AQA

Please write clearly in block capitals.

Centre number | 1 | 2 | 3 | 4 | 5 | Candidate number | 1 | 2 | 3 | 4 |

Surname EXAMPLE

Forename(s) EG

Candidate signature

I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

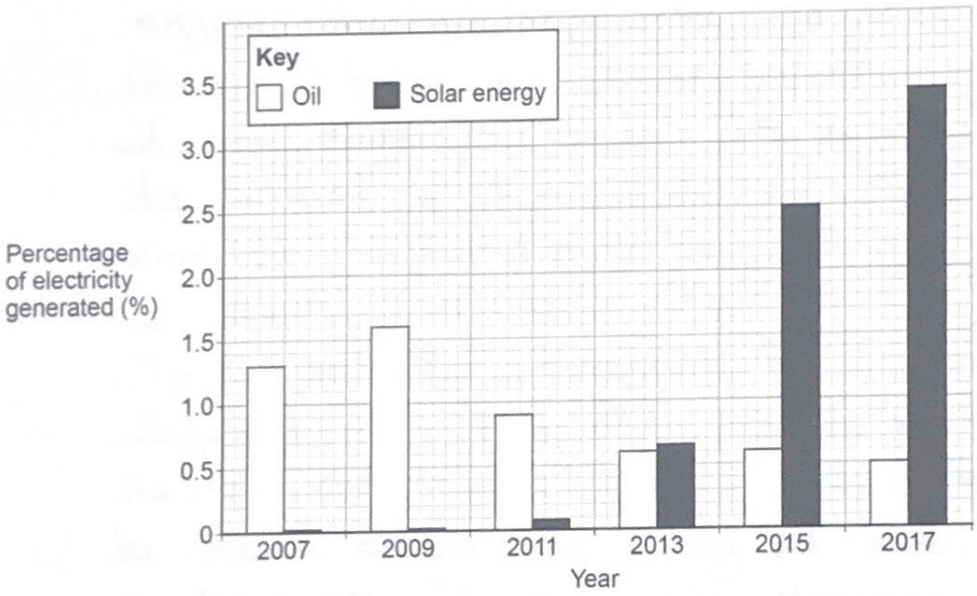
Do not write outside the box

0 1 This question is about fuels and energy.

Figure 1 shows the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Figure 1



0 1 . 1 Describe the changes in the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Use data from **Figure 1** in your answer.

[3 marks]

Between 2007 and 2009 the percentage of oil rose from 1.3% to 1.6 before steadily decling down to 0.5% between 2009 and 20017. Solar remained constant at less than 1% between 200* and 2009 before rapidly increasing to 3.4% by 2017

Do not write outside the box

0 1 . 2 Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

[6 marks]

When oil is burned in a combustion engine, the high temperatures will drive reaction between the sulfur impurities in oil and oxygen from the air. This leads to the formation of sulfur dioxide gas. Once emitted, sulfur dioxide gas will go on to react with water vapour in clouds and the atmosphere to produce sulphuric acid. This then falls to Earth as acid rain. acid rain can do damage to aquatic environments, killing fish and aquatic plants. It may also damage forests as well as man made structures such as lime stone statues. CO_2 is also produced which exacerbates Global warming

Do not write outside the box

0 1 . 3 Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

Sunlight is renewable, oil is not

0 1 . 4 Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

1 Sunlight is not reliable, especially in cloudier climates

2 Solar cells require a lot of space

12

Turn over for the next question

Do not write outside the box

0 2 This question is about alkanes.

Table 1 shows information about some alkanes.

