AQA GCSE CHEMISTRY (HIGHER) · 8462

# CHEMISTRY



EXAM QUESTION PACK

## 4.7.2 REACTIONS OF ALKENES AND ALCOHOLS (PACK 1)

| SCORE | PERCENTAGE |
| --- | --- |
| /320 | % |

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## Q1.

Methylated spirit is a useful product made from a mixture of substances.

The table below shows the mass of the substances in a sample of methylated spirit.

| Substance | Mass in grams |
|---|---|
| Ethanol | 265.5 |
| Methanol | 23.3 |
| Pyridine | 3.0 |
| Methyl violet | 1.5 |

(a) What name is given to a useful product such as methylated spirit?

_____

**(1)**

(b) Calculate the percentage by mass of methanol in methylated spirit.

Use the table above.

_____

_____

_____

_____

Percentage = _____ %

**(2)**

Methylated spirit contains ethanol and is available cheaply.

Methylated spirit also contains:

- pyridine which has a very unpleasant smell
- methyl violet which makes the mixture purple.

(c) Suggest why pyridine and methyl violet are added to ethanol to make methylated spirit.

_____

_____

**(1)**

(d) Suggest **one** use of methylated spirit.

_____

**(1)**

(e) Describe how ethanol is produced from sugar solution.



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Give the name of this process.

_____

_____

_____

_____

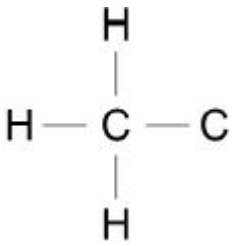
_____

_____

**(3)**

(f) The diagram below shows part of the displayed formula for ethanol.

Complete the diagram.




**(1)**

(g) Name the gas produced when sodium is added to ethanol.

_____

**(1)**

(h) Methanol is used to produce methanoic acid.

What type of substance reacts with methanol to produce methanoic acid?

_____

**(1)**

**(Total 11 marks)**

## Q2.

This question is about alkenes and crude oil.

(a) Pentene is an alkene molecule containing five carbon atoms.

Complete the formula for pentene.

C _____ H _____

**(1)**

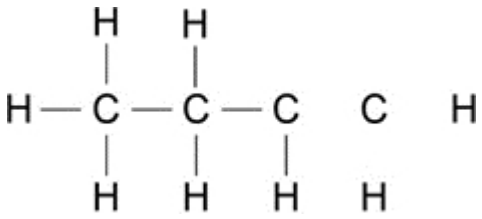
(b) Butene is an alkene molecule containing four carbon atoms.

The diagram shows all of the atoms and some of the bonds in the displayed formula for butene.



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Complete the displayed formula by adding the remaining bonds.



**(1)**

Pentene and butene are produced from crude oil.

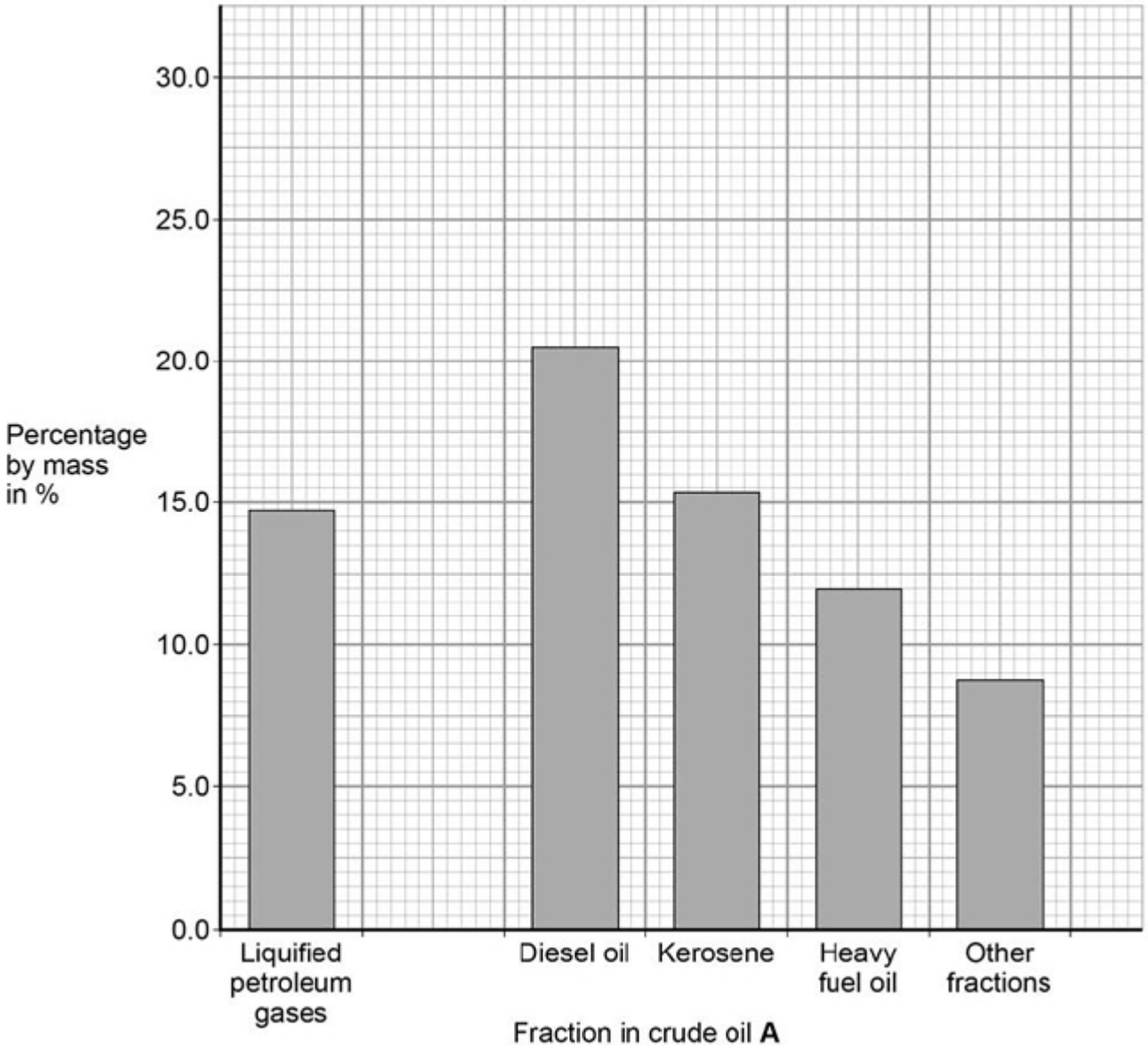
The table shows the percentages of different fractions in two samples of crude oil.

| **Fraction** | **Percentages by mass in %** | |
|---|---|---|
| | **Crude oil A** | **Crude oil B** |
| Liquefied petroleum gases | 14.7 | 7.1 |
| Petrol | 28.6 | 11.1 |
| Diesel oil | 20.5 | 17.2 |
| Kerosene | 15.4 | 38.5 |
| Heavy fuel oil | 12.0 | 16.0 |
| Other fractions | 8.8 | 10.1 |

The graph shows the percentages of different fractions in crude oil **A**.



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(c) Plot the data for petrol in the table above on the graph.

**(1)**

(d) What mass of crude oil **A** is needed to obtain 12 tonnes of heavy fuel oil?.

Use the table above.

10 tonnes ☐

100 tonnes ☐

1000 tonnes ☐

10 000 tonnes ☐

**(1)**



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(e) What mass of crude oil **A** is needed to obtain 12 tonnes of heavy fuel oil?.

Calculate the total mass of car fuel that can be produced from 2000 kg of crude oil **B**.

Use the table above.

_____

_____

_____

_____

Mass of car fuel = _____ kg

**(3)**

(f) Crude oil **B** is a better source of hydrocarbons for cracking than crude oil **A**.

Suggest why.

Use the table above.

_____

_____

**(1)**

(g) Alkenes are obtained from crude oil using fractional distillation followed by cracking.

Explain how alkenes are produced using fractional distillation followed by cracking.

**(6)**

**(Total 14 marks)**

## Q3.

This question is about polymers.

(a) Name the monomer used to form poly(chloroethene).

_____

**(1)**

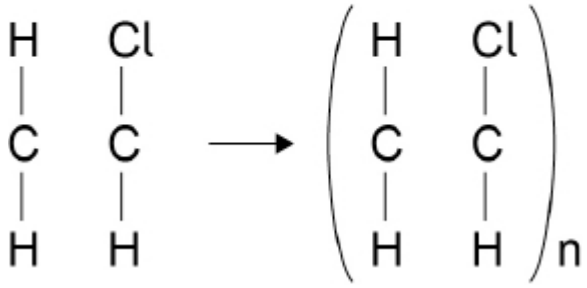
(b) **Figure 1** shows the equation for the formation of poly(chloroethene).

Complete **Figure 1**.



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Figure 1



**(3)**

(c) Poly(chloroethene) is the only product.

What type of polymer is poly(chloroethene)?

_____

**(1)**

Ethanediol reacts with butanedioic acid to produce a polyester and a small molecule.

(d) **Figure 2** shows the structural formula of ethanediol.

Figure 2

$HO–CH_2–CH_2–OH$

Name the functional group present in ethanediol.

_____

**(1)**

(e) **Figure 3** shows the structural formula of butanedioic acid.

Figure 3

$HOOC–CH_2–CH_2–COOH$

Which formula represents the carboxylic acid functional group?

Tick (✔) **one** box.

$–CH_2–$ ☐

$–CH_2–CH_2–$ ☐

$–CH_2–COOH$ ☐

$–COOH$ ☐



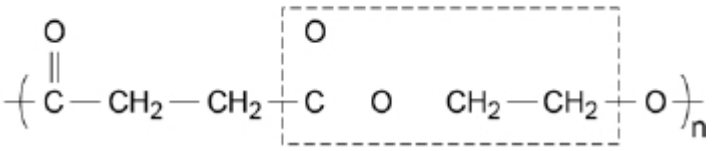
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**(1)**

(f) **Figure 4** shows part of the structure of the polyester.

Complete the box in **Figure 4**.

**Figure 4**



**(2)**

(g) Name the small molecule produced when ethanediol reacts with butanedioic acid.

_____

**(1)**

Starch, proteins and DNA are naturally occurring polymers.

(h) Name the monomers from which starch and proteins are produced.

Starch _____

Proteins _____

**(2)**

(i) Describe the structure of DNA.

_____

_____

_____

_____

**(2)**

**(Total 14 marks)**

## Q4.

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?



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_____

**(1)**

(b) Which statement is correct?

Tick **one** box.

