

GCSE Chemistry (9 – 1)

Organic 1 – Alkanes and Alkenes

Name:

Group:



Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.

For markers use	
Question	Mark
1	/9
2	/11
3	/11
4	/6
5	/8
6	/9
7	/16
8	/12
Total	/82
%	
Grade	

Information

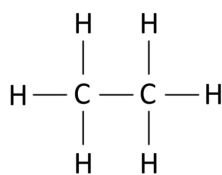
- The maximum mark for this paper is 82 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



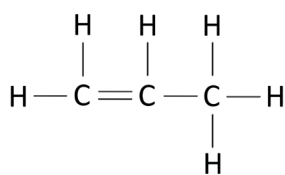
1. Alkanes and alkenes are the two simplest families of hydrocarbons, whose properties and reactions are determined by the presence of single or double carbon-carbon bonds.

Circle the letter of the correct answer for each of the following questions.

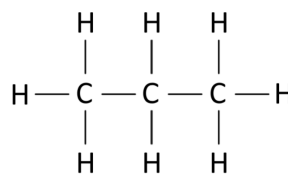
- a. The structures of **four** different organic compounds are shown in the figure below.



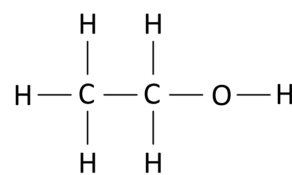
A



B



C



D

Which statement about these compounds is **not** correct?

- A** Only one of the compounds is an alcohol.
- B** Only one of the compounds is unsaturated.
- C** Only three of the compounds are hydrocarbons.
- D** Only one of the compounds is an alkane.

(1 mark)

- b. Which of the following gives the formula of an **alkene**?



A



B



C



D

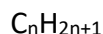
(1 mark)

- c. Alkanes are a homologous series of hydrocarbons.

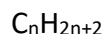
What is the general formula for the alkanes?



A



B



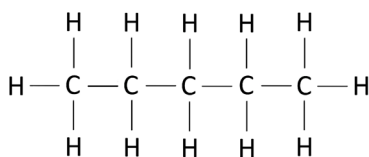
C



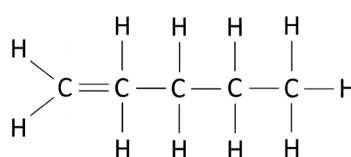
D

(1 mark)

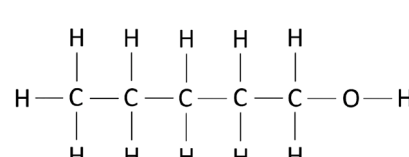
- d. Which of the following molecular structures shows pentene?



A



B



C

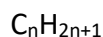
(1 mark)

- e. Alkenes are a homologous series of unsaturated hydrocarbons.

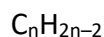
Which of the following represents the general formula for the alkenes?



A



B



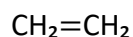
C



D

(1 mark)

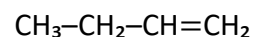
- f. The structures of three hydrocarbons, P, Q, and R, are shown below.



P



Q



R

Which of the following statements about these three compounds is correct?

1. They all contain a carbon-carbon double bond (C=C).
2. They are all members of the same homologous series.
3. They all have the same boiling point.

1 and 2 only

A

2 and 3 only

B

1, 2 and 3

C

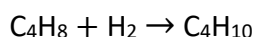
1 and 3 only

D

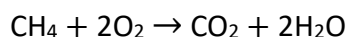
(1 mark)

- g. The oil industry uses **cracking** to break down long-chain alkanes.

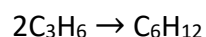
Which equation correctly represents this industrial process?



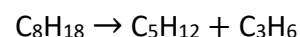
A



B



C



D

(1 mark)

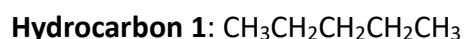
- h. A molecule of propane (C_3H_8) and a molecule of ethene (C_2H_4) are two different hydrocarbons.

Which type of covalent bond is present in both molecules?

- A** A double bond between two carbon atoms.
B A single bond between a carbon atom and a hydrogen atom.
C A single bond between two carbon atoms.
D A double bond between a carbon atom and a hydrogen atom.

(1 mark)

- i. The structural formulae for two hydrocarbons are shown below.



Which statement correctly describes the relationship between these two hydrocarbons?

- A** They undergo addition reactions.
B They are structural isomers.
C They are both alkenes.
D They decolourise aqueous bromine.

(1 mark)

(Total for Question 1 is 9 marks)

2. Propane, C_3H_8 , is an alkane. Propane is the main component of bottled gas and is used in camping stoves.

a. Propane undergoes complete combustion.

Write the balanced symbol equation for the complete combustion of propane.

.....

(2 marks)

The table below gives the viscosity of some different alkanes.

Viscosity is a measure of how easily a liquid flows.

