



Alkanes, alkenes, alcohols, cracking and polymers

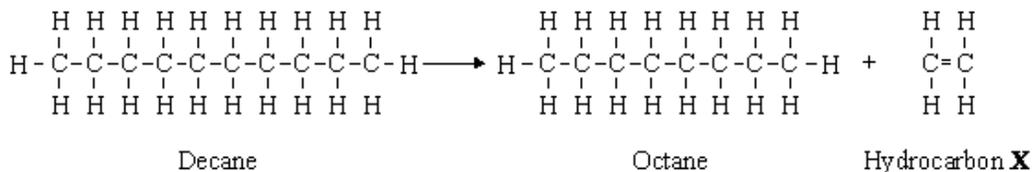


130 minutes



130 marks

Q1. The high demand for petrol (octane) can be met by breaking down longer hydrocarbons, such as decane, by a process known as cracking.



(a) Apart from heat, what is used to make the rate of this reaction faster?

..... (1)

(b) Octane is a *hydrocarbon*.

(i) What does *hydrocarbon* mean?

..... (1)

(ii) Give the molecular formula of octane.

..... (1)

(c) The hydrocarbon **X** is used to make poly(ethene).

(i) What is the name of **X**?

..... (1)

(ii) What is the name of the process in which **X** is changed into poly(ethene)?

..... (1)

(Total 5 marks)

Q2. (a) The hydrocarbon $C_{16}H_{34}$ was heated strongly in the absence of air.

This is one of the reactions which took place:



This type of reaction is carried out because there is a greater demand for the products than for the original hydrocarbon.

Suggest **two** reasons for this.

1

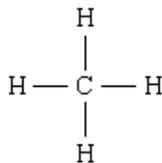
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2

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(2)

(b) A molecule of the compound methane, CH_4 , can be shown like this:

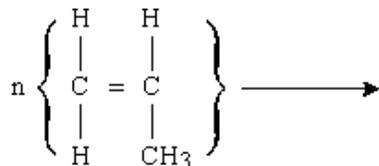


Draw a molecule of the compound ethene, C_2H_4 .

(2)

(c) Small molecules of substances called monomers can be joined together in polymerisation, eg. ethene poly \longrightarrow (ethene).

(i) Complete the equation below to show formation of the polymer from the monomer propene.



(1)

(ii) Suggest the name of the polymer formed.

.....

(1)
(Total 6 marks)

Q3. This question is about compounds produced from crude oil.

The table below shows four of these compounds.

Compound	Melting point in °C	Boiling point in °C
methane (CH ₄)	-183	-164
ethene (C ₂ H ₄)	-169	-104
decane (C ₁₀ H ₂₂)	-30	+174
icosane (C ₂₀ H ₄₂)	+37	+343

(a) Tick (✓) **two** correct statements about the four compounds.

Statement	Tick (✓)
Methane has the lowest melting point and icosane has the highest boiling point.	
Ethene and methane are alkanes.	
Methane and decane are gases at room temperature (20°C).	
Decane and icosane are liquid at 100°C.	

(2)

(b) Petrol contains a mixture of compounds, including octane (C₈H₁₈).

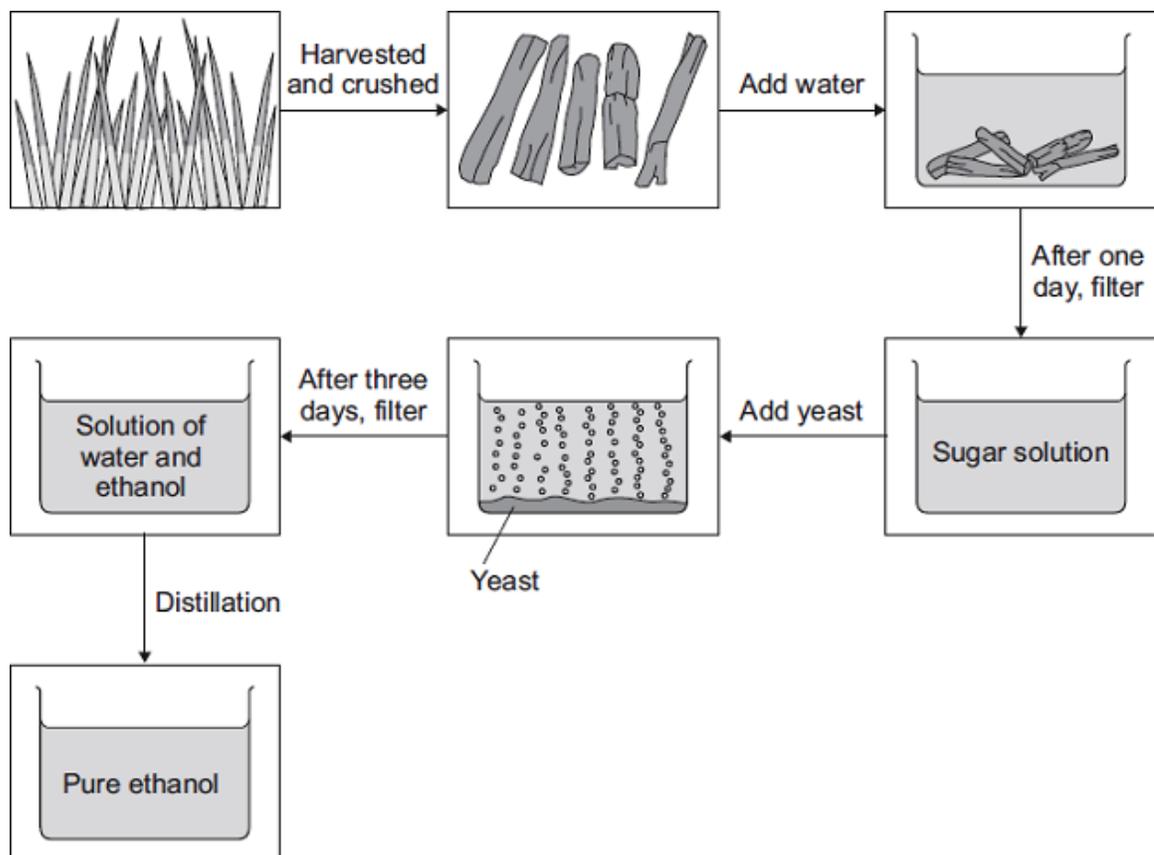
Complete the word equation for the complete combustion of octane.

octane + oxygen → +

(2)

(c) Most petrol used in cars contains about 5% ethanol (C_2H_5OH).

