1 Alkanes are saturated hydrocarbons that can be obtained from crude oil.

The general formula of the homologous series of alkanes is C_nH_{2n+2}

(a) (i) What is the meaning of the term **saturated**?

(1)

.....

.....

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

(2)

.....

.....

.....

.....

(iii) Pentane is an alkane with five carbon atoms in its molecule.

What is the molecular formula of pentane?

(1)

- ☒ **A** C_5H_8
- ☒ **B** C_5H_{10}
- ☒ **C** C_5H_{12}
- ☒ **D** C_5H_{14}

(b) (i) Octane (C_8H_{18}) is an alkane that is present in petrol.

When octane burns completely in oxygen it forms carbon dioxide and water.

Write a chemical equation for the complete combustion of octane.

(2)

.....

(ii) Give the name of a toxic gas that may be produced by the incomplete combustion of octane.

(1)

.....

(c) Dodecane ($C_{12}H_{26}$) is another alkane. When heated and passed over a suitable catalyst, it decomposes to form octane and one other hydrocarbon.

(i) State how a catalyst increases the rate of this decomposition.

(1)

.....

.....

.....

(ii) Give the name of a suitable catalyst for this process.

(1)

.....

(iii) Complete the equation that represents the reaction

(1)

$$C_{12}H_{26} \rightarrow C_8H_{18} + 2 \text{ .....}$$

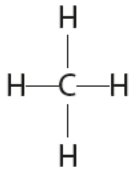
(iv) Name the other hydrocarbon produced in this reaction.

(1)

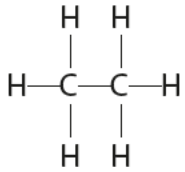
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(Total for Question 1 = 11 marks)

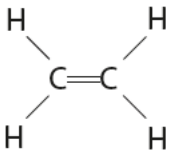
2 The diagram shows the displayed formulae of five hydrocarbons A, B, C, D and E.



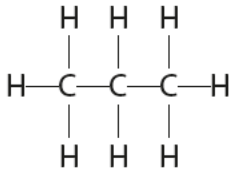
A



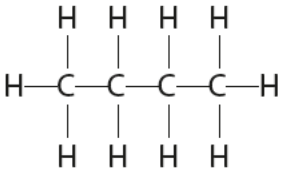
B



C



D



E

(a) Give the letter of a hydrocarbon to answer these questions.

You may use each letter once, more than once or not at all.

(i) Which hydrocarbon is the main component of natural gas?

(1)

.....

(ii) Which other hydrocarbon is produced, together with D, when pentane (C_5H_{12}) is cracked?

(1)

.....

(iii) Which hydrocarbon can undergo an addition reaction with hydrogen to form B?

(1)

.....

(b) Give the molecular formula and the empirical formula of E.

(2)

molecular formula.....

empirical formula.....

(c) Hydrocarbons A, B, D and E all belong to the same homologous series.

(i) Give the name and the general formula of this homologous series.

(2)

name .....

general formula .....

(ii) Draw the displayed formula of an isomer of E.

(1)

(d) Two reactions that can occur when hydrocarbon A is burned in air are represented by these equations.

Equation for reaction 1 $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Equation for reaction 2 $CH_4 + 1\frac{1}{2}O_2 \rightarrow CO + 2H_2O$

Explain why a different product is formed in reaction 2 and why this product is dangerous.

(3)

.....

.....

.....