Alkane	Relative Viscosity
Propane	0.22
Hexane	0.51
Methane	0.11
Octane	0.72

b. State the relationship between the number of carbon atoms in the alkane and its viscosity.

.....

.....

(1 mark)

c. Propane is found in the refinery gas fraction when crude oil is separated by fractional distillation.

The table below shows some information about four molecules that are found in four different fractions.

Molecule	Formula	Boiling point ($^{\circ}C$)
Pentadecane	$C_{15}H_{32}$	271
Nonadecane	$C_{19}H_{40}$	330
Docosane	$C_{22}H_{46}$	
Tetracosane	$C_{24}H_{50}$	391

i. Predict the boiling point of docosane.

Boiling point of docosane = ... $^{\circ}C$

(1 mark)

ii. Tetracosane is separated lower down the fractionating column than pentadecane.

Explain why, using ideas about intermolecular forces.

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(3 marks)

- d. Cracking is used to break down large, less useful alkane molecules into smaller, more useful ones. The equation shows the cracking of tetracosane to make decane and one other product. Complete and balance the equation.



- e. The table below shows the percentage supply and demand for some of the different fractions obtained from crude oil.

Fraction	Percentage supply (%)	Percentage demand (%)
Refinery gas	2	4
Petrol	10	25
Naphtha	12	6
Kerosene	14	8
Diesel oil	17	22
Lubricating oil	45	35

More petrol can be obtained by cracking another fraction.
Suggest and explain which fraction is cracked to obtain petrol.

Fraction:

Reason:

.....
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(2 marks)

(Total for Question 2 is 11 marks)

3. Alkenes are a homologous series of unsaturated hydrocarbons which are made by cracking larger alkane molecules.

a. Explain what is meant by the term “unsaturated hydrocarbon”.

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(2 marks)

b. Alkenes are very useful substances.

i. Write the general formula for alkenes.

.....

(1 mark)

ii. Explain why the products of cracking are economically more important than the large alkane molecules they are made from.

.....

(1 mark)

iii. Describe **two** industrial conditions needed for cracking to occur.

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.....

(2 marks)

c. The table below gives the boiling points of some alkenes.

Alkene	Boiling point in °C
Propene	−48
Butene	−6
Pentene	
Hexene	63
Heptane	93

i. Predict the boiling point of pentene.

.....

(1 mark)

- ii. The melting point of propene is $-185\text{ }^{\circ}\text{C}$.
Deduce the physical state of propene at room temperature ($20\text{ }^{\circ}\text{C}$).
Give a reason for your answer.

Physical state:

Reason:

.....

.....

(2 marks)

- d. Propene reacts with hydrogen to produce propane in an addition reaction.
Complete the symbol equation for this reaction.



(2 marks)

(Total for Question 3 is 11 marks)

- Octane, C_8H_{18} , a liquid alkane
- Octene, C_8H_{16} , a liquid alkene
- Ethanoic acid, $\text{C}_2\text{H}_4\text{O}_2$, a carboxylic acid, in aqueous solution.

Aqueous solutions of carboxylic acids contain hydrogen ions and undergo reactions typical of acids with indicators and carbonates.

Describe, in detail, a logical sequence of tests the chemist could perform to identify each of the three liquids.

Your description should include the expected observations for each liquid and the balanced chemical equations for any reactions described.

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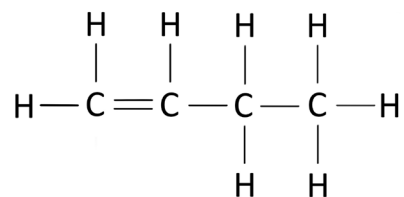
(6 marks)

(Total for Question 4 is 6 marks)

5. The alkenes are a series of unsaturated hydrocarbons.
- a. Deduce, using the general formula for alkenes, the molecular formula of an alkene which has a relative molecular mass of 140. You must show your working.

.....
(2 marks)

The figure below shows the structural formula of butene.



- b. Draw an electron shell diagram showing the arrangement of the electrons in one molecule of butene.
Use dots (•) to represent the electrons for the carbon atoms.
Use crosses (x) represent the electrons for the hydrogen atoms.

(3 marks)

- c. A large alkane P was cracked to form one molecule of pentane, C₅H₁₂, and one molecule of an alkene Q. The relative formula mass of Q is 42. The empirical formula of Q is CH₂.



Deduce the molecular formula of the large alkane P.
You must show your working.

Molecular formula of P = ...
(3 marks)

(Total for Question 5 is 8 marks)

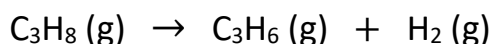
6. Propane, C_3H_8 , is a saturated hydrocarbon used as a fuel in patio heaters.
- a. In a faulty patio heater with a poor oxygen supply, propane undergoes incomplete combustion to form a toxic gas and water.
- i. Name the toxic gas produced during this reaction.

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(1 mark)

- ii. Write the **balanced** chemical equation for this incomplete combustion reaction.

