

**3** Crude oil is a mixture of hydrocarbons.

It can be separated into fractions.

(a) Which of these mixtures shows formulae of substances that could be in the gaseous fraction of crude oil?

(1)

- A**  $C_2H_4$ ,  $C_3H_8$ ,  $C_4H_{10}$ , O
- B**  $C_2H_4$ ,  $C_3H_7Br$ ,  $C_4H_{10}$
- C**  $C_2H_6$ ,  $C_3H_8$ ,  $C_4H_{10}$
- D**  $C_2H_6$ ,  $C_3H_7Br$ ,  $C_4H_{10}$ , O

(b) Figure 3 shows the percentages of the fractions in crude oil from three different oil wells.

| fraction   | percentage of fraction in crude oil from |            |            |
|------------|------------------------------------------|------------|------------|
|            | oil well A                               | oil well B | oil well C |
| gases      | 1                                        | 6          | 9          |
| petrol     | 2                                        | 15         | 24         |
| kerosene   | 6                                        | 14         | 20         |
| diesel oil | 7                                        | 10         | 16         |
| fuel oil   | 26                                       | 28         | 30         |
| bitumen    | 58                                       | 27         | 1          |

**Figure 3**

(i) State which oil well contains the greatest combined total of diesel oil and fuel oil.

(1)

(ii) State which oil well produces a crude oil containing the highest percentage of the high boiling point fractions.

(1)

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(c) Fractions of crude oil contain alkanes.

A sample of decane,  $C_{10}H_{22}$ , cracked using the apparatus in Figure 4.

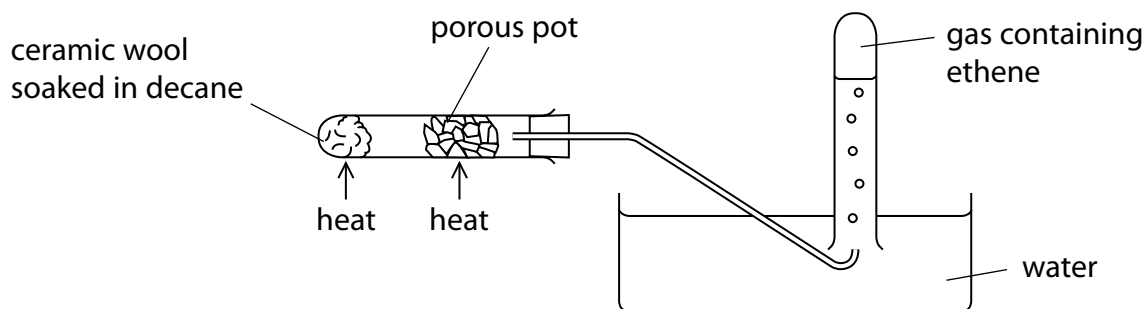


Figure 4

(i) Explain how ethene is produced using the apparatus in Figure 4.

(3)

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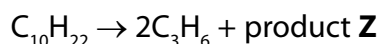
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(ii) One molecule of decane produced two molecules of propene,  $C_3H_6$ , and one molecule of product Z.



What is the formula of product Z?

(1)

- A  $C_4H_8$
- B  $C_4H_{10}$
- C  $C_7H_{14}$
- D  $C_7H_{16}$

(iii) When decane undergoes complete combustion, a mixture of carbon dioxide and water is formed.

Complete the balanced equation for this reaction.

(2)



**(Total for Question 3 = 9 marks)**

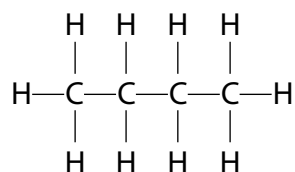
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**4** Alkanes and alkenes are hydrocarbons.

The structure of a molecule of butane is shown.



(a) Which of the following is the empirical formula for butane?

(1)

- A** CH
- B** CH<sub>2</sub>
- C** C<sub>2</sub>H<sub>5</sub>
- D** C<sub>4</sub>H<sub>10</sub>

(b) Figure 5 shows some information about the alkenes, ethene and propene.

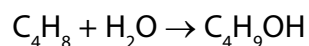
Complete the table. The structure of propene must show all covalent bonds.

(2)

| name of alkene | molecular formula             | structure                                                                                                                                      |
|----------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| ethene         |                               | $\begin{array}{ccc} & \text{H} & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} & \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$ |
| propene        | C <sub>3</sub> H <sub>6</sub> |                                                                                                                                                |

**Figure 5**

(c) Butene reacts with steam to produce butanol.



