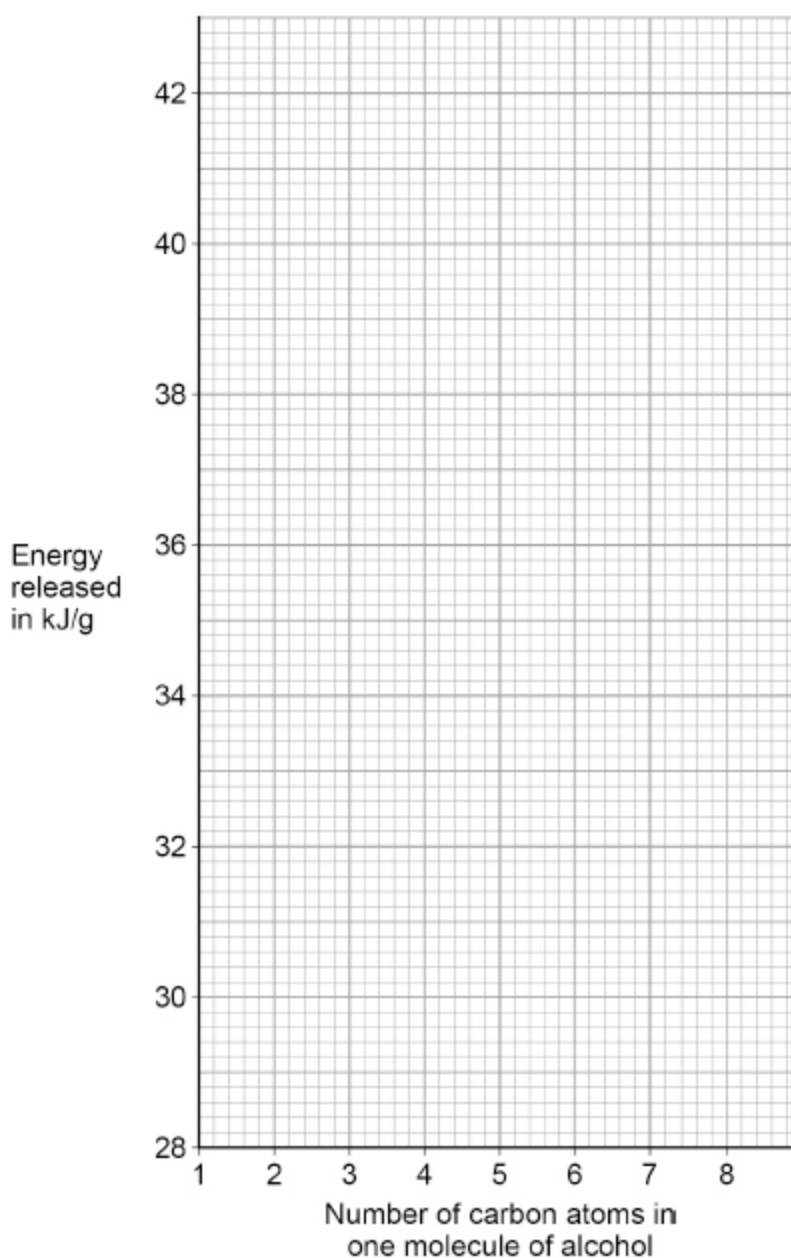
- (a) Calculate the mass of ethanol that must be burned to release the same amount of energy as burning 1.00 g of heptanol.

Mass = _____ g

(2)

- (b) The energy released in kJ/g varies with the number of carbon atoms in one molecule of each alcohol.

Plot the data from the table above on the figure below.



(2)

(c) Estimate the energy released in kJ when 1.00 g of octanol ($C_8H_{17}OH$) is burned.

Use the figure above.

Energy released = _____ kJ

(1)

Carbon dioxide is produced when alcohols are burned.

Carbon dioxide is identified by bubbling the gas through limewater.

(d) Complete the sentence.

Choose the answer from the box.

calcium chloride	calcium hydroxide	calcium nitrate	calcium sulfate
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Limewater is an aqueous solution of _____.

(1)

(e) Give the result of the test when carbon dioxide is bubbled through limewater.

(1)

Ethanoic acid can be produced from ethanol.

(f) What is reacted with ethanol to produce ethanoic acid?

Tick (✓) **one** box.

A halogen

An alkali metal

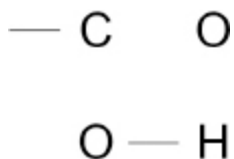
An oxidising agent

Water

(1)

(g) Ethanoic acid contains the functional group -COOH

Complete the displayed structural formula of this functional group.



