Fuels	Covered (✓)	How well can you do this?
1. Fuel is a substance that burns to give energy		✗ ? ✓
2. There are 3 fossil fuels coal, oil and gas which are finite		✗ ? ✓
3. Crude oil is formed from dead marine life compressed for millions of years.		✗ ? ✓
4. Crude oil is extracted from the ground by drilling and sent to a refinery.		✗ ? ✓
5. Crude oil is a mixture of compounds that can be separated by fractional distillation		✗ ? ✓
6. A fraction is a group of chemicals in a boiling point range		✗ ? ✓

	Covered (✓)	How well can you do this?
7. Cracking breaks long chain compounds into shorter more useful ones to meet market demand		✗ ? ✓
8. Hydrocarbons burn in a good supply of oxygen to make carbon dioxide and water		✗ ? ✓
9. Incomplete combustion in a poor supply of oxygen produces carbon monoxide and soot.		
10. All living things are made from carbon		✗ ? ✓
11. The balance of carbon in the environment is controlled by the carbon cycle		✗ ? ✓
12. Burning fossil fuels increases the amount of carbon dioxide in the air		✗ ? ✓
13. An increase in carbon dioxide causes the atmosphere to heat up		✗ ? ✓

	Covered (✓)	How well can you do this?
14. Alternatives to fossil fuels include wind, solar, wave, and biomass		× ? ✓
15. Biomass is a plant based fuel that can be burned or converted into cleaner fuels such as ethanol or bio-diesel		× ? ✓
16. Combustion is an example of an exothermic reaction which will give out energy, endothermic reactions are the opposite		× ? ✓
17. The energy given out by a fuel can be calculated using the equation $E_h = cm\Delta T$		× ? ✓
18. The mass of products produced during combustion can be calculated using balanced equations		× ? ✓

Hydrocarbons	Covered (✓)	How well can you do this?
1. Hydrocarbons contain only hydrogen and carbon		× ? ✓
2. Alkanes are a family of hydrocarbons		× ? ✓
3. Alkanes are saturated and contain only single C-C bonds		× ? ✓
4. **Alkanes have the general formula C_nH2_{n+2}**		× ? ✓
5. Uses of alkanes include fuels, lubricating oil, and tar.		× ? ✓
6. Alkenes are a family of unsaturated hydrocarbons and contain a C=C double bond and begin with ethene		× ? ✓
7. Alkenes are produced by cracking.		× ? ✓
8. Alkenes are used to make plastics		× ? ✓

	Covered (✓)	How well can you do this?
9. **Alkenes general formula is C_nH_{2n}**		× ? ✓
10. The boiling point, melting point and viscosity(thickness) of alkanes and alkenes increases with size		× ? ✓
11. **Draw structural formulae for alkanes and alkenes up to 8 carbons**		× ? ✓
12. Cycloalkanes are a family of hydrocarbons with a ring structure		× ? ✓
13. Cycloalkanes begin with cyclopropane		× ? ✓
14. Cycloalkanes have the general formula C_nH_{2n}		× ? ✓
15. Give uses for cycloalkanes		× ? ✓
16. Draw structural formula up to cycloalkanes with 8 carbons		× ? ✓

17. Alkanes and alkenes can have branches		**× ? ✓**
18. Systematic naming is used to identify branched alkanes and alkenes		**× ? ✓**
19. Alkenes can take part in addition reactions forming alkanes and alcohols		**× ? ✓**
20. Isomers have the same molecular formula but a different structural formula		**× ? ✓**
21. Isomers have different properties.		**× ? ✓**
22. Write balanced equations for the combustion of hydrocarbons .		**× ? ✓**

Consumer Products	Covered (✓)	How well can you do this?
1. Carbohydrates are compounds containing Carbon, hydrogen and oxygen		× ? ✓
2.Fermentation produces alcohol from sources of carbohydrates e.g fruits and veg		× ? ✓
3. Alcohol concentration can be measured in units		× ? ✓
4.Give examples of alcoholic drinks and the units they contain.		× ? ✓
5.The recommended weekly intake of alcohol in units for males and females are		× ? ✓
6. Health problems can be caused by drinking too much alcohol e.g liver disease		× ? ✓
7.Glucose is a simple carbohydrate with formula $C_6H_{12}O_6$		× ? ✓

	Covered (✓)	How well can you do this?
8.Starch is formed when glucose molecules join together		× ? ✓
9.Glucose will turn benedicts solution orange/red from blue		× ? ✓
10.Starch turns iodine blue/black		× ? ✓
11. Glucose is soluble in water and sweet to taste		× ? ✓
12. Starch is insoluble in water and forms a colloid (suspension)		× ? ✓
13. Starch is a large store of energy		× ? ✓
14. Carbohydrates are being used to produce fuels meaning an increase demand and less being used for food.		× ? ✓
15. Alcohols contain the OH, hydroxyl group and have the general formula $C_nH_{2n+1}OH$		× ? ✓
16. Position of OH given in systematic name.		× ? ✓

