1 (a) Plastic bags used to store food are made from a polymer.

Ethene is the monomer used to make the polymer for some plastic bags.

(i) Name the polymer that is made from ethene.

(1)

.....

(ii) Use a word from the box to complete the sentence about ethene.

chromatography	ondensing	ing	ystallising

(1)

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules, using a process called .....

(b) The hydrocarbons used to make ethene are called alkanes.

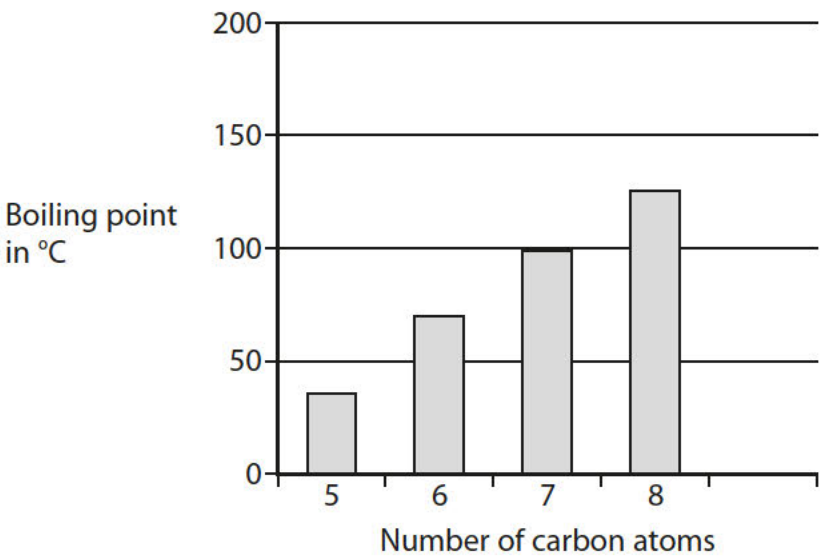
They are obtained from crude oil.

The boiling point of an alkane is related to the number of carbon atoms in the molecule.

Number of carbon atoms in molecule	5	6			
Boiling point in °C	36	69	99	125	151

(i) Use the data in the table to complete the bar chart.

(2)



(ii) What is the relationship between the boiling point of an alkane and the number of carbon atoms in its molecule?

(1)

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.....

(c) Many plastic bags are not biodegradable.

Used plastic bags can be

A buried underground, which is called landfill

or

B burned to release energy, which also produces large amounts of gases.

Suggest which of these methods of disposal is better for the environment, giving two reasons for your choice.

(2)

Choice .....

Reason 1 .....

.....

.....

.....

Reason 2 .....

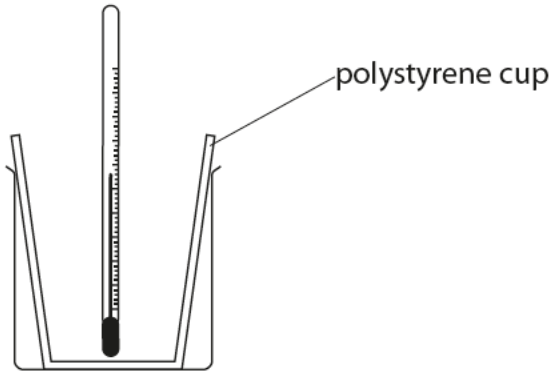
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(Total for Question 1 = 7 marks)

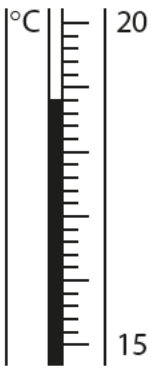
2 A student uses this apparatus to investigate the temperature change that occurs when potassium hydroxide is dissolved in water.



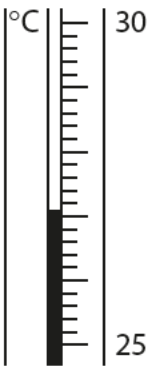
She uses this method.

- pour 50 cm^3 of water into the polystyrene cup and measure the temperature of the water
- add 3 g of potassium hydroxide and stir
- record the highest temperature of the solution

(a) These diagrams show the thermometer readings before and after the student added the potassium hydroxide.



before



after

Use the readings to complete the table.

(3)

temperature in °C after adding potassium hydroxide	
temperature in °C before adding potassium hydroxide	
temperature change in °C	

(b) The student uses her results to calculate the enthalpy change for dissolving potassium hydroxide in water.

She compares her value with a data book value.

Student's value = – 32 kJ/mol.

Data book value = – 55 kJ/mol.

There are no errors in the student's method or in the calculation.

Suggest two reasons why the student's value differs from the data book value.

(2)

1 .....

.....

.....

2 .....