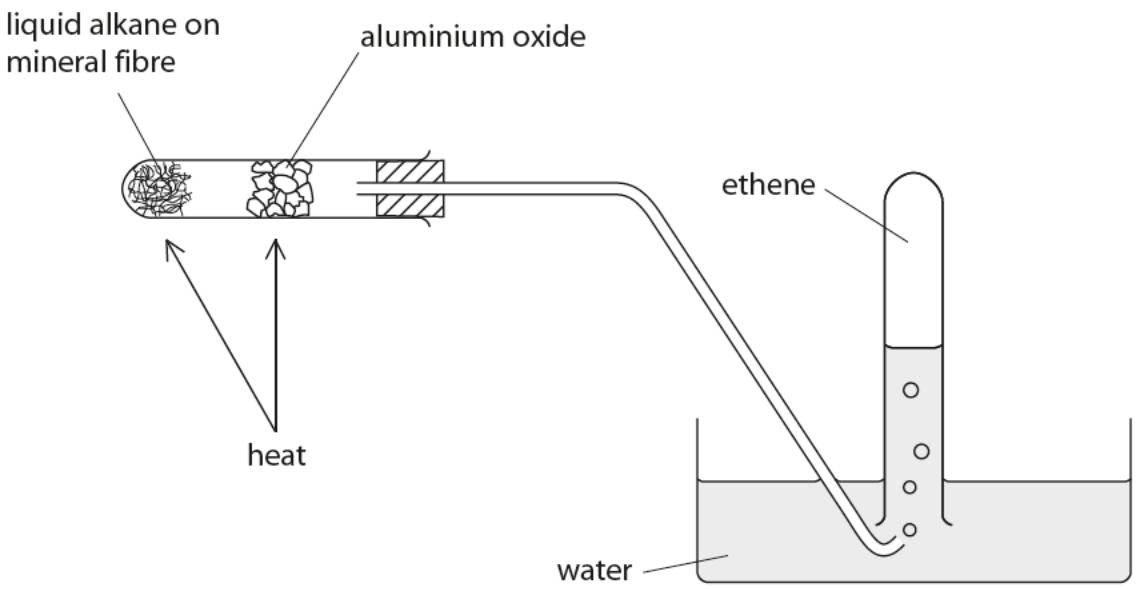
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(Total for Question 2 = 11 marks)

3 This apparatus can be used to obtain ethene by cracking a liquid alkane.



(a) What is meant by the term **cracking**?

(1)

.....

.....

.....

(b) Give a chemical test to show that the gas collected is unsaturated.

(2)

.....

.....

.....

(c) Cracking is also carried out in industry.

Give the name of the catalyst and the temperature used in the catalytic cracking of hydrocarbons.

(2)

catalyst .....

temperature .....

(Total for Question 3 = 5 marks)

4 (a) Explain what is meant by the term **isomerism**.

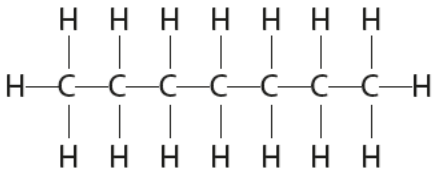
(2)

.....

.....

.....

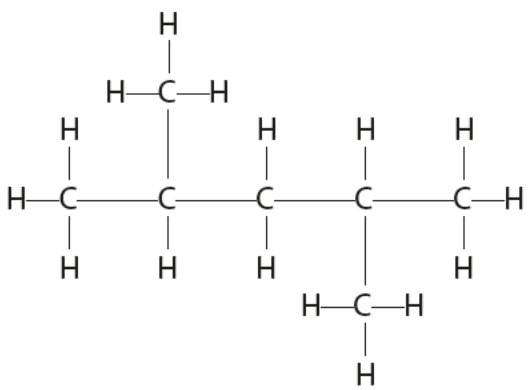
(b) The displayed formula of heptane (C_7H_{16}) is



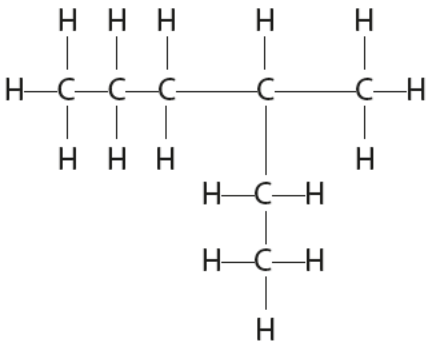
Which one of the displayed formulae below does **not** represent an isomer of heptane?

Place a cross (☒) in the box to indicate your answer.