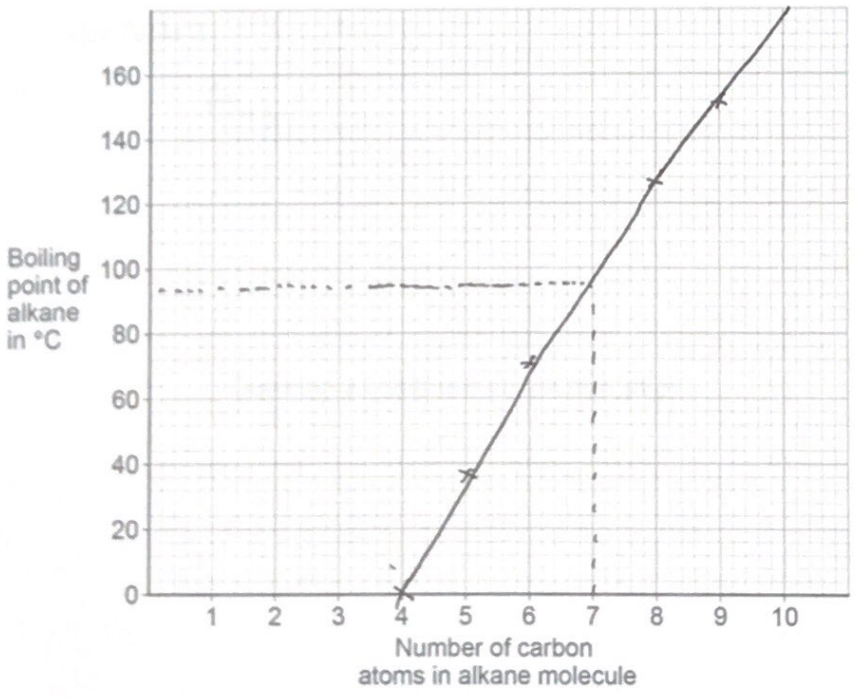
Table 1

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

0 2 . 1 Plot the data from **Table 1** on **Figure 2**.

[2 marks]

Figure 2



Do not write outside the box

0 2 . 2 Predict the boiling point **X** of the alkane with seven carbon atoms in a molecule.

Use **Table 1** and **Figure 2**.

[1 mark]

X = 98 °C

0 2 . 3 **Figure 2** is **not** suitable to show the boiling point of the alkane with three carbon atoms in a molecule.

Suggest **one** reason why.

[1 mark]

The boiling point would be below 0

0 2 . 4 What is the state at 20 °C of the alkane with four carbon atoms in a molecule?

Use **Table 1**.

[1 mark]

Gas

Question 2 continues on the next page

Do not write outside the box

Table 1 is repeated below.

Table 1

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

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

0 2 . 5 Complete the formula of nonane.

[1 mark]

C_9H_{20}

0 2 . 6 Nonane will condense lower in a fractionating column during fractional distillation than the other alkanes in **Table 1**.

Explain why.

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

[2 marks]

Nonane has the highest boiling point. Therefore it will condense at a higher temperature. In a fractional distillation column the highest temperature is at the bottom. Hence nonane condenses low down.

8

Do not write outside the box

0 3 This question is about paper chromatography.

A food colouring contains a dye.

0 3 . 1 Plan an investigation to determine the R_f value for the dye in this food colouring.

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

Your plan should include the use of:

- a beaker
- a solvent
- chromatography paper.

[6 marks]

On a rectangular sheet of chromatography paper, use a pencil to draw a line one cm up from the short edge of the paper. Place a spot of food colouring on the line. Place the paper into a beaker and pour in an appropriate solvent. Do not fill the beaker past the start line on the chromatography paper. Place a lid on the beaker and allow the solvent front to move up the chromatography paper. Once it is almost at the top, remove the paper and draw a line along the front. Dry the paper and measure the distances from the solvent front and the centre of the food colouring dot to the start line. Use these values to calculate R_f

Do not write outside the box

0 3 . 2 Two students investigated a dye in a food colouring using paper chromatography.

Each student did the investigation differently.

The R_f values they determined for the **same** dye were different.

How did the students' investigations differ?

[1 mark]

Tick (✓) **one** box.

- Different length of paper used ☐
- Different period of time used ☐
- Different size of beaker used ☐
- Different solvent used ☑

0 3 . 3 Paper chromatography involves a stationary phase.

What is the stationary phase in paper chromatography?

[1 mark]

Tick (✓) **one** box.

- Beaker ☐
- Dye ☐
- Paper ☑
- Solvent ☐

8

Do not write outside the box

0 4 This question is about poly(ethene) and polyesters.

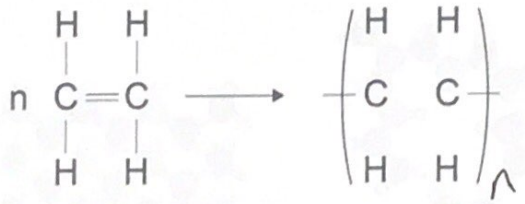
0 4 . 1 Poly(ethene) is produced from ethene.