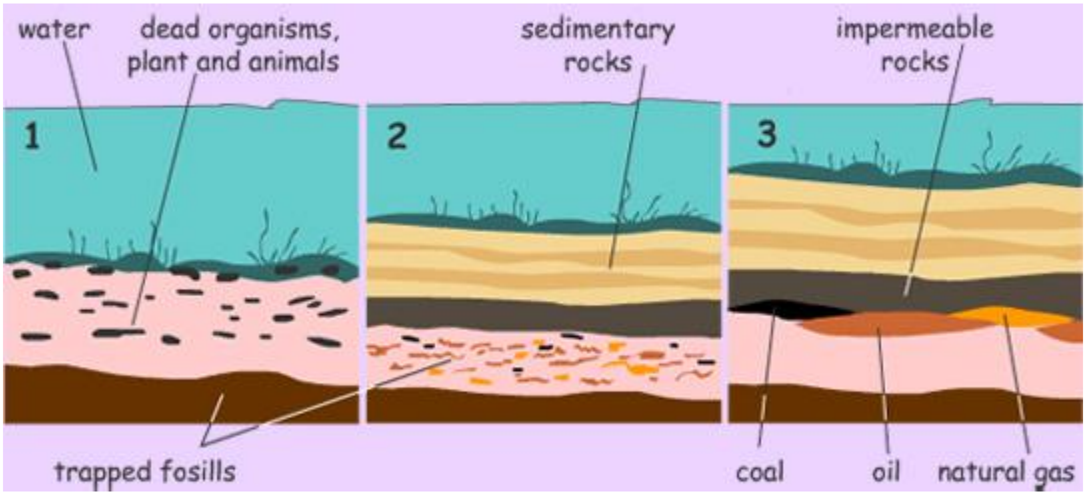
17. Name and draw alcohols C1-C8		× ? ✓
18. Alcohols are good fuels as the burn cleanly and are highly flammable		× ? ✓
19. Alcohols are used as solvents and to make other chemicals such as esters		× ? ✓
20. Carboxylic acids contain the COOH, carboxyl group and have the general formula $C_nH_{2n+1}COOH$		× ? ✓
21. The COOH group always comes at the end of the chain		× ? ✓
22. Draw and name carboxylic acids from C1-C8		× ? ✓
	Covered (✓)	How well can you do this?

23. Carboxylic acids are used as preservatives, solvents, cleaning products and are used to make esters		× ? ✓
24. Esters are made by the condensation reaction between alcohols and carboxylic acids		× ? ✓
25. Esters are sweet smelling chemicals used for fragrances, food flavourings and solvents		× ? ✓
Plants to Product	Covered (✓)	How well can you do this?
1. I have investigated how a plants can be used to make a product and have included the following		× ? ✓
1. Where plant is found or grown 2. The active ingredient in the plant 3. The role of the chemist in extracting the active ingredient 4. The uses of plant ingredients and their impact on everyday life.		

Fuels **National 4**

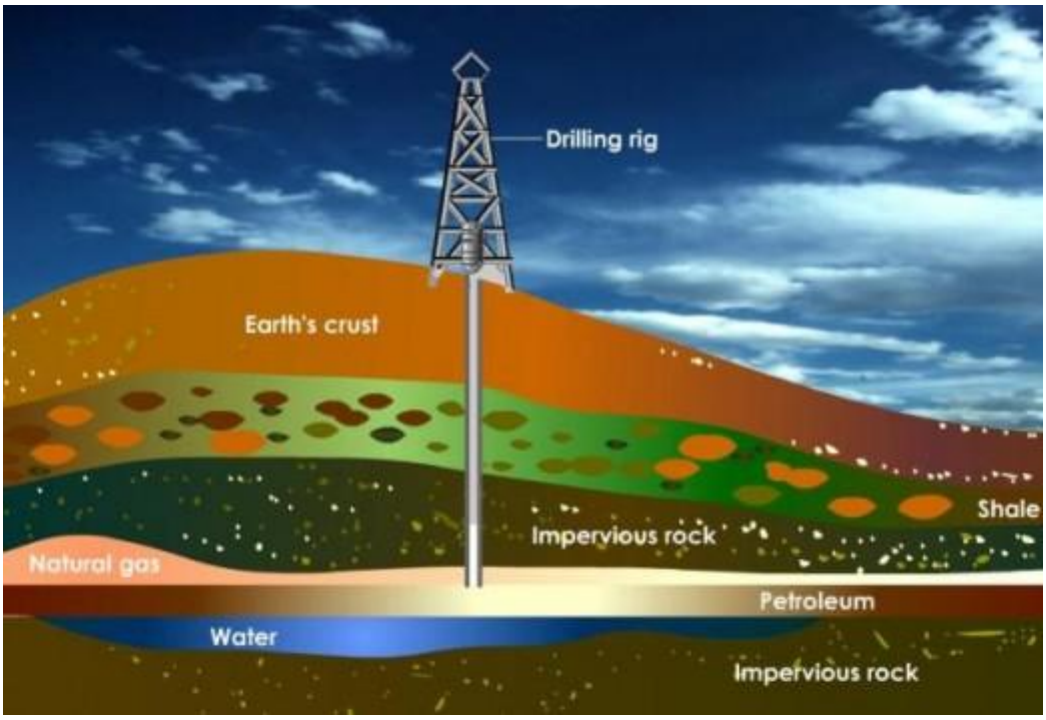
A fuel is a chemical which burns to give out energy. When a fuel burns the chemical reaction is known as combustion. When combustion takes place the fuel is reacting with oxygen from the air and energy is given out. This means that combustion is an example of an exothermic reaction.

Coal, oil and natural gas are fossil fuels. Fossil fuels are described as a finite resource as they will eventually run out. Fossil fuels are formed over millions of years. They are the fossilised remains of dead plants and animals. Plants and animals died and fell to the sea or swamp floor and were quickly covered by sediment. As the layers of sediment increased the remains become heated and pressurised (squashed). After millions of year's coal, oil and natural gas will be formed. Dead plants falling into swamps form coal and dead marine life forms oil and natural gas. The diagram below summarises the formation of fossil fuels.