Ethanol can be produced from sugar cane.



(i) Draw a ring around the correct answer to complete the sentence.

The reaction to produce ethanol from sugar solution is

- combustion.
- displacement.
- fermentation.

(1)

(ii) Some people say that increasing the production of ethanol from sugar cane will be **good** for the environment.

Suggest **two** reasons why.

1

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2

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(2)

- (iii) Other people say that increasing the production of ethanol from sugar cane will be **bad** for the environment.

Suggest **two** reasons why.

1

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2

.....

.....

(2)
(Total 9 marks)

Q4. One reason the oil industry is important is that it uses crude oil to produce many of the plastic materials we use in everyday life.

- (a) The first stage in the formation of a plastic material is called cracking. Butane (C_4H_{10}), a hydrocarbon in crude oil, can be cracked to produce two different hydrocarbons, ethane (C_2H_6) and ethene (C_2H_4)

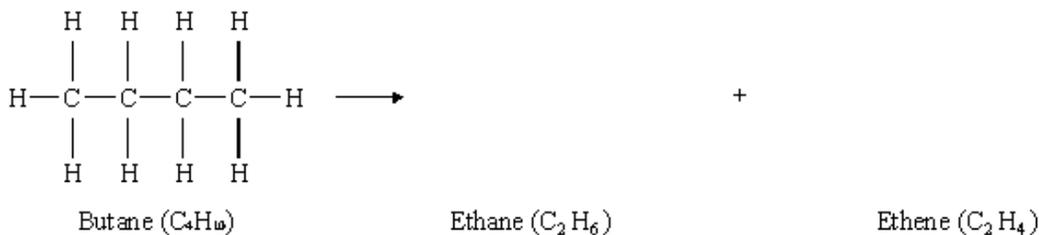
- (i) For cracking to happen what needs to be done to the hydrocarbon?

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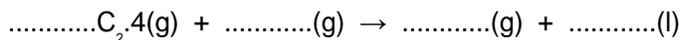
(2)

- (ii) Complete the equation for the cracking of butane using displayed formulae.



(2)

- (iii) Complete the balanced chemical equation for the complete combustion of ethane in oxygen.



(3)

(b) The second stage is the formation of the plastic material by polymerisation.

Describe how ethene (C_2H_4) forms poly(ethene). You do not need to give the reaction conditions or the names of catalysts.

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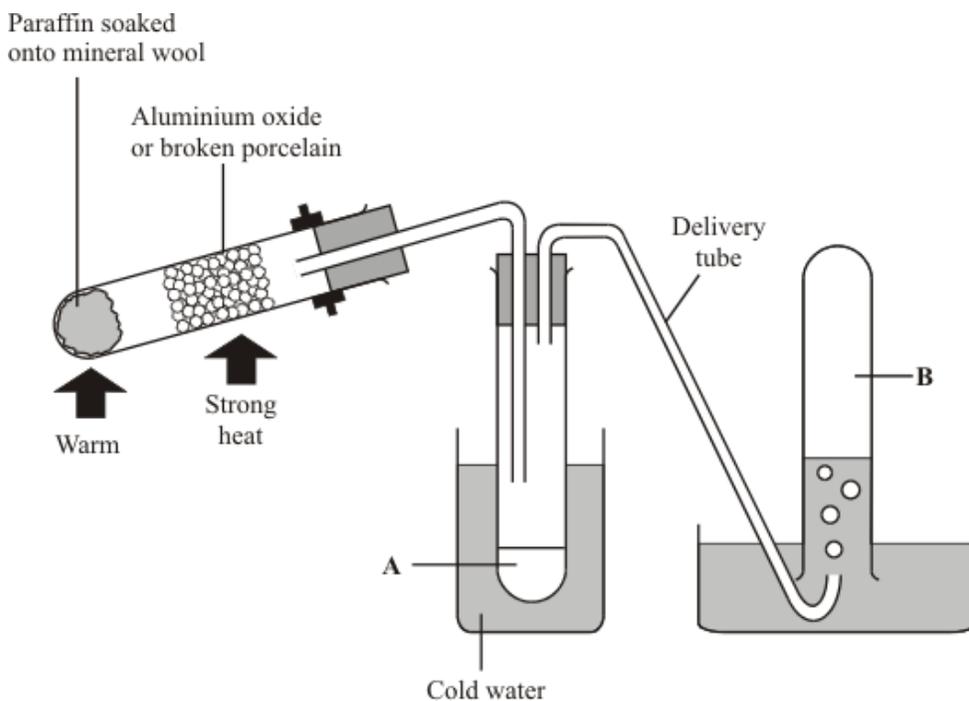
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(3)
(Total 10 marks)

Q5. The diagram shows an apparatus that can be used to carry out cracking reactions in a laboratory.



(a) Why is aluminium oxide or broken porcelain used?

