1 The table below gives information about four alcohols.

Alcohol	Formula	Melting point in °C	Boiling point in °C
Methanol	CH_3OH	−94	65
Ethanol	CH_3CH_2OH	−118	78
Propanol	$CH_3CH_2CH_2OH$	−129	97
Butanol	$CH_3CH_2CH_2CH_2OH$	−89	118

(a) Which alcohol in the table is liquid over the greatest temperature range?

_____

(1)

(b) Which statement is correct?

Tick **one** box.

A molecule of ethanol has 5 hydrogen atoms ☐

Butanol has the highest boiling point ☐

Methanol has the largest molecules ☐

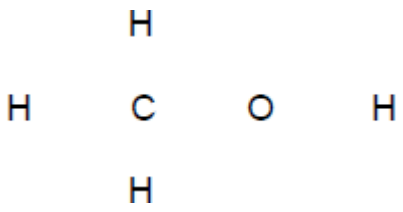
Propanol has the highest melting point ☐

(1)

(c) A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 1** to complete the displayed formula for methanol.

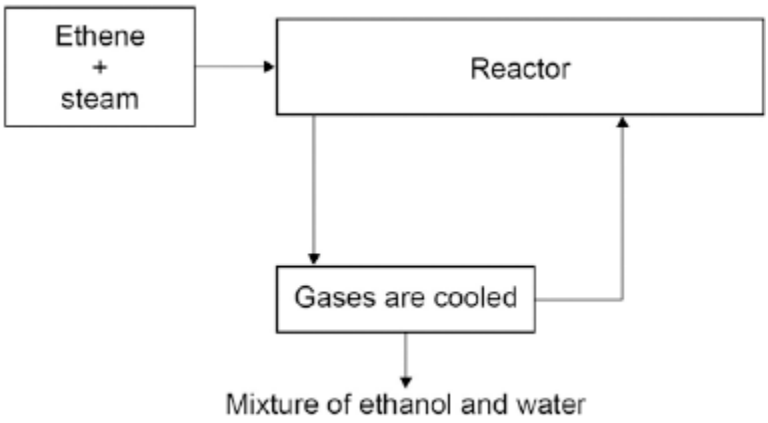
Figure 1



(1)

(d) **Figure 2** shows a flow diagram of the process to produce ethanol.

Figure 2



Complete the word equation for the reaction to produce ethanol.

_____ + _____ → ethanol

(1)

(e) What happens to the unreacted ethene?

_____

_____

(1)

(f) Wine contains ethanol.
A bottle of wine was left open in air.
After a few days, the wine tasted of vinegar.
Vinegar is a solution of ethanoic acid in water.

Explain how oxidation causes the wine to taste of vinegar after a few days.

_____

_____

_____

_____

_____

_____

_____

_____

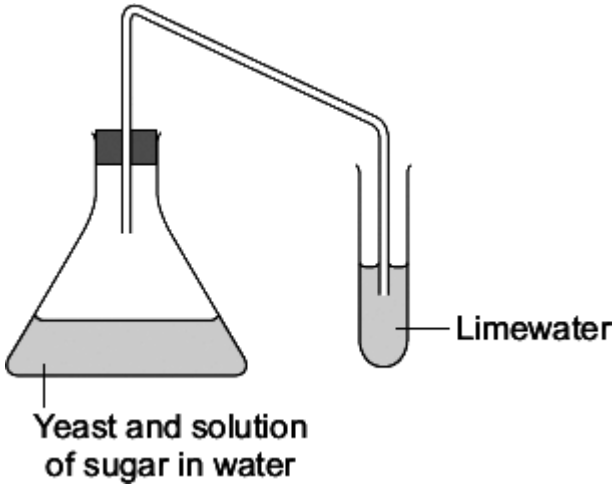
(3)

(Total 8 marks)

2 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 _____ .

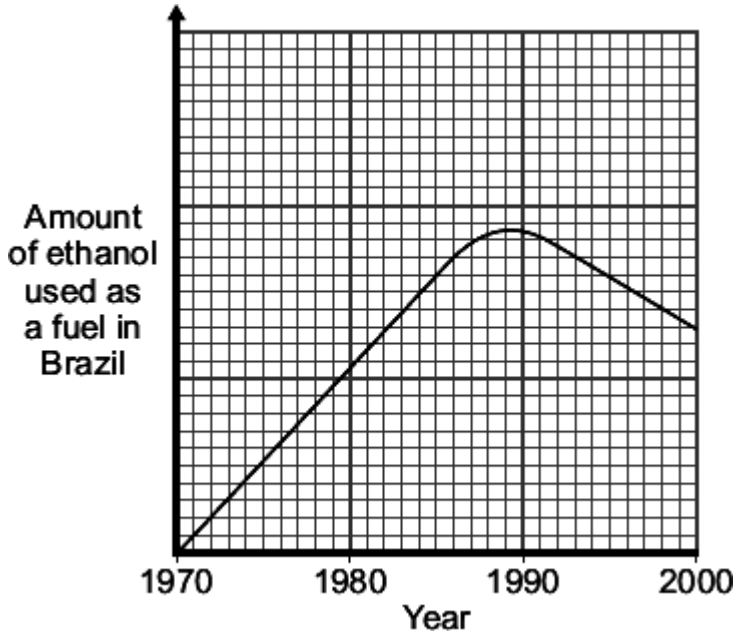
(2)

(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)

3 This question is about organic compounds.

(a) Ethanol is an alcohol.
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

_____

_____

(2)

(b) Which gas is produced when sodium reacts with ethanol?

Tick (✓) **one** box.

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Oxygen ☐

(1)

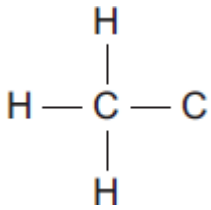
(c) Ethanoic acid (CH_3COOH) can be produced from ethanol (CH_3CH_2OH).

(i) What type of reaction produces ethanoic acid from ethanol?

_____

(1)

(ii) Complete the displayed structure of ethanoic acid.



(1)

(iii) Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

_____

_____

_____

_____

(2)

(d) Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

(i) Name the ester made from ethanol and ethanoic acid.

_____

(1)

(ii) What type of chemical is used as a catalyst in this reaction?

_____

(1)

(iii) Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

_____

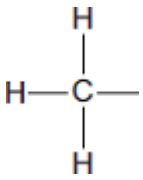
(1)

(Total 10 marks)

4 This question is about organic compounds.

(a) Wine contains ethanol (CH_3CH_2OH).

(i) Complete the displayed structure of ethanol.



(1)

(ii) Wine left in a glass for several days turns sour.
The sour taste is caused by ethanoic acid.

Complete the sentences.

The ethanoic acid is produced from a reaction between ethanol

and _____ .

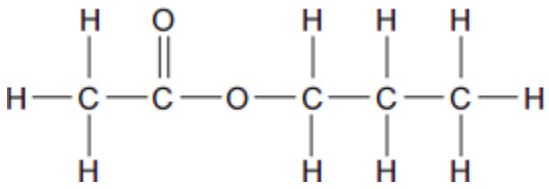
This type of reaction is _____ .

(2)

(b) Propyl ethanoate, a fragrance, can be produced by reacting ethanoic acid with an alcohol.

Propyl ethanoate is a member of a series of organic compounds. The members of the series all have the same functional group.