(1)

(h) Ethanoic acid reacts with different compounds.

Draw **one** line from each compound to a product of the reaction of the compound with ethanoic acid.

Compound	Product of the reaction with ethanoic acid
	Carbon dioxide
Ethanol	Ethene
	Ethyl ethanoate
Sodium carbonate	Hydrogen
	Poly(ethene)

(2)

(Total 11 marks)

3.

This question is about the Earth's atmosphere.

The table below shows:

- the estimated percentages of gases in the Earth's early atmosphere
- the percentages of gases in the Earth's atmosphere today.

Gas	Estimated percentage (%) in the Earth's early atmosphere	Percentage (%) in the Earth's atmosphere today
Nitrogen	1.8	X
Oxygen	0.2	20.95
Carbon dioxide	96.0	0.04
Other gases	2.0	0.92

(a) Calculate value **X** in the table above.

$$X = \text{_____}\%$$

(1)

(b) Which **two** other gases may have been in the Earth's early atmosphere?

Tick (✓) **two** boxes.

- Ammonia
- Coal
- Limestone
- Methane
- Poly(ethene)

(2)

Algae and plants increased the percentage of oxygen in the Earth's atmosphere.

The same process in algae and plants decreased the percentage of carbon dioxide in the Earth's atmosphere.

- (c) Which process in algae and plants increased the percentage of oxygen in the Earth's atmosphere?

Tick (✓) **one** box.

Fermentation

Photosynthesis

Rusting

Sedimentation

(1)

- (d) Which **two** other processes decreased the percentage of carbon dioxide in the Earth's atmosphere?

Tick (✓) **two** boxes.