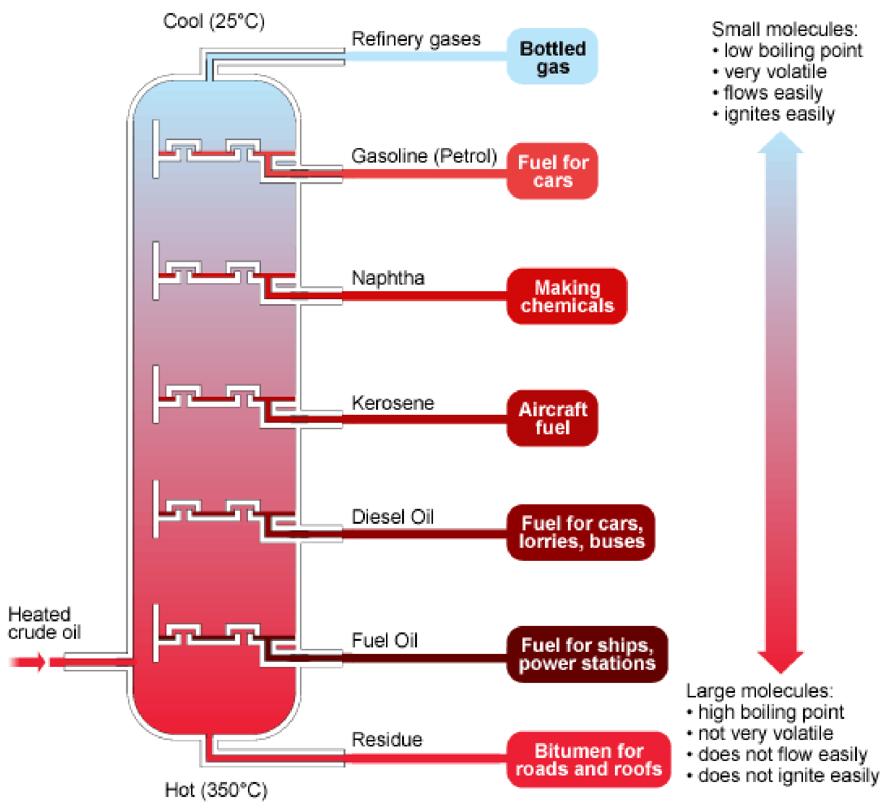


Crude Oil **National 4**

Crude oil is a fossil fuel that has a major impact on our economy. Large amounts of money are spent on oil exploration and when a source of oil is found we have to be able to extract it. When oil is formed it gets trapped under impervious rock, this is sometimes called a cap rock. When a source is found the oil is extracted by drilling a well and the pressure the oil is under enables it to come to the surface. Once we have extracted the oil it is sent to a chemical plant called a refinery for processing. The diagram shows how this extraction happens.



Crude oil is a mixture of hydrocarbons. A hydrocarbon is a compound containing only hydrogen and carbon atoms. The different hydrocarbons present in the crude oil have different boiling points. This property is used to separate the different hydrocarbons into fractions using a process called fractional distillation.



In this process the crude oil is heated until almost all of the hydrocarbons boil and turn into a gas. This mixture enters a tall structure called a fractionating tower. As the gasses rise up the tower they start to cool down and condense back into a liquid. Each fraction is collected at a specific height and temperature in the column. A fraction is a group of compounds with boiling points within a definite range. Each of these fractions have a specific use and the diagram above show some of these and how the properties change depending on where the fractions are removed from the tower.

Cracking National 4

When we separate crude oil there are not enough of the useful small molecules produced, and there is a surplus of the heavier fractions like residue. To overcome this shortfall and to meet market demands another process called cracking is carried out. This process involves breaking the long chain hydrocarbons into shorter more useful ones. A catalyst is used to reduce the temperature required for this reaction to take place. The catalyst is aluminium oxide. The diagram below shows how we can carry this process out in a school laboratory.