Figure 3 shows part of the displayed structural formula equation for the reaction.

Complete **Figure 3**.

[2 marks]

Figure 3



0 4 . 2 Poly(ethene) is a thermosoftening polymer.

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

[2 marks]

Poly(ethene) can be melted down and turned into new products by reshaping it.

0 4 . 3 Ethene produces different forms of poly(ethene).

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

[1 mark]

By using different reaction conditions

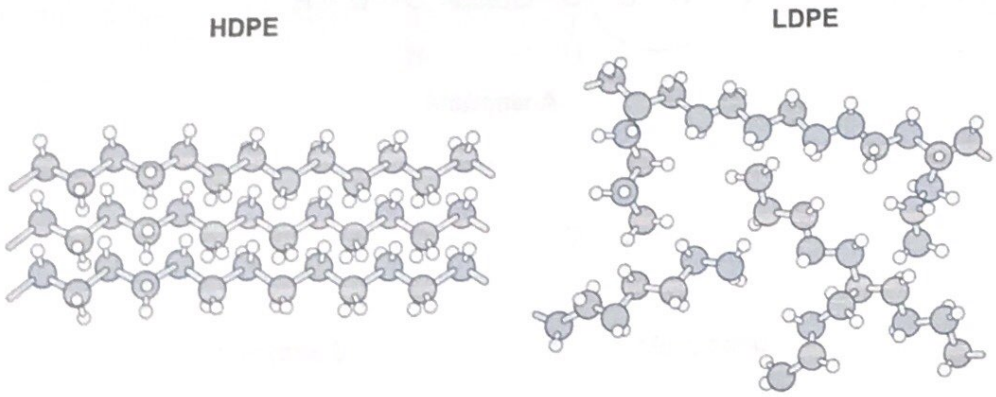
Do not outside box

0 4 . 4 Two different forms of poly(ethene) are:

- high density poly(ethene) (HDPE)
- low density poly(ethene) (LDPE).

Figure 4 represents part of the structures of HDPE and LDPE.

Figure 4



Explain why HDPE has a higher density than LDPE.

[2 marks]

The polymer chains are closer together and so there are more atoms contained within a unit volume

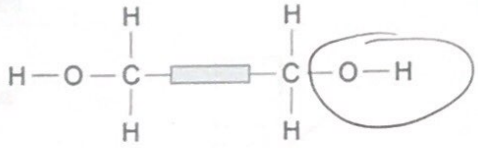
Question 4 continues on the next page.

Do not w outside box

Figure 5 shows three monomers, **A**, **B** and **C**.

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

Figure 5



Monomer **A**

Monomer **B**

Monomer **C**

0 4 . 5 Draw a circle on **Figure 5** around an alcohol functional group.

[1 mark]

0 4 . 6 Complete **Table 2** to show the formula of the small molecule produced when:

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

[1 mark]

Table 2

Reacting monomers	Formula of small molecule produced
A and **B**	H_2O
A and **C**	HCl

9

Do not write outside the box

0 5 This question is about fertilisers.

Some fertilisers are described as NPK fertilisers because they contain three elements needed for healthy plant growth.

0 5 . 1 Which **two** compounds each contain **two** of these elements? **[2 marks]**

Tick (✓) **two** boxes.

- Ammonium nitrate ☐
- Ammonium phosphate ☑
- Calcium chloride ☐
- Calcium phosphate ☐
- Potassium chloride ☐
- Potassium nitrate ☑

0 5 . 2 Rocks containing calcium phosphate are treated with acid to produce soluble salts that can be used as fertilisers.

Name the soluble salts produced when calcium phosphate reacts with:

- nitric acid
- phosphoric acid.

[2 marks]

Nitric acid Calcium nitrate

Phosphoric acid Calcium dihydrogenphosphate

Do not write outside the box

0 5 . 3 Ammonium sulfate is a compound in fertilisers.

Ammonium sulfate can be made using an industrial process or in the laboratory.

In the industrial process, the following steps are used.

1. React streams of ammonia solution and sulfuric acid together.
2. Evaporate the water by passing the solution down a warm column.
3. Collect dry crystals continuously at the bottom of the column.

In the laboratory, the following steps are used.