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(2 marks)

- b. Propane can also be used as a chemical feedstock. It can be converted into propene, C_3H_6 , and hydrogen gas in a process called dehydrogenation. The equation for the reaction is:



A chemist reacts 8.8 g of propane.

Calculate the volume of hydrogen gas, in dm^3 , that would be produced at room temperature and pressure (RTP).

(Relative atomic masses: $\text{H} = 1.0$, $\text{C} = 12.0$. The molar volume of any gas at RTP is $24.0 \text{ dm}^3/\text{mol}$.)

Volume of hydrogen gas = ... dm^3
(4 marks)

- c. Alkanes can also react with halogens in the presence of ultraviolet (UV) light.
- i. Name the type of reaction that occurs when ethane (C_2H_6) reacts with bromine (Br_2).

.....
(1 mark)

- ii. State the essential condition required for this reaction to occur.

.....
(1 mark)

(Total for Question 6 is 9 marks)

7. Ethene, C_2H_4 , is the first member of the alkene homologous series. It is a key industrial chemical produced by cracking long-chain alkanes.
- a. A student is given two unlabelled samples, one of ethane (C_2H_6) and one of ethene (C_2H_4). Describe a chemical test the student could carry out to distinguish between the two hydrocarbons. Include the expected result for both samples.

Test:

Result with ethane:

Result with ethene:

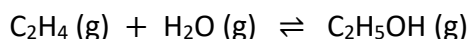
(3 marks)

- b. The reaction of ethene with the chemical in part (a) is an example of an addition reaction. Explain why alkenes undergo addition reactions but alkanes do not. Refer to the bonding in your answer.

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(2 marks)

- c. Ethene is used to produce ethanol by reacting it with steam. This is a reversible reaction.



- i. State the industrial conditions of temperature and pressure used for this reaction.

Temperature:

Pressure:

(2 marks)

- ii. Name the catalyst used in this process.

(1 mark)

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- iii. The forward reaction to produce ethanol is exothermic. Explain why a compromise temperature of $300^\circ C$ is used rather than a lower temperature which would give a higher yield.

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(2 marks)

- iv. The atom economy of this reaction is 100%.
Explain why the atom economy for this reaction is 100%.

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.....
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(2 marks)

- d. In a laboratory experiment, a student reacted 7.0 g of ethene with excess steam and produced 9.2 g of ethanol.

Calculate the percentage yield of ethanol for this experiment.

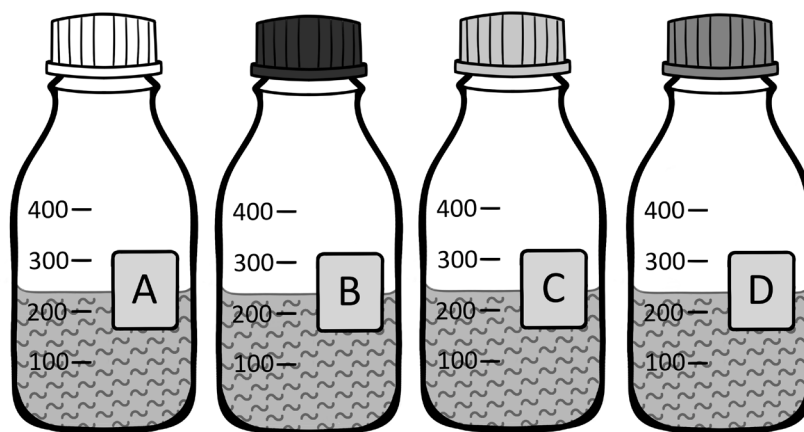
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

Percentage yield = ... %

(4 marks)

(Total for Question 7 is 16 marks)

8. A student is provided with four unlabelled bottles (A, B, C, and D), each containing a different clear, colourless liquid.



The liquids are known to be:

- Hexane, C_6H_{14} , a saturated hydrocarbon
- Hex-1-ene, C_6H_{12} , an unsaturated hydrocarbon
- Cyclohexane, C_6H_{12} , a saturated hydrocarbon
- Ethanol, C_2H_5OH , an alcohol which is soluble in water

The student is told that hexane and cyclohexane are immiscible (do not mix) with water.

- a. Describe a logical sequence of tests the student could carry out to identify each of the four liquids. Your plan should explain how you would use the results to distinguish the liquids from each other. You should include the expected observations for all four liquids at each stage of your procedure.

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(6 marks)

- b. The student performs a test that confirms one of the liquids is hex-1-ene.

Write the balanced chemical equation for the reaction that takes place in this test.

.....

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(2 marks)

- c. To confirm the identity of another liquid as hexane, the student carries out a combustion analysis.
When 1.29 g of the liquid is burned completely in excess oxygen, 3.96 g of carbon dioxide is produced.

Show by calculation that this result is consistent with the liquid being hexane (C_6H_{14}).

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

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(4 marks)

(Total for Question 8 is 12 marks)