- (i) Calculate the maximum mass of butanol,  $\text{C}_4\text{H}_9\text{OH}$ , that can be produced when 1.4 kg of butene,  $\text{C}_4\text{H}_8$ , reacts with excess steam.

(relative atomic masses: H = 1, C = 12, O = 16  
relative molecular mass of butene,  $\text{C}_4\text{H}_8$  = 56)

(3)

mass of butanol = ..... kg

- (ii) What type of reaction takes place between butene and steam?

(1)

- A addition
- B dehydration
- C neutralisation
- D substitution

(d) A sample of each of three hydrocarbons, **X**, **Y** and **Z**, was shaken with bromine water. Bromine water is orange coloured.

The results are:

**X** orange mixture becomes colourless

**Y** orange mixture becomes colourless

**Z** mixture remains orange

Using the results, comment on the structures of the hydrocarbons **X**, **Y** and **Z**.

(2)

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**(Total for Question 4 = 9 marks)**

## Propene

6 Propene is an alkene.

The formula of its molecule is  $C_3H_6$ .

(a) (i) Draw the structure of a propene molecule, showing all of the bonds.

(2)

(ii) One molecule of decane,  $C_{10}H_{22}$ , can be cracked to produce one molecule of propene and one molecule of an alkane **X** only.

Complete the sentence by putting a cross (☒) in the box next to your answer.

The formula of a molecule of alkane **X** is

(1)

- A**  $C_7H_{14}$
- B**  $C_7H_{16}$
- C**  $C_8H_{16}$
- D**  $C_{13}H_{28}$

(b) Propane is an alkane.

Propane and propene are both gases.

Given a sample of each gas, describe a test to show which gas is propane and which gas is propene.

(3)

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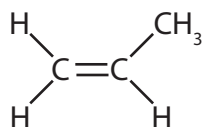






## Propene

2 The structure of a molecule of propene is



(a) Propene is an unsaturated hydrocarbon.

(i) Explain what is meant by **unsaturated hydrocarbon**.

(3)

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(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

Propene can be made by using heat to decompose large alkane molecules into smaller, more useful molecules.

This process is known as

(1)

- A combustion
- B cracking
- C fractional distillation
- D polymerisation

(iii) Describe what is seen when a sample of propene is shaken with bromine water.

(2)

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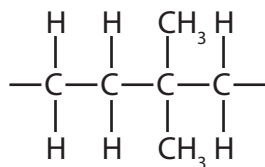
(b) Molecules of propene can be combined to form a molecule of poly(propene).

(i) Which of these shows part of the structure of a molecule of poly(propene)?

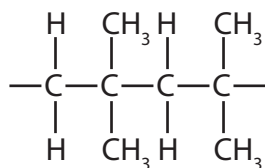
Put a cross (☒) in the box next to your answer.

(1)

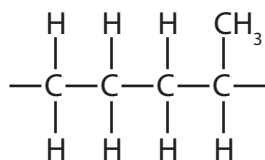
**A**



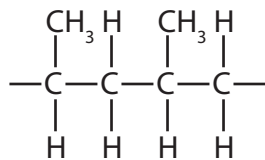
**B**



**C**



**D**



(ii) Ropes used on boats are often made from poly(propene).

poly(propene) rope



State a property of poly(propene) that makes it suitable for use as ropes on boats.

(1)

(iii) State a problem caused by the disposal of poly(propene) ropes in landfill sites.

(1)

**(Total for Question 2 = 9 marks)**



## Fuels and crude oil

- 5 (a) Some fuels are better fuels than others.

State one factor that makes a good fuel.

(1)

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- (b) Bioethanol is a fuel that can be obtained from the plant, sugar beet.

- (i) Bioethanol and petrol can both be used as fuels.

Explain one advantage of using bioethanol produced from sugar beet, rather than petrol produced from crude oil.

(2)

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- (ii) The main component of bioethanol is ethanol.

When burnt completely, ethanol,  $C_2H_5OH$ , reacts with oxygen to produce carbon dioxide and water.

Write the balanced equation for this reaction.