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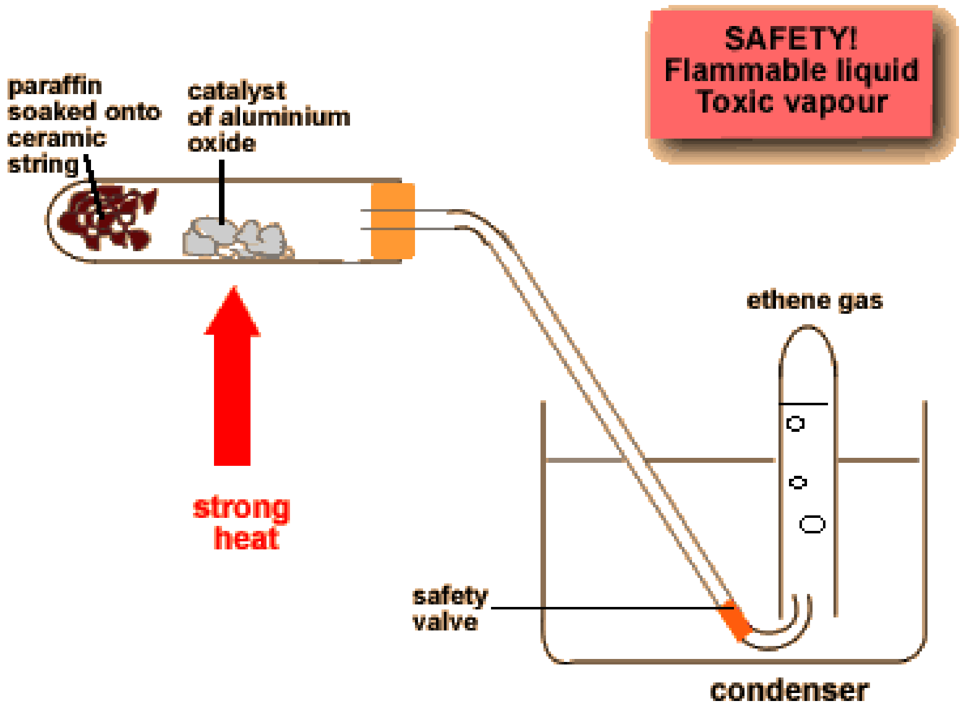
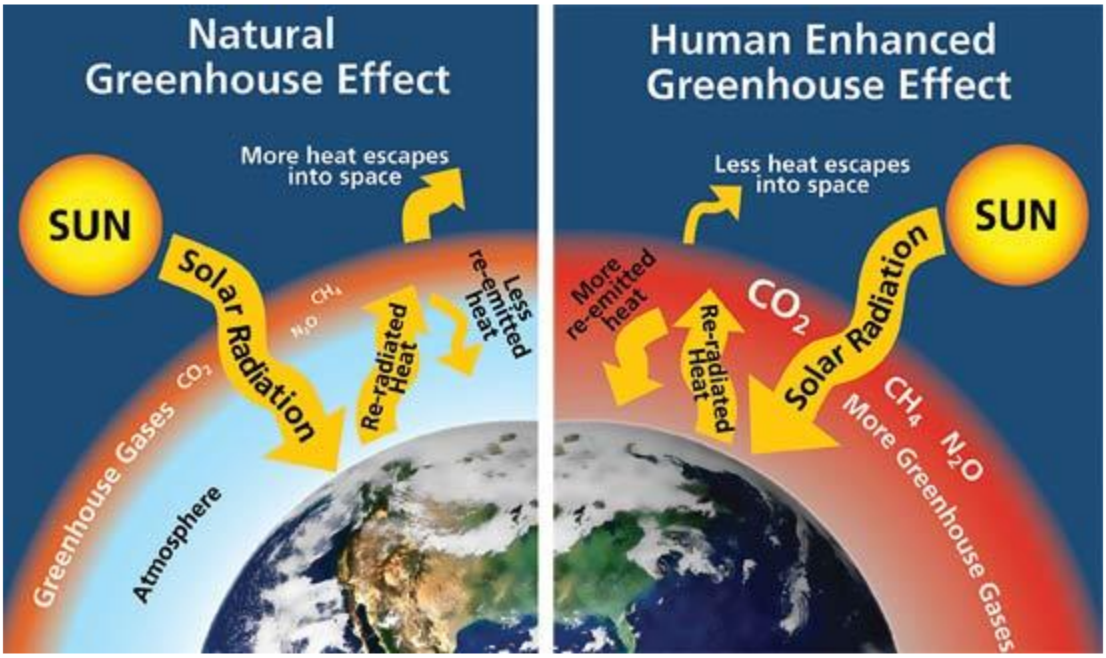


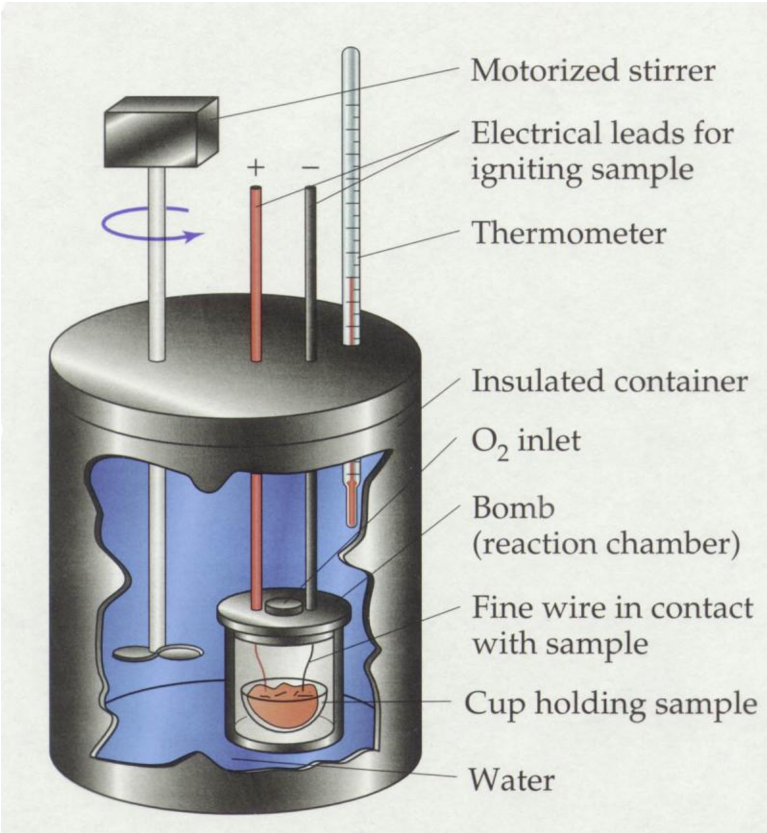
Burning fossil fuels has released vast quantities of carbon dioxide into the atmosphere. This carbon dioxide is not being absorbed by the plant life mainly due to large deforestation of equatorial rain forests throughout the world. This increase in carbon dioxide has caused the temperature of the atmosphere to rise which has in turn started to melt the ice caps at the North Pole. This warming process is known as the greenhouse effect, where the carbon dioxide traps the heat in the atmosphere similar to how glass traps heat in a green house.