The displayed structure of propyl ethanoate is:



(i) Draw a ring around the functional group for this series on the displayed structure of propyl ethanoate.

(1)

(ii) Name the series of organic compounds with this functional group.

_____

(1)

(iii) The alcohol used to make propyl ethanoate has the formula $CH_3CH_2CH_2OH$

Name this alcohol.

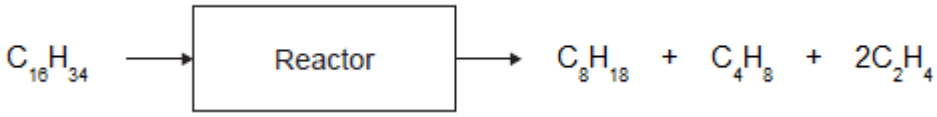
_____

(1)

(Total 6 marks)

5 Poly(butene) is a polymer made from crude oil in two stages.

(a) The first stage in making poly(butene) is to break down large hydrocarbon molecules from crude oil into smaller hydrocarbon molecules, as shown in the figure below.



(i) The products contain two types of hydrocarbon with different general formulae.

Name the two types of hydrocarbon.

_____

(1)

(ii) Describe the conditions in the reactor.

(2)

(iii) Suggest why air must **not** enter the reactor.

(1)

(iv) Suggest a method that can be used to separate butene (C_4H_8) from the other hydrocarbons.

(1)

(b) The second stage is to use butene (C_4H_8) to produce poly(butene).

(i) Draw the displayed structure of a butene (C_4H_8) molecule.

(1)

(ii) Describe how molecules of butene (C_4H_8) form poly(butene).

(2)

(Total 8 marks)

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

(a) The complete combustion of ethanol produces carbon dioxide and water.

Complete and balance the symbol equation for the complete combustion of ethanol.

C_2H_5OH + ____O_2 → _____ + _____

(2)

(b) Ethanol can be produced from octane (C_8H_{18}).

The two chemical equations represent the production of ethanol from octane.

Equation 1: $C_8H_{18} \rightarrow C_4H_{10} + 2C_2H_4$

Equation 2: $C_2H_4 + H_2O \rightarrow C_2H_5OH$

(i) In **Equation 1** the products are a mixture of two gases.

Describe a chemical test that would indicate the presence of ethene (C_2H_4) in the mixture.

_____

_____

_____

_____

(2)

(ii) Describe, as fully as you can, the conditions used for the two reactions to produce ethanol from octane.

Use **Equation 1** and **Equation 2** to help you with your answer.

(4)

(Total 8 marks)

7 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_2H_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)

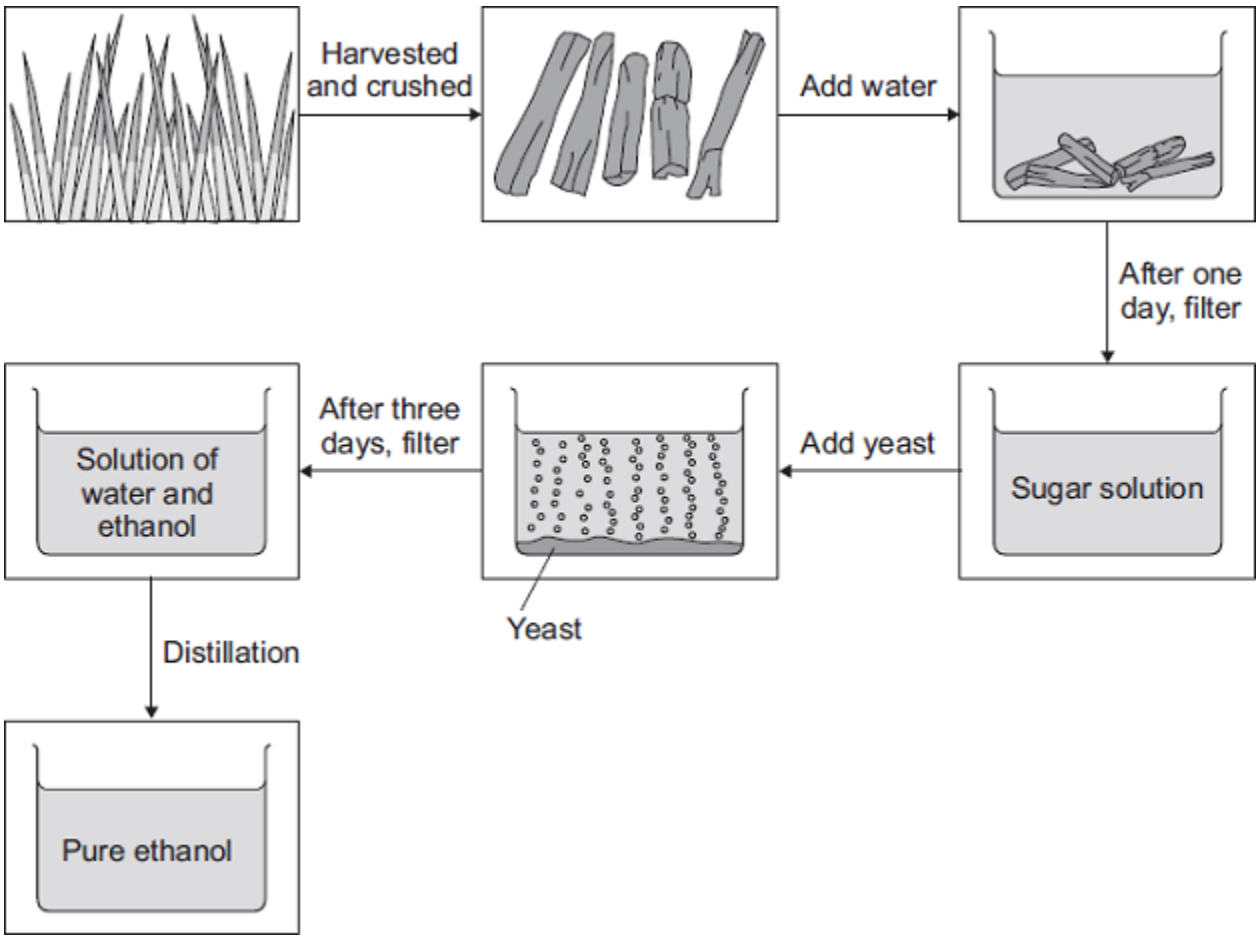
(b) Petrol contains a mixture of compounds, including octane (C_8H_{18}).

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. _____

_____

_____

2. _____

_____

_____

(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. _____

_____

_____

2. _____

_____

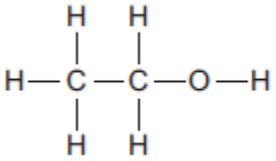
_____

(2)

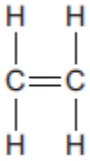
(Total 9 marks)

8 The figure below shows the displayed structures of five organic compounds, **A, B, C, D** and **E**.

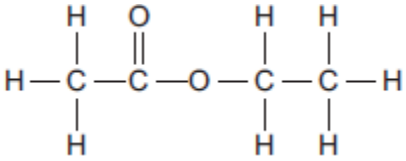
A



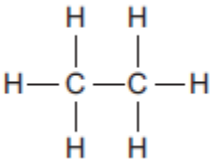
B



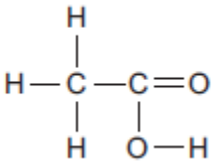
C



D



E



(a) Choose which organic compound, **A, B, C, D** or **E**, matches the descriptions.