1. React ammonia solution and sulfuric acid in a conical flask.
2. Evaporate water from the solution until crystals start to form.
3. Leave to cool and crystallise further.
4. Separate the crystals using filtration.
5. Dry the crystals between pieces of filter paper.

Evaluate the two methods for producing a large mass of ammonium sulfate.

[4 marks]

The industrial process is continuous and so can produce more Ammonium Sulfate per unit time than the lab process. It is also larger scale and so is able to meet demand for a large mass. The lab process is small scale and therefore unable to meet mass demand.

8

Do not write outside the box

0 6 This question is about cycloalkenes.

Cycloalkenes are ring-shaped hydrocarbon molecules containing a double carbon-carbon bond.

Cycloalkenes react in a similar way to alkenes.

0 6 . 1 Describe a test for the double carbon-carbon bond in cycloalkene molecules.

Give the result of the test.

[2 marks]

Test Add Bromine water to a solution suspected of containing Cyclo alkenes

Result if double bonds are present, the orange bromine water will turn colourless

0 6 . 2 **Table 3** shows the name and formula of three cycloalkenes.

Table 3

Name	Formula
Cyclobutene	C_4H_6
Cyclopentene	C_5H_8
Cyclohexene	C_6H_{10}

Determine the general formula for cycloalkenes.

[1 mark]

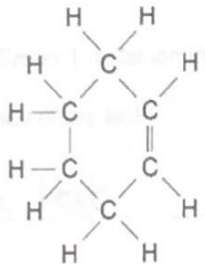
$C_n H_{2n-2}$

General formula = _____

Do not write outside the box

Figure 6 shows the displayed structural formula of cyclohexene, C_6H_{10}

Figure 6

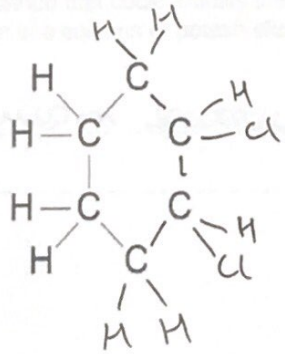


Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

0 6 . 3 Complete **Figure 7** to show the displayed structural formula of $C_6H_{10}Cl_2$

[2 marks]

Figure 7



0 6 . 4 Calculate the percentage by mass of chlorine in a molecule of $C_6H_{10}Cl_2$

Relative atomic masses (A_r): H = 1 C = 12 Cl = 35.5

[3 marks]

$M_r = 10 + 6(12) + 2(35.5)$

$= 153$

$\%Cl = \frac{2(35.5)}{153} \times 100$

$= \frac{71}{153} \times 100$

$= 46.4\%$

Percentage by mass = 46.4 %

8

Do not outside box

0 7 Potash alum is a chemical compound.

The formula of potash alum is $KAl(SO_4)_2$

0 7 . 1 Give a test to identify the Group 1 metal ion in potash alum.

You should include the result of the test.

[2 marks]

Test Flame test

Result A lilac flame

0 7 . 2 Name **one** instrumental method that could identify the Group 1 metal ion **and** show the concentration of the ion in a solution of potash alum.

[1 mark]

flame emission spectroscopy

Do not outside box

A student identifies the other metal ion in potash alum.

The student tests a solution of potash alum by adding sodium hydroxide solution until a change is seen.

0 7 . 3 Give the result of this test. **[1 mark]**

White precipitate

0 7 . 4 This test gives the same result for several metal ions.

What additional step is needed so that the other metal ion in potash alum can be identified?

Give the result of this additional step. **[2 marks]**

Additional step add excess Sodium hydroxide solution

Result precipitate dissolves

0 7 . 5 Describe a test to identify the presence of sulfate ions in a solution of potash alum.

Give the result of the test. **[3 marks]**

Test Add barium chloride solution and then hydrochloric acid

Result white precipitate will form

9

0 8 This question is about copper and alloys of copper.

Solders are alloys used to join metals together.

Some solders contain copper.

Table 4 shows information about three solders, **A**, **B** and **C**.

Table 4

Solder	Melting point in °C	Metals in solder
A	183	tin, copper, lead
B	228	tin, copper, silver
C	217	tin, copper, silver

0 8 . 1 Solder **B** and solder **C** are now used more frequently than solder **A** for health reasons.

Suggest **one** reason why.

Use **Table 4**.