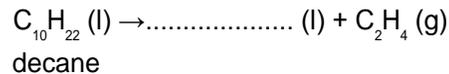
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(1)

- (b) Paraffin contains decane. The cracking of decane can be represented by the equation below. A decane molecule is split into two smaller molecules.

Complete the equation by adding the formula of the other product.



(1)

- (c) Would you expect C_2H_4 molecules to collect at position **A** or **B** shown on the diagram?

Position

Explain your answer.

.....
.....

(1)

- (d) Cracking reactions involve *thermal decomposition*.

What is meant by thermal decomposition?

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.....
.....

(2)

- (e) Explain, as fully as you can, why cracking is used in the oil industry.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(3)

(ii) Complete the structural formula for ethene, C_2H_4 .

C C

(1)

(iii) Name the compound that is added to ethene to produce ethanol, C_2H_5OH .

.....

(1)

(c) As explained in parts (a) and (b), ethanol can be made using either sugar or alkanes as the starting material.

Evaluate the advantages and disadvantages of using these two starting materials to produce ethanol.

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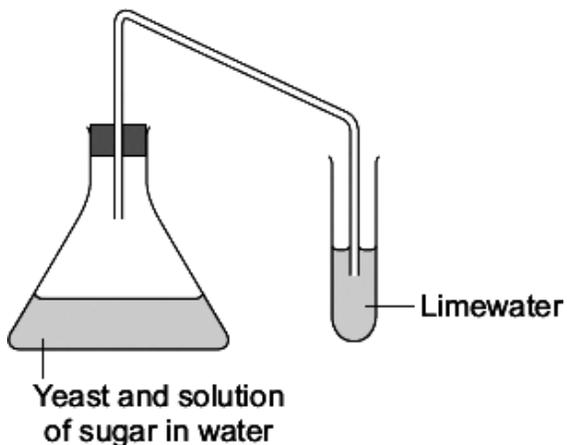
(4)

(Total 10 marks)

Q7. Two fuels that can be used for cars are:

- petrol from crude oil
- ethanol made from sugar in plants.

(a) A student used the apparatus shown to investigate the reaction to make ethanol from sugar.



(i) Draw a ring around the correct answer to complete the sentence

This reaction to make ethanol from sugar is

- | |
|----------------|
| combustion. |
| decomposition. |
| fermentation. |

(1)

(ii) Complete the sentences.

The limewater turns

This happens because

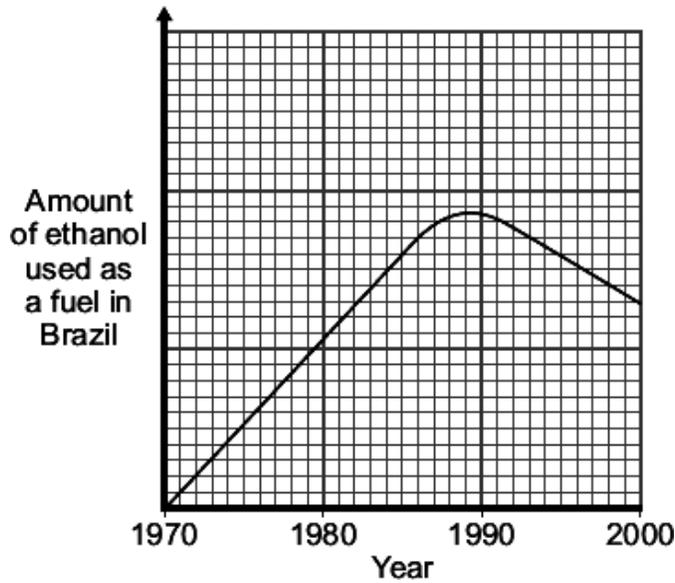
(2)

(b) In 1970, the Brazilian Government stated that all petrol must contain more than 25% ethanol.

The reasons for this statement in 1970 were:

- Brazil did not have many oilfields
- Brazil has a climate suitable for growing sugar cane.

The graph shows the amount of ethanol used as a fuel in Brazil from 1970 to 2000.



- (i) Use the graph to describe the changes in the amount of ethanol used as a fuel in Brazil from 1970 to 2000.

.....

.....

.....

.....

(2)

- (ii) In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%.

Suggest **one** reason for their decision.

.....

.....

(1)

(Total 6 marks)

Q8. Ethanol (C_2H_5OH) can be made from ethene or from sugar.

- (a) Complete the table which shows the number of atoms of each element in the formula of ethanol.

Use the Chemistry Data Sheet to help you to complete the table.

Element	Symbol	Number of atoms in the formula C_2H_5OH
Carbon	C	2
Hydrogen	H
.....	O	1

(2)

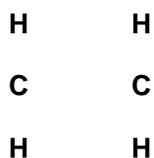
- (b) Ethene (C_2H_4) is produced when hydrocarbons are cracked.

- (i) Tick (✓) **two** conditions needed to crack a hydrocarbon.

Condition	Tick (✓)
The presence of an emulsifier.	
Heating the hydrocarbon to a high temperature.	
Adding oxygen to the hydrocarbon.	
The presence of a catalyst.	

(2)

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



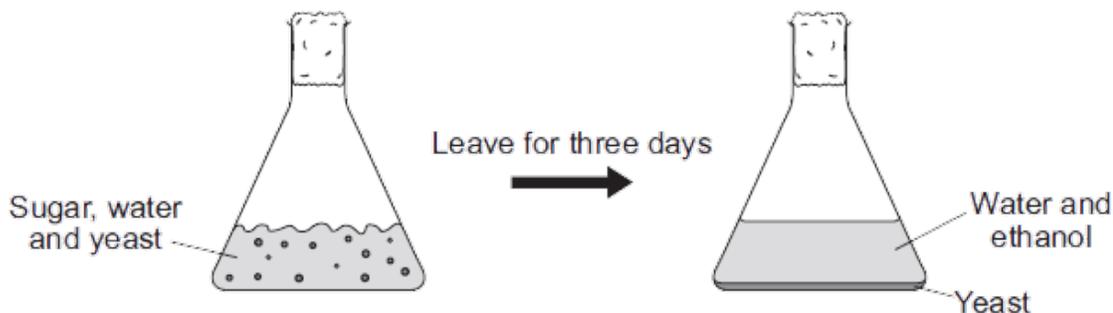
(1)

- (iii) Name the substance added to ethene (C_2H_4) to produce ethanol (C_2H_5OH).