You may choose each compound once, more than once or not at all.

Write the letter of the compound that:

(i) is a saturated hydrocarbon ☐ **(1)**

(ii) comes from a homologous series with the general formula C_nH_{2n} ☐ **(1)**

(iii) has the empirical formula C_2H_6O ☐ **(1)**

(iv) reacts with calcium carbonate to produce carbon dioxide ☐ **(1)**

(v) reacts with compound **A** to produce compound **C**. ☐ **(1)**

(b) Compound **B** (C_2H_4) and C_8H_{18} are produced by cracking $C_{14}H_{30}$

$$C_{14}H_{30} \longrightarrow 3C_2H_4 + C_8H_{18}$$

(i) Give **two** conditions for cracking.

_____

_____

(2)

(ii) Explain why C_8H_{18} has a lower boiling point than $C_{14}H_{30}$

_____

_____

_____

_____

(2)

(c) Compound **B** is a colourless gas.

Give a chemical test and its result to show that compound **B** is unsaturated.

Test _____

_____

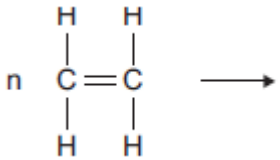
Result _____

_____

(2)

(d) Compound **B** is ethene.

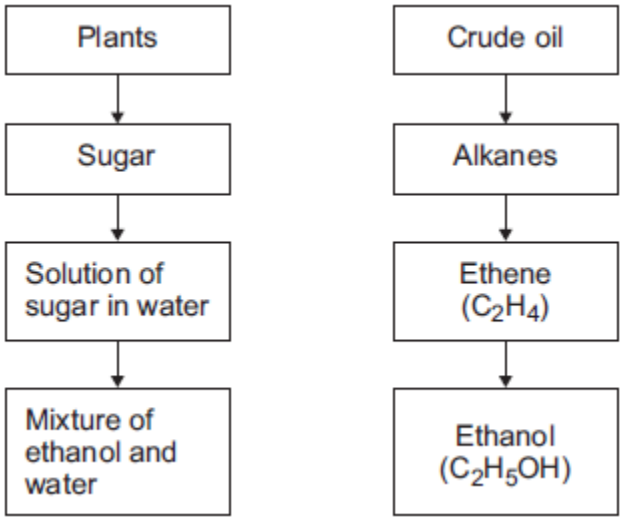
Complete the equation to show the formation of poly(ethene) from ethene.



(3)

(Total 14 marks)

9 Ethanol can be made from plants and from crude oil as shown in the diagram below.



(a) Describe how the solution of sugar in water is used to produce the mixture of ethanol and water.

_____

_____

_____

_____

(2)

(b) Ethanol has a boiling point of 78 °C.
Water has a boiling point of 100 °C.

Describe how distillation is used to separate a mixture of ethanol and water.

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

10 This question is about organic compounds.

(a) Ethanol burns in air.

Use the correct answer from the box to complete the word equation for the reaction.

carbon	hydrogen	oxygen

ethanol + _____ → carbon dioxide + water

(1)

(b) Use the correct answer from the box to complete the sentence.

milk	hard water	vinegar

Ethanoic acid is in _____ .

(1)

(c) Ethanoic acid is a carboxylic acid.

Which diagram, **A, B** or **C**, has a ring around the functional group of a carboxylic acid?

Write your answer in the box.

Diagram A

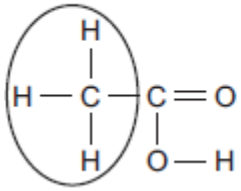


Diagram B

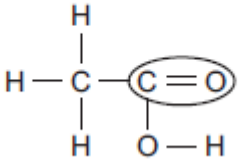


Diagram C

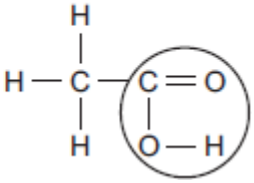


Diagram ☐

(1)

(d) Ethyl propanoate is produced by reacting ethanol with propanoic acid.

What type of organic compound is ethyl propanoate?

Tick (✓) **one** box.

Alcohol ☐

Carboxylic acid ☐

Ester ☐

(1)

(e) Organic compounds such as ethyl propanoate are used in perfumes.

Give **two** properties of these compounds that make them suitable for use in perfumes.

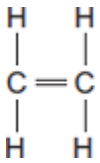
_____

_____

(2)

(Total 6 marks)

11 A molecule of ethene (C_2H_4) is represented as:



(a) A sample of ethene is shaken with bromine water.

Complete the sentence.

The bromine water turns from orange to _____ .

(1)

(b) Most ethene is produced by the process of cracking.

(i) Complete the sentence.

Cracking is a type of thermal _____ .

(1)

(ii) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

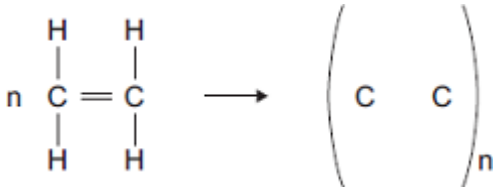
Complete the equation to show the formula of the other product.

$C_{10}H_{22} \longrightarrow C_2H_4 +$ _____

(1)

(c) Many molecules of ethene join together to produce poly(ethene).

(i) Complete the structure of the polymer in the equation.



(2)

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

_____

_____

_____

_____

(2)

(Total 7 marks)

12 This question is about ethanol.

(a) Ethanol can be made by fermentation of sugars from plants.

(i) What is a suitable temperature for fermentation?

Draw a ring around the correct answer.

0 °C **25 °C** **450 °C**

(1)

(ii) Fermentation produces a dilute solution of ethanol in water.

Name the process used to obtain ethanol from this dilute solution.

_____

(1)

(b) Ethanol made by fermentation can be used as a biofuel.

(i) Explain why increasing the use of biofuels may cause food shortages.

_____

_____

_____

_____

(2)

(ii) Explain why burning biofuels contributes less to climate change than burning fossil fuels.

_____

_____

_____

_____

_____

(2)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate**.

Ethanol can also be made by reacting ethene with steam in the presence of a catalyst.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

Figure 1 shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures.

