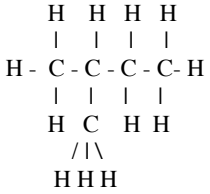
Alkanes and alkenes 5.1

You should know from previous work

* How fossil fuels coal, oil and gas were formed.
* How and why crude oil is separated into fractions by fractional distillation.
* That molecular structure and physical properties are related.
* That names, molecular and structural formulae of the alkenes [C_1- C_{10}], alkenes [C_2- C_{10}] and cycloalkanes [C_3-C_{10}]
* How to identify isomers and draw their structural formulae.
* What is meant by saturated and unsaturated hydrocarbons and how to distinguish between them.
* What happens during cracking and addition reactions.

Naming branched chain alkanes



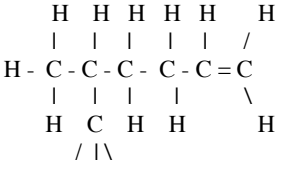
i. Main group butane

ii. Side group methyl

iii Position 2

2- methyl butane

Naming branched chain alkenes

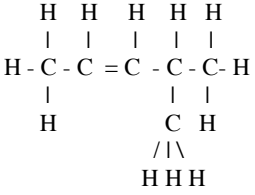


i. Main group hexene

ii Side group methyl

iii. Position 5

5-methyl hex-1-ene



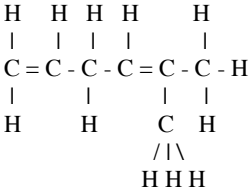
i. Main group pent-2-ene

ii. Side group methyl

iii. Position 4

4 - methyl pent - 2 - ene

Note some alkenes can have two double bonds



i. Main group hex 1,4 diene

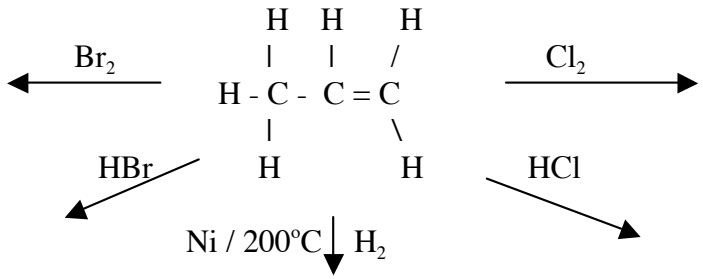
ii Side group methyl

iii. Position 5

5-methyl hex 1,4 diene

Alkene Reactions 5.2

Alkanes usually undergo addition reactions.

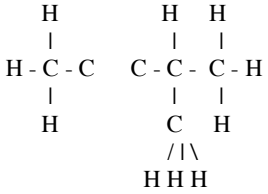


Alkyne Family 5.3

An alkyne is a hydrocarbon with a triple C to C bond. Alkynes have the General Formula CnH2n-2. They form a homologous series.

Alkyne	Molecular formula	Structural formula
ethyne	C_2H_2	
propyne	C_3H_4	
butyne	C_4H_6	