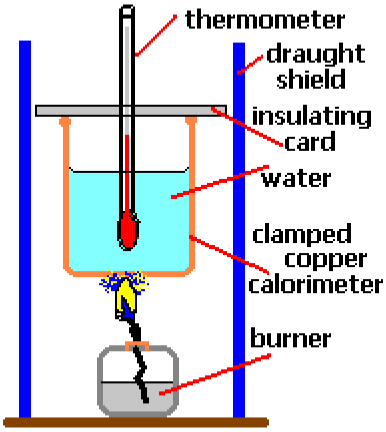
Other forms of energy sources are required to replace the use of fossil fuels. These forms of energy are classed as renewable. Some renewable sources include, wind, solar, wave and biomass. Biomass fuels are produced from living things such as sugar cane being used to make ethanol. Most commonly biomass is used to produce methane gas through the process of anaerobic respiration; this involves the decomposition of organic matter.

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

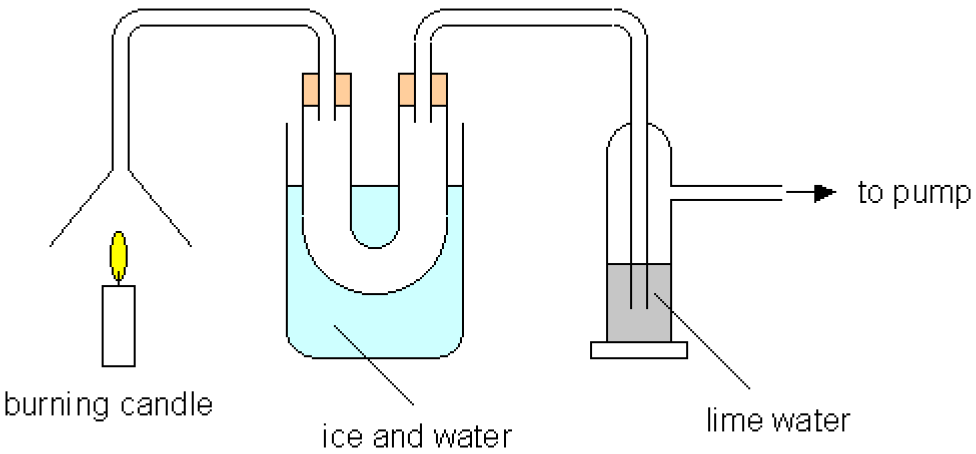
Example:

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 x0.1 x 12	m= 100/1000 = 0.1
Eh = 5.016 kJ	ΔT = 38-24 =12

<u>Combustion of Hydrocarbons</u> <u>National 4</u>

When a hydrocarbon burns in a plentiful supply of oxygen carbon dioxide is produced along with water. When any compound burns the elements present combine with oxygen to make the oxide. This is known as complete combustion however if there is not enough oxygen present incomplete combustion can take place. Incomplete combustion of a hydrocarbon will produce soot (pure carbon) and carbon monoxide a poisonous gas. We can test the products of combustion of hydrocarbons by carrying out the experiment shown below.



The ice water cools the gases down to condense the water produced, this can be tested using anhydrous copper sulphate which turns a dark blue colour, adding cobalt chloride paper which turns pink or checking the freezing and boiling point as water is the only liquid that freezes at 0°C and boils at 100°C. The lime water will react with the carbon dioxide produced and turn a milky colour.

We can use the calculation from a balanced equation to calculate the mass of products produced when a hydrocarbon burns. We have met this calculation in unit 1 however a worked example is shown below.

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} + $6.5O_2$ ⟶ $4CO_2$ + $5H_2O$

1 Mole C_4H_{10} ⟶ 4 moles of CO_2

58 g ⟶ 176g

1g ⟶ 176/58

2.9g ⟶ (176/58) x 2.9

= 8.8g

Hydrocarbons – Alkanes **Nat 4 and 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

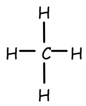
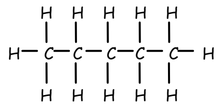
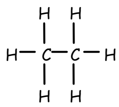
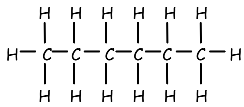
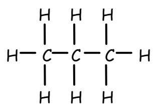
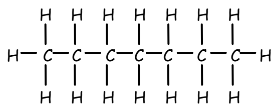
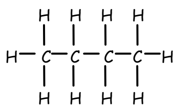
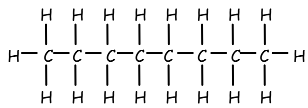
- contain only single bonds
- have the general formula C_nH_{2n+2}.
- burn to produce carbon dioxide and water
- boiling points, melting points and viscosity increases with increasing number of carbon atoms.

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.