Figure 1

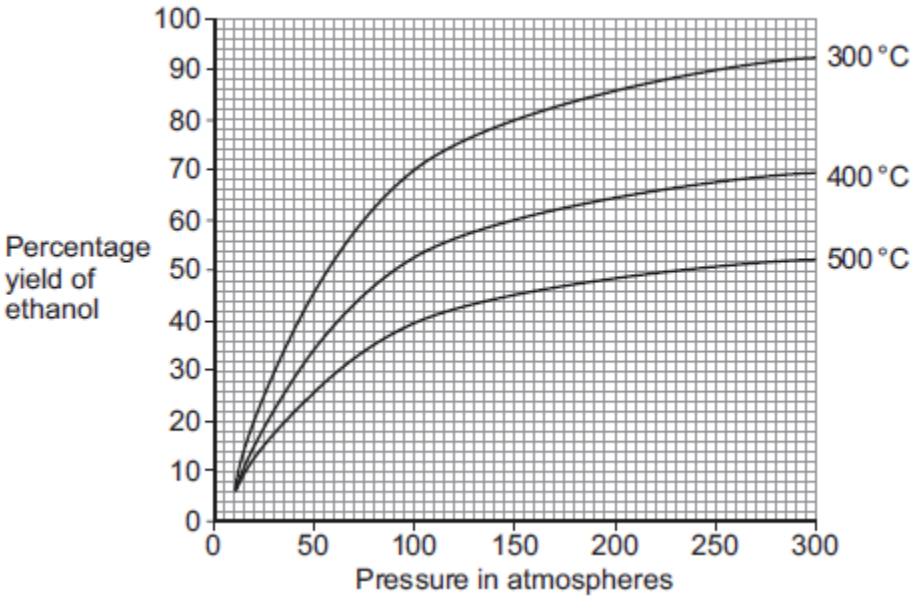
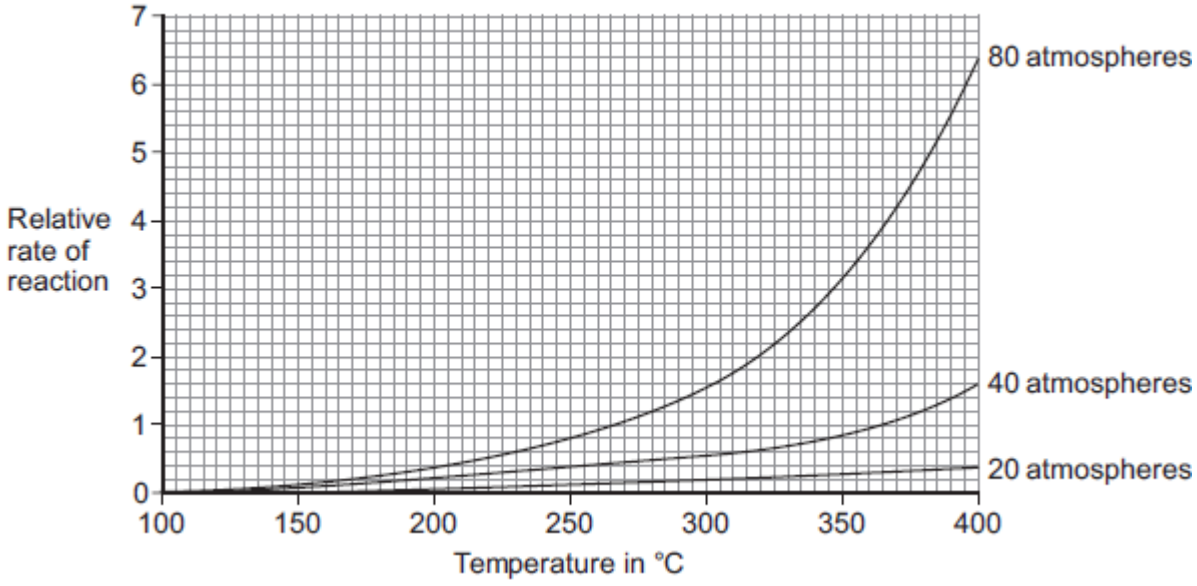


Figure 2 shows how the rate of reaction changes as the temperature changes at three different pressures.

Figure 2



In one process for the reaction of ethene with steam the conditions are:

- 300 °C
- 65 atmospheres
- a catalyst.

Use the information in **Figure 1** and **Figure 2**, and your own knowledge, to justify this choice of conditions.

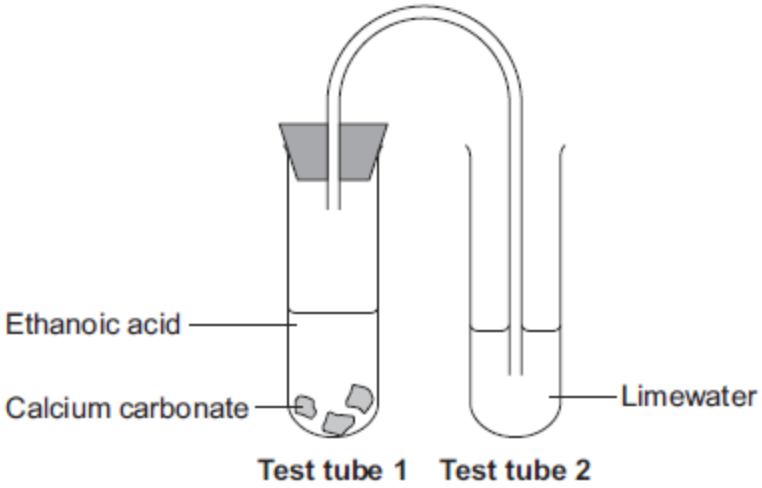
(6)

(Total 12 marks)

13 This question is about reactions of ethanoic acid and the analysis of salts.

(a) **Figure 1** shows the apparatus used to investigate the reaction of ethanoic acid with calcium carbonate.

Figure 1



(i) Describe a change that would be seen in each test tube.

Give a reason for each change.

Test tube 1 _____

_____

_____

_____

Test tube 2 _____

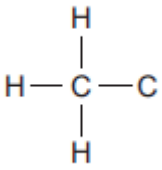
_____

_____

_____

(4)

(ii) Complete the displayed structure of ethanoic acid.



(1)

(iii) Ethanoic acid is a carboxylic acid.
Complete the sentence.

Carboxylic acids react with alcohols in the presence of an

_____

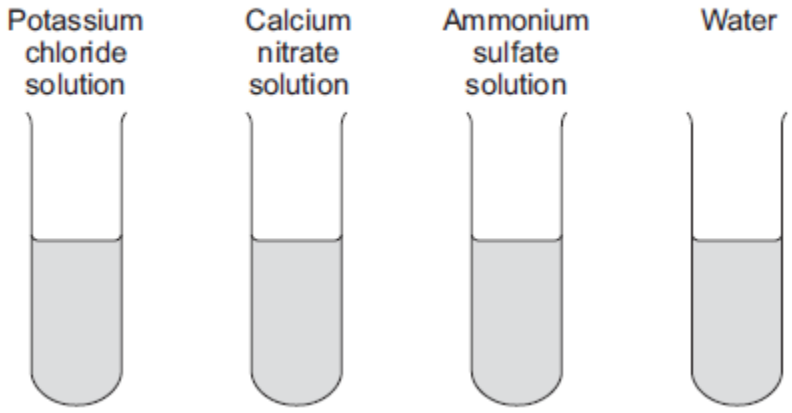
catalyst to produce pleasant-smelling compounds

called _____ .

(2)

(b) **Figure 2** shows four test tubes containing three different salt solutions and water.

Figure 2



Each solution and the water was tested with:

- silver nitrate in the presence of dilute nitric acid
- barium chloride in the presence of dilute hydrochloric acid.

Complete the table of results.

	Potassium chloride solution	**Calcium nitrate solution**	**Ammonium sulfate solution**	**Water**
Test with silver nitrate in the presence of dilute nitric acid			no change	no change
Test with barium chloride in the presence of dilute hydrochloric acid		no change	white precipitate	

(2)

(c) Flame tests can be used to identify metal ions.

(i) Complete the following sentences.

The flame colour for potassium ions is _____ .

The flame colour for calcium ions is _____ .

(2)

(ii) Give **one** reason why a flame test would **not** show the presence of both potassium ions and calcium ions in a mixture.