[1 mark]

Solder A contains Lead which is toxic

0 8 . 2 Suggest **one** reason why solders **B** and **C** have different melting points.

Use **Table 4.**

[1 mark]

The proportions of the metals used are different.

Do not write outside the box

Copper can be obtained by:

- processing copper ores
- recycling scrap copper.

0 8 . 3 Suggest **three** reasons why recycling scrap copper is a more sustainable way of obtaining copper than processing copper ores.

[3 marks]

1 Conserves copper ore supplies

2 recycling uses less energy than manufacture from scratch

3 Reduction of waste.

Question 8 continues on the next page

Do not write outside the box

Copper is extracted from low-grade ores by phytomining.

0 8 . 4 Describe how copper is extracted from low-grade ores by phytomining.

[4 marks]

Plants are grown on land containing copper ore. These plants are then burnt to produce ash. This ash is dissolved in acid to produce a copper containig solution. The solution is electrolysed to remove the copper for use

0 8 . 5 Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

[2 marks]

1 Phytomining takes a long time

2 It requires a lot of land that may not be available.

11

Do not w outside box

0 9 A student investigated how a change in concentration affects the rate of the reaction between zinc powder and sulfuric acid.

The equation for the reaction is:

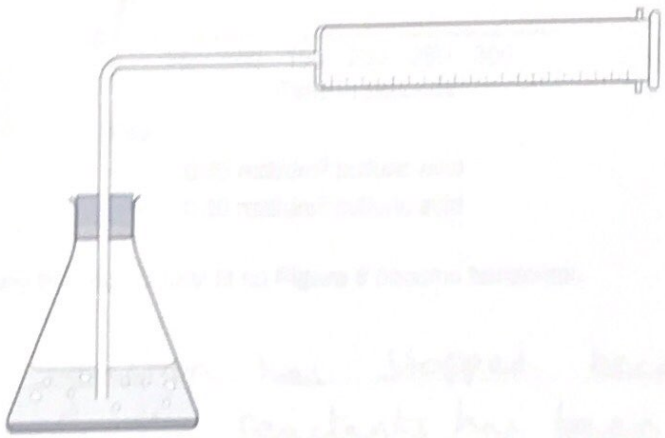
$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

This is the method used.

1. Pour 50 cm^3 of sulfuric acid of concentration 0.05 mol/dm^3 into a conical flask.
2. Add 0.2 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of gas collected every 30 seconds for 5 minutes.
5. Repeat steps 1 to 4 with sulfuric acid of concentration 0.10 mol/dm^3

Figure 8 shows the apparatus used.

Figure 8



0 9 . 1 The student made an error in setting up the apparatus in **Figure 8**.

What error did the student make?

[1 mark]

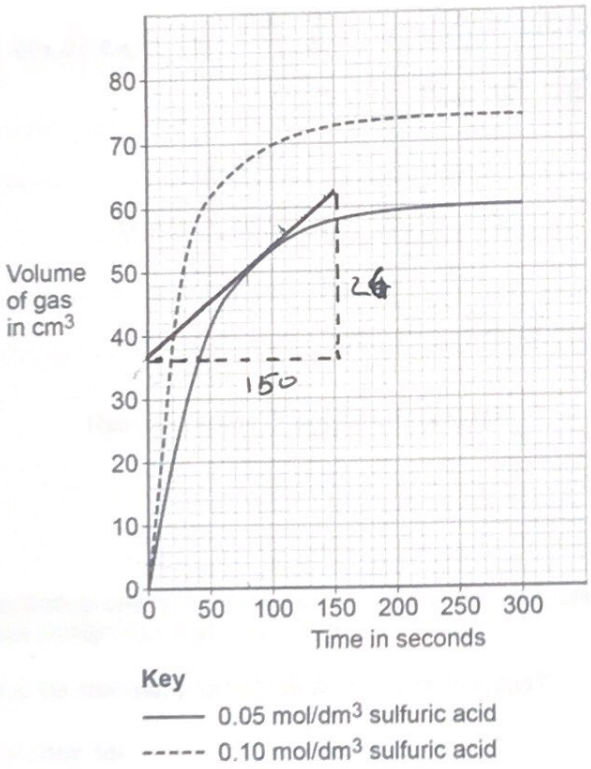
The delivery tube is in the sulfuric acid

Do not write outside the box

The student corrected the error.