Alkynes with branched chains



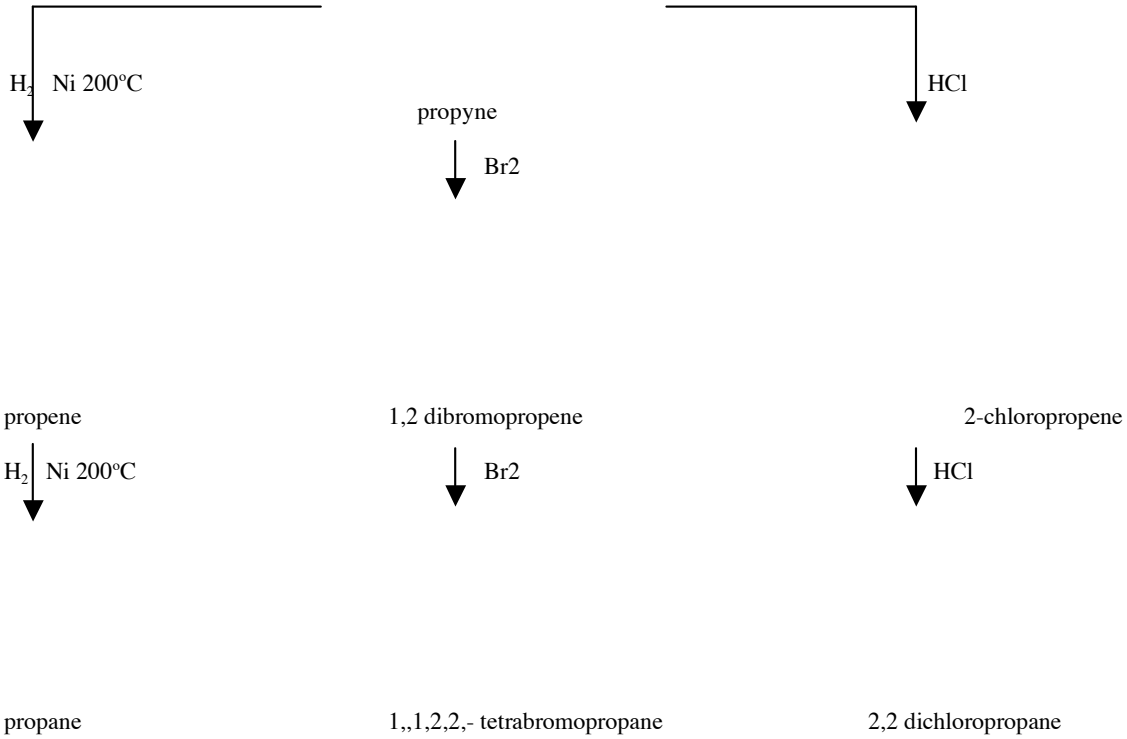
i. Main group pent-2 yne

ii Side group methyl

iii. Position 4

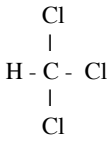
4-methyl pent-2-yne

Reactions of alkynes



Halogen Derivitives 5.4

One of the most commonly known halogenoalkanes is chloroform, used as an anaestetic.



Name	Molecular Formula	Structural formula	Use
1,1,1 trichloroethane	$C_2H_3Cl_3$		Solvent in correction fluid
1,1,2,2 tetrachloroethene	C_2Cl_4		Dry cleaning agent
Chloroethene	C_2H_3Cl		Making PVC

Chlorofluorocarbons[CFC's]

The smallest of the CFC's are gases is dichloro,difluoro[CCl_2F_2] methane also known as 'FREON'.

properties	
Colour	Colourless
Smell	Odourless
Solubility	Insoluble in water
Burning	Does not burn
Liquified	Easily
Reactivity	Unreactive

These properties make CFC's ideal for use in fridges, freezers and air conditioning units.
Also used in aerosol cans.

CFC's seemed perfect until it was discovered that they were destroying the ozone layer.

Being unreactive it will diffuse through the air to reach the upper atmosphere

Ozone Problem

Ozone is protecting us from the harmful effects of U.V. radiation.
Ozone is formed in the upper atmosphere by the formation of free radicals

Oxygen atoms with unpaired electrons

$$O_2 \xrightarrow{\text{U.V. radiation}} O + O$$

$$O_2 + O \longrightarrow O_3$$

Chlorofluorocarbons produce chlorine free radicals when exposed to u.v. radiation.

$$CCl_2F_2 \xrightarrow{\text{U.V. radiation}} CClF_2 + Cl$$

The chlorine free radicals react with ozone forming oxygen and oxygen chloride free radical, this radical reacts with ozone to give oxygen and chlorine free radical and a cycle of reactions occur depleting the ozone layer.

$$Cl + O_3 \longrightarrow O_2 + OCl$$

$$OCl + O_3 \longrightarrow 2\,O_2 + Cl$$

THE OZONE LAYER

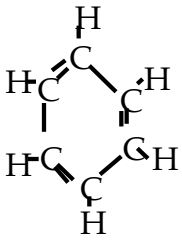
In the upper part of the atmosphere, the stratosphere, the gas ozone, O3, absorbs ultra-violet radiation. If it were not for this natural 'sunscreen gas' the number of skin cancers and eye cataracts would be much higher than it is. A reduction of 10% in the ozone content could lead to an increase in the number of skin cancers by 30% in some parts of the world.