_____

_____

_____

(1)

(Total 12 marks)

14 This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

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

$$C_{18}H_{38} \rightarrow C_6H_{14} + C_4H_8 + 2\,C_3H_6 + C_2H_4$$

(a) Which product of the reaction shown is an alkane?

Tick **one** box.

C_2H_4 ☐

C_3H_6 ☐

C_4H_8 ☐

C_6H_{14} ☐

(1)

(b) The table below shows the boiling point, flammability and viscosity of $C_{18}H_{38}$ compared with the other hydrocarbons shown in the equation.

	Boiling point	**Flammability**	**Viscosity**
A	highest	lowest	highest
B	highest	lowest	lowest
C	lowest	highest	highest
D	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}?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) 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?

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 ☐

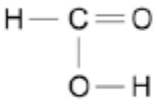
D ☐

(1)

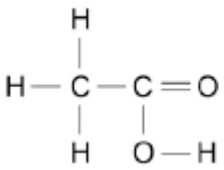
(d) Propanoic acid is a carboxylic acid.

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

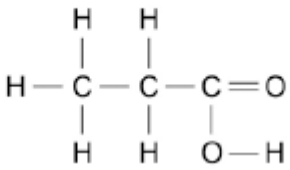
A



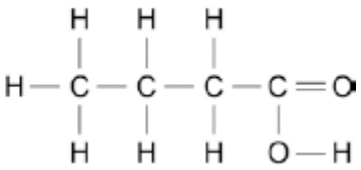
B



C



D



Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(e) Propanoic acid is formed by the oxidation of which organic compound?

Tick **one** box.

Propane ☐

Propene ☐

Propanol ☐

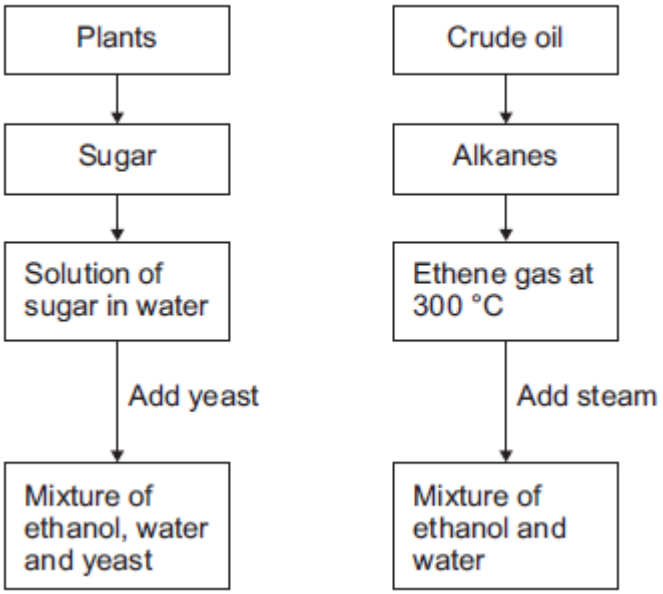
Polyester ☐

(1)

(Total 5 marks)

15 **Figure 1** shows how ethanol is made from plants and from crude oil.

Figure 1



(a) What is the name of the reaction to produce ethanol from sugar?

Tick (✓) **one** box.

fermentation ☐

polymerisation ☐

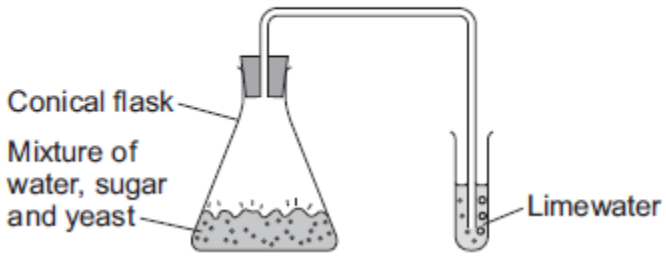
reduction ☐

(1)

(b) A student made ethanol from sugar.

Figure 2 shows the apparatus used.

Figure 2



(i) What change is seen in the limewater?

Give a reason for your answer.

_____

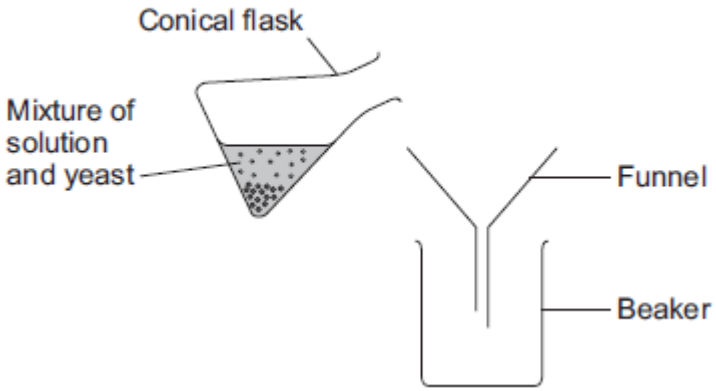
_____

(2)

(ii) The student wanted to separate the solid yeast from the solution.

Figure 3 shows the apparatus used.

Figure 3



What is missing from the apparatus in **Figure 3**?

_____

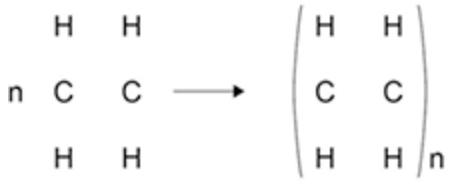
_____

(1)

(Total 4 marks)

16 Ethene is used to produce poly(ethene).

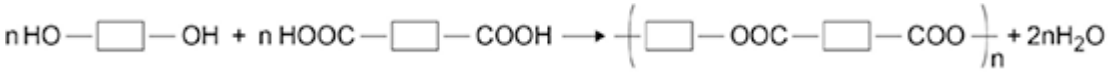
(a) Draw the bonds to complete the displayed formulae of ethene and poly(ethene) in the equation.



(2)

(b) 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)

(Total 6 marks)

1

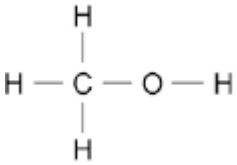
(a) Propanol

1

(b) Butanol has the highest boiling point

1

(c)



1

(d) ethene + water (→ ethanol)

allow answers in either order

allow steam for water

1

(e) goes back to reactor

allow is recycled

1

(f) air contains oxygen

1

which oxidises ethanol

allow ethanol reacted with oxygen

1

to produce ethanoic acid

1

[8]

2

(a) (i) fermentation

1

(ii) cloudy

accept milky / white

1

there is carbon dioxide / CO_2

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]

3 (a) any **two** from:

- fuel
  allow source of energy
- solvent
  allow perfume / aftershave
- antiseptic
  allow antibacterial

2

(b) Hydrogen

1

(c) (i) oxidation
*do **not** allow redox*

1

(ii) correct structure

1

(iii) ethanoic acid is a weak / weaker acid
it = ethanoic acid

1

because it does not completely ionise.
allow because it does not completely dissociate
allow it has a lower concentration of hydrogen ions
allow converse for hydrochloric acid
*do **not** allow ionising*