.....

(1)

- (c) The diagram shows how a solution of ethanol is made from sugar dissolved in water.
The boiling point of ethanol is 78°C and the boiling point of water is 100°C .



- (i) Name the gas produced during this reaction.

.....

(1)

- (ii) What are the main steps needed to obtain pure ethanol from the mixture produced after three days?

.....

(2)

(Total 9 marks)

Q9. The plastic used for shopping bags is made from crude oil.



- (a) Complete each sentence.

- (i) The compounds of hydrogen and carbon
in crude oil are called

(1)

- (ii) Crude oil is separated into fractions, such as naphtha, using
fractional

(1)

- (b) Plastics are made from alkenes.
The alkenes are made from naphtha.

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

- (i) First the liquid naphtha is made into a gas. This process is called

distilling.
filtering.
vaporising.

(1)

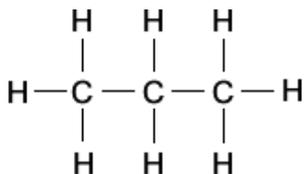
- (ii) The naphtha gas is then passed over a hot catalyst.

This process is called

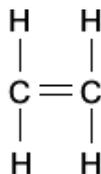
boiling.
bonding.
cracking.

(1)

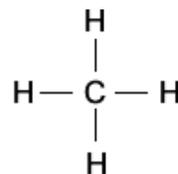
- (c) The displayed formulas of three molecules are:



Molecule A



Molecule B



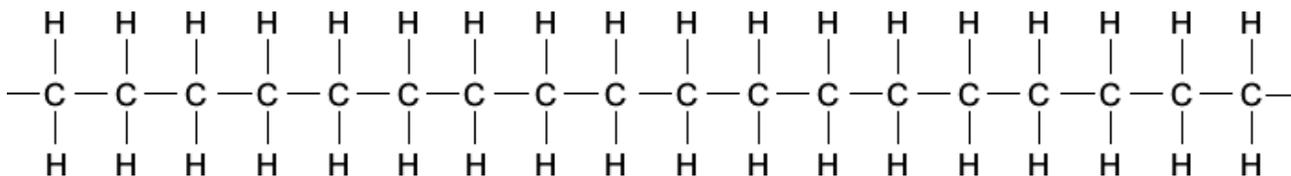
Molecule C

Which molecule, **A**, **B** or **C**, is an alkene?

(1)

- (d) The plastic for the bag is made when many alkene molecules are joined together to make the polymer called poly(ethene).

Part of a very large poly(ethene) molecule is shown below.



After plastic bags have been used for shopping, the bags can be reused, recycled, buried in landfill sites or burned.

- (i) Reusing and recycling used plastic bags is good for the environment because this conserves crude oil.

Tick (✓) another reason why recycling used plastic bags is good for the environment.

Reason	Tick (✓)
energy is used to transport and melt the used plastic bags	
new plastic products are made from the used plastic bags	
new plastic bags made from crude oil are cheap to produce	

- (ii) Complete the sentence.

One reason why burying used plastic bags in landfill sites is not good for the environment is that poly(ethene)

(1)

(iii) Some statements about burning used plastic bags are given below.

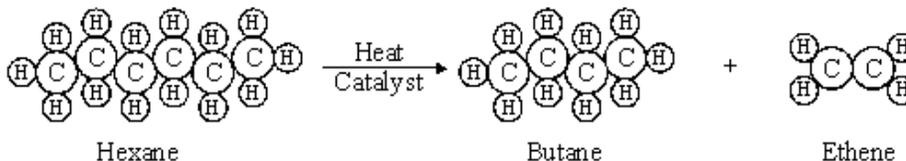
Tick (✓) **one** advantage and tick (✓) **one** disadvantage of burning used plastic bags.

	Advantage Tick (✓)	Disadvantage Tick (✓)
new plastic bags can be produced		
carbon dioxide is produced		
water is one of the products		
energy is released		

(2)
(Total 9 marks)

Q10. The many hydrocarbons in crude oil are separated into fractions.

(a) Some of the larger hydrocarbon molecules can be broken down to produce smaller, more useful hydrocarbon molecules.



Hexane and butane are alkanes. Describe the structure of alkanes.

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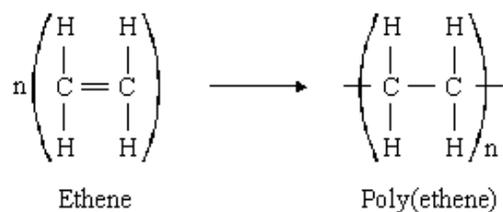
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(3)

(b) Ethene is used to make poly(ethene).



This process is called polymerisation. Explain what is meant by polymerisation.

.....

.....

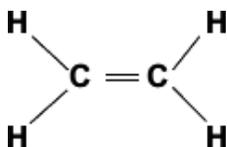
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(2)
(Total 5 marks)

Q11. Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers.
Plastic bags are made from a polymer.
The polymer is made from ethene.

The structural formula of ethene is shown.



Ethene is made by cracking hydrocarbons.
These hydrocarbons come from crude oil.

(a) Complete these sentences about ethene.

