Fuels	Covered (✓)	How well can you do this?
1. Combustion is an example of an exothermic reaction which will give out energy, endothermic reactions are the opposite		✗ ? ✓
2. The energy given out by a fuel can be calculated using the equation Eh = cmΔT		✗ ? ✓
3. The mass of products produced during combustion can be calculated using balanced equations		✗ ? ✓

Hydrocarbons	Covered (✓)	How well can you do this?
1 **Alkanes have the general formula C_nH2_{n+2}**		× ? ✓
2. **Alkenes general formula is C_nH_{2n}**		× ? ✓
3. **Draw structural formulae for alkanes and alkenes up to 8 carbons**		× ? ✓
4. Cycloalkanes are a family of hydrocarbons with a ring structure		× ? ✓
5. Cycloalkanes begin with cyclopropane		× ? ✓
6. Cycloalkanes have the general formula C_nH_{2n}		× ? ✓
7. Give uses for cycloalkanes		× ? ✓
8. Draw structural formula up to cycloalkanes with 8 carbons		× ? ✓

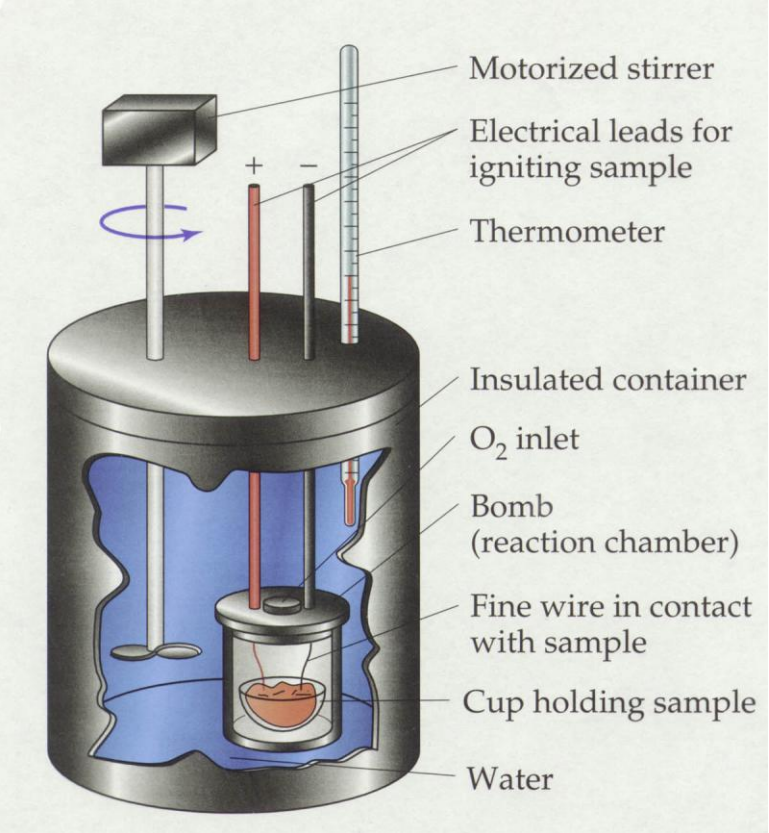
	Covered (✓)	How well can you do this?
9. Alkanes and alkenes can have branches		× ? ✓
10.Systematic naming is used to identify branched alkanes and alkenes		× ? ✓
11. Alkenes can take part in addition reactions forming alkanes and alcohols		× ? ✓
12. Isomers have the same molecular formula but a different structural formula		× ? ✓
13. Isomers have different properties		× ? ✓
14. Write balanced equations for the combustion of hydrocarbons .		× ? ✓

Consumer Products	Covered (✓)	How well can you do this?
1. Alcohols contain the OH, hydroxyl group and have the general formula $C_nH_{2n+1}OH$		× ? ✓
2. Position of OH given in systematic name.		× ? ✓
3.Name and draw alcohols C1-C8		× ? ✓
4. Alcohols are good fuels as the burn cleanly and are highly flammable		× ? ✓
5 Alcohols are used as solvents and to make other chemicals such as esters		× ? ✓
6. Carboxylic acids contain the COOH, carboxyl group and have the general formula $C_nH_{2n+1}COOH$		× ? ✓
7. The COOH group always comes at the end of the chain		× ? ✓

