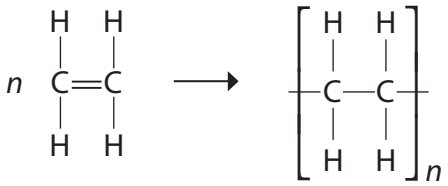
1 This question is about polymers.

The formation of poly(ethene) can be represented as



(a) What is the name of this type of reaction?

(1)

☒ **A** addition

☒ **B** decomposition

☒ **C** reduction

☒ **D** substitution

(b) Which of these is a correct description of a monomer?

(1)

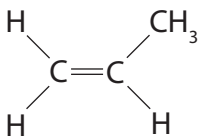
☒ **A** a molecule used to make a polymer

☒ **B** a molecule with only single bonds

☒ **C** an atom in a polymer

☒ **D** a repeat unit in a polymer

(c) This compound is used to make a polymer.



(i) State the name of this compound.

(1)

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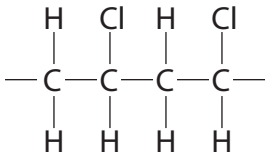
(ii) Draw the structure of the repeat unit of the polymer formed from this compound.

(2)

(d) This is part of the structure of another polymer.



Draw the displayed formula of the monomer used to make this polymer.

(1)

(e) Many polymers do not biodegrade when they are thrown away.

(i) State the meaning of the term **biodegrade**.

(2)

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(ii) What property of these polymers prevents them from biodegrading?

(1)

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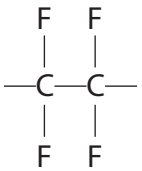
(Total for Question 1 = 9 marks)

2 Tetrafluoroethene (C_2F_4) is a gas that is stored in cylinders.

A chemist opened the valve on a new cylinder of tetrafluoroethene. He was surprised when no gas came out.

He decided to check the contents of the cylinder. He found it contained a white powder. The tetrafluoroethene had formed a polymer.

(a) The displayed formula for the repeat unit of the addition polymer formed is



(i) Draw the displayed formula of the monomer.

(1)

(ii) What is the meaning of the term **polymer**?

(2)

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(iii) Suggest the name of this polymer.

(1)

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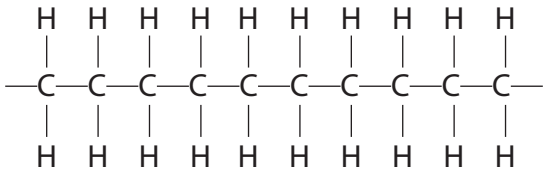
(b) The displayed formula for a section of another addition polymer is



Give the name and molecular formula of the monomer used to form this polymer.

(2)

name .....

molecular formula .....

(c) Explain why addition polymers that are buried in landfill sites remain chemically unchanged for many years.

(2)

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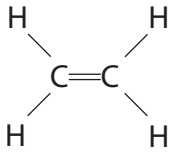
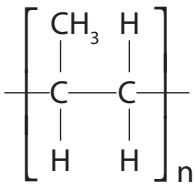
(Total for Question 2 = 8 marks)

3 (a) The table shows information about two common addition polymers.

Complete the table for these two polymers.

(4)

Name of polymer	Structure of monomer	Structure of polymer	One use for the polymer
poly(ethene)			
			water pipes

(b) State two changes that occur in the formation of an addition polymer from its monomer.

(2)

1 .....

.....

2 .....

.....

(c) Addition polymers such as poly(ethene) are very difficult to dispose of because they do not biodegrade easily.

(i) State a reason why addition polymers do not biodegrade easily.

(1)

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(ii) Burning and landfill (burying in the ground) are two methods used to dispose of addition polymers.

Suggest a problem with each method of disposal.

(2)

burning.....

.....

landfill.....

.....

(Total for Question 3 = 9 marks)

4 Alkenes are unsaturated hydrocarbons.

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

(1)

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(b) One method of producing alkenes is by cracking alkanes.

(i) Complete the equation for the cracking of decane into octane (C_8H_{18}) and ethene.

(1)

$C_{10}H_{22} \rightarrow$ ..... + ...

decane

(ii) State two conditions used for cracking alkanes in industry.

(2)

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(c) The diagram shows two alkenes that are isomers of each other.

(i) Explain why these two compounds are isomers.

(2)

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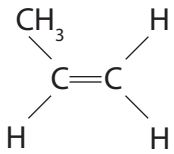
(ii) Draw a diagram to show the structure of an alkene that is another isomer of these two compounds.