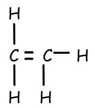
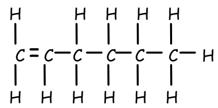
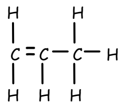
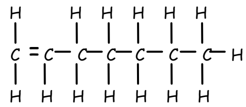
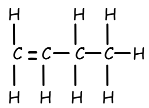
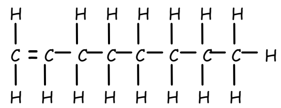
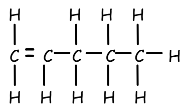
The alkenes

- 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	**CH_2CH_2**
propene	C_3H_6	**CH_2CHCH_3**
butene	C_4H_8	**$CH_2CHCH_2CH_3$**
pentene	C_5H_{10}	**$CH_2CHCH_2CH_2CH_3$**
hexene	C_6H_{12}	**$CH_2CHCH_2CH_2CH_2CH_3$**
heptene	C_7H_{14}	**$CH_2CHCH_2CH_2CH_2CH_2CH_3$**
octene	C_8H_{16}	**$CH_2CHCH_2CH_2CH_2CH_2CH_2CH_3$**

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

Uses of Alkenes

Small alkenes such as ethene and propene are used in the plastics industry to make polythene and polypropene.

Cycloalkanes **Nat 5**

The cycloalkanes are a third homologous series of hydrocarbons.

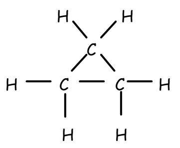
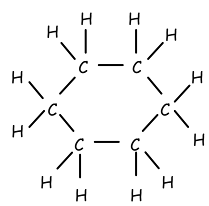
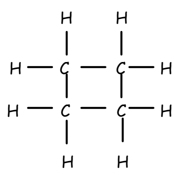
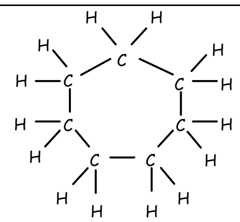
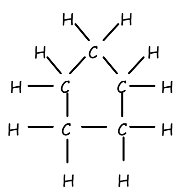
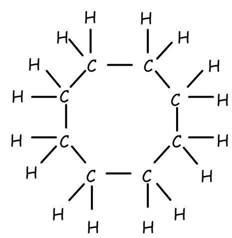
Cycloalkanes

- **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.

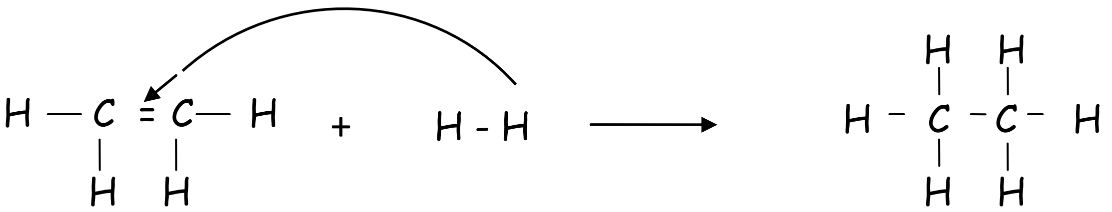
Saturated and Unsaturated **Nat 4**

Saturated hydrocarbons contain only single bonds (the carbons are "are full up" with hydrogens). The alkanes and cycloalkanes are examples of saturated hydrocarbons. Unsaturated hydrocarbons contain at least one carbon to carbon double bond. The alkenes are examples of unsaturated hydrocarbons.

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.



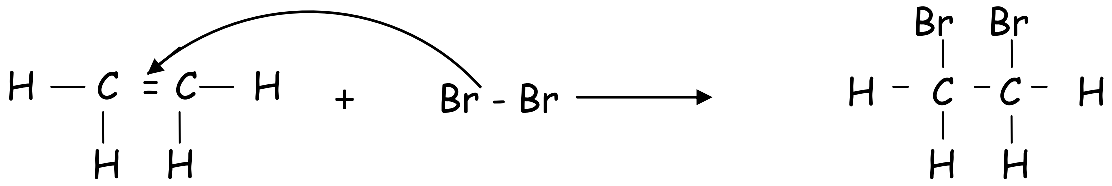
$$CH_2 = CH_2 + H_2 \longrightarrow CH_3CH_3$$

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.



$CH_2 = CH_2$ + Br_2 → CH_2BrCH_2Br

(colourless) (Brown) (colourless)

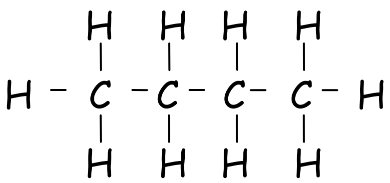
Alkanes and cycloalkanes do not undergo addition reactions.

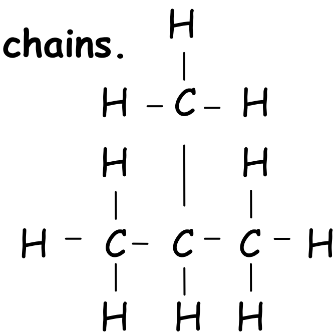
Isomers

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

Alkanes can have isomers with branched chains.

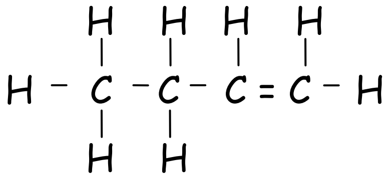
Two examples of C_4H_{10} can be:

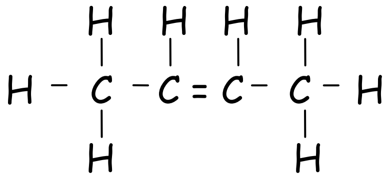




Alkenes can have isomers with branched chains and also with the double bond in a different position.

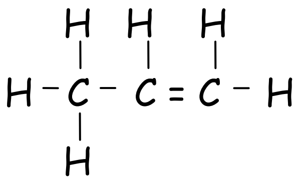
Two examples of C_4H_8 can be:

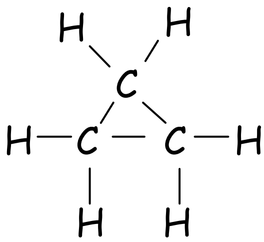




Cycloalkanes are isomers of the alkenes.