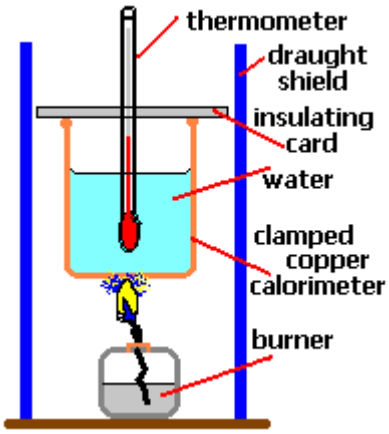
	Covered (✓)	How well can you do this?
8. Draw and name carboxylic acids from C1-C8		× ? ✓
9. Carboxylic acids are used as preservatives, solvents, cleaning products and are used to make esters		× ? ✓
10. Esters are made by the condensation reaction between alcohols and carboxylic acids		× ? ✓
11. Esters are sweet smelling chemicals used for fragrances, food flavourings and solvents		× ? ✓

Measuring Energy Given Out During Combustion National 5

The energy given out when a fuel burns can be measured. This process involves burning the fuel in the presence of oxygen to heat up a specific volume of water. This is achieved in industry using a special machine called a bomb calorimeter shown below.



The rise in temperature is recorded and a calculation is used to work out the amount of energy released. We can carry this out in the school laboratory using a simpler set up, however not as accurate as the bomb calorimeter.



The fuel is burned and will cause the temperature of the water to rise. We then use the following equation to calculate the amount of heat energy released.

$Eh = cm\Delta T$ c = the heat capacity of water (4.18 $kJkg^{-1}{}^{o}C^{-1}$)

m = the mass of water in kg (the volume in litres)

ΔT = the change in temperature

Eh = heat energy released in kJ

Example:

When a fuel burns the temperature of 100cm3 of water increased from 24 °C to 38 °C calculate the amount of energy released

$Eh = cm\Delta T$ c= 4.18

$Eh = 4.18 \times 0.1 \times 12$ m= 100/1000 = 0.1

Eh = 5.016 kJ ΔT = 38-24 =12

Example **National 5**

Calculate the mass of carbon dioxide produced when 2.9g of butane (C_4H_{10}) is burned completely in oxygen.

$C_4H_{10} + 6.5O_2 \longrightarrow 4CO_2 + 5H_2O$

1 Mole $C_4H_{10} \longrightarrow$ 4 moles of CO_2

58 g $\longrightarrow$ 176g

1g $\longrightarrow$ 176/58

2.9g $\longrightarrow$ (176/58) x 2.9

= 8.8g

Hydrocarbons – Alkanes **Nat 5**

The alkanes are a family of hydrocarbons and an example of a homologous series (a set of compounds which show similar chemical properties, a gradual change in physical properties and can be represented by a general formula).

The alkanes

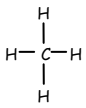
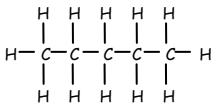
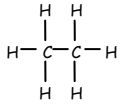
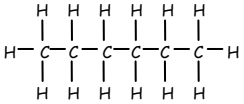
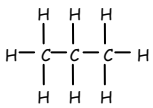
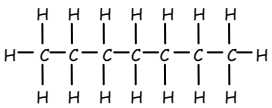
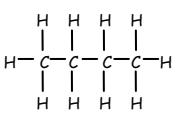
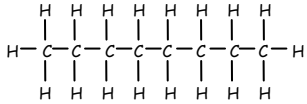
- contain only single bonds
- have the general formula C_nH_{2n+2}.
- burn to produce carbon dioxide and water
- boiling points, melting points and viscosity increases with increasing number of carbon atoms.

Alkanes can be identified by the –ane ending and a prefix which indicates the number of carbon atoms in the molecules.

Prefix	Number of C atoms	Prefix	Number of C atoms
meth	1	pent	5
eth	2	hex	6
prop	3	hept	7
but	4	oct	8

The names, molecular formulae, shortened and full structural formulae for the first eight alkanes are shown below.

Name	Molecular Formula	**Shortened Structural Formula**
methane	CH_4	**CH_4**
ethane	C_2H_6	**CH_3CH_3**
propane	C_3H_8	**$CH_3CH_2CH_3$**
butane	C_4H_{10}	**$CH_3CH_2CH_2CH_3$**
pentane	C_5H_{12}	**$CH_3CH_2CH_2CH_2CH_3$**
hexane	C_6H_{14}	**$CH_3CH_2CH_2CH_2CH_2CH_3$**
heptane	C_7H_{16}	**$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$**
octane	C_8H_{18}	**$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$**

Name	Full Structural Formula	Name	Full Structural Formula
methane		pentane	
ethane		hexane	
propane		heptane	
butane		octane	

Alkenes **Nat 4 and 5**

The alkenes are another homologous series of hydrocarbons.