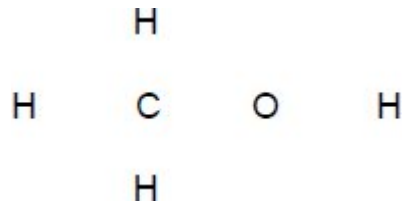
| | |
|---|---|
| A molecule of ethanol has 5 hydrogen atoms | ☐ |
| Butanol has the highest boiling point | ☐ |
| Methanol has the largest molecules | ☐ |
| Propanol has the highest melting point | ☐ |

**(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.

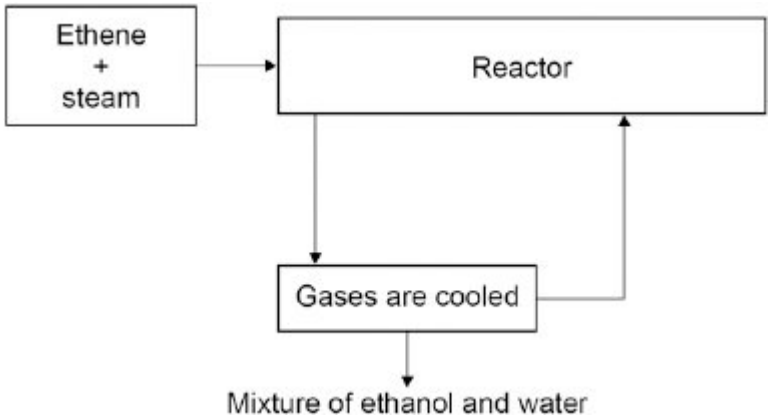
**Figure 1**




**(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?

_____



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_____

**(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)**

## Q5.

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.



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| | 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)**

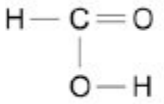
(d) Propanoic acid is a carboxylic acid.

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

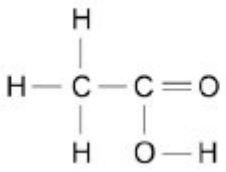


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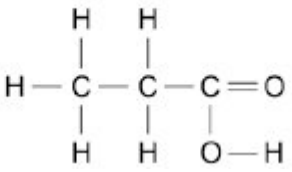
**A**



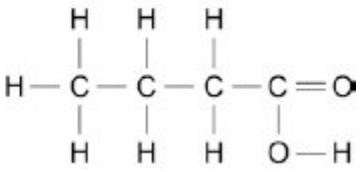
**B**



**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 ☐

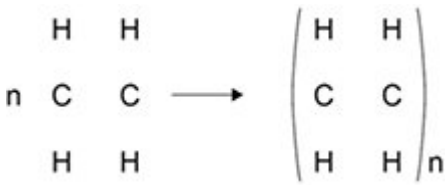
**(1)**

**(Total 5 marks)**

## Q6.

Ethene is used to produce poly(ethene).

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



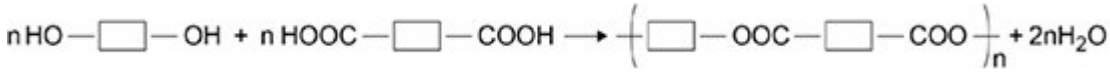
**(2)**

(b) Polyesters are made by a different method of polymerisation.

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



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

_____

_____

_____

_____

_____

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_____

**(4)**

**(Total 6 marks)**

## Q7.

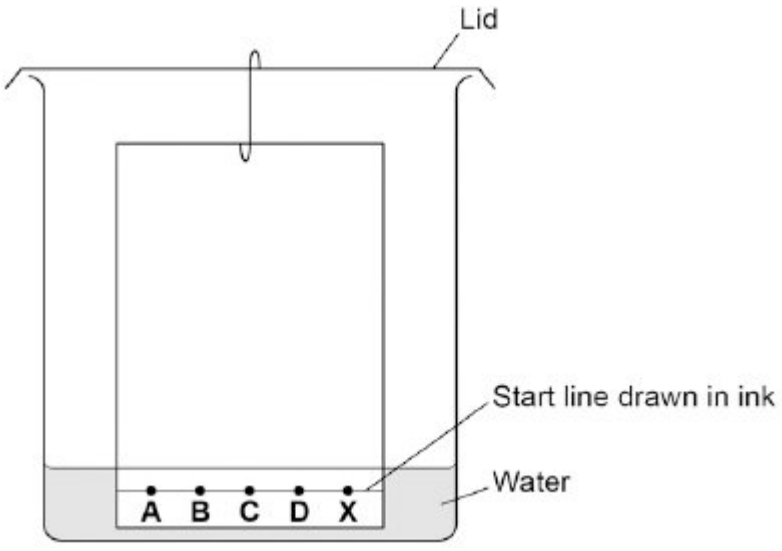
A student investigated food dyes using paper chromatography.

This is the method used.

1. Put a spot of food colouring **X** on the start line.
2. Put spots of four separate dyes, **A**, **B**, **C** and **D**, on the start line.
3. Place the bottom of the paper in water and leave it for several minutes.

**Figure 1** shows the apparatus the student used.

**Figure 1**






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(a) Write down **two** mistakes the student made in setting up the experiment and explain what problems one of the mistakes would cause.

_____

_____

_____

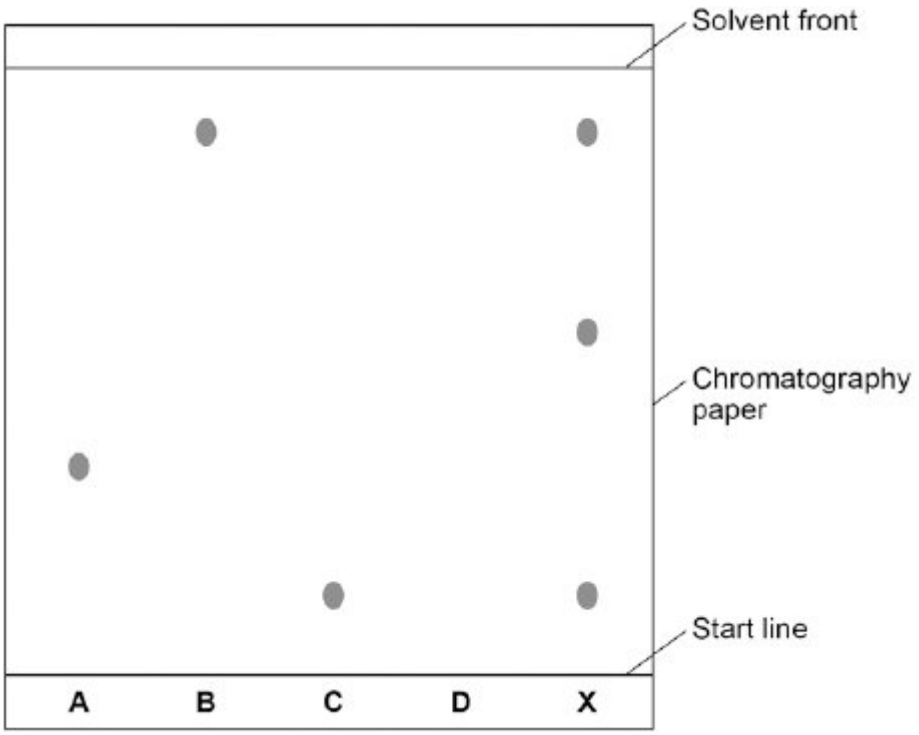
_____

**(2)**

(b) Another student set up the apparatus correctly.

**Figure 2** shows the student's results. The result for dye **D** is not shown.

**Figure 2**




Calculate the $R_f$ value of dye **A**

Give your answer to two significant figures.

_____

_____

_____

_____

$R_f$ value = _____

**(3)**

(c) Dye **D** has an $R_f$ value of 0.80. Calculate the distance that dye **D** moved on the chromatography paper.



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_____

_____

Distance moved by dye **D** = _____

**(1)**

(d) Explain how the different dyes in **X** are separated by paper chromatography.

_____

_____

_____

_____

_____

_____

_____

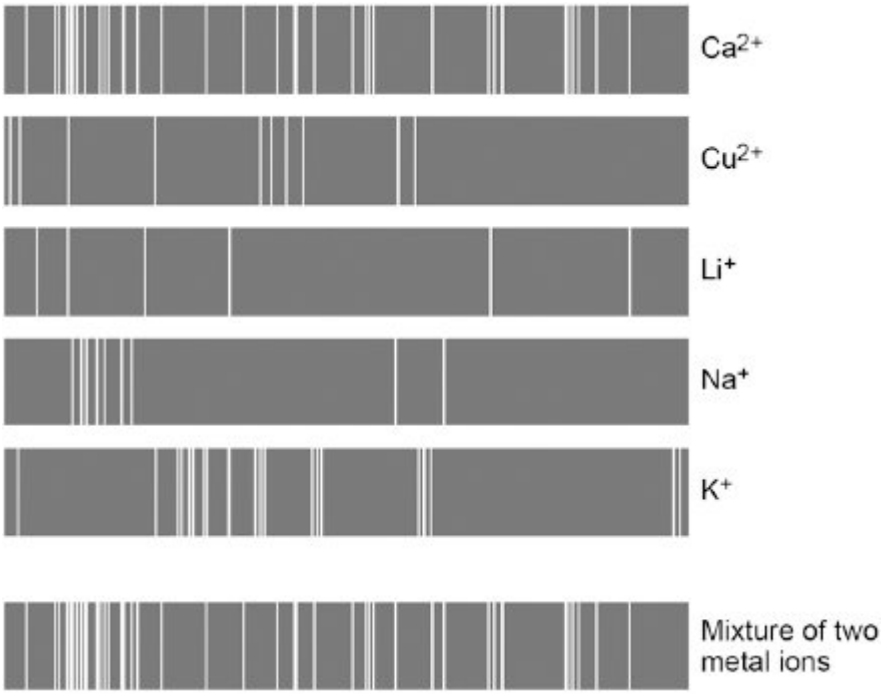
_____

**(4)**

(e) Flame emission spectroscopy can be used to analyse metal ions in solution.

**Figure 3** gives the flame emission spectra of five metal ions, and of a mixture of two metal ions.

**Figure 3**




Use the spectra to identify the **two** metal ions in the mixture.

_____



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_____

**(2)**

(f) Explain why a flame test could **not** be used to identify the two metal ions in the mixture.

_____

_____

_____

_____

**(2)**

(g) Two students tested a green compound **X**.
The students added water to compound **X**.
Compound **X** did not dissolve.

The students then added a solution of ethanoic acid to compound **X**.
A gas was produced which turned limewater milky.

Student **A** concluded that compound **X** was sodium carbonate.
Student **B** concluded that compound **X** was copper chloride.

Which student, if any, was correct?