(i) Ethene is a hydrocarbon because it contains only and

(2)

(ii) Ethene is unsaturated because it has a bond.

(1)

(b) Tick (✓) the name of the polymer formed when many ethene molecules join together.

Name of polymer	Tick (✓)
poly(chloroprene)	
poly(ethene)	
poly(propene)	

(1)

(c) Suggest **two** reasons why supermarkets should stop giving plastic bags to customers.

1

.....

2

.....

(2)

(Total 6 marks)

Q12. Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers. The Government states that this is because plastic bags use up resources that are not renewable and that the manufacture of plastic bags produces carbon dioxide. Most of these plastic bags are made from poly(ethene). The table shows methods to deal with large numbers of used plastic bags.

Method	Description of what happens to the plastic bag
Reused	used again by the customer
Recycled	collected, transported, washed and melted to make new plastic items
Burned	collected, transported and burnt to release heat energy
Dumped	mixed with other household waste, collected, transported and disposed of at a landfill site

Use the information and your knowledge and understanding to briefly give **one advantage and one disadvantage** for each of these methods.

Reused

.....

.....

Recycled

.....

.....

Burned

.....

.....

Dumped

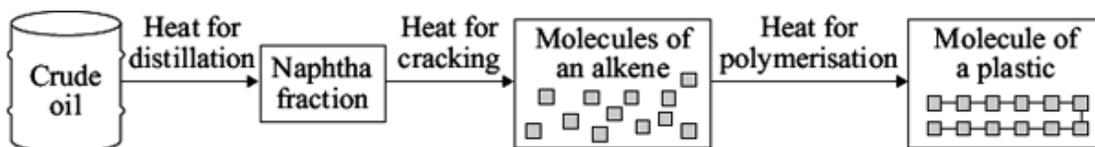
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(4)
(Total 4 marks)

Q13. Crude oil is used to make plastics.

(a) To make a plastic from crude oil involves many processes.



(i) How do alkene molecules form a molecule of a plastic?

.....
.....

(1)

(ii) Suggest **one** of the main costs of making a plastic from crude oil.

.....
.....

(1)

(iii) Suggest **two** problems caused by the disposal of plastics in landfill sites.

- 1
-
- 2
-

(2)

(b) Some companies are using bio-plastics made from plants such as corn. Less fossil fuel is used to make bio-plastics than is used to make plastics from crude oil.

Plastics made from plants would be more environmentally friendly than plastics made from crude oil.

Explain why.

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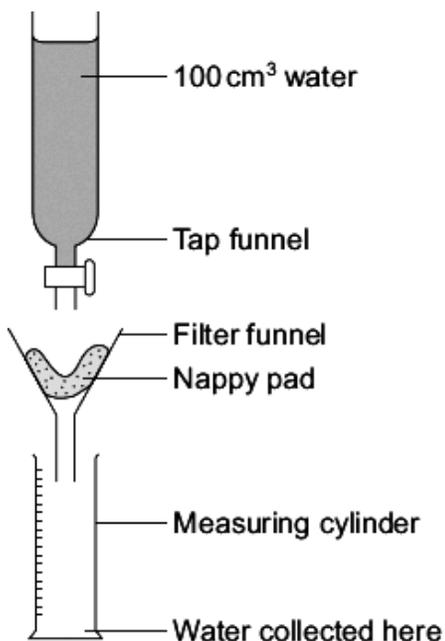
(2)
(Total 6 marks)

Q14. Disposable nappies for babies need to absorb as much water as possible.

Disposable nappies have a pad containing a special polymer called a hydrogel.

Hydrogels absorb water.

A company called Aqanaps compared the water absorption of its nappy pads with nappy pads made by other companies.



- A scientist from Aqanaps poured 100cm³ of water onto the pad of one of its nappies.
- He measured the volume of water that passed through.
- He did the test three times using a new nappy pad for each test.
- The scientist then repeated the procedure using the nappy pads from three other companies, **A**, **B** and **C**.

The results are shown in the table.

Company	Volume of water collected in cm ³		
	Pad 1	Pad 2	Pad 3
Aqanaps	55	57	55
A	47	46	39
B	65	63	64
C	38	39	38

(a) (i) Choose **one** result in the table that should be tested again.

Result: Company Pad

Explain why you chose this result.

.....

.....

.....

(2)

(ii) Suggest **one** variable that should be controlled in this investigation.

.....
.....

(1)

(iii) Suggest **one** possible cause of error in this investigation.

.....
.....

(1)

(b) (i) The Aqanaps company studied the results. The company concluded that it should increase the amount of hydrogel used in its nappy pads.

Give **two** reasons why the company decided to increase the amount of hydrogel used in its nappy pads.

1

.....

2

.....

(2)

(ii) Suggest **one** disadvantage for the company if it increases the amount of hydrogel used in its nappy pads.

.....

.....

(1)

(Total 7 marks)

Q15. Poly(propene) is a polymer made from propene. Propene is made by cracking longchain saturated hydrocarbons from crude oil.

(a) (i) Use words from the box to complete the sentences.

alkanes	alkenes	catalyst	fuel
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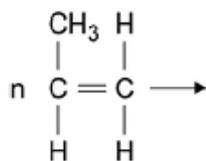
Cracking involves heating the to make a vapour.

The vapour is either passed over a hot or mixed with steam

and heated to a very high temperature.

(2)

- (ii) Complete the equation to represent the formation of poly(propene) from propene.



(3)

- (b) Propene and poly(propene) behave in different ways when shaken with bromine water.

- (i) What colour is bromine water?

Draw a ring around the correct answer.

green

orange

purple

(1)

- (ii) Complete the table to show the colour changes that are seen when bromine water is shaken with propene and poly(propene).