Burning fossil fuels

Dissolving carbon dioxide in oceans

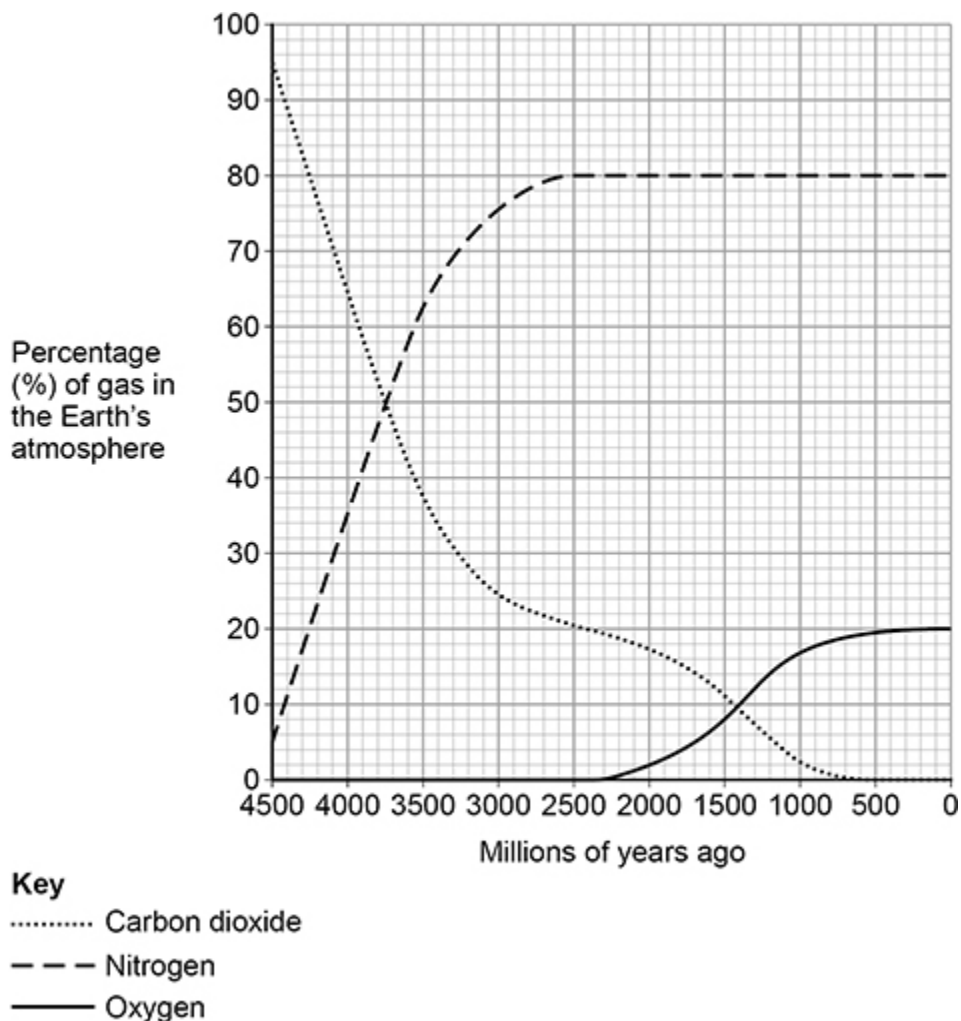
Eruption of volcanoes

Evolution of animals

Formation of sedimentary rocks

(2)

The figure below shows how the percentages of gases in the Earth's atmosphere may have changed since the atmosphere was formed.



(e) When was the percentage of oxygen in the Earth's atmosphere 8%?

Use the figure above.

_____ millions of years ago

(1)

(f) When did the percentage of nitrogen in the Earth's atmosphere become constant?

Use the figure above.

_____ millions of years ago

(1)

(g) Crude oil was formed from an ancient biomass as the Earth's atmosphere evolved.

What did this ancient biomass mainly consist of?

Tick (✓) **one** box.

Limestone

Plankton

Sand

(1)

(h) Most of the percentages of the gases in the figure above are estimated values.

Why have scientists used estimated values for the percentages of the gases in the figure above?

(1)

(Total 10 marks)

4.

This question is about the fractions obtained from crude oil.

(a) Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

Table 1 shows the boiling point range of these fractions.

- (b) Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which **two** are useful materials produced from this feedstock?

Tick (✓) **two** boxes.

Alloys

Ceramics

Detergents

Fertilisers

Solvents

(2)

Another fraction obtained from crude oil is petrol.

- (c) Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.



(2)

- (d) Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines.

(2)

- (e) **Table 2** shows information about two more fractions obtained from crude oil.

Table 2

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction.

(2)

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

(f) Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process.

Name of process _____

Conditions _____

(3)

- (g) Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would **both** turn bromine water colourless?

Tick (✓) **one** box.

C_7H_{14} and C_8H_{16}

C_7H_{14} and C_8H_{18}

C_7H_{16} and C_8H_{16}

C_7H_{16} and C_8H_{18}

(1)
(Total 16 marks)

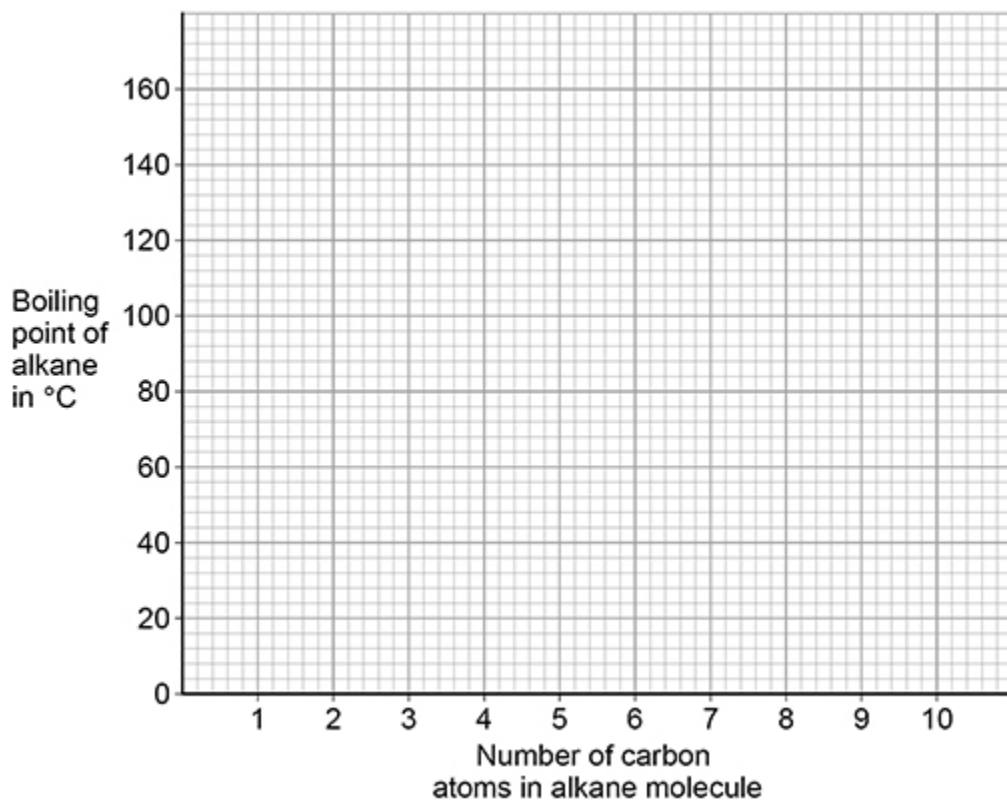
5.