Explain your reasoning.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

**(Total 18 marks)**

## Q8.

In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

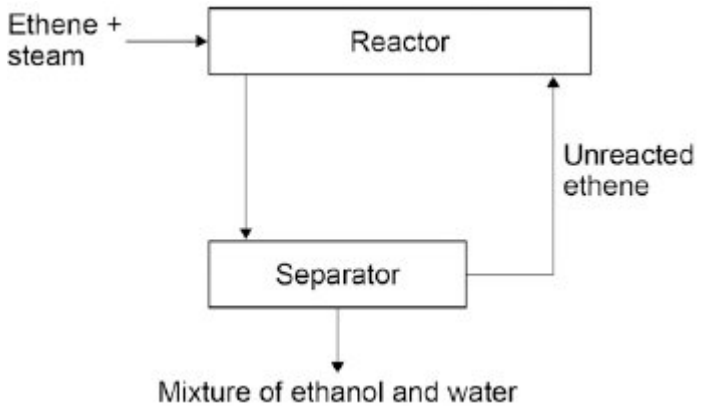
The equation for the reaction is:

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

The figure below shows a flow diagram of the process.



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(a) Why does the mixture from the separator contain ethanol and water?

_____

_____

**(1)**

(b) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium.

Give a reason for your prediction.

_____

_____

_____

_____

**(2)**

(c) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

_____

_____

_____

_____

**(2)**

**(Total 5 marks)**

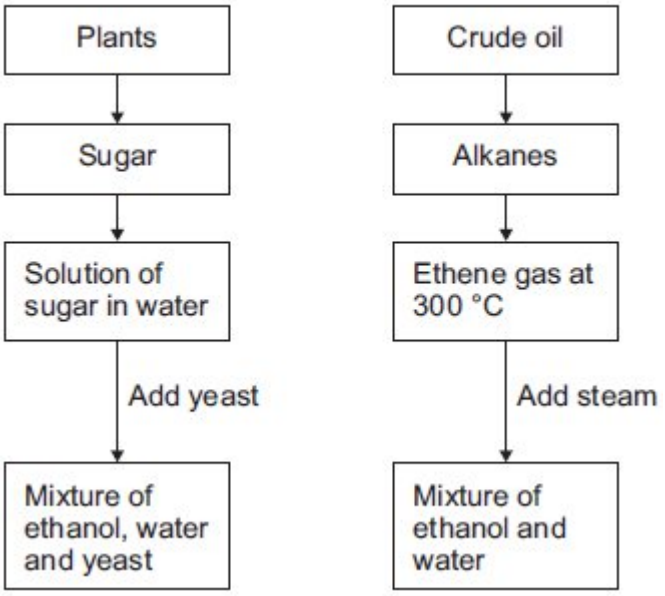
## Q9.

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



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**Figure 1**




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

Tick (✔) **one** box.

fermentation ☐

polymerisation ☐

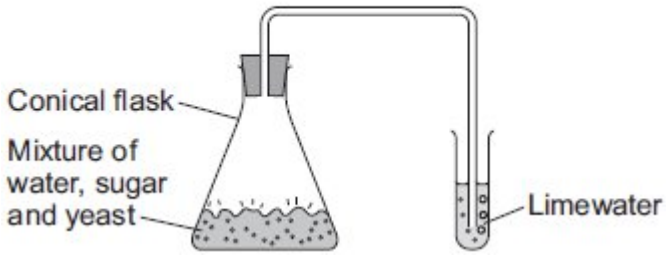
reduction ☐

**(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)**

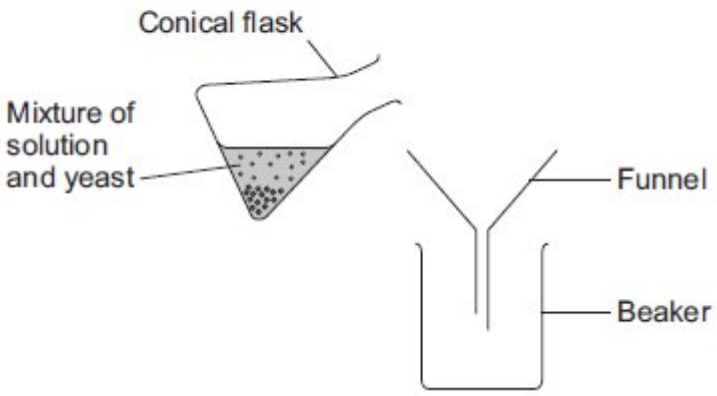


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(ii) The student wanted to separate the solid yeast from the solution.

**Figure 3** shows the apparatus used.

**Figure 3**




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

_____

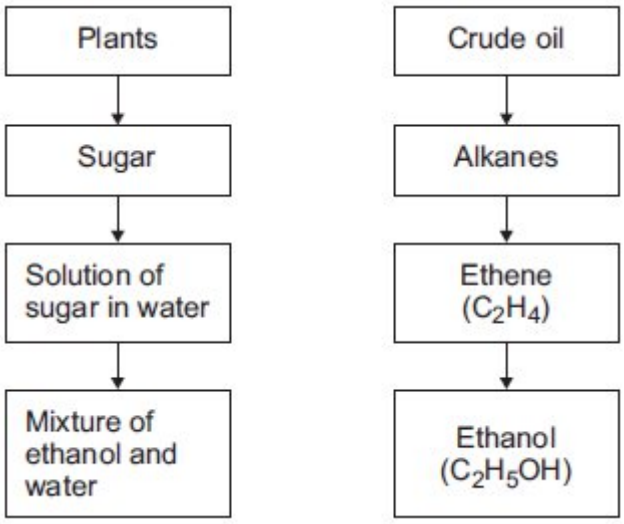
_____

**(1)**

**(Total 4 marks)**

## Q10.

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.

_____

_____

_____

_____



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**(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)**

## Q11.

This question is about energy changes in chemical reactions.

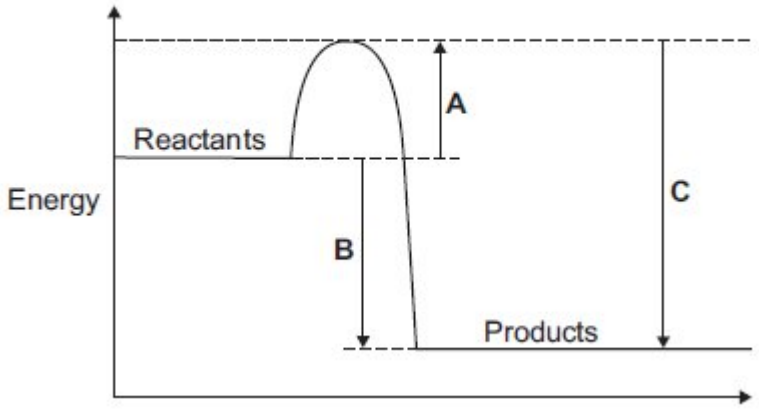
(a) Complete the word equation for the combustion of hydrogen.

hydrogen + oxygen ⟶ _____

**(1)**

(b) **Figure 1** shows a simple energy level diagram.

**Figure 1**




(i) Which arrow, **A**, **B** or **C**, shows the activation energy?

Tick (✔) **one** box.

**A** ☐

**B** ☐

**C** ☐



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**(1)**

(ii) What type of reaction is shown by the energy level diagram in **Figure 1**?
Give a reason for your answer.

Type of reaction _____

Reason _____

_____

**(2)**

(iii) For a reaction, the value of **A** is 1370 kJ and **C** is 3230 kJ.
Calculate the value of **B**.

_____

_____

**B** = _____ kJ

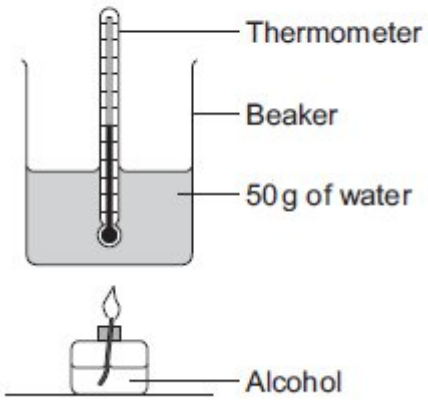
**(1)**

(c) Alcohols are used as fuels.

A group of students investigated the amount of energy released when different alcohols are burned.

The students used the apparatus shown in **Figure 2**.

**Figure 2**

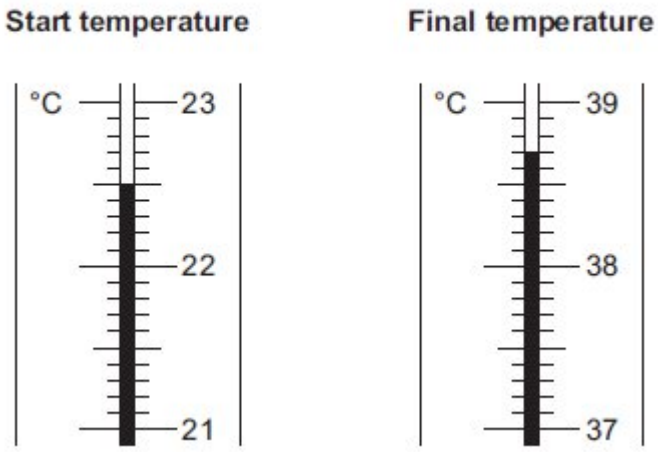



(i) **Figure 3** shows the start temperature and the final temperature of the water.



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Figure 3




Write the start temperature and the final temperature of the water in **Table 1**.
Work out the increase in temperature to complete **Table 1**.

**Table 1**

| | |
|---|---|
| Start temperature of the water in °C | |
| Final temperature of the water in °C | |
| Increase in temperature in °C | |

**(3)**

(ii) The students worked out the heat energy released by burning 1 g of each alcohol.
The students used the equation:

Heat energy released = m × 4.2 × increase in temperature

Look at **Figure 2**. What is the value of m?

m = _____ g

**(1)**

(iii) **Table 2** shows the students' results.

**Table 2**

| Name of alcohol | Number of carbon atoms in one molecule of alcohol | Heat energy released when 1 g of alcohol is burned in kJ |
|---|---|---|
| Methanol | 1 | 11.4 |
| Ethanol | 2 | 13.5 |
| Propanol | 3 | 20.1 |
| Butanol | 4 | 16.8 |
| Pentanol | 5 | 17.2 |



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Which value of heat energy released is anomalous?

_____

**(1)**

(iv) Look at **Table 2**.
What is the relationship between the number of carbon atoms in one molecule of alcohol and the heat energy released when 1 g of the alcohol is burned?

_____

_____

**(1)**

(v) The value in a data book for the amount of heat energy released when 1 g of butanol is burned completely is 36.2 kJ.

Suggest two reasons why the students' result for butanol is lower than the data book value.

