1 Fractional distillation and cracking are important steps in processing crude oil.

(a) Place ticks (✓) in the columns to show which statements apply to each step.
You may place a tick in one column, in both columns or in neither column.

The first one has been done for you.

(5)

Statement	Fractional distillation	Cracking
Crude oil is heated	✓	
A catalyst may be used		
Alkenes are formed		
Decomposition reactions occur		
Fuels are obtained		
Separation is the main purpose		

(b) The formula $CH_3CH_2CH_2CH_2CH_3$ represents one of the compounds in crude oil.

(i) Give the molecular formula of this compound.

(1)

.....

(ii) Give the displayed formula of this compound.

(1)

(iii) Give the empirical formula of this compound.

(1)

.....

(iv) Give the name of this compound.

(1)

.....

(v) Give the general formula of the homologous series that contains this compound.

(1)

.....

(c) The products of the complete combustion of hydrocarbons are carbon dioxide and water.

(i) Bal e the equation to show the complete combustion of ethene (C_2H_4).

(2)

$$C_2H_4 + \ldots\ldots O_2 \rightarrow \ldots\ldots CO_2 + \ldots\ldots H_2O$$

(ii) Draw a dot and cross diagram to show the bonding in an ethene molecule.

Show only the outer electrons in each atom.

(2)

(d) Ethanol can be manufactured by the hydration of ethene. The equation for this reaction is

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

(i) Identify the catalyst and state the temperature used in this process.

(2)

Catalyst .....

Temperature .....

(ii) A 20 mol sample of ethanol was produced using this reaction.

Deduce the amount, in moles, of ethene needed and the volume, in dm^3, that this amount of ethene would occupy at room temperature and pressure.

Assume that all of the ethene is converted into ethanol and that the molar volume of ethene is 24 dm^3 at rtp.

(3)

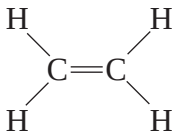
Amount of ethene ..... mol

Volume of ethene

Volume = ... dm^3

(Total for Question 1 = 19 marks)

2 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)

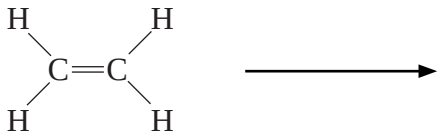
$$C_2H_5OH \rightarrow C_2H_4 +$$

(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 2 = 7 marks)

3 Ethene is an unsaturated hydrocarbon.

(a) (i) The molecular formula of ethene is

(1)

- ☒ **A** CH_4
- ☒ **B** C_2H_6
- ☒ **C** C_2H_4
- ☒ **D** C_3H_6

(ii) Ethene is bubbled into bromine water until there is no further change.

What is the appearance of the solution formed?

(1)

- ☒ **A** brown
- ☒ **B** colourless
- ☒ **C** purple
- ☒ **D** red

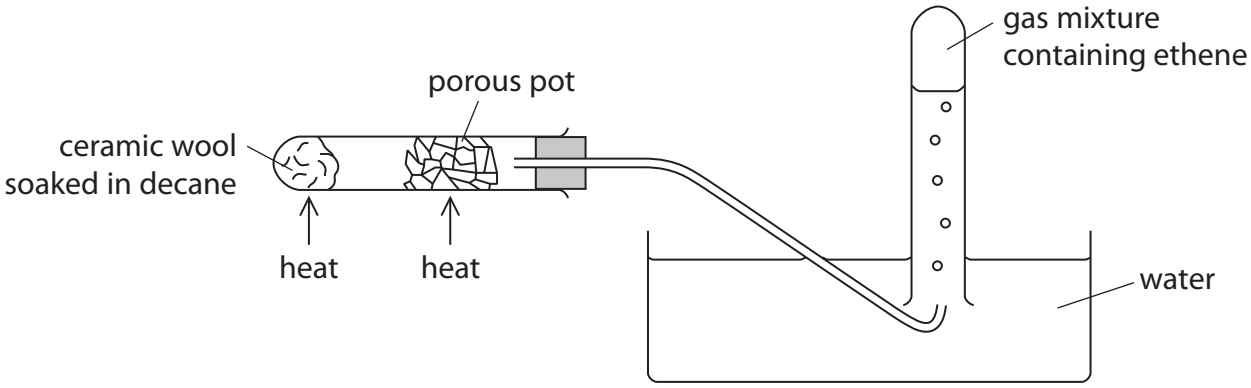
(iii) Ethene can be formed from ethanol.

This type of reaction is called

(1)

- ☒ **A** dehydration
- ☒ **B** oxidation
- ☒ **C** reduction
- ☒ **D** substitution

(b) This apparatus can be used to decompose decane ($C_{10}H_{22}$).



(i) What name is given to this type of thermal decomposition?

(1)

.....

(ii) Porous pot contains oxides such as silica and alumina.

What is the purpose of the porous pot in this experiment?

(1)

.....

.....

(iii) Suggest why the gas collected is a mixture and not pure ethene.

(1)

.....

.....

(Total for Question 3 = 6 marks)

4 (a) Ethanol can be manufactured by two different processes.