REPLACEMENTS FOR CFCs.

Chemists have come up with a replacement for CFCs – hydrofluorocarbons (HFCs). The advantage of these molecules is that the H–C bonds in these molecules break down in the lower atmosphere (the troposphere)

Aromatic Hydrocarbons 5.5

Most aromatic structures are based on the benzene ring



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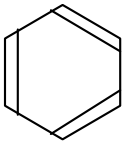

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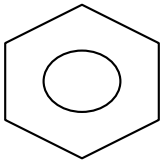

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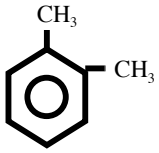
All three above represent benzene C6H6

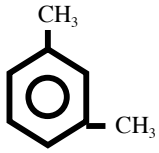
MonoSubstituted benzene

toluene

Disubstituted benzenes



1,2 dimethylbenzene

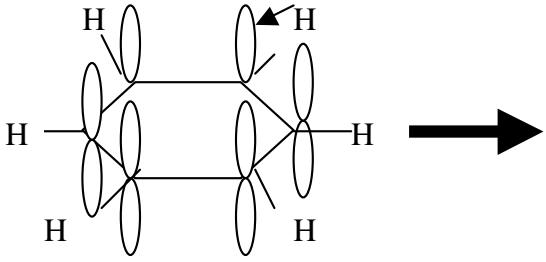


1,3 dimethylbenzene

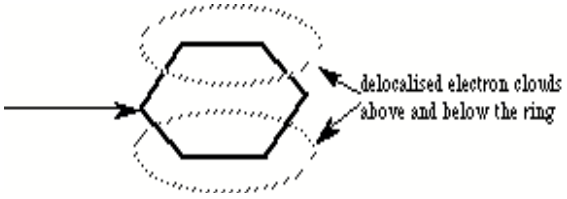
1,4 dimethylbenzene

As only three examples of disubstituted benzene rings are found then * is thought to be the best representation of the modern benzene ring. In addition modern spectroscopic analysis shows only one type of C-C bond in a benzene ring. Energy 519 kJ mol-1 which is between that of a single and a double bond

overlapping electron orbitals



planar ring of 6 carbon and



Represents a phenyl group.

Each C-C bond has been found to be intermediate between a single and a double bond. In the ring structure each of the carbon atoms uses three of its four outer shell electrons to form covalent bonds with a hydrogen and two carbon atoms.
The electron clouds above and below the ring contain the remaining 6 electrons (1 from each carbon atom). The electrons in the ring are not attached to any one carbon atom in particular but are shared by all 6 carbon atoms in the ring. The electrons in these clouds are said to be **delocalised.**

Aromatic Properties

Toluene is used to examine the properties of aromatic compounds as benzene can cause cancer (carcinogenic)

Property		saturated or unsaturated?
Colour	colourless liquid	either
Smell	petrol	either
Solubility	insoluble in water	either
Combustion	burns with a smokey flame	unsaturated
Bromine test	does not immediately decolourise bromine water	saturated

Ayhough a smokey flame suggests unsaturation . It would decolourise bromine water if double bonds were present.
Aromatic compounds do not easily take place in addition reactions, another piece of evidence against double bonds.

Feedstocks

A feedstock is a starting substance that is used to make other products.
The main source of aromatic feedstocks is the naphtha fraction from crude oil. These feedstocks are also used for blending in petrol to help raise the octane number of the petrol.

Petrol 5.6

In petrol engines a mixture of petrol vapour and air is compressed and then ignited with an electric spark. When the petrol air mixture is compressed rapidly it becomes very hot. It self ignites before the piston has reached the correct position. This is called pinking. Pinking is not wanted so petrol engines must be tuned correctly and also contain a fuel which does not self ignite easily. The fuel should burn rapidly and smoothly when ignited by the spark. Efficient burning should emit little smoke and as little unburnt fuel as possible.