1. _____

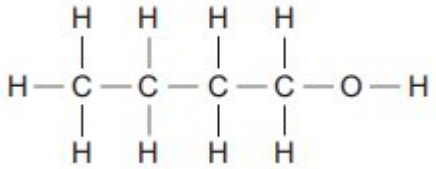
_____

2. _____

_____

**(2)**

(vi) The displayed structure of butanol is:



What is the functional group of the alcohol?

Tick (✔) **one** box.

— C — C ☐

— C — H ☐

— O — H ☐

**(1)**

**(Total 14 marks)**

## Q12.

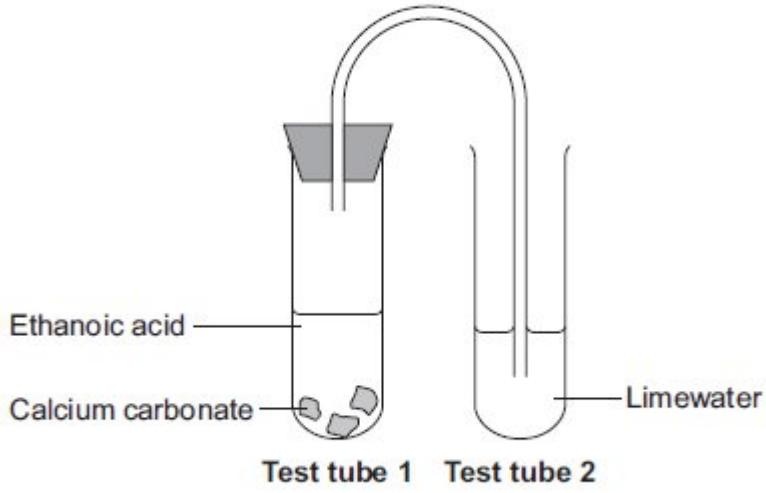
This question is about reactions of ethanoic acid and the analysis of salts.



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(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** _____

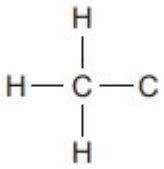
_____

_____

_____

**(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



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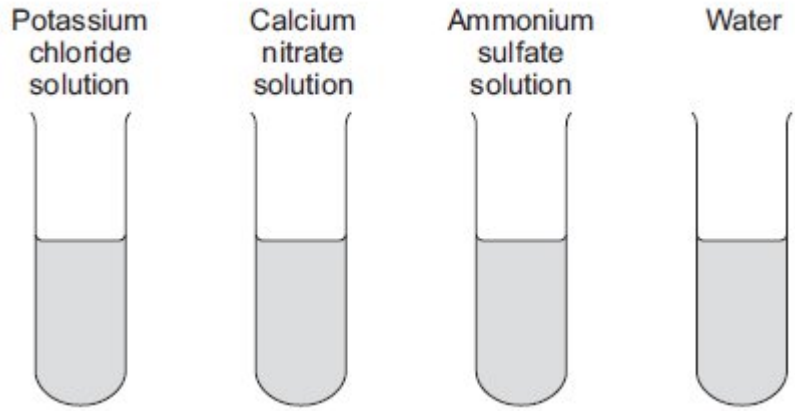
_____ catalyst to produce pleasant-smelling compounds

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)**



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(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)**

## Q13.

This question is about energy changes in chemical reactions.

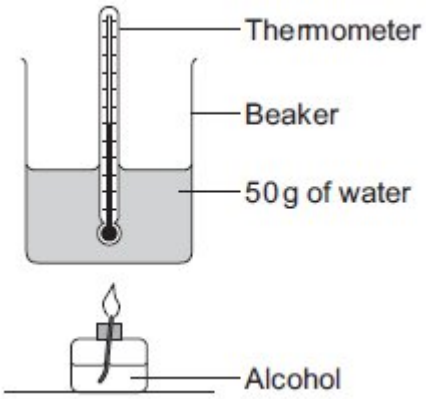
(a) Balance the chemical equation for the combustion of methane.

$$CH_4 \quad + \quad O_2 \quad \longrightarrow \quad CO_2 \quad + \quad H_2O$$

**(1)**

(b) Alcohols are used as fuels.

A group of students investigated the amount of energy released when an alcohol was burned. The students used the apparatus shown in the diagram below.




In one experiment the temperature of 50 g of water increased from 22.0 °C to 38.4 °C.
The mass of alcohol burned was 0.8 g.

Calculate the heat energy (Q) in joules, released by burning 0.8 g of the alcohol.
Use the equation:

$$Q = m \times c \times \Delta T$$

Specific heat capacity (c) = 4.2 J / g / °C

_____

_____

_____

_____



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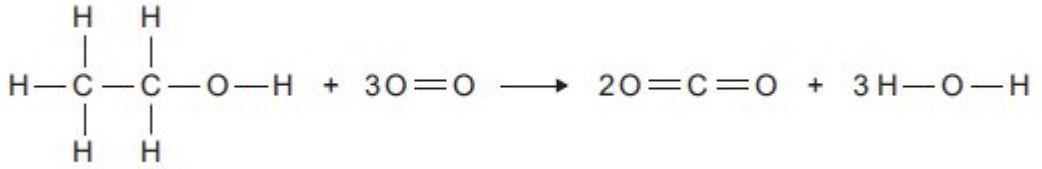
Heat energy (Q) = _____ J

**(3)**

(c) The chemical equation for the combustion of ethanol is:

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

(i) The equation for the reaction can be shown as:



| Bond | Bond energy in kJ per mole |
|---|---|
| C — H | 413 |
| C — C | 347 |
| C — O | 358 |
| C ▬ O | 799 |
| O — H | 467 |
| O ▬ O | 495 |

Use the bond energies to calculate the overall energy change for this reaction.

_____

_____

_____

_____

_____

_____

Overall energy change = _____ kJ per mole

**(3)**

(ii) The reaction is exothermic.
Explain why, in terms of bonds broken and bonds formed.

_____

_____

_____

_____



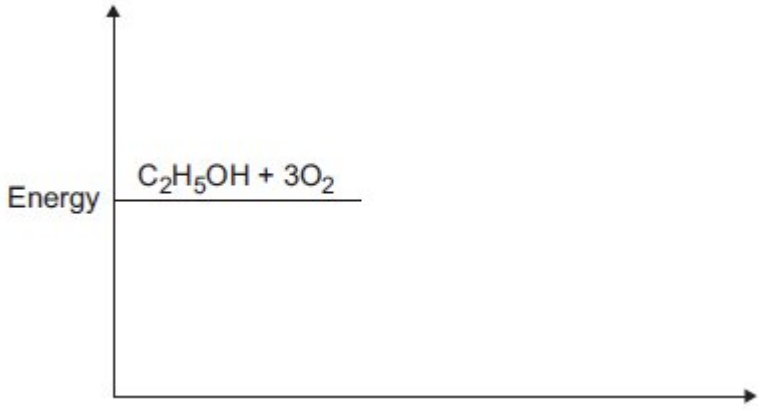
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**(2)**

(iii) Complete the energy level diagram for the combustion of ethanol.

On the completed diagram, label:

- activation energy
- overall energy change.




**(3)**
**(Total 12 marks)**

## Q14.

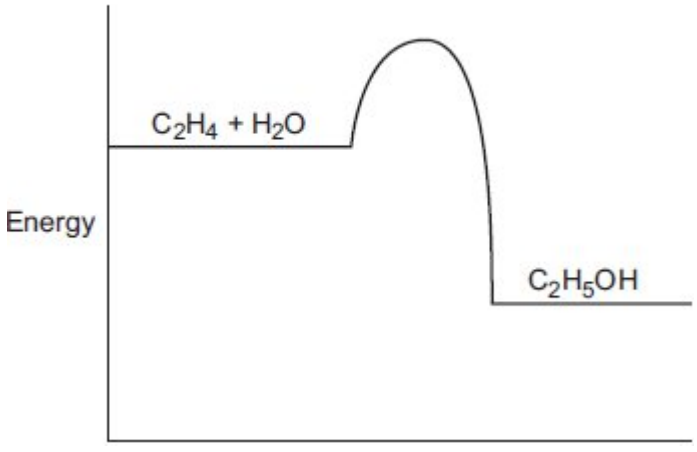
This question is about ethanol.

(a) Ethanol is produced by the reaction of ethene and steam:

$$C_2H_4 + H_2O \longrightarrow C_2H_5OH$$

(i) **Figure 1** shows the energy level diagram for the reaction.

**Figure 1**




How does the energy level diagram show that the reaction is exothermic?

_____

_____

**(1)**



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(ii) A catalyst is used for the reaction.

Explain how a catalyst increases the rate of the reaction.

_____

_____

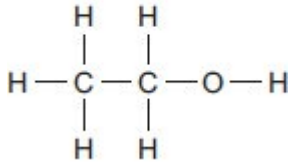
_____

_____

**(2)**

(b) **Figure 2** shows the displayed structure of ethanol.

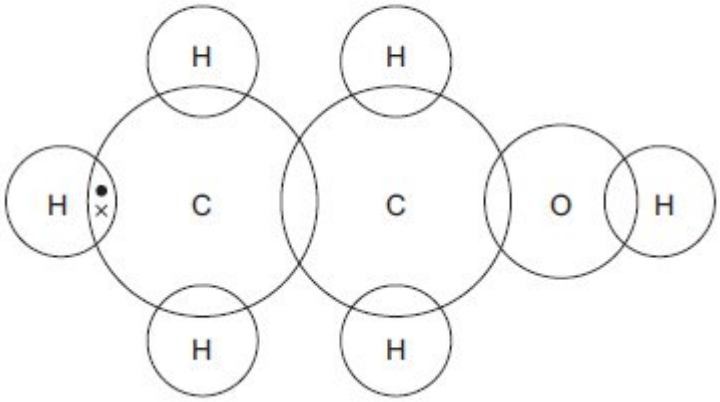
**Figure 2**




Complete the dot and cross diagram in **Figure 3** to show the bonding in ethanol.

Show the outer shell electrons only.

**Figure 3**




**(2)**

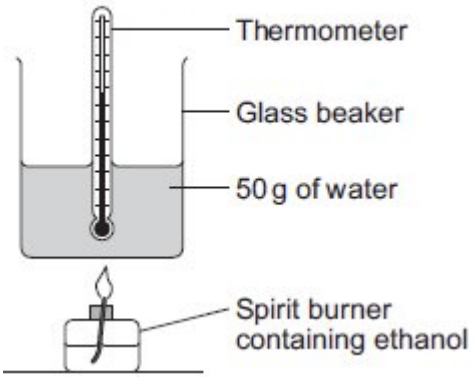
(c) A student burned some ethanol.

**Figure 4** shows the apparatus the student used.



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**Figure 4**




(i) The student recorded the temperature of the water before and after heating.

His results are shown in **Table 1**.