Process 1 suc ose $\xrightarrow{\text{stage 1}}$ glucose $\xrightarrow{\text{stage 2}}$ ethanol

Process 2 ethene $\longrightarrow$ ethanol

(i) What is the general name for compounds such as sucrose and glucose?

(1)

.....

(ii) What type of reaction occurs in stage 2?

(1)

.....

(iii) What is the catalyst used in stage 2?

(1)

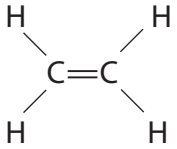
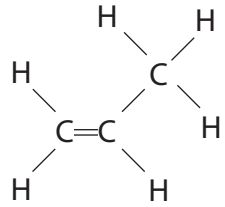
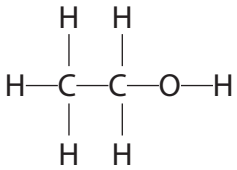
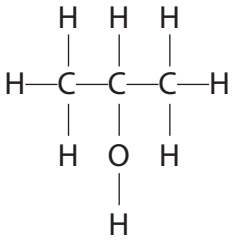
.....

(iv) What type of reaction occurs in process 2?

(1)

.....

(b) The table shows the displayed formulae of four organic compounds.

ethene	propene
	
ethanol	**compound D**
	

Ethanol and compound D are members of the homologous series of alcohols.

(i) The first member of this homologous series is methanol.

Draw the displayed formula of methanol.

(1)

(ii) Suggest the name of compound D.

(1)

.....

(c) In industry, the conversion of propene to compound D uses the same conditions as those used in the conversion of ethene to ethanol.

Identify a suitable catalyst and temperature for these conversions.

(2)

catalyst .....

temperature ..... °C

(d) Ethene and acetylene can both be used for welding metals.

The equations for the reactions of these gases in welding are

ethene $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

acetylene $C_2H_2 + 2.5O_2 \rightarrow 2CO_2 + H_2O$

One problem with using hydrocarbons as fuels is incomplete combustion.

(i) Incomplete combustion is a bigger problem with ethene than with acetylene.

Suggest why.

(1)

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(ii) One of the gases produced during incomplete combustion is dangerous to humans.

Identify this gas and explain how it is dangerous.

(3)

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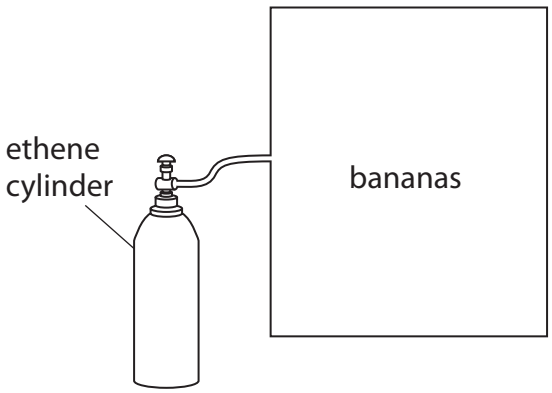
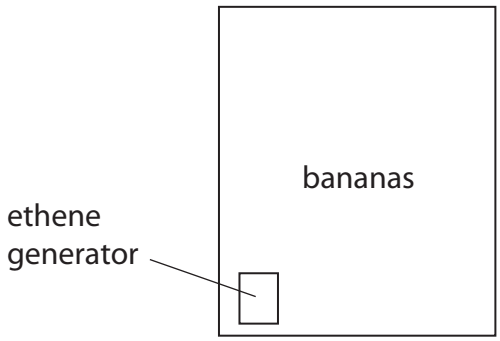
(e) Ethene can be used to ripen bananas.

Bananas are placed in a large container and ethene is added. The ethene can be added in two different ways.

Method 1	Method 2
	

(i) In method 1, ethene is stored under pressure and passed through a pipe into the container.

Suggest one risk in using this method.

(1)

.....

.....

(ii) In method 2, the generator contains a known quantity of ethanol that is slowly decomposed to ethene using a catalyst.

Write a chemical equation for this decomposition.

(1)

.....

(Total for Question 4 = 14 marks)

5 An industrial chemical company has supplies of ethene and ethanol.

The company considers using these two processes.

process 1 converting ethene to ethanol

process 2 converting ethanol to ethene

A chemical equation for process 1 is

$$C_2H_4 + H_2O \rightarrow C_2H_6O$$

(a) Which condition does the chemical company use in process 1?

(1)

☒ **A** aluminium oxide as a catalyst

☒ **B** a pressure of 65 atm

☒ **C** a temperature of 1000 °C

☒ **D** sodium hydroxide as a solvent

(b) The equation for process 1 shows the molecular formulae of ethene and ethanol.

Draw the displayed formulae of ethene and ethanol.

(2)

Compound	Displayed formula
ethene	
ethanol	

(c) Why is it correct to describe ethanol as saturated, but incorrect to describe it as a hydrocarbon?

(2)

(d) A scientist working for the chemical company makes the following predictions that could affect processes 1 and 2 in the future:

- crude oil will be less available and more expensive
- the climate will be warmer and allow more sugar cane to be grown

Suggest how each of these predictions would affect the two processes.

(3)

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(Total for Question 5 = 8 marks)