This question is about alkanes.

The table below shows information about some alkanes.

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	X
8	126
9	151

(a) Plot the data from the table above on the graph below.



(2)

(b) Predict the boiling point **X** of the alkane with seven carbon atoms in a molecule.

Use the table and the graph.

X = _____ °C

(1)

(c) The graph above is **not** suitable to show the boiling point of the alkane with three carbon atoms in a molecule.

Suggest **one** reason why.

(1)

(d) What is the state at 20 °C of the alkane with four carbon atoms in a molecule?

Use the table above.

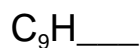
(1)

The table in part (a) is repeated below.

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	X
8	126
9	151

The alkane with nine carbon atoms in a molecule is called nonane.

(e) Complete the formula of nonane.



(1)

(f) Nonane will condense lower in a fractionating column during fractional distillation than the other alkanes in the table above.

Explain why.

You should refer to the temperature gradient in the fractionating column.

(2)

(Total 8 marks)

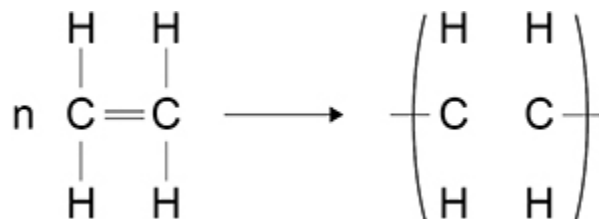
6. This question is about poly(ethene) and polyesters.

(a) Poly(ethene) is produced from ethene.

Figure 1 shows part of the displayed structural formula equation for the reaction.

Complete **Figure 1**.

Figure 1



(2)

(b) Poly(ethene) is a thermosoftening polymer.

Suggest why poly(ethene) is easier to recycle than thermosetting polymers.

(2)

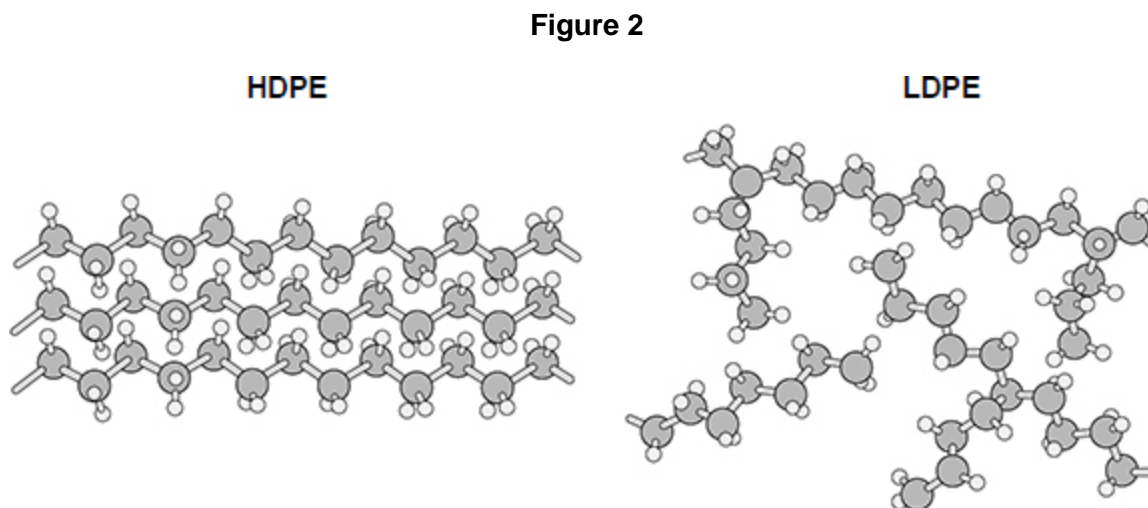
(c) Ethene produces different forms of poly(ethene).

How can different forms of poly(ethene) be produced from ethene?