**Table 1**

| | |
|---|---|
| Temperature before heating | 20.7 °C |
| Temperature after heating | 35.1 °C |

Calculate the energy used to heat the water.

Use the equation $Q = m \times c \times \Delta T$

The specific heat capacity of water = 4.2 J / g / °C

_____

_____

_____

_____

_____

Energy used = _____ J

**(3)**

(ii) **Table 2** shows the mass of the spirit burner before the ethanol was burned and after the ethanol was burned.

**Table 2**

| | |
|---|---|
| Mass of spirit burner before ethanol was burned | 72.80 g |
| Mass of spirit burner after ethanol was burned | 72.10 g |

Calculate the number of moles of ethanol ($C_2H_5OH$) that were burned.



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Relative atomic masses ($A_r$): H = 1; C = 12; O = 16

_____

_____

_____

_____

_____

Number of moles burned = _____

**(3)**

(iii) Calculate the energy released in joules per mole.

You should assume that all the energy from the ethanol burning was used to heat the water.

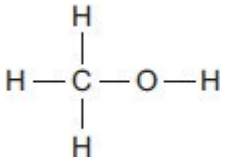
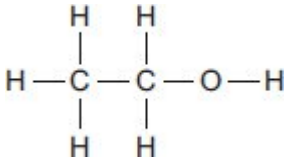
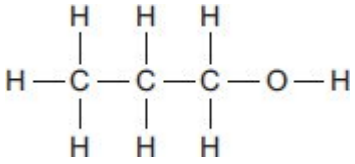
_____

Energy = _____ J / mole

**(1)**

(d) The names, structures and boiling points of ethanol and two other alcohols are shown in **Table 3**.

**Table 3**

| **Name** | **Methanol** | **Ethanol** | **Propanol** |
|---|---|---|---|
| **Structure** |  |  |  |
| **Boiling point in °C** | 65 | 78 | 97 |

Use your knowledge of structure and bonding to suggest why the boiling points increase as the number of carbon atoms increases.

_____

_____

_____

_____

_____

_____

_____



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**(3)**

**(Total 15 marks)**

## Q15.

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.



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

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

**Figure 1**

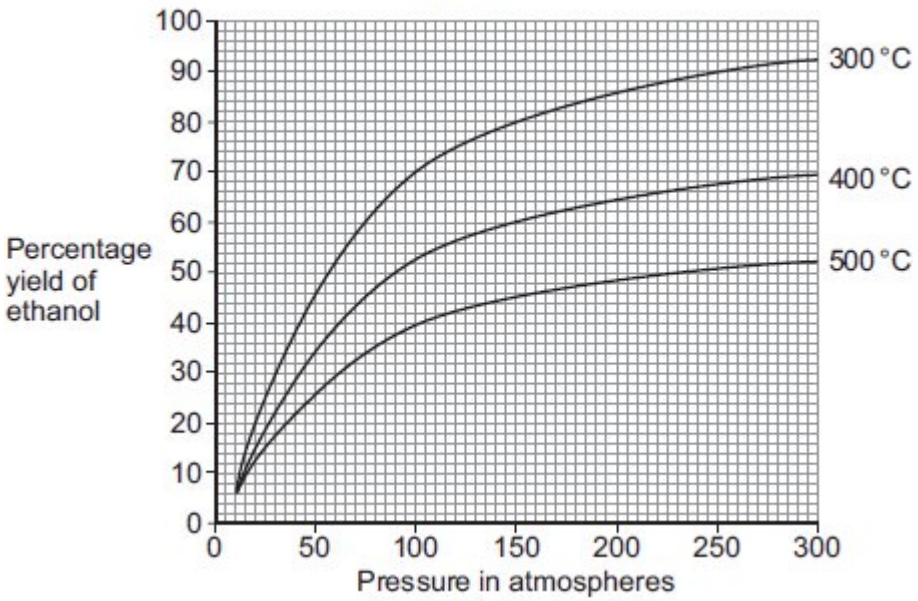
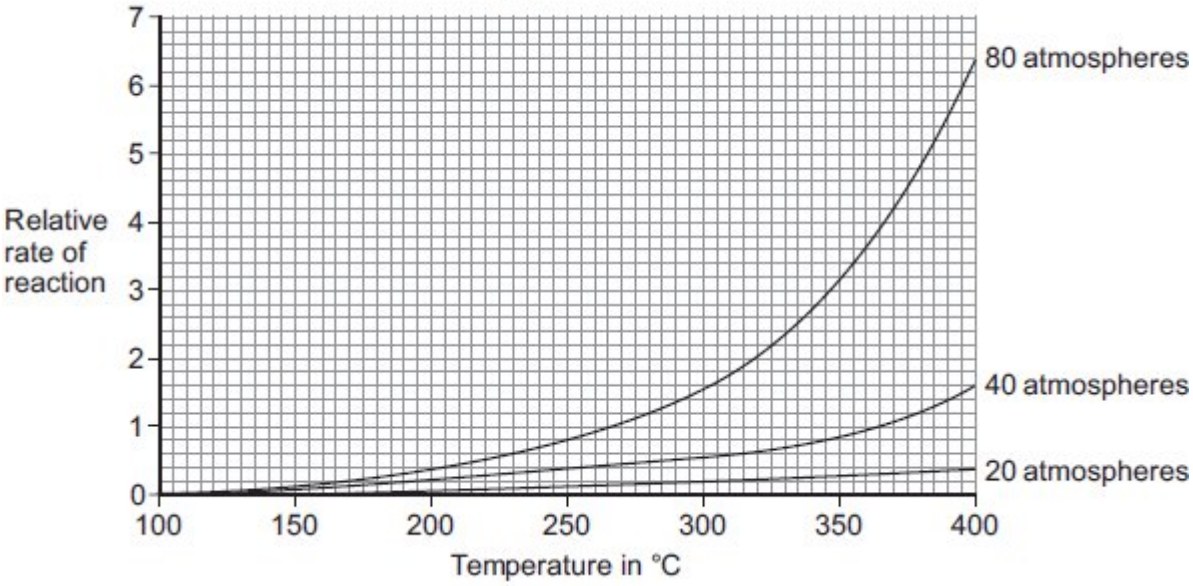



**Figure 2** shows how the rate of reaction changes as the temperature changes at three different pressures.

**Figure 2**




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

- 300 °C
- 65 atmospheres
- a catalyst.



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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**

**(Total 12 marks)**

## Q16.

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.



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**Diagram A**

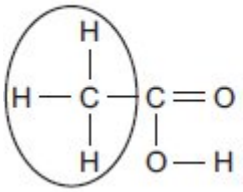


**Diagram B**

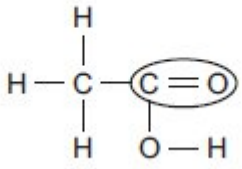


**Diagram C**

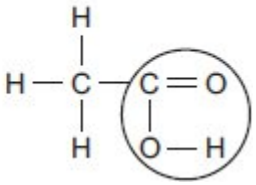


Diagram ☐

**(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)**

## Q17.

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.

_____

_____



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**(2)**

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

Tick (✓) **one** box.

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Oxygen ☐

**(1)**

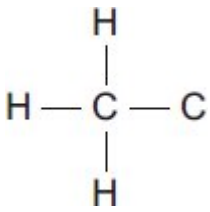
(c) Ethanoic acid ($CH_3COOH$) can be produced from ethanol ($CH_3CH_2OH$).

(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.



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(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?

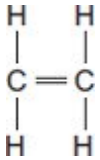
_____

**(1)**

**(Total 10 marks)**

## Q18.

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.

$C_{10}H_{22}$ ⟶ $C_2H_4$ + _____

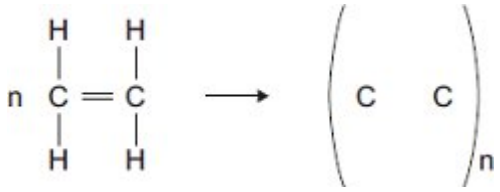
**(1)**

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

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



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**(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.

_____

_____

_____

_____

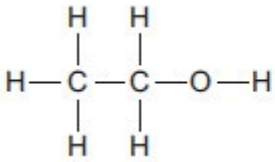
**(2)**

**(Total 7 marks)**

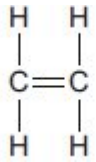
## Q19.

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

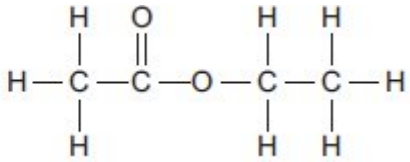
**A**



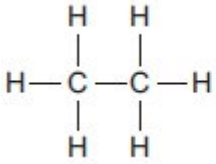
**B**



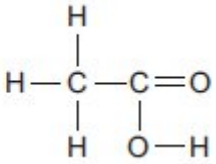
**C**



**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)**



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(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 _____

_____

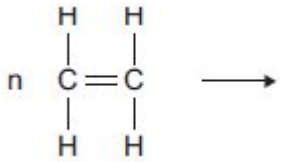
**(2)**

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

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



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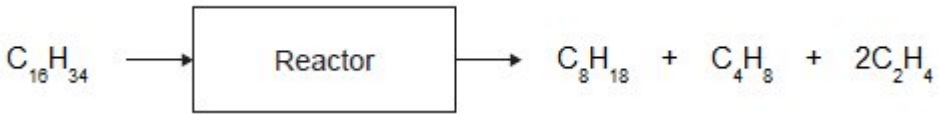
**(3)**

**(Total 14 marks)**

## Q20.

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.



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**(1)**

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

_____

_____

_____

_____

**(2)**

**(Total 8 marks)**

## Q21.

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.