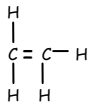
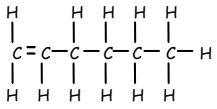
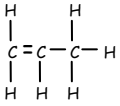
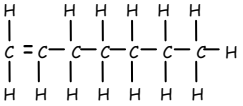
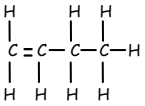
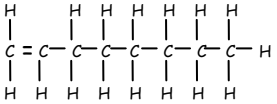
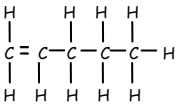
The alkenes

- contain at least one carbon to carbon double bond (C=C). This is called a functional group
- have the general formula C_nH_{2n}
- burn to produce carbon dioxide and water
- boiling points,melting points and viscosity increases with increasing number of carbon atoms.
- are much more reactive than alkanes

Alkenes can be identified by the –ene ending to their names.

The names, molecular formulae, shortened and full structural formulae for the first seven alkenes are shown below.

Name	Molecular Formula	**Shortened Structural Formula**
ethene	C_2H_4	$\mathbf{CH_2CH_2}$
propene	C_3H_6	$\mathbf{CH_2CHCH_3}$
butene	C_4H_8	$\mathbf{CH_2CHCH_2CH_3}$
pentene	C_5H_{10}	$\mathbf{CH_2CHCH_2CH_2CH_3}$
hexene	C_6H_{12}	$\mathbf{CH_2CHCH_2CH_2CH_2CH_3}$
heptene	C_7H_{14}	$\mathbf{CH_2CHCH_2CH_2CH_2CH_2CH_3}$
octene	C_8H_{16}	$\mathbf{CH_2CHCH_2CH_2CH_2CH_2CH_2CH_3}$

Name	Full Structural Formula	Name	Full Structural Formula
ethene		hexene	
propene		heptene	
butene		octene	
Pentene			

Cycloalkanes **Nat 5**

The cycloalkanes are a third homologous series of hydrocarbons.

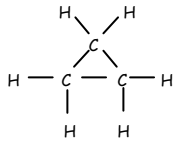
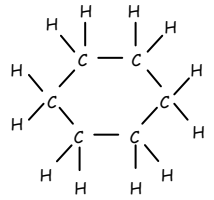
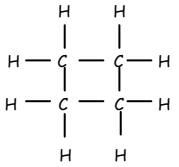
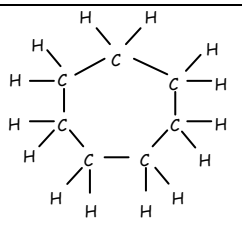
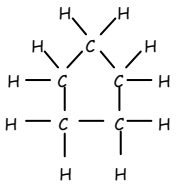
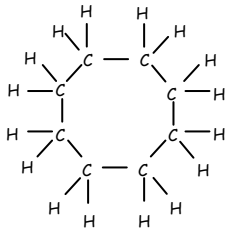
Cycloalkanes

- **have a ring structure and contain only single bonds**
- **have the general formula C_nH_{2n}**
- **burn to produce carbon dioxide and water**
- **boiling points increase with increasing number of carbon.**

Cycloalkanes can be identified by the –ane ending and a prefix which starts with cyclo and indicates the number of carbon atoms in the molecules.

The names, molecular formulae, shortened and full structural formulae for the first four cycloalkanes are shown below.

Name	Molecular Formula
cyclopropane	C_3H_6
cyclobutane	C_4H_8
cyclopentane	C_5H_{10}
cyclohexane	C_6H_{12}
cycloheptane	C_7H_{14}
cyclooctane	C_8H_{16}

Name	Full Structural Formula	Name	Full Structural Formula
cyclopropane		cyclohexane	
cyclobutane		cycloheptane	
cyclopentane		cyclooctane	

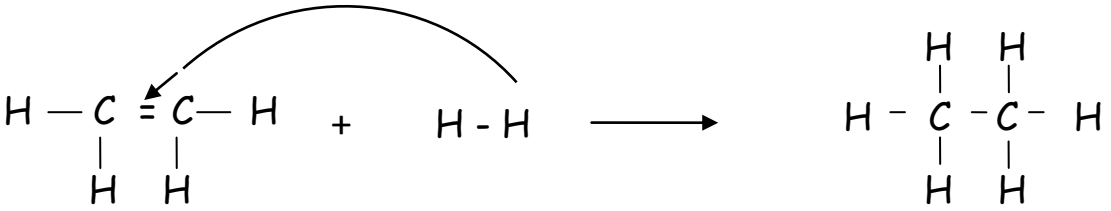
Uses of Cycloalkanes

Cyclopentane is used in place of CFCs in refrigerators, cyclohexane in the manufacture of nylon and cycloheptane is used as an industrial solvent.