Pollutants

Nitrogen oxides caused by the nitrogen and oxygen combining when sparked, the oxides form nitric acid when dissolved in water, this is a cause of acid rain.

Carbon monoxide and unburnt hydrocarbons are produced when a limited supply of aiir (oxygen) is present.

All petrols contain small amounts of sulphur which forms sulhur dioxide when combined with oxygen from the air.

Older cars still run on petrol with lead added to reduce “pinking” Leaded fuel is no longer

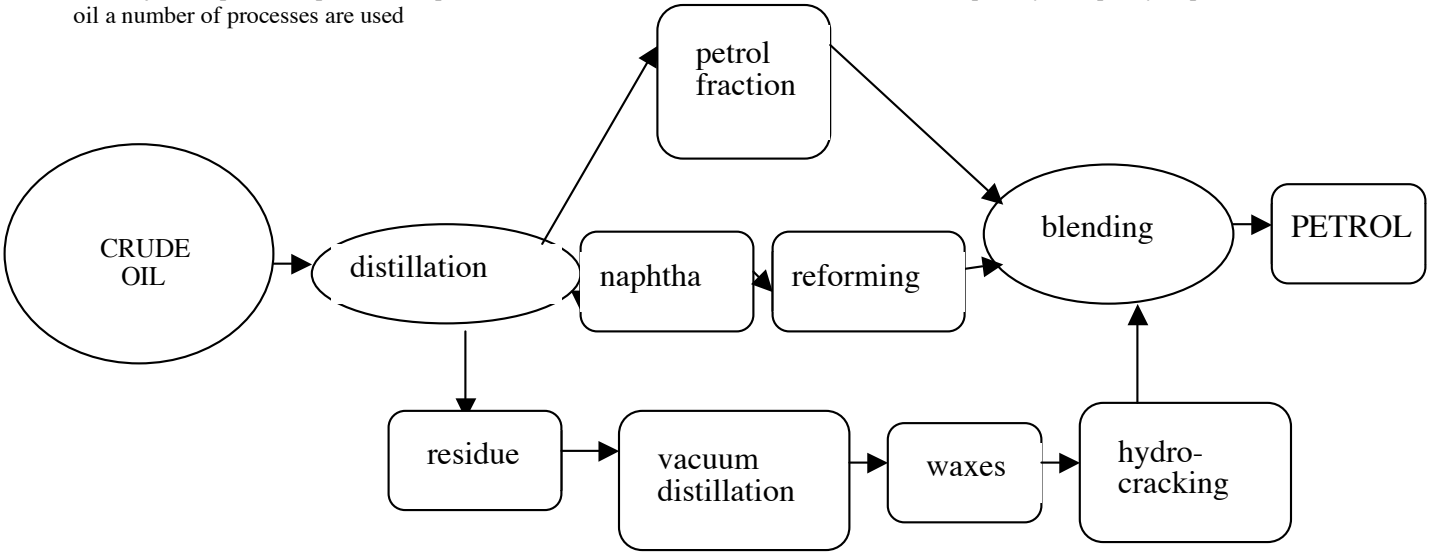
Carbon dioxide is produced by all cars burning petrol or diesel which although not a pollutant contributes towards ‘global warming.

