1 The table shows the percentage composition of the mixture of gases in the exhaust fumes of a car.

Name of gas	Percentage of the gas in the exhaust fumes
carbon dioxide	14.0
carbon monoxide	2.0
hydrocarbons	0.3
nitrogen oxides	0.2
sulfur dioxide	trace amounts
water vapour	12.0
gas Z	71.5

(a) Identify gas Z.

(1)

.....

(b) The carbon dioxide is produced from the combustion of hydrocarbons such as octane.

Complete the word equation for the complete combustion of octane.

(1)

octane + ... → carbon dioxide + ...

(c) How is the carbon monoxide in the exhaust fumes produced?

(1)

.....

.....

(d) (i) Write a chemical equation to show how nitrogen dioxide (NO_2) is produced in a car engine.

(1)

.....

(ii) State one problem caused by nitrogen dioxide in the atmosphere.

(1)

.....

(Total for Question 1 = 5 marks)

2 Ethane (C_2H_6) is used as a starting material to manufacture addition polymers. It is first cracked to form ethene (C_2H_4).

(a) Identify the fuel that also forms in this reaction.

(1)

.....

(b) Ethane is described as saturated.

What feature of an ethane molecule is responsible for this description?

(1)

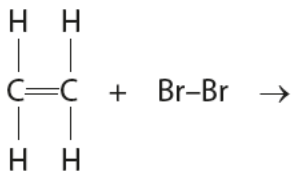
.....

.....

(c) Bromine water can be used to show that a hydrocarbon is ethene rather than ethane.

(i) Complete the equation to show the displayed formula of the product of the reaction between ethene and bromine.

(1)



(ii) Which is the correct statement about this test?

(1)

☒ **A** the colour of ethene is brown

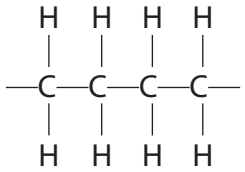
☒ **B** the product of the reaction is a white precipitate

☒ **C** the product of the reaction is colourless

☒ **D** the test involves a substitution reaction

(d) Alkenes can be polymerised.

Part of the structure of poly(ethene) can be represented as

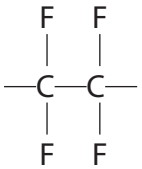


This structure shows the atoms coming from two molecules of ethene.

Draw part of the structure of poly(propene) that shows the atoms coming from two molecules of propene (CH_2═CH—CH_3).

(2)

(e) The repeat unit of another addition polymer can be represented as



Draw the structure of the monomer used to make this polymer.

(1)

(f) The disposal of most addition polymers is a problem because they do not biodegrade.

(i) What is meant by the term **biodegrade**?

(2)

.....

.....

.....

.....

(ii) Identify the property that prevents addition polymers from easily biodegrading.

(1)

.....

(Total for Question 2 = 10 marks)

3 The table gives some data about the first six members of a homologous series of compounds called the alkanes.

Alkane	Molecular formula	Relative formula mass	Boiling point in °C
methane	CH_4	16	–164
ethane	C_2H_6	30	–87
propane	C_3H_8	44	–42
butane	C_4H_{10}		0
pentane	C_5H_{12}	72	
hexane		86	69

(a) Complete the table by

- giving the molecular formula of hexane
- giving the relative formula mass of butane
- suggesting the boiling point of pentane

(3)

(b) What does the data show about the relationship between boiling point and relative formula mass?

(1)

.....

.....

.....

(c) The molecular formula of ethene is C_2H_4

Ethene and ethane are in different homologous series.

Explain how the formulae of these compounds show that they are in different series.

(1)

.....

.....

(d) (i) In the table, draw displayed formulae for the two alkanes with the molecular formula C_4H_{10}

(2)

Displayed formula 1	Displayed formula 2

(ii) What is the name given to compounds that have the same molecular formula but different displayed formulae?

(1)

.....

(e) The reaction between ethane and bromine (Br_2) is similar to the reaction between methane and bromine.

(i) Write a chemical equation for the reaction between ethane and bromine.

(2)

.....

(ii) What is the name given to the type of reaction that occurs when ethane reacts with bromine?

(1)

.....

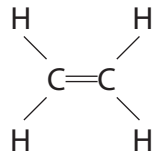
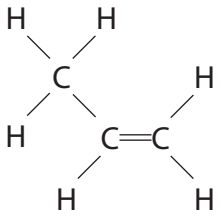
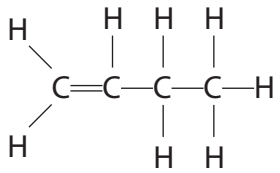
(iii) Suggest the condition necessary for this reaction to occur.

(1)

.....

(Total for Question 3 = 12 marks)

4 The table shows the displayed formulae of three unsaturated hydrocarbons.

		
Compound **A**	Compound **B**	Compound **C**

(a) Explain the meaning of the term **hydrocarbon**.

(2)

(b) Explain the meaning of the term **unsaturated**.

(1)

(c) Compounds **A**, **B** and **C** belong to the same homologous series. One characteristic of the compounds in a homologous series is that they have the same general formula.

(i) State the name of this homologous series.

(1)

(ii) State the general formula of this homologous series.

(1)

(iii) State **two** other characteristics of the compounds in a homologous series.

(2)

1

2

(d) Compound **C** has several isomers.

(i) What is the name of compound **C**?

(1)

.....

(ii) What is the molecular formula of compound **C**?

(1)

.....

(iii) Explain the meaning of the term **isomers**.

(2)

.....

.....

.....

.....

(iv) Draw the displayed formula of an isomer of compound **C**.

(1)

(e) Bromine water can be used to distinguish compound **A** from ethane.

(i) Complete the sentence to show the colour change when compound **A** is bubbled through bromine water.

(1)

Bromine water changes from orange to ..... .

(ii) Complete the chemical equation for the reaction between compound **A** and bromine water.

(1)

$C_2H_4 + Br_2 \rightarrow$ .....

(Total for Question 4 = 14 marks)