Reactions of Alkenes **Nat 5**

Alkenes, because they are unsaturated, are more reactive than alkanes and cycloalkanes. The double bond allows them to undergo addition reactions with halogens, hydrogen and water.

Alkenes undergo addition reactions with hydrogen to form the corresponding alkanes. In the reaction the double bond breaks open and the two hydrogen atoms add on to the carbons on either side.



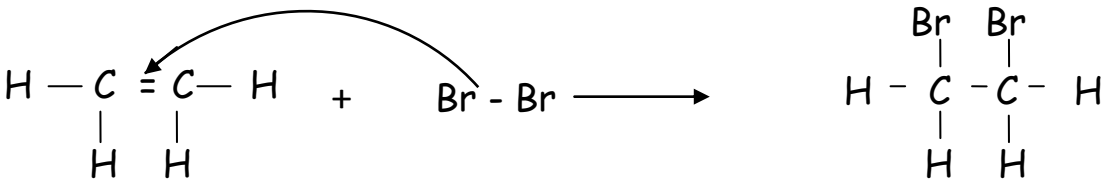
$C H_2 = C H_2 + H_2 \longrightarrow C H_3 CH_3$

Ethene + Hydrogen ⟶ Ethane
(unsaturated) (saturated)

Adding hydrogen across a double bond changes the unsaturated alkene into the saturated alkane.

Identifying an Alkene

An unsaturated hydrocarbon can be distinguished from a saturated hydrocarbon by testing with bromine solution.
When bromine, which is brown, is added to an alkene (unsaturated) it is instantly decolourised, where as this does not happen with an alkane or cycloalkane.



$C H_2 = C H_2$ + Br_2 ⟶ $C H_2 Br C H_2 Br$

(colourless) (Brown) (colourless)

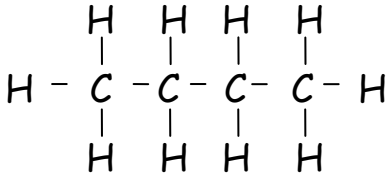
Alkanes and cycloalkanes do not undergo addition reactions.

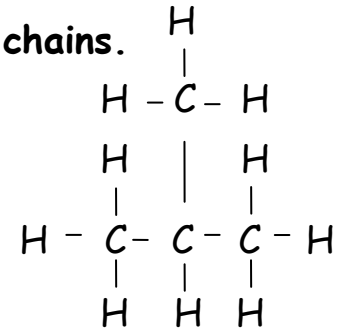
Isomers

Isomers are molecules with the same molecular formulae but different structural formulae. Isomers have different properties.

Alkanes can have isomers with branched chains.

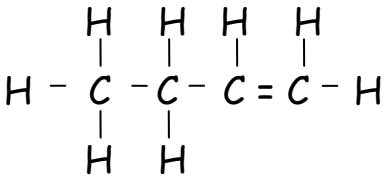
Two examples of C_4H_{10} can be:

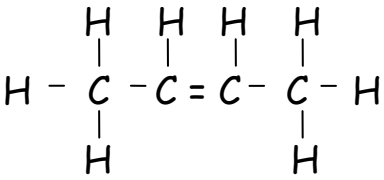




Alkenes can have isomers with branched chains and also with the double bond in a different position.

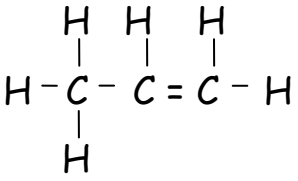
Two examples of C_4H_8 can be:

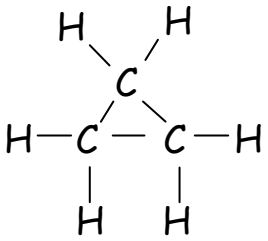




Cycloalkanes are isomers of the alkenes.