	Colour when shaken with bromine water
Propene	
Poly(propene)	

(2)

- (c) (i) Why can disposal of waste poly(propene) result in problems?

.....

(1)

- (ii) Poly(propene) has a low melting point. This means that waste poly(propene) can be melted down and moulded into new products.
 Explain why poly(propene) has a low melting point.

.....

(3)

- (d) (i) Some polymers are described as being **thermosetting**

How are the polymer chains held together in thermosetting polymers?

.....
.....

(1)

- (ii) Describe a simple experiment you could use to see if a polymer is a thermosetting polymer. State the result you would expect to obtain if the polymer was thermosetting.

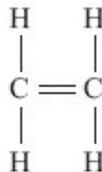
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(3)

(Total 16 marks)

Q16. Crude oil is used to make useful substances such as alkenes and plastics.

- (a) The alkene shown is ethene.



- (i) Tick (✓) the correct formula for ethene.

Formula	(✓)
CH_4	
C_2H_4	
C_2H_6	

(1)

(ii) Tick (✓) the name of the plastic formed when many ethene molecules join together.

Name of plastic	(✓)
Poly(ethene)	
Poly(ethanol)	
Poly(propene)	

(1)

(b) Read the article about plastics and then answer the questions.

THE PROBLEM WITH PLASTIC WASTE

The UK produces about 3 million tonnes of plastics from crude oil every year.
Most of the litter found on UK beaches is plastic waste.
80% of the plastics produced end up in landfill sites.
The UK recycles only 7% of plastic waste.

(i) Draw a ring around the correct answer in the box to complete the sentence.

Litter that is plastic waste needs to be removed from beaches

because it

decomposes
is flammable
is not biodegradable

.

(1)

(ii) Suggest a problem caused by 80% of the plastics going to landfill sites.

.....
.....

(1)

(iii) The UK government has set a target to recycle 30% of plastic waste.

How are resources saved by recycling more plastics?

.....
.....

(1)

(Total 5 marks)

##

Modern window frames are often made from uPVC which contains the plastic poly(chloroethene).

WONDERFUL WINDOWS

Replace your old wooden windows
with our super high quality uPVC
windows!

NO PAINTING - MAINTENANCE FREE



(a) State why plastic window frames need no painting or maintenance.

.....
.....

(1)

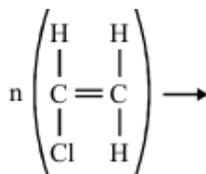
(b) Poly(chloroethene) is a polymer formed by the *addition polymerisation* of chloroethene.

(i) Chloroethene is an unsaturated molecule. Why is this molecule said to be unsaturated?

.....
.....

(1)

(ii) Complete the diagram to represent how poly(chloroethene) is formed from chloroethene.



(3)

(iii) Explain what is meant by the term *polymerisation*.

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.....
.....
.....

(2)

(iv) Why is this an *addition polymerisation*?

.....
.....

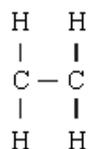
(1)
(Total 8 marks)

- M1.** (a) catalyst 1
- (b) (i) made up of **only** carbon and hydrogen 1
- (ii) C_8H_{18} 1
- (c) (i) ethene 1
- (ii) polymerisation 1

[5]

- M2.** (a) smaller, more useful molecules more reactive (molecules)/(molecules) used to make plastics more easily ignited/better fuels produces unsaturated compounds/alkenes
any two for 1 mark each 2

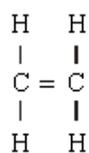
(b)



gains 1 mark

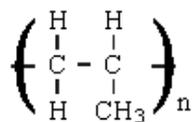
2

but



gains 2 marks

(c) (i)



for 1 mark

1

- (ii) poly(propene)
(N.B. brackets not required; *allow* “polypropylene”)
for 1 mark

1

[6]

M3. (a) Methane has the lowest melting point and icosane has the highest boiling point

1

Decane and icosane are liquid at 100°C

1

(b) water / H₂O

either order

1

carbon dioxide / CO₂

allow hydrogen oxide

1

(c) (i) fermentation

1

(ii) any **two** from:

- sugar cane / plants absorb carbon dioxide
ignore oxygen released
- growing sugar cane / plants reduces global warming
allow ethanol from plants is carbon neutral
- renewable resource / sustainable
accept conserves fossil fuels / petrol

2

(iii) any **two** from:

- destruction of habitats / forests (to grow sugar cane/crops)
- fermentation releases carbon dioxide
- production plants cause visual pollution
- pollution from the transportation of sugar cane / Ethanol
- growing sugar cane / plants uses a lot of land

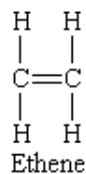
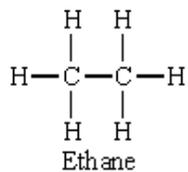
2

[9]

M4. (a) (i) heat
accept increase temperature ignore pressure 1

with a catalyst 1

(ii) 1



accept displayed formulae only

1

(iii) O₂ 1

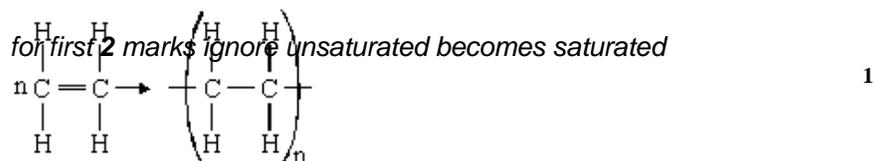
CO₂ + H₂O
ignore state symbols 1

correct balancing
2 + 7 → 4 + 6
accept 1 + 3½ → 2 + 3 only if reactants and products correct 1

(b) double bond breaks 1

many (ethene) molecules
accept many monomers 1

bond together
accept join **or** combine for bond
accept



M5. (a) catalyst **or** speeds up the reaction (owtte)
accept lowers activation energy **not** just helps reaction to take place
ignore increased surface area 1