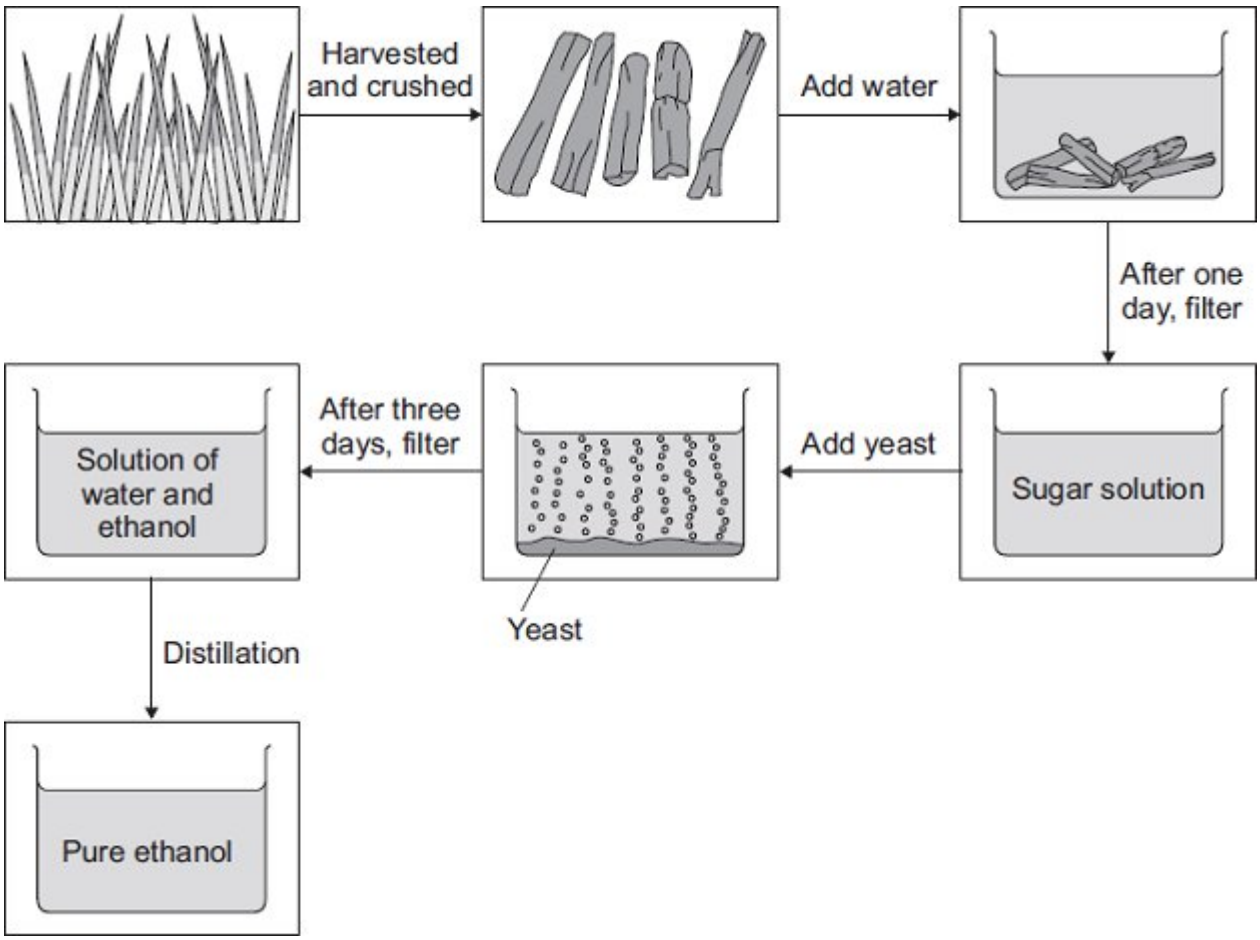
octane + oxygen → _____ + _____

**(2)**



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(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. _____

_____

_____



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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. _____

_____

_____

2. _____

_____

_____

**(2)**

**(Total 9 marks)**

## Q22.

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.



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_____

_____

_____

_____

_____

_____

_____

_____

_____

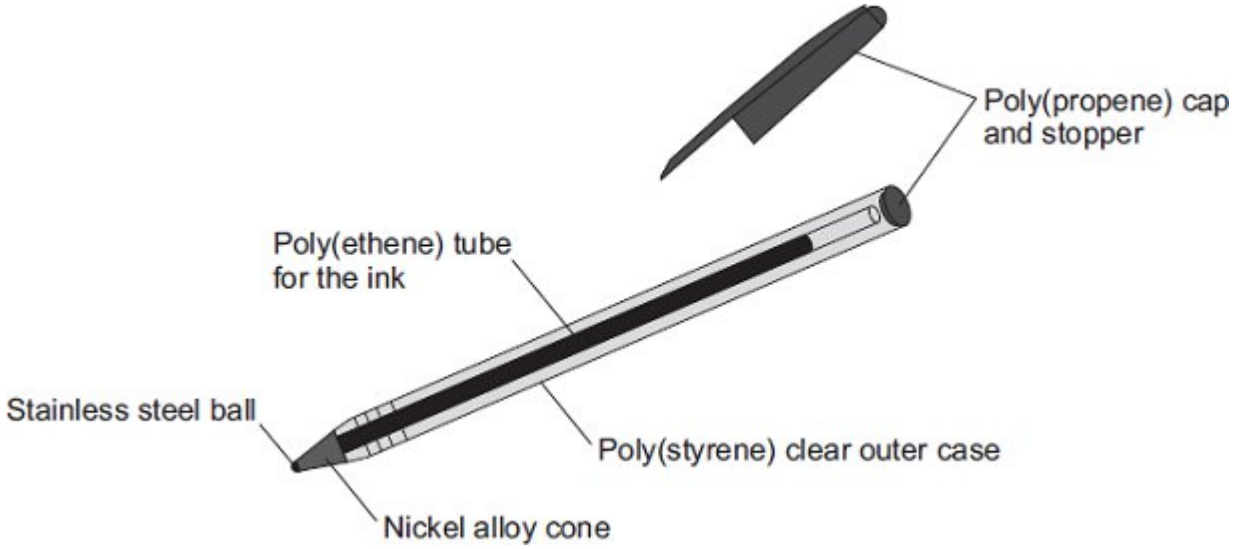
_____

**(4)**

**(Total 8 marks)**

## Q23.

The diagram shows a ballpoint pen.




(a) Polymers are used to make the ballpoint pen.

(i) Name the monomer used to make poly(ethene).

_____

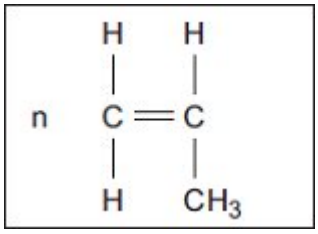
**(1)**

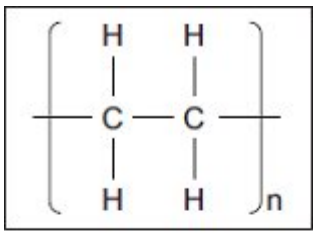
(ii) Draw **one** line from the monomer propene to its polymer poly(propene).

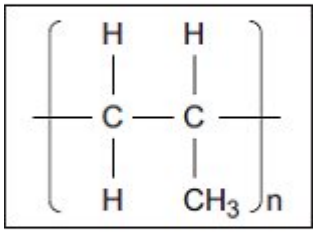
**Monomer** **Polymer**

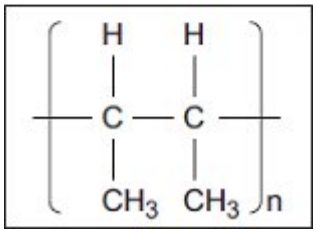


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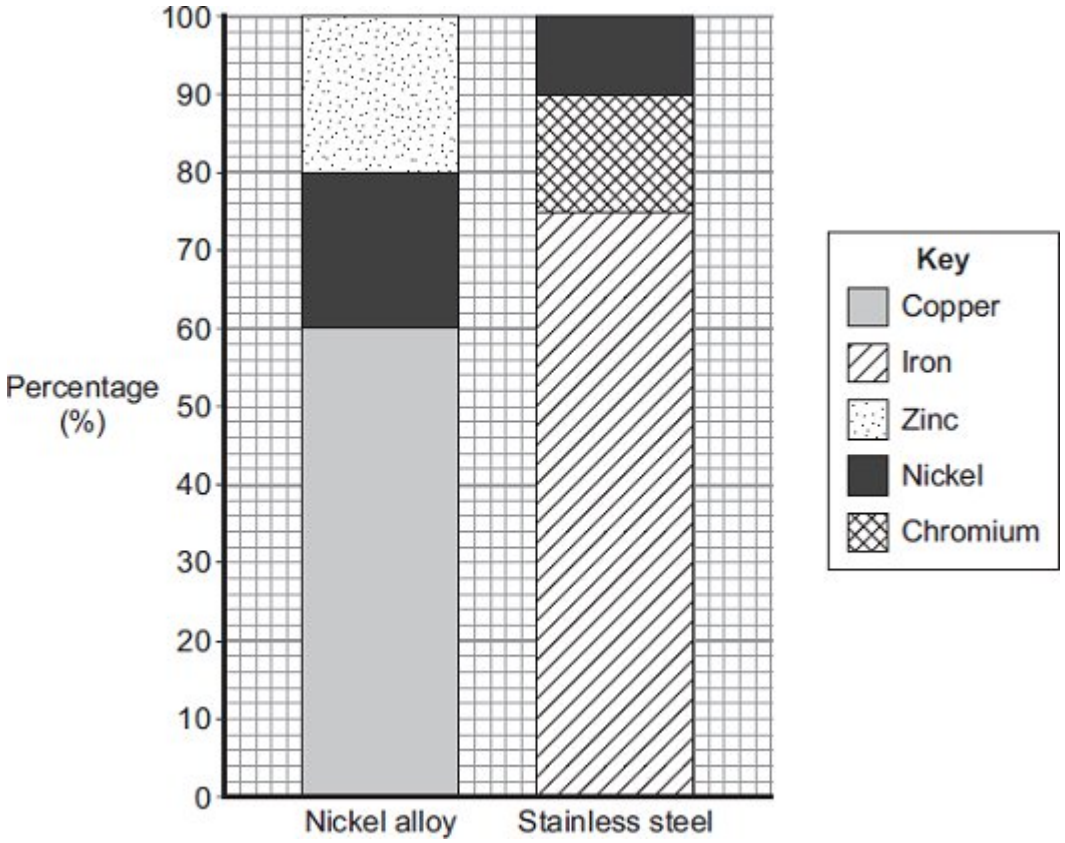




**(1)**

(b) Two alloys are used to make the ballpoint pen.




Use the bar chart to answer these questions.

(i) Which metal is in both of these alloys?

_____



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**(1)**

(ii) What is the percentage of iron in the stainless steel?

_____ %

**(1)**

(iii) The alloy stainless steel is used instead of pure iron for the ball of the pen.

Give **two** reasons why.

_____

_____

_____

_____

**(2)**

(c) Tick (✓) **one** advantage and tick (✓) **one** disadvantage of **recycling** this type of ballpoint pen.

| | **Advantage Tick (✓)** | **Disadvantage Tick (✓)** |
|---|---|---|
| Can be refilled and reused | | |
| Conserves resources of crude oil and ores | | |
| High cost of separating materials | | |
| Polymers and alloys are not expensive | | |

**(2)**

**(Total 8 marks)**

## Q24.

There has been research into fuels for car engines.

| **Fuel** | **Content** | **Melting point in °C** | **Flashpoint in °C** | **Energy released in MJ per litre** |
|---|---|---|---|---|
| Ethanol | $C_2H_5OH$ | −114 | +14 | 21.2 |
| Diesel | hydrocarbons | About −24 | +64 | 38.6 |
| Petrol | hydrocarbons | About −57 | −45 | 34.8 |
| Rapeseed oil | fats | About +5 | +130 | 32.8 |



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The flashpoint is the lowest temperature a fuel vapour ignites in air.