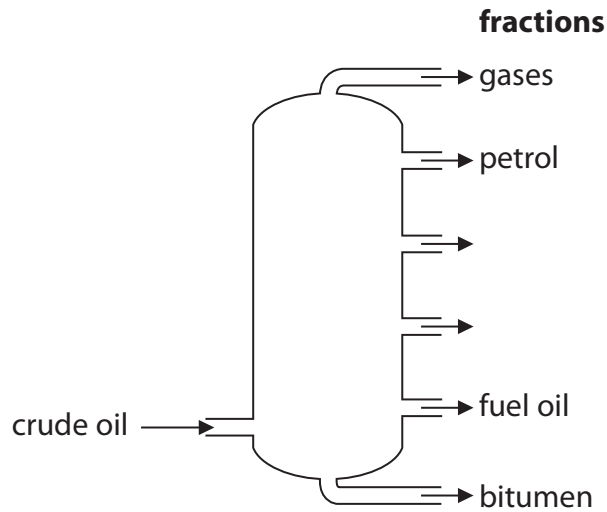
(3)

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\*(c) Useful products can be obtained by the fractional distillation of crude oil.

The diagram shows a fractional distillation column and the fractions obtained.



The petrol fraction is obtained from near the top of the column.  
The bitumen fraction is obtained from the bottom of the column.

Explain how the petrol and bitumen fractions differ in their properties and uses.

(6)

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### Alkenes and polymers

4 (a) Complete the sentence by putting a cross (☒) in the box next to your answer. (1)

Alkenes are

- A saturated carbohydrates
- B saturated hydrocarbons
- C unsaturated carbohydrates
- D unsaturated hydrocarbons

(b) Propene is an alkene and has the molecular formula  $C_3H_6$ .

(i) Draw the structure of a propene molecule, showing all of the bonds. (2)

(ii) Propane is an alkane.  
Propane and propene are both gases.

Given a sample of each gas, describe a test, carried out on both gases, to show which gas is propane and which gas is propene.

(3)

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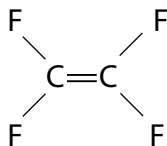
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(c) The diagram shows the structure of a tetrafluoroethene molecule.



Tetrafluoroethene can form the polymer PTFE.

(i) Draw a diagram to show part of a PTFE molecule formed from two tetrafluoroethene molecules.

(2)

(ii) PTFE does not allow other substances to stick to it.  
State a use of PTFE related to this property.

(1)

(d) Many polymers cause problems because they persist for a long time when they are put in landfill sites.

State an alternative way of disposing of polymer waste.

(1)

**(Total for Question 4 = 10 marks)**



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### Products from crude oil

6 Crude oil is separated into different fractions by fractional distillation.

- (a) Fraction X is obtained from near the top of the fractionating column.  
Fraction Y is obtained from near the bottom of the fractionating column.

Which row of the table shows the boiling point, ease of ignition and viscosity of fraction X compared with fraction Y?

Put a cross (☒) in the box next to your answer.

(1)

|                            | boiling point | ease of ignition      | viscosity     |
|----------------------------|---------------|-----------------------|---------------|
| <input type="checkbox"/> A | lower than Y  | more difficult than Y | higher than Y |
| <input type="checkbox"/> B | lower than Y  | easier than Y         | lower than Y  |
| <input type="checkbox"/> C | higher than Y | more difficult than Y | lower than Y  |
| <input type="checkbox"/> D | higher than Y | easier than Y         | higher than Y |

- (b) Pentane, C<sub>5</sub>H<sub>12</sub>, can be obtained from crude oil.  
When pentane burns completely in air, it forms carbon dioxide and water.

Write the balanced equation for this reaction.

(3)

- (c) Sulfur is present as an impurity in some fuels.

Explain how the product of combustion of this impurity in a fuel can damage the environment.

(2)

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\*(d) The table below shows the percentages of three fractions obtained from crude oil and the percentages of these fractions required by customers.

| <b>fraction</b> | <b>number of carbon atoms in molecules</b> | <b>percentage obtained from crude oil</b> | <b>percentage required by customers</b> |
|-----------------|--------------------------------------------|-------------------------------------------|-----------------------------------------|
| gases           | 1 to 4                                     | 2                                         | 5                                       |
| petrol          | 5 to 10                                    | 10                                        | 26                                      |
| kerosene        | 10 to 16                                   | 13                                        | 8                                       |

Oil companies use cracking to convert some of the molecules in the kerosene fraction into molecules with fewer carbon atoms.

Cracking can also be carried out on a small scale using liquid paraffin in a school laboratory.

Describe how cracking can be carried out in the laboratory experiment, explaining why it is necessary for oil companies to use cracking on some fractions obtained from crude oil.

You may wish to use diagrams to help parts of your answer.

(6)