(b) C_8H_{18}
allow H_{18}C_8
must be upper case
do **not** accept powers 1

(c) B
because it is a gas **or** because it has small molecules **or** because they are small
position **and** reason for mark
allow it has a lower / very low boiling point than **A**
ignore references to solubility
accept does not condense
do **not** accept light molecules **or** bubbles into B
do **not** accept it is small 1

(d) breakdown of a substance (owtte)
do **not** accept decompose unqualified 1

by the action of heat (owtte) 1

(e) **Quality of written communication**

if the written communication makes sense and it is in context then award Q mark

Q ✓ Q ✗

1

large to small molecules **or** scientific word that implies smaller,
e.g. alkene / ethane / petrol

any name or formula of alkane / alkene smaller than decane

1

either advantages of smaller molecules **or** disadvantages of larger molecules
e.g. hydrocarbons with large molecules are limited in their usefulness

***or** converse for smaller molecules*

1

large hydrocarbon molecules do not ignite easily / do not flow easily /
are not very volatile

***or** converse for smaller molecules*

more large hydrocarbon molecules are produced than are needed

***or** converse for smaller molecules*

smaller molecules are useful as fuels

alkenes / products can be used to make polymers

(f) (fractional) distillation

accept fractionation

accept good description

*do **not** accept just diagram*

1

[9]

M6. (a) (i) by (fractional) distillation

*accept a description of the distillation process (heat and how separation works) eg heat **and** condense
accept boil / vapourise etc for heat*

or

fractionation

1

(ii) CO₂

note the order of these products must be correct

1

H₂O

wrong way round = 1 mark

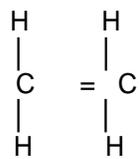
1

(b) (i) (hexane) has been broken down (into smaller hydrocarbons / molecules)

1

accept (thermal) decomposition / cracked / split / broken up owtte

(ii)



accept $\text{CH}_2 = \text{CH}_2$

1

(iii) water / hydrogen oxide / steam

accept H_2O

1

- (c) candidates must include both sugar cane and crude oil in their evaluation **and** both an advantage and a disadvantage to gain full marks. if they do not then the maximum mark is three

any **four** from:

advantages of using sugar

- country has no wealth to buy (large quantities of) crude oil
not 'expensive' alone
 - country has limited technological development
- or**
- underdeveloped / third world country
 - able / suitable climate to grow sugar cane
 - enough land to grow sugar cane / land cannot be used to grow food / deforestation
 - sugar is a renewable source

or

- crude oil is a non-renewable resource / finite resource / limited resources
- CO₂ / carbon neutral

advantages of using alkanes:

- economic costs are low
- continuous process
- country has large oil resources
- country has oil refineries / cracking plants
- very pure product
- faster process

4

[10]

M7. (a) (i) fermentation

1

(ii) cloudy
accept milky / white

1

there is carbon dioxide / CO₂
accept calcium carbonate forms

1

allow a (white) solid / precipitate forms

- (b) (i) (the amount of ethanol used) increases (from 1970) to 1989
if no year(s) or incorrect year(s) indicated then max 1
correct year(s) only needs to be indicated once to gain full marks
accept values in range 1987-1992

1

then it decreases from 1989 (to 2000)

1

- (ii) any **one** from:

- Brazil had more oilfields
- cost of crude oil had decreased
- cost of ethanol / sugar (cane) had increased
- demand for ethanol / sugar (cane) had increased
- availability of ethanol / sugar (cane) had decreased
accept availability of land to grow sugar (cane) had decreased
- climate change affects growing sugar (cane)

1

[6]

M8. (a) 6

1

oxygen

1

- (b) (i) heating the hydrocarbon to a high temperature

1

the presence of a catalyst

1

- (ii) all bonds correct

four C—H bonds **and**

one C=C bond

1

- (iii) water

accept hydrogen oxide/steam

allow H₂O

1

- (c) (i) carbon dioxide

allow CO₂

1

- (ii) by filtering/decanting/centrifuging (to remove yeast)
ignore sieving 1
- (fractional) distillation (to separate ethanol from water)
accept a description of (fractional) distillation 1

[9]

- M9.**
- (a) (i) hydrocarbons
accept alkanes 1
 - (ii) distillation 1
 - (b) (i) vaporising 1
 - (ii) cracking 1
 - (c) B 1
 - (d) (i) new plastic products are made from the used plastic bags 1
 - (ii) not biodegradable
accept does not decompose
allow does not rot 1
 - (iii) advantage – energy is released 1
 - disadvantage – carbon dioxide is produced 1

[9]

- M10.**
- (a) any **three** from
carbon (atom) spine / chain
accept idea of 'backbone' of carbon (atoms)
surrounded by hydrogen (atoms)
accept idea of only bonded to hydrogen (atoms) 3

single (covalent) bonds between carbon atoms

accept no double bonds

saturated (hydrocarbons)

(general formula) $C_n H_{2n+2}$

(b) many small molecules/ monomers

*accept many unsaturated molecules **or** alkenes*

1

join together to form a large / long molecule / polymer

1

[5]

M11. (a) (i) carbon

1

hydrogen

accept in either order

ignore number eg 2 carbons

4 hydrogens

1

(ii) (a carbon carbon) double (bond)

1

(b) poly(ethene)

1

(c) any **two** from:

ignore pollution / cost / global warming / harms environment / recycling

- made from crude oil
- non-renewable resources
accept resources are running out
- litter
accept go to landfill
- not biodegradable
- use energy to make
- when burned or biodegraded carbon dioxide is released
- encourage customers to reuse bags / use their own bags
accept reduces carbon emissions / footprint

2

[6]