(1)

(d) The structure of propene is



Propene can be polymerised.

(i) Give the name of the polymer formed from propene.

(1)

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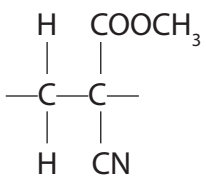
(ii) Draw the repeat unit for this polymer.

(2)

(e) The repeat unit of an addition polymer used in a type of glue is shown in the diagram.



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

(1)

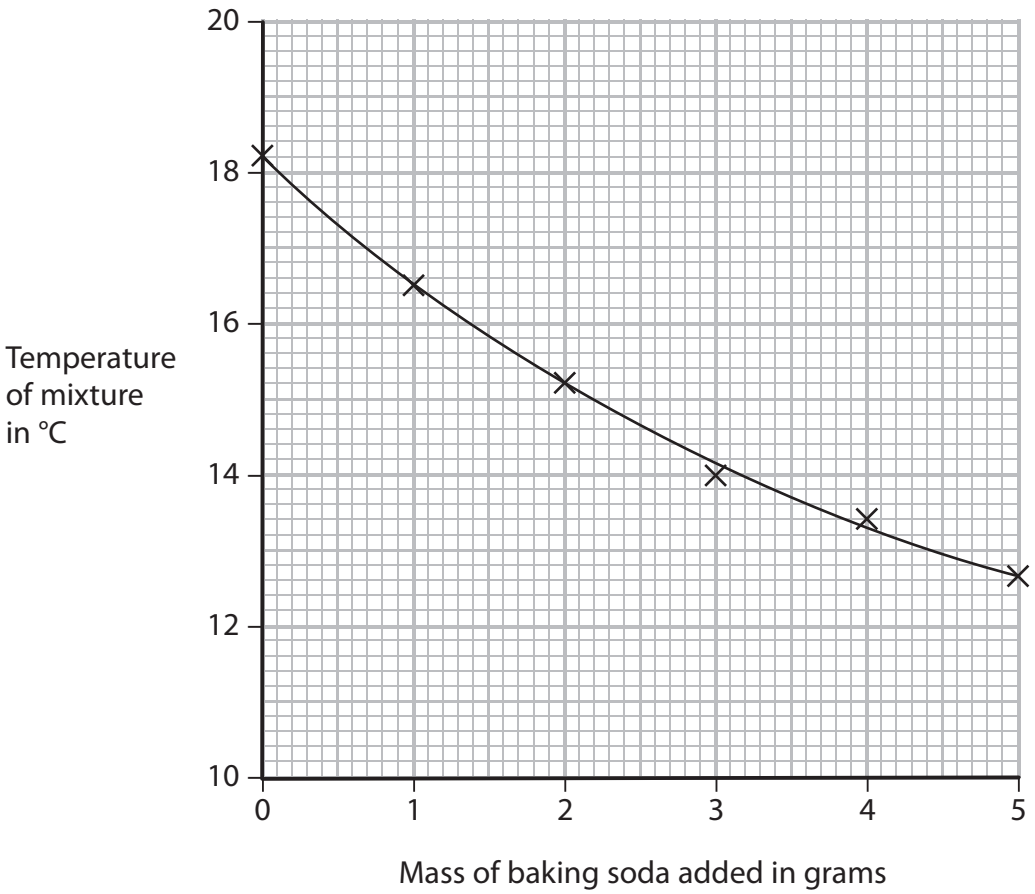
(Total for Question 4 = 11 marks)

5 A teacher asked her students to suggest some experiments that could be done using chemicals found in the home. One student planned an experiment to measure the temperature change when baking soda is added to vinegar.

She wrote this plan.

- pour 100 cm^3 of vinegar into a polystyrene cup
- weigh out five separate 1 g portions of baking soda
- measure the temperature of the vinegar
- add 1 g of baking soda to the vinegar and stir
- record the new temperature
- add the other portions of baking soda, stirring and recording the temperature after each portion is added

The graph shows her results.



(a) The student said that the reaction in her experiment was not complete.

How does the graph support her statement?

(1)

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(b) The student used a polystyrene cup rather than a glass beaker.

Why is it better to use a polystyrene cup?

(1)

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(c) Vinegar contains ethanoic acid. Baking soda contains sodium hydrogencarbonate.

The student found this equation for the reaction:

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

(i) There is no colour change during this reaction.

Suggest one observation, other than the change in temperature, that could be made during the reaction.