Two examples of C_3H_6 can be:



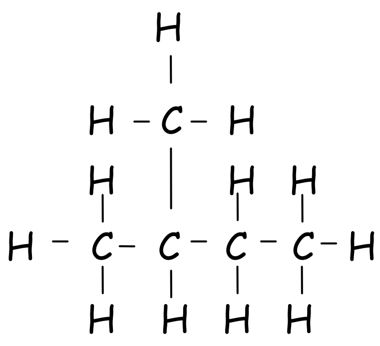


Naming Branched Alkanes

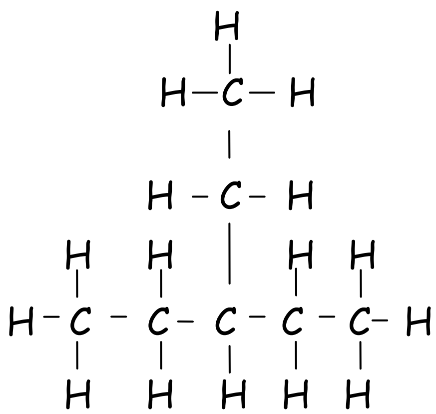
To name a branched alkane

- **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.**

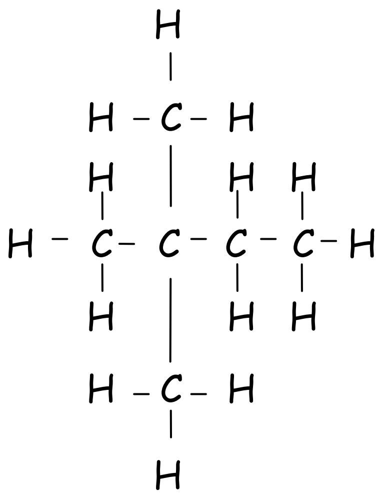
Number of carbons in branch	Name of branch
1	methyl
2	ethyl
3	propyl
4	butyl



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		



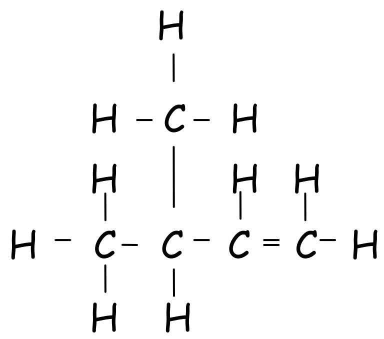
1	Main chain	=	butane
2	Branch	=	methyl
3	Position	=	2,2
4	The complete name is 2,2-dimethylbutane		

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

Cracking **Nat 4**

Cracking is an industrial process for producing smaller, more useful hydrocarbons. Cracking an alkane will always produce a mixture of alkanes (saturated) and alkenes (unsaturated) because there are not enough hydrogen atoms for all the products to be saturated.

$$C_8H_{18} \longrightarrow C_5H_{12} + C_3H_6$$

octane → pentane + propene

National 4

Carbohydrates are naturally occurring compounds which contain the elements **Carbon, Hydrogen and Oxygen**, with the Hydrogen and Oxygen in the ratio of two to one.

Plants are a source of **carbohydrates** which can be used for food of fuel.

Carbohydrates are formed when carbon dioxide and water react in the leaves of plants in a process called **Photosynthesis.**

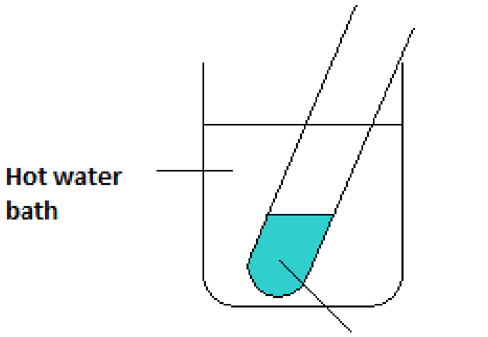
Glucose is a simple carbohydrate with the formula $C_6H_{12}O_6$. Many Glucose molecules can join together in a process called **Condensation Polymerisation** to form the complex carbohydrate **Starch**.

Green plants convert glucose to starch in this way as a means of storing energy.

Glucose is **soluble** in water and sweet tasting.

Starch however, due to its large molecular size is **insoluble** in water and forms a colloid (suspension).

We can chemically test for **Glucose** by heating it with **Benedict's Solution**.



Colour change - from blue to a brick red precipitate

We can chemically test for **Starch** by adding **Iodine Solution**.

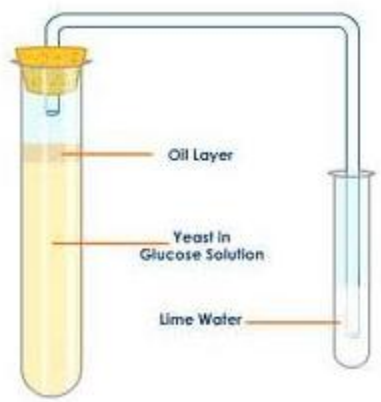
Colour change – from red/brown to Blue/black

During **digestion** Starch is broken down in the body, to form Glucose. Water is used in this process and as such, this is an example of an **Hydrolysis** reaction.

Glucose, due to its small molecular size can, can pass through the gut wall into the bloodstream to be used in cells, throughout the body, during **respiration**.