M12. Reused

- saves raw materials / crude oil
 - *unable to reuse many times*
 - *bags easily split*
- saves energy / fuel / transport
- fewer bags needed / made
- reduces carbon / CO₂ emissions
- reduces use of landfill
- saves cost of a new bag
- no waste

1

Recycled

- saves raw materials / crude oil
 - *has to be collected / transported / washed / separated / melted*
- saves energy / use of fuel
- reduces carbon / CO₂ emissions
- reduces use of landfill
- can be used for new products
 - *ignore uses energy*

1

Burned

- heat / energy released can be used (for heating / generating electricity)
 - *has to be collected / transported*
- reduces use of landfill
 - *wastes the resource / plastic*
 - *releases harmful gases / toxic gases / CO₂*

1

Dumped

- collected / transported with household waste
 - *wastes the resource*
 - *plastic uses landfill*
- (slowly) biodegrades **or** produces methane which can be used as a fuel
 - *produces methane which is a greenhouse gas / could cause explosions*
- (not biodegradable so) does not release CO₂ / green house gas into the air
 - *not biodegradable / take years to decompose*

ignore cost / litter / waste / global warming / habitats unless mentioned above

1

[4]

M13. (a) (i) any **one** from:

- bond / join (together)
ignore polymerisation / heat
- double bond opens

1

(ii) any **one** from:

- heat / energy
ignore many processes / distillation / cracking / polymerisation
- cost of fuels / the crude oil
- construction of the factory / plant
- wages / salaries

1

(iii) any **two** from:

ignore gases released / burning / habitats

- non-biodegradable
accept remains a long time
- landfill sites are filling up / limited
accept land / space used up
- waste of a resource / could be recycled / reused
accept crude oil is running out

2

(b) any **two** from:

- renewable / sustainable
ignore recycling
ignore crude oil is running out
- less fuel burned
accept less energy / heat needed
- biodegradable
- natural resource
- plants absorb carbon dioxide

2

[6]

M14. (a) (i) A **and** 3

*accept A **and** 39*

1

anomalous result

independent mark

*accept not close to other two volumes **or** correct comparison using the results*

ignore does not fit the pattern

1

(ii) any **one** from:

- volume of water (used)
allow amount of water (used)
- time (for water to run through)
accept rate / speed (at which water runs through)
- temperature
- mass / surface area of pad
accept amount / size / volume / thickness of pad
- same filter funnel
ignore other equipment

1

- (iii) any **one** from:
- ignore human error unqualified*
 - incorrect / volume / amount of water added
 - reading / volume / amount of water collected
 - some water does not go through the pad
allow spillage / poorly placed pad
 - not enough time allowed for water to drain through
accept rate / speed at which water is added
 - pads (from one company) not identical / faulty

1

- (b) (i) any **two** from:

- it was not the best (at absorbing the water)
*accept correct descriptions of 'not the best' / third best **or** only better than B*
- (needed) to absorb more (water)
allow not absorbing enough (water)
- to improve their image / sales
*accept (needs) to absorb more (water) than A and C for **2** marks*

2

- (ii) any **one** from:

must relate to the company

- cost (more)
- use (more) resources
- use (more) energy

1

[7]

- M15.** (a) (i) alkanes

1

catalyst

1

- (ii) correct structure

1

continuation bonds

1

()_n around structure

1

- (b) (i) orange 1
- (ii) propene: colourless 1
- poly(propene): orange 1
- (c) (i) because poly(propene) is not biodegradable
owtte 1
- (ii) because there are weak forces 1
- between molecules 1
- which need little energy to overcome 1
- no bonds / cross links between molecules = first two points*
- (d) (i) held in place by cross links
or
held in place by covalent bonds 1
- (ii) idea of warming / heating 1
- by a suitable method 1
- the polymer does not become soft / bend 1

[16]

- M16.** (a) (i) C_2H_4 1
- (ii) poly(ethene) 1
- (b) (i) is not biodegradable 1
- (ii) not enough landfill sites / space
*accept landfill sites are filling up or plastics remain for years or
plastics not broken down
ignore cost / waste of resources / not biodegradable / wildlife* 1

- (iii) less (crude) oil / fuels / energy used
accept (crude) oil is a non-renewable resource

1

[5]

- M17.** (a) not broken down by microorganisms **or** not bio-degradable

*accept alternative answers such as:
do not rot / corrode / fade / react with atmosphere etc
any answers which imply the inertness or non-biodegradability of
this plastic
accept they don't react, they are 'inert'
ignore rusting
do **not** accept weathering*

1

- (b) (i) (have a) double bond **or** do not have maximum number of
(hydrogen) atoms attached

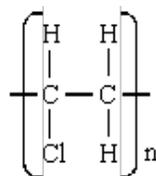
*accept can add / react with hydrogen
accept can take part addition reactions
do **not** accept it is a double bond
do **not** accept additional reactions
do **not** accept has 'spare' / 'free' bond
do **not** accept alkene alone*

1

- (ii) single bond between carbon atoms

1

all atoms correct + 2 'linking' bonds
(linking bonds need not go through bracket)



1

n moved to bottom right of bracket i.e. is below $\frac{1}{2}$ way on the right
*first 2 marks are possible for chain structures
accept $[-\text{CHCl}-\text{CH}_2-]_n$*

1

- (iii) many molecules **or** many monomers

1

joined / bonded / linked **or** form long
chain molecules / large molecules **or** to
form a long chain polymer

*accept many alkenes **or** many (ethene) molecules
do **not** accept many ethene alone etc.
to form a long polymer is not enough for 2nd mark*

1

- (iv) no other substances formed
(A + B → C)

allow because double bond breaks so other atoms can add

allow one product only

*do **not** accept saturation occurs*

1

[8]