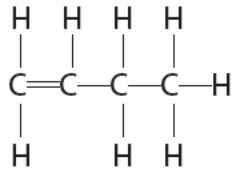
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(Total for Question 2 = 5 marks)

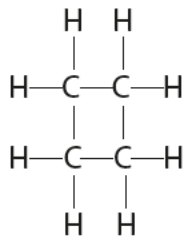
3 But-1-ene is a member of the homologous series of alkenes.

The displayed formula of but-1-ene is



The saturated compound cyclobutane is an isomer of but-1-ene.

The displayed formula of cyclobutane is



(a) (i) State what is meant by the term **isomers**.

(2)

.....

.....

.....

.....

(ii) Draw the displayed formula of another isomer of but-1-ene.

(1)

(iii) Describe a test that would distinguish between but-1-ene and cyclobutane.

(3)

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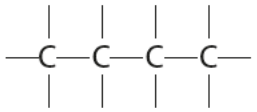
.....

(b) Using your knowledge of the reactions of ethene, complete the two chemical equations to show the formula of the organic product.

(i) The reaction between but-1-ene and steam.

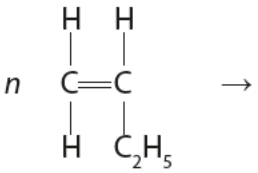
(1)

$$CH_2 = CHCH_2CH_3 + H_2O \rightarrow$$



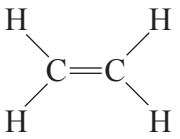
(ii) The polymerisation of but-1-ene.

(2)



(Total for Question 3 = 9 marks)

4 Here are some statements about the compound ethene.

- ethene has the displayed formula 

- ethene is a gas at room temperature
- ethene burns with a smoky flame
- ethene is unsaturated
- ethene is insoluble in water
- ethene can be prepared from ethanol
- ethene is used to make the polymer poly(ethene)

(a) (i) State why ethene is described as **unsaturated**.

(1)

(ii) Describe a chemical test to show that ethene is an alkene.

(2)

Test

Result

(b) (i) Complete the following equation that represents the preparation of ethene from ethanol.

(1)

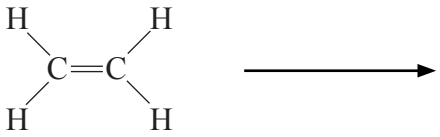
$$C_2H_5OH \rightarrow C_2H_4 +$$

(ii) What is the name given to this type of reaction?

(1)

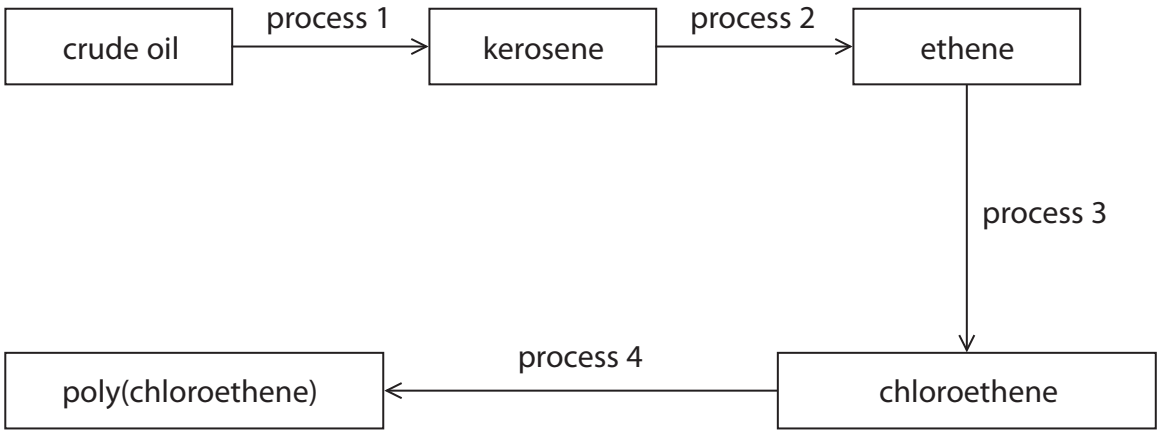
(c) Complete the equation to show the formation of poly(ethene) from ethene.

(2)

n 

(Total for Question 4 = 7 marks)

5 The diagram shows some important conversion processes used in the oil industry.



(a) Process 1 is called

(1)

- ☒ **A** catalytic cracking
- ☒ **B** condensation polymerisation
- ☒ **C** fractional distillation
- ☒ **D** thermal decomposition

(b) Describe the differences between crude oil and kerosene. In your answer you should refer to

- the average size of the molecules in the two liquids
- the covalent bonding in the molecules
- the viscosities of the two liquids

(3)

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.....

(c) The equation for one reaction that could occur in process 2 is

$$C_xH_y \rightarrow C_5H_{12} + 2C_2H_4$$

(i) Deduce the formula of C_xH_y

(1)

.....

(ii) Give the name of the compound C_5H_{12}

(1)

.....