1

(d) (i) ethyl ethanoate

1

(ii) acid

allow any strong acid

allow correct formulae

1

(iii) evaporates easily / quickly

allow low boiling point

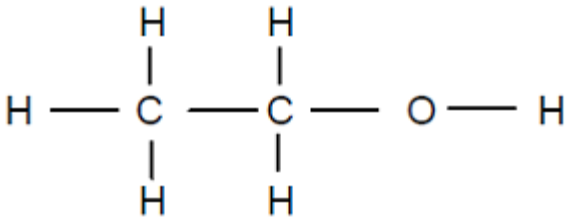
*do **not** allow flammable*

1

[10]

4

(a) (i)



allow other arrangements provided connectivity is correct

allow —— *OH*

1

(ii) oxygen

accept O_2

allow O

1

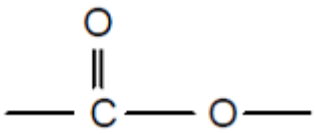
oxidation

allow oxidisation / oxidising / oxidised

allow redox

1

(b) (i) ring around



1

(ii) ester(s)

*do **not** allow ether(s)*

1

(iii) propanol

propanol accept propan-1-ol

allow propyl alcohol

1

[6]

5

(a) (i) alkanes **and** alkenes

any order

*allow saturated **and** unsaturated (hydrocarbons)*

1

(ii) high temperature

allow temperatures from 300 – 900 °C

allow vapours

*ignore heat / hot **or** pressure*

1

catalyst **or** steam

allow zeolite / aluminium oxide

ignore names of other catalysts

1

(iii) *oxygen* could react / *burn* with the hydrocarbons

allow oxygen could cause an explosion

1

(iv) *(fractional)* distillation

1

(b) (i) displayed structure of butene drawn

1

(ii) many monomers **or** many butene molecules

1

*form chains **or** very large molecules*

*if no other mark awarded allow double bond breaks / opens up **or** double bond forms a single bond for **1** mark*

1

[8]

6 (a) CO_2 (+) H_2O

correct products

1

3 (O_2) **2** (CO_2) **3** (H_2O)

correct balancing

1

(b) (i) add bromine water

allow iodine

1

changes (from orange) to colourless / decolourised

ignore clear

1

(ii) octane vapours

ignore any references to butane ($C_4 H_{10}$)

1

are passed over a catalyst (to produce ethene)

ignore incorrect names of catalysts

1

OR

octane mixed with steam (1)

at a (very) high temperature (1)

for steam cracking, second mark is conditional on 'steam'

steam is added (to ethene)

ignore the formula H_2O / water

1

in the presence of a catalyst (to produce ethanol)

*if no other marks awarded then allow **1** mark for cracking of octane **or** hydration of ethene*

1

[8]

7 (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 / H_2O

either order

1

carbon dioxide / CO_2

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]

8

(a) (i) D

1

(ii) B

1

(iii) A

1

(iv) E

1

(v) E

1

(b) (i) high temperature

ignore hot / heat

allow temperature quoted (range 300-900 °C)

1

catalyst **or** steam

1

(ii) C_8H_{18} smaller molecule

It = C_8H_{18}

1

therefore there are weaker intermolecular forces

allow intermolecular bonds

*do **not** accept breaking covalent bonds / bonds*

or

weaker intermolecular forces in C_8H_{18} (1)

allow intermolecular bonds

so less energy to break (1)

1

(c) add bromine water

1

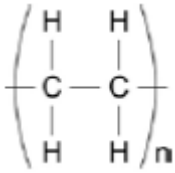
turns (from orange / yellow / red / brown) to colourless **or** decolourises

do not accept discoloured

*ignore clear incorrect test = **0** marks*

1

(d)



single C – C bond

1

four carbon-hydrogen bonds in place and two trailing bonds

1

structure in brackets and n at bottom right

1

[14]

9 (a) add yeast

1

and ferment **or** by fermentation

*allow in a warm place **or** temperatures within the range 20-45^{o}C **or** with an airlock / absence of air*

1

(b) heat (the mixture)

1

ethanol has a lower boiling point than water **or** more ethanol than water vaporises **or** ethanol evaporates first or when the temperature reaches 78^{o}C

allow ethanol and water boil at different temperatures

1

condense (the vapour)

allow condense at different temperatures for the last two marking points

if no other mark is awarded, allow repeat distillation or use fractional distillation apparatus for 1 mark

1

[5]

10 (a) oxygen

allow correct answer shown in box if answer line blank

1

(b) vinegar

allow correct answer shown in box if answer line blank

1

(c) C

1

(d) Ester

1

(e) pleasant smell

1

volatile

allow low boiling point / evaporates

1

[6]

11 (a) colourless

ignore clear

1

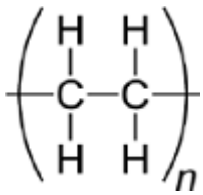
(b) (i) decomposition

1

(ii) C_8H_{18}

1

(c) (i)



two single trailing bonds extending from the carbons (through the brackets) ***1*** *mark*

five single bonds (1 C–C bond and 4 C–H bonds) ***1*** *mark*

2

(ii) any **two** from:

- (polymers made from) cornstarch are biodegradable
- less space needed in landfill sites
- polymers from cornstarch come from a renewable source.

allow converse for poly(ethene)

2

[7]

12 (a) (i) 25 °C

1

(ii) (fractional) distillation

1

(b) (i) (fertile) land is used to grow fuel crops **or** crops are grown for fuel **or** farmers get a better price for crops for fuel **or** crops for biofuels take up space

ignore biofuels are made from food or plants

1

less food grown **or** food prices rise **or** less (fertile) land to grow food

1

(ii) (crops / plants) take in carbon dioxide (while growing / during photosynthesis)

1

so the CO_2 given out was previously taken in

*do **not** accept burning biofuels does not release CO_2 or releases less CO_2 unqualified*

*if no other mark awarded, a statement of "carbon neutral" scores **1** mark*

1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
At least one statement about the effect of a condition on either rate **or** yield.

Level 2 (3−4 marks)
Correct statements about the effect of at least one condition on rate **and** yield.

Level 3 (5−6 marks)
Correct statements about the effect of at least one condition on rate and yield **and** at least one correct statement about compromise conditions.

Examples of the points made in the response

Temperature
- a higher temperature gives a lower yield
- a higher temperature gives a faster rate

Pressure
- a higher pressure gives a higher yield
- increase in yield gets less as pressure increases
- a higher pressure gives a faster rate
- increase in rate increases as pressure increases

Catalyst
- using a catalyst speeds up reaction
- catalysts allow a lower temperature to be used and so save energy / reduce energy costs

Compromise
- a higher pressure gives a greater yield but increases costs / (safety) risks
- a high pressure gives a faster rate but increases costs / risks
- a high temperature makes reaction faster but reduces yield
- a catalyst makes reaction faster so a lower temperature can be used which will increase the yield

6

[12]

13 (a) (i) fizz / effervescence / bubbles

allow calcium carbonate decreases in size or dissolves

1

because carbon dioxide produced / released

allow because gas produced / released

1

limewater turns cloudy / milky / white

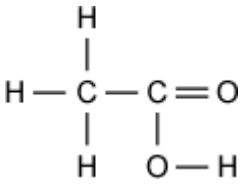
1

because (a precipitate of or solid) calcium carbonate forms

allow because of carbon dioxide if not already credited

1

(ii)



allow -OH

do not allow lower case 'h'

1

(iii) acid

must be in this order

ignore any name of an acid

1

ester(s)