(a) The melting point of ethanol is precise but the other melting points are approximate.

Suggest why.

_____

_____

_____

**(2)**

(b) Ethanol is produced by fermentation of sugar cane. Rapeseed oil is produced by pressing rapeseeds. Waste plant material from both processes is used to feed animals.

(i) Describe how the process of fermentation is done.

_____

_____

_____

_____

**(2)**

(ii) Carbon neutral fuels do **not** increase the amount of carbon dioxide in the atmosphere.

Suggest why using a biofuel, such as ethanol or rapeseed oil, is thought to be carbon neutral.

_____

_____

_____

_____

**(2)**

(c) When any fuel from the table is used in a car engine, the exhaust gases contain nitrogen oxides.

Explain why.

_____

_____

_____

_____

**(2)**

(d) Evaluate replacing petrol with ethanol as a fuel for cars.



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To gain full marks you should give a justified conclusion.

Use the information from the table and your knowledge to answer this question.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

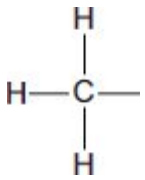
**(Total 12 marks)**

## Q25.

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.



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The ethanoic acid is produced from a reaction between ethanol

and _____ .

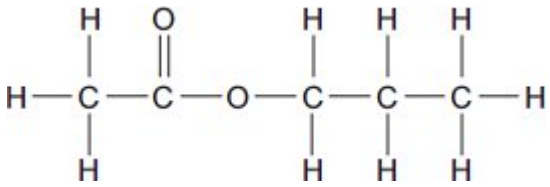
This type of reaction is _____ .

**(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)**

## Q26.

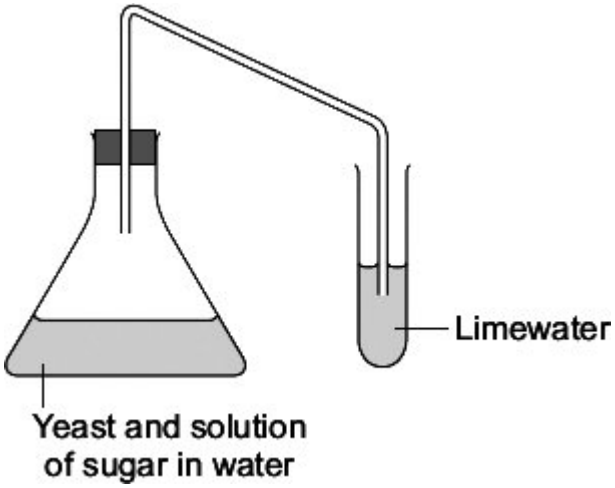
Two fuels that can be used for cars are:

- 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.



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(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)**

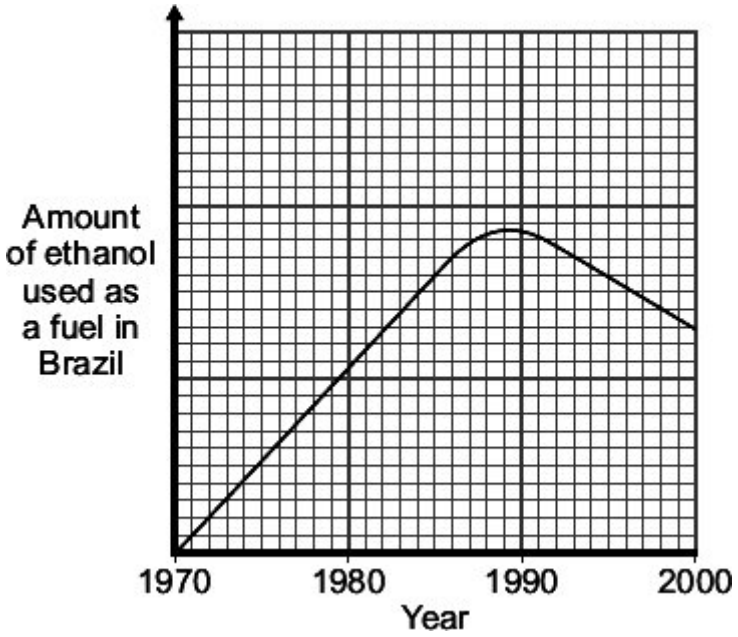
(b) In 1970, the Brazilian Government stated that all petrol must contain more than 25% ethanol.

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.



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(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)**

## Q27.

Ethene is used as a starting material for the production of many other substances, including ethanol.

(a) Ethene is produced when hydrocarbons are cracked. To do this hydrocarbons are heated to vaporise them. The vapours are then passed over a hot catalyst. The symbol equation shows the reaction for one hydrocarbon.

$$C_{28}H_{58} \rightarrow C_{11}H_{24} + C_{11}H_{22} + C_4H_8 + C_2H_4$$

(i) One of the products is a different type of hydrocarbon to the other products.

Complete the sentences.



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The formula of the product that is a different type of hydrocarbon is

_____

The chemical structure of this product is different to the other products because

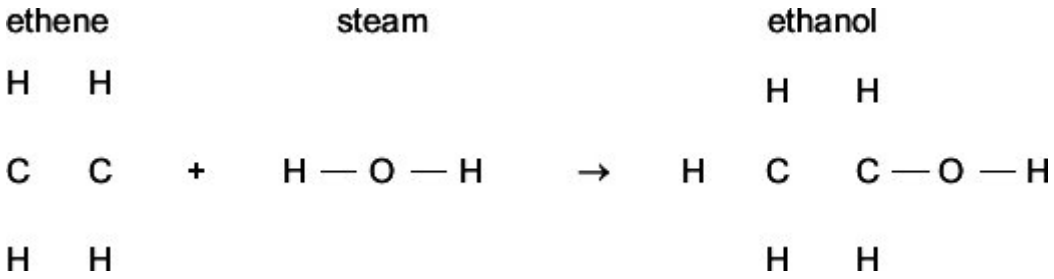
_____

_____

**(2)**

(ii) Ethanol is produced when ethene reacts with steam in the presence of a hot catalyst.

Draw the missing bonds to complete the displayed structures in the equation.




**(2)**

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

In 1970, the Brazilian Government had stated that all petrol must contain more than 25% ethanol. The reasons for this statement in 1970 were:

- the oilfields in Brazil at that time only supplied 20% of the crude oil needed to make petrol
- Brazil has a climate suitable for growing sugar cane.

To produce ethanol the sugar cane plants are crushed and soaked in water for one day. The sugar solution is separated from the plant material by filtration. Yeast is added to the sugar solution and fermented for three days. The yeast is separated from the solution of water and ethanol by filtration. Ethanol is separated from water by fractional distillation.

In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%. The reasons were that in 2011:

- the demand for ethanol and the price of ethanol had greatly increased
- very large offshore oilfields had been discovered. These offshore oilfields would make Brazil one of the biggest crude oil producers in the world.

Use the information above and your own knowledge and understanding to evaluate whether Brazil should in future produce ethanol from crude oil or produce ethanol from sugar cane.

You should include environmental and economic or social factors in your evaluation.



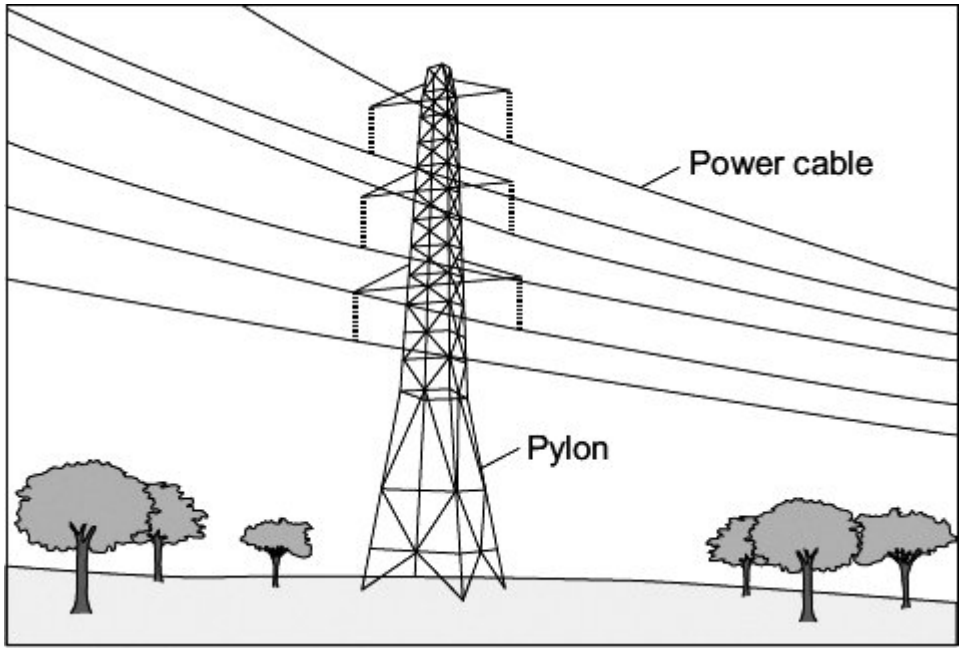
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**(6)**

**(Total 10 marks)**

## Q28.

Metals are used in the manufacture of pylons and overhead power cables.






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(a) Suggest **one** reason why iron (steel) is used to make pylons.

_____

_____

**(1)**

(b) The table shows some of the properties of two metals.

| Metal | Density in g per $cm^3$ | Melting point in °C | Percentage(%) relative electrical conductivity | Percentage(%) abundance in Earth's crust |
|---|---|---|---|---|
| **copper** | 8.92 | 1083 | 100 | 0.007 |
| **aluminium** | 2.70 | 660 | 60 | 8.1 |

Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

_____

_____

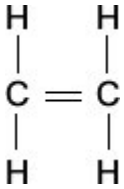
_____

_____

**(2)**

(c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



Draw a ring around the correct answer to complete each of the sentences.

(i) The chemical formula of this alkene is

CH

$CH_4$

$C_2H_4$

**(1)**

double bond.



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(ii) The two lines between the carbon atoms are called a

| |
|---|
| nucleus. |
| single bond. |

**(1)**

(iii) The name of the polymer formed when many of these alkene molecules join together is

| |
|---|
| poly(ethene). |
| poly(ethenol). |
| poly(propene). |

**(1)**

**(Total 6 marks)**

## Q29.

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.