(1)

- (d) Two different forms of poly(ethene) are:
- high density poly(ethene) (HDPE)
 - low density poly(ethene) (LDPE).

Figure 2 represents part of the structures of HDPE and LDPE.

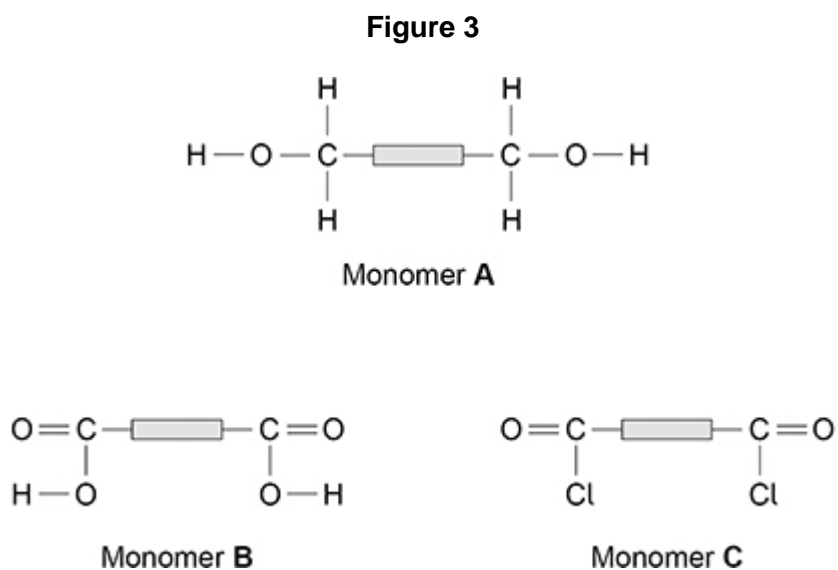


Explain why HDPE has a higher density than LDPE.

(2)

Figure 3 shows three monomers, A, B and C.

Monomer A can react with monomer B and with monomer C to produce polyesters.



(e) Draw a circle on **Figure 3** around an alcohol functional group.

(1)

(f) Complete the table below to show the formula of the small molecule produced when:

- monomer **A** reacts with monomer **B**
- monomer **A** reacts with monomer **C**.

Reacting monomers	Formula of small molecule produced
A and B	
A and C	

(1)

(Total 9 marks)

Mark schemes

1.

- (a) (the poly(propene) beaker will begin to) melt
allow poly(propene) has a low melting point

1

(the poly(propene) beaker will) burn / ignite
allow poly(propene) is flammable

1

- (b) (poly(propene) beakers are) less easily broken
allow (poly(propene) beakers are) less likely to shatter

allow (poly(propene) beakers are) tougher

allow (poly(propene) beakers have a) higher resistance to impact

1

- (c) boron trioxide

1

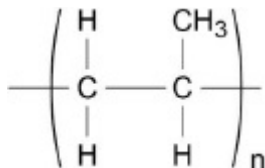
- (d)

Symbol for element	Name of element	Number of atoms of element in one molecule of propene
C	carbon	3
H	hydrogen	6

if no other mark awarded allow 1 mark for a correct column

2

- (e)



1

- (f) (**Stage 1** is) fractional distillation

1

(**Stage 2** is) cracking

1

(**Stage 3** is) polymerisation

1

(g) alkene

1

monomer

1

[12]

2.

(a) (mass =)
 $\frac{39.8}{29.6} (\times 1)$

1

= 1.34 (g)

allow 1.34459459 (g) correctly rounded to at least 2 significant figures

1

(b) all six points plotted correctly

allow a tolerance of $\pm \frac{1}{2}$ a small square

allow 1 mark for four or five points plotted correctly

2

(c) 40.6 (kJ)

allow a value in the range 40.4 - 40.8 (kJ)

allow a value consistent with the plotted points

1

(d) calcium hydroxide

1

(e) (limewater turns) milky / cloudy

allow white precipitate (formed)