1

(b) white (precipitate) no change

no change no change

all four correct 2 marks

any two correct 1 mark

2

(c) (i) lilac

allow purple

1

red

1

must be in this order

(ii) colours are masked / changed by each flame colour

1

[12]

14 (a) C_6H_{14}

1

(b) **A**

1

(c) **B**

1

(d) **C**

1

(e) Propanol

1

[5]

15 (a) fermentation

1

(b) (i) turns cloudy / milky / white

ignore bubbles

1

because carbon dioxide is produced

allow CO_2 produced

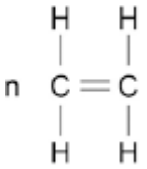
1

(ii) filter paper

1

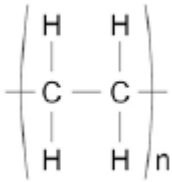
[4]

16 (a) *(ethene)*



1

(polyethene)



1

(b) any **four** from:

- poly(ethene) produced by addition polymerisation whereas polyester by condensation polymerisation
- poly(ethene) produced from one monomer wheareas polyester produced from two different monomers
- poly(ethene) produced from ethene / alkene whereas polyester from a (di)carboxylic acid and a diol / alcohol
- poly(ethene) is the only product formed whereas polyester water also produced
- poly(ethene) repeating unit is a hydrocarbon whereas polyester has an ester linkage

4

[6]

Examiner reports

2

(a) (i) Most students could not identify that the reaction to make ethanol from sugar is fermentation.

(ii) Most students answered the first part correctly but fewer were able to identify the gas that turned the limewater cloudy. A significant proportion thought that the limewater turned cloudy because it was reacting with the yeast or with the sugar. A number of students instead of using words wrote the carbon dioxide formula, this would have been acceptable but many used a superscript.

(b) (i) Generally well answered. Most students gave a correct, simple description of the trend for the amount of ethanol used and usually made accurate reference to the years indicated. There were a number of students who referred to a decade (80s or 90s) rather than using a specific year for when the increase in ethanol used changed and began to decrease. Several students incorrectly referred to the label on the vertical axis, describing this as ‘the number of people using ethanol’ rather than the ‘amount of ethanol used as a fuel’.

(ii) Nearly half of the students gave a variety of correct suggestions. Confusion was evident in some suggestions over the source of the ethanol. Some students thought the ethanol came from petrol or from oilfields

3

(a) Most students were able to provide at least one use, ‘fuels’ being by far the most common. ‘Solvents’ was also frequently seen. Uncreditworthy responses included cleaning products and disinfectants, although the antiseptic use of ethanol in hand rubs and sanitisers is now commonplace and was allowed.

(b) More than half of students knew that hydrogen is produced, but a large number thought it was carbon dioxide, perhaps becoming confused with the reaction between carboxylic acids and carbonates.

(c) (i) Fewer than half knew that this is an oxidation reaction. Popular alternatives included exothermic and fermentation, but many others were seen too. Oxidisation was often seen and given credit.

(ii) More than half of students were able to correctly complete the displayed structure of ethanoic acid. The most common ‘nearly correct’ error was to get the carbon − oxygen double and single bonds the wrong way round. A small number of students drew propanoic acid instead.

(iii) Poorly answered by many with more than half scoring zero marks. Large numbers of students thought that a higher pH was equivalent to a higher hydrogen ion concentration and thus stated that ethanoic acid was stronger and / or completely ionised. There were also references to ethanoic acid releasing hydroxide ions.

(d) (i) More than half of students were able to name ethyl ethanoate.

(ii) Only the better prepared students were able to state that an acid catalyst is required. Others used their knowledge of the specification to suggest that a transition metal was needed. A named weak acid was also sometimes given.

(iii) Only around a quarter of students were able to explain the meaning of volatile. Common misconceptions were confusion with viscosity, reactivity (by using volatile in its non-scientific sense) and flammability.

4

(a) (i) The structure was completed correctly by the majority of students. Amongst wrong answers the drawing of methanol or the inclusions of a double bond were most common.

(ii) Few students were awarded two marks, although a reasonable number realised that the ethanol was reacting with oxygen. Guesses were very apparent.

(b) (i) Responses varied widely and relatively few succeeded in identifying the functional group.

(ii) Slightly more were able to identify the compound as an ester than were able to correctly identify the functional group in (b)(i) but the question was still poorly attempted.

(iii) Naming the compound proved easier and almost a third were able to do so.

5

(a) (i) About half of the students knew the two types of hydrocarbon with different general formulae.

(ii) Most students knew at least one of the conditions needed to crack large hydrocarbon molecules into smaller hydrocarbon molecules. Better answers gave catalyst, often correctly named, with a specific temperature in the range 300 to 900 °C. Weaker students tended to incorrectly name the catalyst as nickel, however, 'catalyst' gained the mark because the name of the catalyst was ignored. Vague answers, such as hot instead of high temperature, were not credited.

(iii) This question was poorly answered. The majority of students had the correct idea of something reacting with the hydrocarbons. Only a few students specified that it was oxygen in the air that would react with the hydrocarbons.

(iv) This question was correctly answered by nearly half of the students. Cracking was the most common incorrect response followed closely by polymerisation as the process to separate a hydrocarbon from other hydrocarbons. Some students stated two methods, one correct and one incorrect, thus losing the mark because of the list principle.

(b) (i) Less than a quarter of the students managed to correctly draw the displayed structure of a butene (C_4H_8) molecule. Most students managed to show four carbons and eight hydrogens, however, many of displayed structures had more than one carbon-carbon double bond or none at all.

(ii) Many students managed to score one mark, but few got both. Most students mentioned 'monomers' but did not state 'many'. 'Monomers join together to form polymers or poly(butene)' was a very common response which did not gain any credit. Some students described cracking instead of polymerisation.

6

(a) This equation gained more marks than usual, although there was a large percentage of students who did not gain any marks. It was encouraging to note that many gained the mark for the correct products, and an encouraging number were able to balance the equation.

(b) (i) Considering that this question, in one form or another, has appeared on virtually every series it was very disappointing to note the low proportion of students that gained full marks.

(ii) Students found this question quite challenging and only a very small percentage gained three or four marks. The cracking of octane using a catalyst was the best known process, but knowledge of the conditions used was weak. Too many students did not say that octane had to be a vapour for cracking and that it was steam, not water, which was used for the hydration of ethene.

7

(a) Most students scored at least one mark.

(b) It was disappointing that there were very few students scoring both marks,with many students not attempting an answer. A significant number of students do not have a basic understanding of chemical equations. If students gained a mark it was usually for carbon dioxide. Many students incorrectly thought that the complete combustion of octane produces carbon and hydrogen. Also a common incorrect product was 'octane oxide'.

(c) (i) Most students knew that the reaction to produce ethanol from sugar solution is fermentation.

(ii) Very few students were awarded both marks. There were many poor answers such as carbon dioxide being given off rather than the plants taking it in or the incorrect idea that ethanol does not produce carbon dioxide when burnt. There were mostly vague reasons such as 'ecofriendly', 'natural', 'cheap' or 'no pollution'. If students gained a mark it was usually for 'renewable resource' or 'ethanol produced from plants is carbon neutral'.

(iii) Again very few students were awarded both marks. There were mostly vague answers. No credit was awarded for students who stated that it was a long process because it takes time for crops to grow or that ethanol would run out if we use or drink too much. Most students were not linking a reason to the bad effect on the environment, for example, 'land could be used for food crops' instead of growing more sugar cane requires a lot of land'.