The chemical process of Fermentation is used to convert carbohydrates from various sources (e.g. fruit and vegetables) into alcohol. Different plants are used to produce different alcoholic beverages.

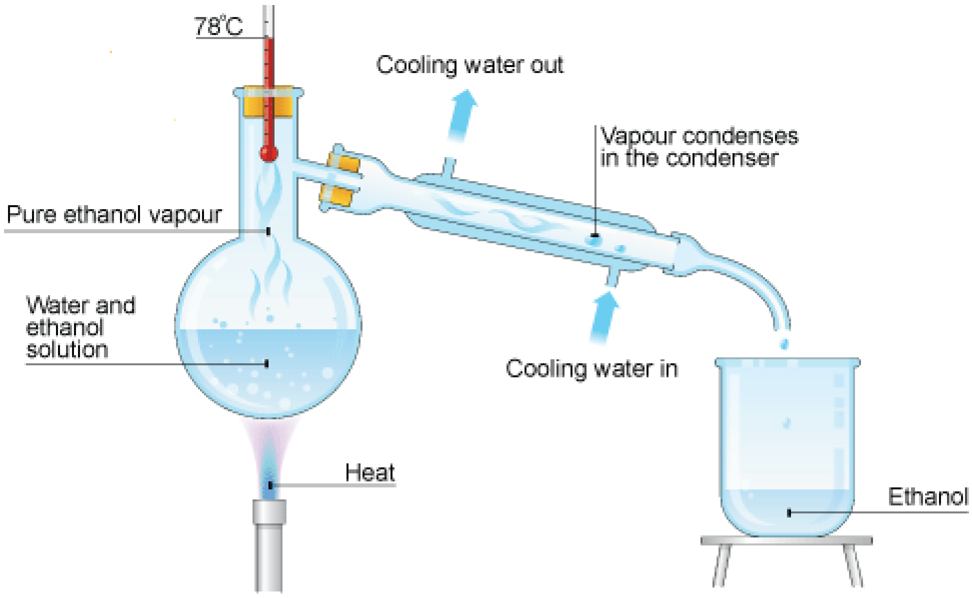
During Fermentation **Enzymes** present in **yeast** can convert glucose into **Ethanol**.



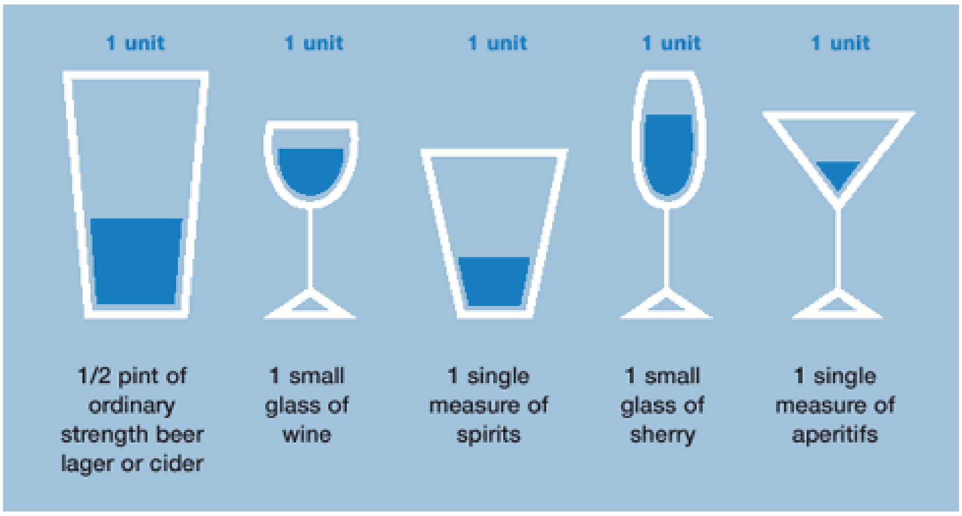
Enzymes operate under optimal conditions. As the fermentation process continues the increasing concentration of ethanol causes the enzymes to stop working. This limits the ethanol concentration achievable by the fermentation process.

To achieve higher concentrations of ethanol for production of spirits, **distillation** must be carried out.   This process allows liquids to be separated according to differences in their boiling points.

Laboratory Distillation apparatus



The alcohol content of drinks is measured in units.



The recommended weekly intake of alcohol in units for males and females is shown in the table below:

Consumption Levels	Males	Females
Sensible weekly maximum limits	Up to 21 units with 1 or 2 alcohol free days per week	Up to 14 units with 1 or 2 alcohol free days per week
Sensible daily maximum limits	3-4 units per day	2-3 units per day
Binge Drinking	More than 8 units per day	More than 6 units per day

Alcohol can be quickly absorbed into the bloodstream where it can interfere with some of the chemical reactions in the body.

Alcohol slows reaction time down. In small quantities it can relax a person, but in larger quantities it can slow reactions so much that a person can have trouble speaking, moving and thinking clearly.

Regular **heavy drinking** can lead to **alcohol addiction**. Heavy drinking can also **damage your liver and brain**.

Carbohydrates can also be converted to alcohol (ethanol) for use as a **Renewable Fuel**. An example of this is the fermentation of sugar cane in Brazil to produce **Bioethanol** which can be used as source of fuel to power cars and other vehicles. In the USA maize is used as an alternative to sugar cane.

Many plants can also be used by chemists in the design and manufacture of everyday products such as **pharmaceuticals, soaps, cosmetics, dyes, medicines, foods** and **food colourings.**

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 aci**d'

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.