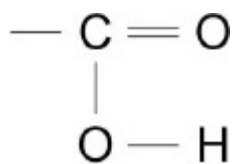
allow calcium carbonate is produced

1

(f) an oxidising agent

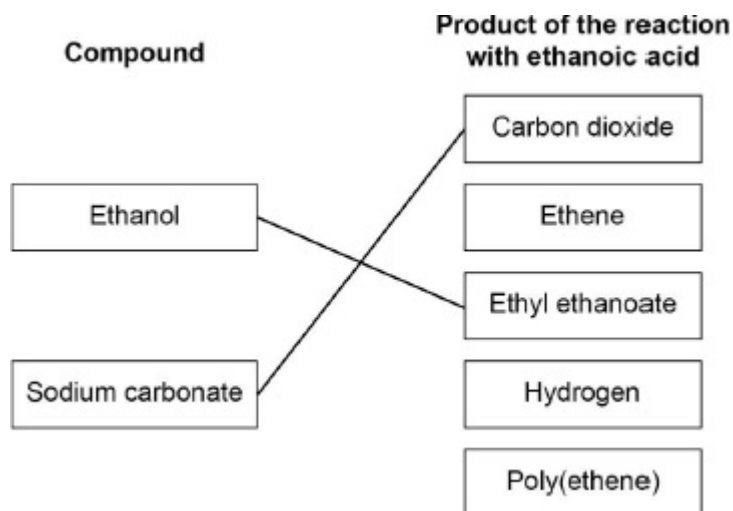
1

(g)



1

(h)



do **not** accept more than **one** line from a box on the left

2

[11]

3.

(a) 78.09 (%)

1

(b) ammonia

1

methane

1

(c) photosynthesis

1

(d) dissolving carbon dioxide in oceans

1

formation of sedimentary rocks

1

(e) 1500 (millions of years ago)

1

(f) 2500 (millions of years ago)

allow a value in the range 2500 to 2700 (millions of years ago)

1

(g) plankton

1

(h) (there is) limited evidence

allow the timescale was millions / billions of years

1

[10]

4.	(a) crude oil is heated to vaporise (the hydrocarbons)	1
	there is a temperature gradient in the (fractionating) column <i>allow a (fractionating) column is cooler going up</i>	1
	(so) the gases condense at different levels or (so) lubricating oil condenses below naphtha (and petroleum gases do not condense)	1
	(because of their) different boiling points	1
	(b) detergents	1
	solvents	1
	(c) $C_9H_{20} + 14 O_2 \rightarrow 9 CO_2 + 10 H_2O$ <i>allow multiples</i> <i>allow 1 mark for</i> $C_9H_{20} + O_2 \rightarrow CO_2 + H_2O$ with incorrect / no multipliers	2
	(d) (when burned sulfur impurities) produce sulfur dioxide	1
	(which) causes acid rain or (which) causes respiratory problems <i>allow specified effects of acid rain</i> <i>allow specified respiratory problems</i>	1
	(e) as molecular size increases viscosity increases	1
	(and) heavy fuel oil has larger molecules (than kerosene) <i>allow converse statements</i>	1
	(f) (name of process) cracking	1
	(conditions) high temperature <i>allow a stated temperature in the range 300 to 900 °C</i>	1
	steam / catalyst	1

(g) C_7H_{14} and C_8H_{16}

1

[16]

5.

(a) all five points plotted correctly

allow a tolerance of $\pm \frac{1}{2}$ a small square

allow 1 mark for three or four points plotted correctly

2

(b) 98 ($^{\circ}C$)

allow a value in the range 92 to 104 ($^{\circ}C$)

1

(c) the boiling point is lower than 0 ($^{\circ}C$)

allow the graph cannot show negative temperatures

1

(d) gas

allow (g)

1

(e) C_9H_{20}

1

(f) (nonane) has a higher boiling point

allow converse for the other alkanes

1

(so nonane) condenses where the column has a higher temperature

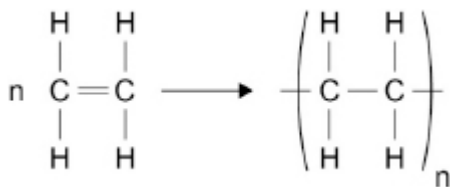
allow (so nonane) collects where the column has a higher temperature

1

[8]

6.

(a)



if equation incorrect

allow 1 mark for 5 single bonds

or

allow 1 mark for n

2

- (b) (poly(ethene)) melts
allow converse statements about thermosetting polymers
allow thermosoftening polymers melt 1
- (so) can be reshaped (into new products) 1
- (c) use different (reaction) conditions
allow use different temperatures / pressures 1
- (d) (in HDPE) polymer chains / molecules are closer together
allow converse statements about LDPE
allow (HDPE has) unbranched polymer chains / molecules 1
- (so) more atoms per unit volume
allow (so) more molecules per unit volume 1
- (e) circle around HO- **or** -OH on monomer **A** 1
- (f) H₂O
and
HCl
must be in this order 1
- [9]