Figure 9 shows the student's results.

Figure 9



0 9 . 2 Explain why the lines of best fit on **Figure 9** become horizontal.

[2 marks]

The reaction has stopped because one of the reactants has been used up

0 9 . 3 How does **Figure 9** show that zinc powder reacts more slowly with 0.05 mol/dm^3 sulfuric acid than with 0.10 mol/dm^3 sulfuric acid?

[1 mark]

The line for 0.05 mol/dm^{-3} is less steep than that for 0.10 mol/dm^{-3}

Do not write outside the box

0 9 . 4 Determine the rate of the reaction for 0.05 mol/dm^3 sulfuric acid at 80 seconds.

Show your working on **Figure 9**.

Give your answer to 2 significant figures.

[5 marks]

Gradient = $\frac{\Delta y}{\Delta x}$ $\Delta y = 26$ cm^3

$\Delta x = 150$ s

Gradient = $\frac{26}{150}$

$= 0.173$ cm^{3}s^{-1}

Rate of reaction (2 significant figures) = 0.17 cm^3/s

0 9 . 5 The activation energy for the reaction between zinc and sulfuric acid is lowered if a solution containing metal ions is added.

What is the most likely formula of the metal ions added?

[1 mark]

Tick (✓) **one** box.

- Al^{3+} ☐
- Ca^{2+} ☐
- Cu^{2+} ☑
- Na^{+} ☐

10

Do not write outside the box

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- Cu^{2+} ☑
- Na^{+} ☐

10

1 0 This question is about alkenes and alcohols.

Ethene is an alkene produced from large hydrocarbon molecules.

Large hydrocarbon molecules are obtained from crude oil by fractional distillation.

1 0 . 1 Name the process used to produce ethene from large hydrocarbon molecules.

[1 mark]

Cracking

1 0 . 2 Describe the conditions used to produce ethene from large hydrocarbon molecules.

[2 marks]

A high temperature between 300-900°C and the use of either steam or a catalyst.

Do not write outside the box

1 0 . 3 Ethanol can be produced from ethene and steam.

The equation for the reaction is:

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

2 (g) 1 (g)

The forward reaction is exothermic.

Explain how the conditions for this reaction should be chosen to produce ethanol as economically as possible.

[6 marks]

Firstly a reasonable Compromise temperature must be found. A High temperature will drive a fast reaction by raising the number of sucessful reactant collisions. However a high temperature will also favour the left side of the equilibrium to compensate for its exothermicity. The Compromise temperatwe will have to balance these competing factors of rate and yeild whilst also considering cost. A Compromise pressure will also be needed. Here a higher pressure increases both rate and yeild as it drives more frequent collisions and shifts the equilibrium left right as there are half the moles of gass present. However, a high pressure is costly to safely maintain so is not economically viable. The choosen pressure must balance rate and yield against cost.

Do not write outside the box

10.4 Ethanol can also be produced from sugar solution by adding yeast.

Name this process. **[1 mark]**

fermentation

10.5 Butanol can be produced from sugar solution by adding bacteria.

Sugar solution is broken down in similar ways by bacteria and by yeast.

Suggest the reaction conditions needed to produce butanol from sugar solution by adding bacteria. **[2 marks]**

The bacteria need a warm and anaerobic environment to fermentat the sugar

Do not write outside the box

Ethanol and butanol can be used as fuels for cars.

1 0 . 6 A car needs an average of 1.95 kJ of energy to travel 1 m

Ethanol has an energy content of 1300 kilojoules per mole (kJ/mol).

Calculate the number of moles of ethanol needed by the car to travel 200 km

[3 marks]

200 km = 200×10^3 m = 2×10^5 m

moles ethanol / meter = $\frac{1.95}{1300} = 1.5 \times 10^{-3}$ mole

moles for 200 km = $2 \times 10^5 \times 1.5 \times 10^{-3}$ = 300 moles

Number of moles = 300 mol

1 0 . 7 When butanol is burned in a car engine, complete combustion takes place.

Write a balanced equation for the complete combustion of butanol.

You do **not** need to include state symbols.

[2 marks]

$C_4H_9OH + 6O_2 \rightarrow 4CO_2 + 5H_2O$

17

END OF QUESTIONS