Octane Number

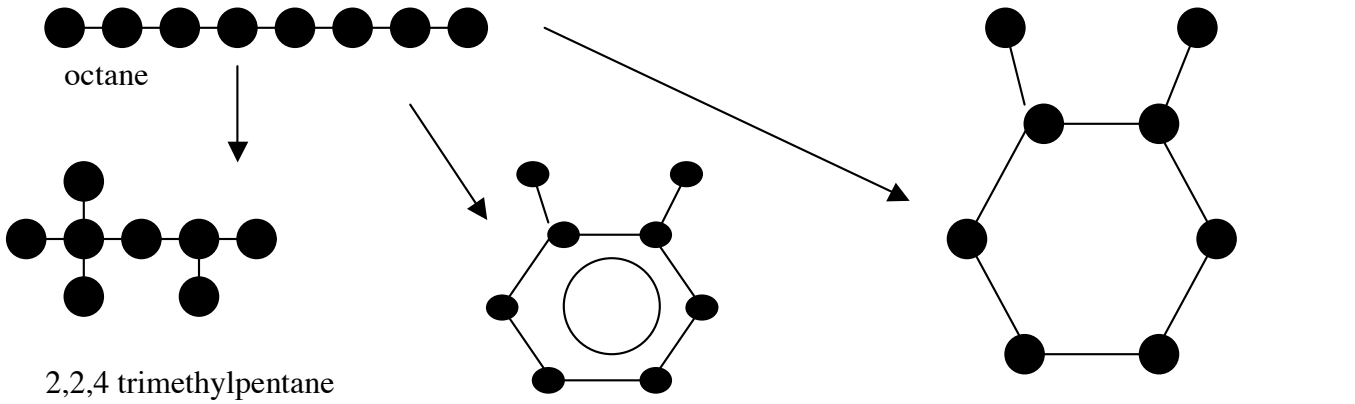
The suitability of a hydrocarbon for use as petrol is measured by its octane number.
Iso-octane burns very smoothly and is given the octane number 100. Heptane does not burn smoothly and is given the octane number 0.

Petrol Production

The major component in petrol is the petrol fraction from crude oil. However to increase the quantity and quality of petrol obtained from crude oil a number of processes are used

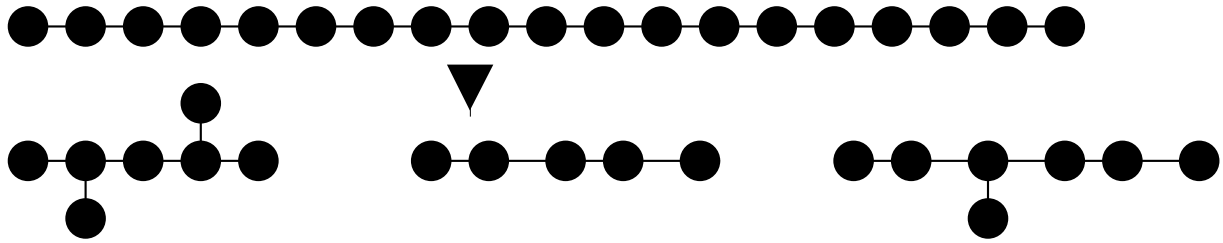


Reforming



The reforming process uses high temperatures, high pressures and a catalyst. The shapes of the molecules are changed but the number of carbon atoms remains the same. The products are branched alkanes, cycloalkanes and aromatics. All these have higher octane numbers than octane which has an octane number -19.

Hydrocracking



Hydrocracking takes place at high temperatures in the presence of hydrogen to produce small branched alkane and straight chain alkanes. Suitable ones are blended into petrol.

Small molecules are added to petrol in winter to make it more volatile. Both hydrocracking and reforming increase the octane numbers of products

Alternative Fuels 5.7

Alternative fuels are needed because

1. Fossil fuels are running out, only a about 200 years left.
2. When burned fossil fuels give out various forms of pollution.

Biofuels

One option is to turn to biofuels that can be quickly produced from growing materials. The fuels shown can be used in place of the internal combustion engine.

Biofuel	How is it produced	Advantages	Disadvantages
Ethanol	Fermentation of sugars	Renewable High octane rating of 111 Neutral in regard to CO2 Mixes well with petrol	Expensive compared to petrol
Methanol	Produuced from synthesis gas $CH_4 + H_2O \Rightarrow CO + 3\ H_2O$ $CO + 2\ H_2 \Rightarrow CH_3OH$	Good combustion, less CO2 than petrol No aromatics, no carcinogens Cheaper than petrol Less explosive than petrol	Difficult to mix with petrol Methanol absorbs water causes engines to rust Toxic Less energy than petrol, bigger engine needed. Increases greenhouse gases
Methane	Produced by decaying plants and animals	Burns with clean flame. Methane fron decaying plants and animals is neutral in global warming.	No refilling network available. Uses pipelines or pressurised containers.

Hydrogen Economy

Hydrogen, especially in the liquid form has been proposed as an alternative energy source to fossil fuels