(1)

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(ii) The compound CH_3COOH is an acid and the compound CH_3COONa is a salt.

The graph shows that the temperature goes down during the reaction.

Use this information to state the two types of reaction occurring.

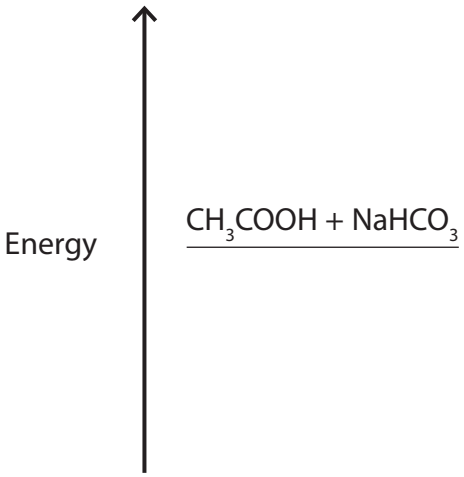
(2)

1 .....

2 .....

(d) (i) Complete the energy level diagram by showing the products of the reaction.

(1)



(ii) Label the diagram to show the energy change, ΔH, for the reaction.

(1)

(e) The student repeated the experiment using the same method with a different sample of vinegar. She recorded these results.

Volume of vinegar = 100 cm^3

Mass of baking soda = 5.0 g

Temperature at start = 18.7 °C

Temperature at end = 13.2 °C

(i) Calculate the heat energy change in this experiment using the expression

heat energy change = volume of vinegar × 4.2 × temperature change

(2)

Heat energy change = ... J

(ii) The student wanted to calculate the amount, in moles, of ethanoic acid in the vinegar.

Apart from the volume of vinegar, what other information would she need to be able to calculate the amount of ethanoic acid?

(1)

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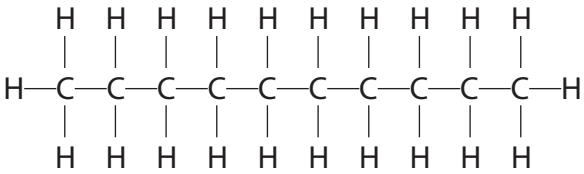
(Total for Question 5 = 10 marks)

6 Decane is a hydrocarbon found in crude oil.

The diagram shows the structure of a decane molecule.



(a) (i) Explain why decane is described as a hydrocarbon.

(2)

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(ii) Give the molecular formula for decane.

(1)

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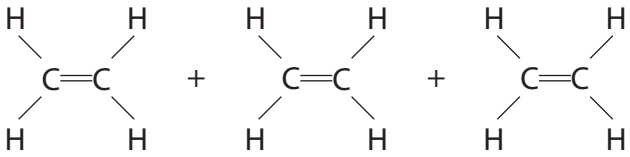
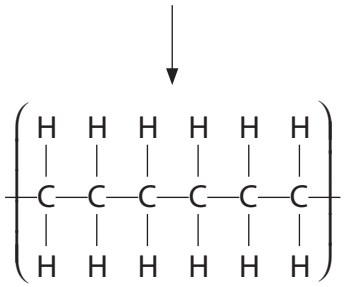
(b) Decane and ethene, C_2H_4, are produced during the cracking of eicosane, $C_{20}H_{42}$

Ethene is used to make poly(ethene).



ethene



poly(ethene)

(i) What is the name given to this type of polymerisation?

(1)

(ii) Use the diagram to state **two** changes that occur during the formation of poly(ethene).

(2)

(c) Explain why cracking is an important process in the oil industry.

(4)

(Total for Question 6 = 10 marks)

7 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)

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(b) Ethane is described as saturated.

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

(1)

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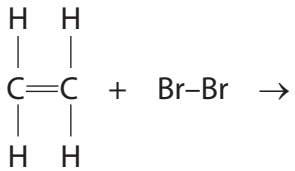
(c) Bromine water can be used to show that a hydrocarbon is ethene rather than ethane.

(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

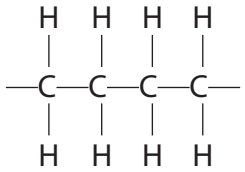
☒ **B** the product of the reaction is a white precipitate

☒ **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

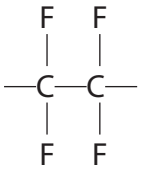


This structure shows the atoms coming from two molecules of ethene.

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)

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

(1)

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(Total for Question 7 = 10 marks)