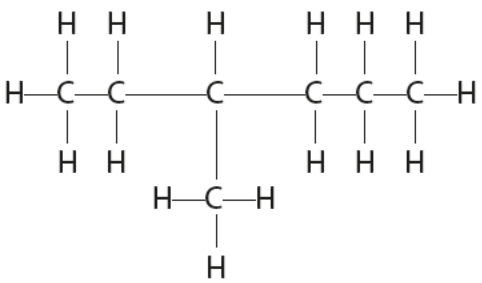
(1)



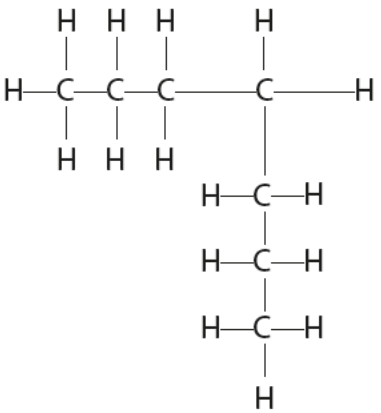
A ☐



B ☐



C ☐



D ☐

(c) Heptane belongs to a homologous series of compounds called alkanes.

The general formula of the alkanes is C_nH_{2n+2}

(i) Heptene belongs to a homologous series of compounds called alkenes.

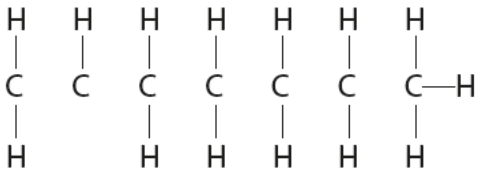
Give the general formula of the alkenes.

(1)

.....

(ii) Complete the following diagram to show the structural formula of heptene (C_7H_{14}) by inserting lines to represent the covalent bonds between the carbon atoms.

(2)



(d) When heptene is added to bromine water, and the mixture is shaken, a reaction occurs.

State the type of reaction and give the colour of the bromine water before and after the reaction with heptene.

(3)

Type of reaction.....

Colour before.....

Colour after.....

(e) Explain, in terms of the bonds present, why heptane is described as saturated and heptene as unsaturated.

(2)

.....

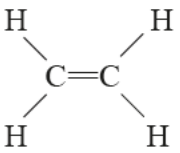
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.....

.....

(Total for Question 4 = 11 marks)

5 A teacher explained the different types of formula used in organic chemistry, using ethene as an example.

Description	Formula
general	C_nH_{2n}
empirical	CH_2
molecular	C_2H_4
structural	$CH_2{=}CH_2$
displayed	

(a) Use this example to help you write the formulae described below.

(i) The empirical formula of methane

(1)

(ii) The molecular formula of ethane

(1)

(iii) The structural formula of propane

(1)

(iv) The displayed formula of butane

(1)

(b) All the compounds in part (a) belong to the same homologous series and 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** characteristics of the compounds in a homologous series, other than having the same general formula.

(2)

1

2

(c) All the compounds in part (a) are hydrocarbons. They can undergo complete combustion when burned in oxygen to form carbon dioxide and water.

(i) Write a chemical equation for the **complete** combustion of propane (C_3H_8).

(2)

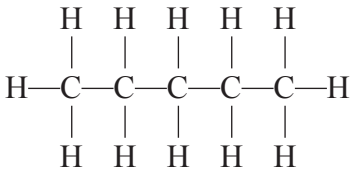
(ii) Identify one solid product and one gaseous product that could form during the **incomplete** combustion of propane.

(2)

Solid product

Gaseous product

(d) The displayed formula of pentane is



Draw a displayed formula for each of the two isomers of pentane.

(2)

Isomer 1 Isomer 2

(e) When methane reacts with bromine, one of the products is hydrogen bromide.

(i) State a condition needed for this reaction.

(1)

(ii) Name the organic product of the reaction.

(1)

(iii) Write a chemical equation for the reaction.

(2)

(Total for Question 5 = 18 marks)