(iii) Draw the displayed formula of C_2H_4

(1)

(d) The structural formula of chloroethene formed in process 3 is $CH_2{=}CHCl$

The polymer formed in process 4 is poly(chloroethene).

Draw the **displayed** formula for the repeat unit of poly(chloroethene).

(2)

(e) Poly(chloroethene) is formed by addition polymerisation.

Nylon is formed by condensation polymerisation.

(i) How does condensation polymerisation differ from addition polymerisation?

(1)

.....

.....

(ii) Poly(chloroethene) and nylon do not biodegrade easily.

What is meant by the term **biodegrade**?

(2)

.....

.....

.....

.....

(iii) What feature of addition polymers makes it difficult for them to biodegrade?

(1)

.....

.....

(Total for Question 5 = 13 marks)

6 This is a recipe for making plum wine.

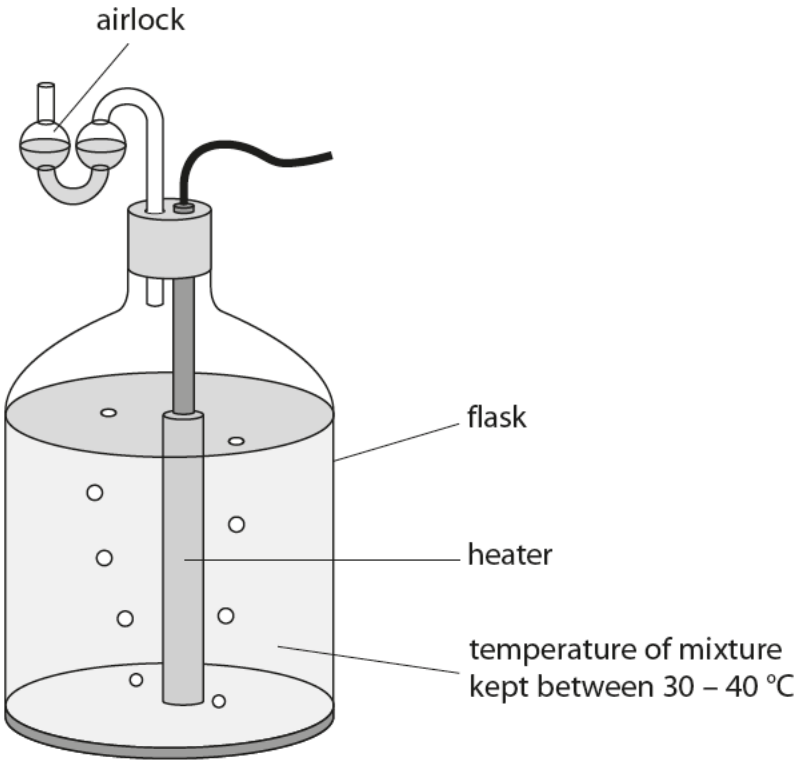
Dissolve 1.5 kg of sugar in 5 dm^3 of warm water.

Add yeast and 8 kg of plums.

Pour the mixture into a flask.

Leave the flask for several weeks until the reaction has stopped.

Remove the solid yeast and pour the clear liquid into bottles.



(a) Sugar contains sucrose, $C_{12}H_{22}O_{11}$

When yeast is added, water reacts with sucrose to form glucose, $C_6H_{12}O_6$

Write a chemical equation for this reaction.

(1)

(b) The glucose is then converted into ethanol by the yeast

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

(i) How would you know when the reaction has stopped?

(1)

.....

(ii) How could the solid yeast be removed from the mixture?

(1)

.....

(c) Ethanol can be converted into chloroethene, $CH_2{=}CHCl$, in three stages.

Stage 1 Ethanol is dehydrated to form ethene, $CH_2{=}CH_2$

Stage 2 Ethene is converted into 1,2-dichloroethane, CH_2ClCH_2Cl

Stage 3 1,2-dichloroethane is converted into chloroethene and hydrogen chloride

(i) Why is the reaction in **Stage 1** described as dehydration?

(1)

.....

(ii) Identify the catalyst used in the reaction in **Stage 1**.

(1)

.....

(iii) Suggest the name or formula of the substance used to react with ethene in **Stage 2**.

(1)

.....

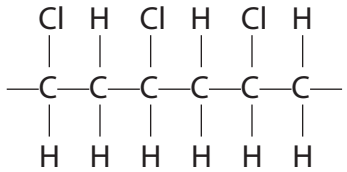
(iv) Write a chemical equation for the reaction in **Stage 3**.

(1)

.....

(d) Chloroethene can be used to make the polymer poly(chloroethene), also known as PVC.

The displayed formula for part of the PVC molecule is



(i) Draw a displayed formula for a chloroethene molecule.

(1)

(ii) Describe, in terms of structure and bonding, what happens when chloroethene molecules are converted into poly(chloroethene).

(3)

(Total for Question 6 = 11 marks)