**H H**



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**C C**

**H H**

**(1)**

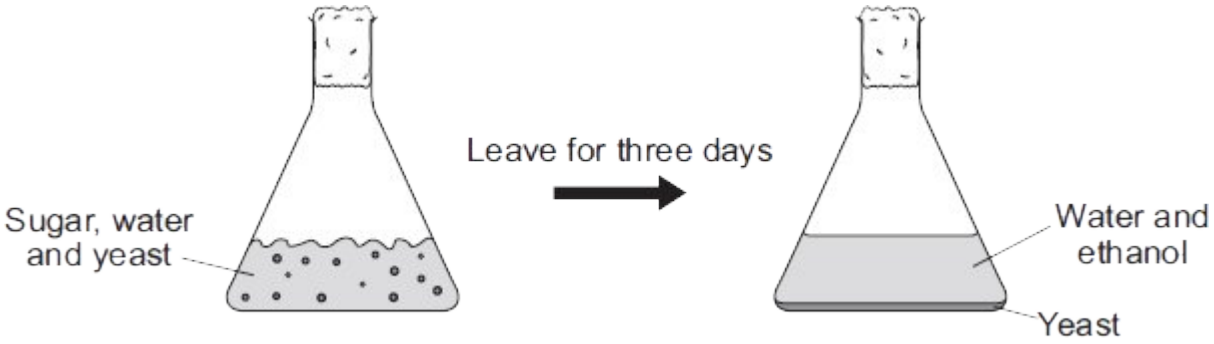
(iii) Name the substance added to ethene ($C_2H_4$) to produce ethanol ($C_2H_5OH$).

_____

**(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)**

## Q30.

Ethanol ($C_2H_5OH$) is produced from ethene or from sugar cane.

The two different methods to produce ethanol are summarised in the table.

| **Ethanol from sugar cane is a batch process** | **Ethanol from crude oil is a continuous process** |
|---|---|
| Sugar cane plants are crushed and soaked in water for one day. | Crude oil is distilled to separate the naphtha fraction. |



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| | |
|---|---|
| The sugar solution is separated by filtration. | The naphtha fraction is cracked when the vaporised hydrocarbons are passed over a hot catalyst. |
| Yeast is added to the sugar solution and fermented for three days. | The ethene produced is separated by distillation. |
| The solution of water and ethanol produced is separated by filtration. | Ethene is reacted with steam in the presence of a catalyst. |
| Distillation of this solution produces a 50% solution of ethanol. | This hydration reaction produces 100% ethanol. |

(a) Complete and balance an equation for the cracking of the hydrocarbon $C_6H_{14}$ to produce ethene.

$C_6H_{14}$ ⟶ _____ + _____

**(2)**

(b) What is **seen** when the sugar solution and yeast are fermented?

_____

_____

**(1)**

(c) Evaluate the issues involved with the production of ethanol from sugar cane compared with the production of ethanol from crude oil.
You should explain why each issue you describe is important.

_____

_____

_____

_____

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_____

_____



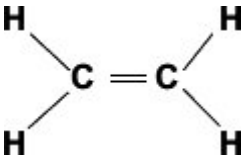
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**(5)**
**(Total 8 marks)**

## Q31.

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)**

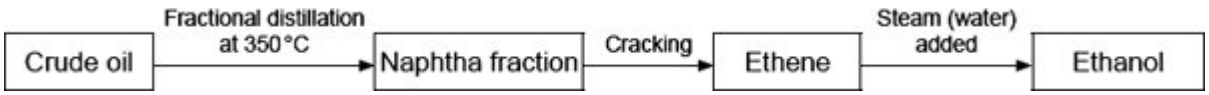


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## Q32.

Petrol sold in most countries now contains at least 5% ethanol.
The production of ethanol, for use as a fuel, is being increased.

The flow diagram shows how ethanol can be produced from crude oil.




(a) Why does crude oil need to be fractionally distilled?

_____

_____

**(1)**

(b) Hydrocarbons, such as decane, in the naphtha fraction are cracked to produce ethene.
The balanced chemical equation shows the cracking of decane.

| $C_{10}H_{22}$ | → | $C_8H_{18}$ | + | $C_2H_4$ |
|---|---|---|---|---|
| decane | | octane | | ethene |

(i) Describe how cracking is done.

_____

_____

_____

_____

**(2)**

(ii) Complete the structural formula of ethene by drawing lines to represent each covalent bond.

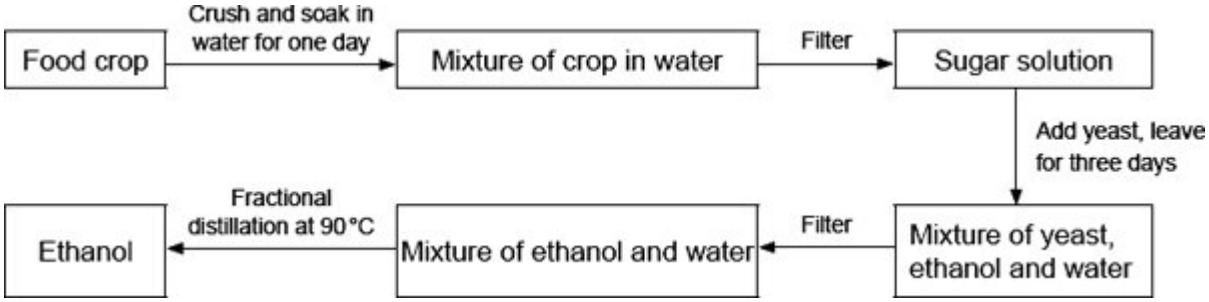
**H H**

**C C**

**H H**

**(1)**

(c) The flow diagram below shows how ethanol, for use as a fuel, can also be produced from food crops.






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Use the information in the two flow diagrams and your own knowledge and understanding to evaluate whether more of this ethanol should be produced from food crops or from crude oil.

Remember to give a conclusion to your evaluation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(5)**

**(Total 9 marks)**

## Q33.

Chlorine and bromine are important Group 7 elements.

(a) Explain why chlorine is added to drinking water.

_____

_____

**(1)**

(b) Describe what you would **see** when bromine water is added to an unsaturated organic compound.

_____

_____

**(1)**

(c) Bromine can be extracted from seawater. The dissolved bromide ions are reacted with chlorine. Bromine and chloride ions are formed.

(i) Complete and balance the equation below, which represents the reaction between chlorine and bromide ions.



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$Cl_2 + 2Br^- \rightarrow$ _____ + _____

**(1)**

(ii) Describe what you **see** when chlorine is added to a solution containing bromide ions.

_____

_____

**(1)**

(d) In terms of electronic structure:

(i) state why bromine and chlorine are both in Group 7

_____

_____

**(1)**

(ii) explain why bromine is less reactive than chlorine.

_____

_____

_____

_____

_____

_____

_____

**(3)**

(e) What is the result of adding acidified silver nitrate solution to a solution containing:

(i) chloride ions

_____

**(1)**

(ii) bromide ions?

_____

**(1)**

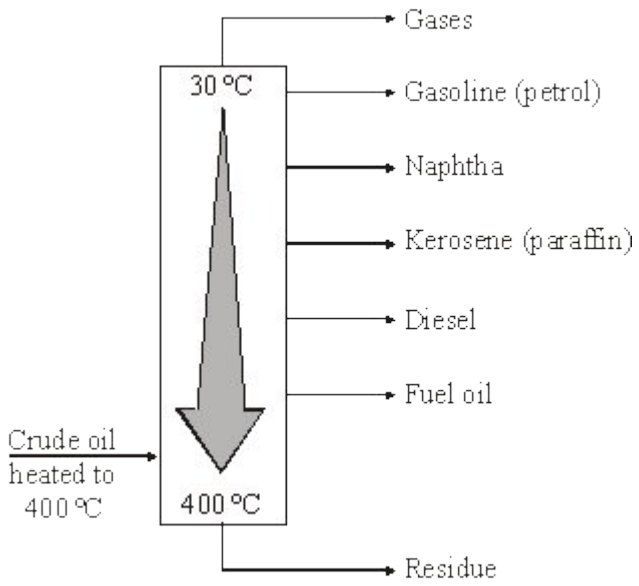
**(Total 10 marks)**

## Q34.

Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



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(a) Describe how the naphtha fraction separates from the other fractions.

_____

_____

_____

_____

**(2)**

(b) The naphtha fraction is often used to make other useful materials.

This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane → hexane + ethene

$C_{10}H_{22}$ → $C_6H_{14}$ + $C_2H_4$

(i) Balance the symbol equation given above.

**(1)**

(ii) Describe how cracking is carried out.

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**(2)**

(iii) Why does ethene have different chemical properties from decane and hexane?

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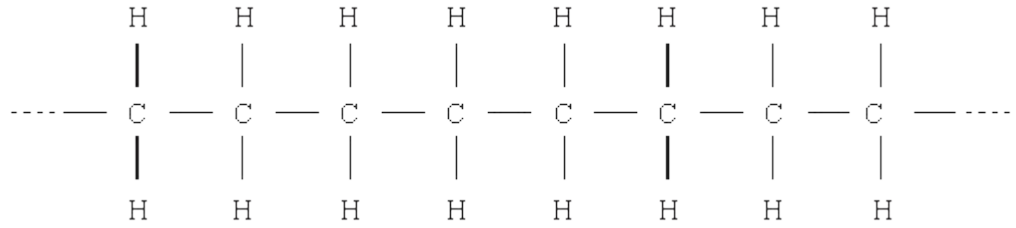
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**(2)**

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.

H H

C C

H H

**(1)**

(d) Read the following information.

**Landfill, Incineration, Recycling and Re-use of Poly(ethene)**

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.



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You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?
(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

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**(4)**

**(Total 12 marks)**

## Q35.

Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

(a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmospheres of Mars and Earth as they are now.

| **Mars** | | **Earth** | |
|---|---|---|---|
| nitrogen | 3% | nitrogen | 78% |
| oxygen | trace | oxygen | 21% |
| water | trace | water | trace |
| carbon dioxide | 95% | carbon dioxide | trace |
| Average surface temperature –23 °C | | Average surface temperature 15 °C | |

Suggest what has caused the main gases in the Earth's atmosphere of millions of years ago to change to the present-day atmosphere.



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**(2)**

(b) Titan is the largest moon of the planet Saturn. It has an atmosphere that, like the Earth's, contains mainly nitrogen. Methane is the other main gas.

| Main gases in Titan's atmosphere | Percentage (%) | Boiling point in °C |
|---|---|---|
| Nitrogen | 95 | –196 |
| Methane | 5 | –164 |
| Average surface temperature –178 °C | | |

When it rains on Titan, it rains methane! Explain why.

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**(2)**

(c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene and propene, from methane in Titan's atmosphere.

(i) Draw the structure of propene, $C_3H_6$, to show the covalent bonds.

**(1)**

(ii) Explain how propene molecules form a polymer. You should name the polymer formed.

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**(3)**

**(Total 8 marks)**



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