8

(a) (i) The majority of students correctly identified D as the only saturated hydrocarbon.

(ii) The idea of general formula was well understood, with most students identifying B as having the general formula CnH2n

(iii) Students understood the concept of empirical formula and displayed structure with almost all students giving the correct answer of A.

(iv) This question proved to be demanding, with students having to recognise E as an acid and know that an acid reacts with metal carbonates to produce carbon dioxide. Only about half scored this mark.

(v) There were only three real options here, as A and C were mentioned in the question. Almost all students correctly identified E as the answer.

(b) (i) About half of students gained two marks, although many included vague statements such as 'heat' or 'hot', while 'high pressure' was a common incorrect answer. Some students quoted values of temperature, which in some cases related to other industrial processes they had studied.

(ii) Good answers gaining two marks were few. Students often could not distinguish between bonds within the alkane and intermolecular forces. Many students identified that octane was a smaller hydrocarbon and scored one mark but then went on to refer to the breaking of bonds, often quoting that it was the bonds between carbon and hydrogen in the molecule, rather than to intermolecular forces.

(c) The majority of students gained two marks, quoting bromine water and the correct colour change or that it was decolourised. Some incorrect tests were given, most commonly using limewater or a burning spill. Some confusion between saturated and unsaturated was evident.

(d) This question was generally well answered, with most students gaining full marks. The most common error was to retain the double bond between the carbon atoms.

9

(a) This question generated an even spread of marks and a wide range of answers. However, many students did not appreciate the role of yeast in the fermentation process.

(b) The question was well answered with the majority of students appreciating the need to heat the mixture and condense vapours. The separation marking point was expressed in a wide range of ways, although sometimes students did not explain this aspect successfully.

10

(a) Well over half knew that oxygen supports burning.

(b) Nearly all students knew that vinegar contains ethanoic acid.

(c) Two thirds of students correctly identified the carboxyl group.

(d) Nearly three quarters knew that ethyl propanoate is an ester.

(e) Only a few students scored two marks here. The vast majority could not pick out the 'volatile' mark. They were talking in terms of it being 'non corrosive', 'unreactive' or 'not harmful'.

12

(a) (i) Most students knew that 25 °C was a suitable temperature for fermentation. The most popular incorrect answer was 450 °C, presumably confusing fermentation with the Haber Process.

(ii) Most students correctly stated fractional distillation or distillation as the process used to obtain ethanol from a dilute solution of ethanol in water.

(b) (i) There were many very clearly expressed responses, indicating a sound understanding of the issues involved. There appeared to be some confusion over the term 'crops'. Some students thought that crops are specifically plants grown for food, not biofuels, even though they understood the nature of the problem they were attempting to explain.

(ii) There were many well expressed, fully correct responses. However, there were many misunderstandings.
Some students referred to gases other than carbon dioxide as greenhouse gases, eg sulfur dioxide. Students also wrote about the effect of these gases on acid rain, and particulates on climate change. Some students thought that burning biofuels releases only hydrogen. Others simply referred to 'carbon', limiting themselves to 1 mark. A number gained no other credit than that for 'carbon neutral' (without understanding what it means), or said that biofuels do not release carbon dioxide when burned.

(c) There were many excellent answers to this question with the most common mark being 6. The best students made notes on Figures 9 and 10 (which were creditworthy) and used these notes to craft a well-planned and concise answer. Many students had not read the question and offered an explanation rather than a justification of the conditions used which was ignored. It was clear from some of the answers that some students did not understand the difference between rate and yield.
A minority of students appeared not to have an understanding of the factors involved, so attempted to give simple statements drawn directly from the graphs.

13 **Foundation**

(a) (i) Reasonably well answered by the majority, with three marks being the most common score. Many students described either effervescence or reduction in size of calcium carbonate in the first test tube and some went on to link this with the evolution of carbon dioxide. More often, though, credit was given for carbon dioxide when it was used as an explanation for the formation of cloudy limewater in the second tube. The least well known feature was that the cloudy observation is caused by a precipitate of calcium carbonate. Some students thought that the limewater would be drawn back into the first tube. A significant minority wrote their responses for the two tubes in the wrong spaces but were given credit if it was clear what was meant.

(ii) Fewer than one in ten of the students could draw the structure of ethanoic acid. Incorrect responses included completion with hydrogen atoms to show ethane, or something completely infeasible.

(iii) Most students had no idea what the catalyst was, so chose a substance they knew was a catalyst from other parts of the specification – usually iron, sometimes nickel. However, ester was known by more, even if often spelled like the female name. 'Perfume' and 'fragrance' were commonly seen. No credit was available for ether.

(b) Poorly attempted by many. It is clear that students do not know or understand these anion tests. Often a random scatter of white, cream and yellow precipitates were seen, and even flame colour precipitates like lilac and crimson. However, some students at least recognised that water would do nothing in either test.

(c) (i) Nearly one-third of students knew both flame colours.

(ii) This question stretched the powers of expression of many students to the limit. Many inadequate statements such as 'you can't see two colours at once' or 'only one colour can be seen at a time' were seen. However, credit was given to those students who thought the colours would mix or blend.

Higher

(a) (i) Reasonably well answered by the majority, with three marks being the most common score. Many students described either effervescence or reduction in size of calcium carbonate in the first test tube and some went on to link this with the evolution of carbon dioxide. More often, though, credit was given for carbon dioxide when it was used as an explanation for the formation of cloudy limewater in the second tube. The least well known feature was that the cloudy observation is caused by a precipitate of calcium carbonate. Some students thought that the limewater would be drawn back into the first tube. A significant minority wrote their responses for the two tubes in the wrong spaces but were given credit if it was clear what was meant.

(ii) Fewer than half of the students could draw the structure of ethanoic acid. A small minority extended the diagram and drew propanoic acid instead. The weaker responses involved completion with hydrogen atoms to show ethane.

(iii) Most students had no idea what the catalyst was, so chose a substance they knew was a catalyst from other parts of the specification – usually iron, sometimes nickel. However, ester was well known, even if often spelled like the female name. No credit was available for ether.

(b) Quite poorly attempted by many. It is clear that students do not know or understand these anion tests. Often a random scatter of white, cream and yellow precipitates were seen, and even flame colour precipitates like lilac and crimson. However, most students recognised that water would do nothing in either test.

(c) (i) Nearly three-quarters of students knew both flame colours.

(ii) This question stretched the powers of expression of many students to the limit. Many inadequate statements such as ‘you can’t see two colours at once’ or ‘only one colour can be seen at a time’ were seen. However, credit was given to those candidates who thought the colours would mix or blend.

15 (a) The majority of the students knew that the reaction to produce ethanol from sugar is called fermentation.

(b) (i) This familiar gas test was not known by many students. There were many vague answers such as ‘the limewater changes colour because a gas is produced’. Many students got the colour change correct but then stated this was caused by air, oxygen, ethanol, yeast or sugar. A misconception was that limewater produced carbon dioxide.

(ii) Several students did not attempt this question and overall this question was poorly answered. The majority of students gave descriptions of things missing from the funnel, including various types of paper such as tissue paper, but most did not give the correct name ‘filter paper’. There were also those who did not even consider that it was something to do with separating the liquid and solid and said a Bunsen burner, sugar or limewater were missing or that the funnel needed clamping.