Two examples of C_3H_6 can be:



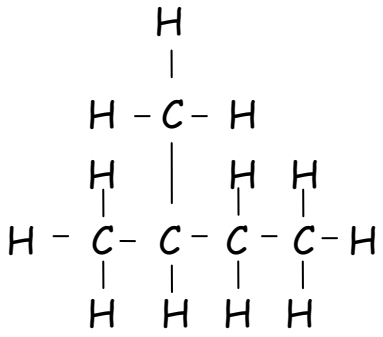


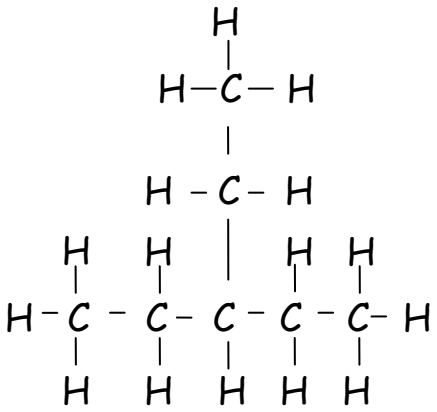
Naming Branched Alkanes

To name a branched alkane

- **Select the longest continuous chain of carbon atoms and name it after the appropriate straight chain alkane.**
- **Number the carbon atoms from the end of the chain nearer the branch.**
- **Name the branch(es) and indicate the position(s) of the branch(es) on the chain.**

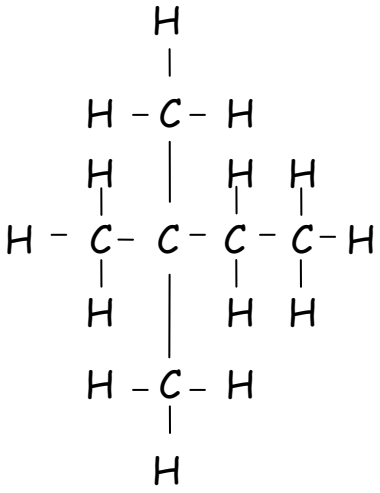
Number of carbons in branch	Name of branch
1	methyl
2	ethyl
3	propyl
4	butyl





1	Main chain	=	butane
2	Branch	=	methyl
3	Position	=	2
4	The complete name is 2-methylbutane		

1	Main chain	=	pentane
2	Branch	=	ethyl
3	Position	=	3
4	The complete name is 3-ethylpentane		



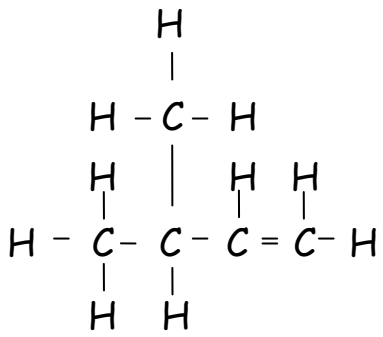
1	Main chain	=	butane
2	Branch	=	methyl
3	Position	=	2,2
4	The complete name is 2,2-dimethylbutane		

di is used as there are two methyl groups

Naming Branched Alkenes

To name a branched alkene

- **Select the longest continuous chain of carbon atoms containing the double bond and name it after the appropriate straight chain alkene.**
- **Number the carbon atoms from the end of the chain nearer the double bond and indicate the position of the double bond.**
- **Name any branch(es) and indicate the position(s) of the branch(es) on the chain.**



1	Main chain = butene
2	Double bond position = 1
3	Branch position = 3
4	Branch = methyl
5	The complete name is 3 methylbut-1-ene

Summary – Consumer Products

National 5

Alcohols

Alcohols are a family of compounds that contain the characteristic **Hydroxyl (OH)** functional group. Their names end with the letters '**ol**'.

Straight and branched chain alcohols are identified and named from the structural formulae.

The systematic name of alcohols details the position of the **OH** functional group.

Given the name of any alcohol the structural and molecular formulae of the compounds can be deduced.

Uses of alcohols include **fuels, solvents** and to make other chemicals such as **esters**.

Alcohols make good fuels as they are highly flammable and burn very cleanly.

Carboxylic Acids

Carboxylic Acids are a family of compounds that contain the characteristic **Carboxyl (COOH)** functional group. Their names end with the letters '**oic acid**'

The COOH functional group is found at the end of the main carbon chain.

Straight and branched chain Carboxylic Acids are identified and named from the structural formulae.

Given the name of any Carboxylic Acid the structural and molecular formulae of the compounds can be deduced.

Vinegar is a solution of **Ethanoic Acid**. **Vinegar** can be used in household **cleaning products** and as a **preservative** in the food industry. In addition to this Carboxylic Acids can be used as **solvents** and to make **esters**.

Esters

Esters are compounds that are formed when an **Alcohol** reacts with a **Carboxylic acid**. This is classed as a **Condensation** Reaction as **Water** is also formed in this process.

The general word equation for this process is:

Alcohol + Carboxylic Acid → Ester + Water

Simple esters are sweet-smelling liquids and are widely used as **fruit flavourings** in the food industry.

In addition to this esters can be used industrially and cosmetically as **solvents** for example in **paint** and **nail varnish.** They can also be used in **perfume** manufacture.