WJEC England GCSE Chemistry

Topic 10: Carbon compounds

Notes

(Content in bold is for Higher Tier only)

Crude oil, hydrocarbons and alkanes

Crude oil:

- Is a main source of hydrocarbons
- Is a feedstock for the petrochemical industry
- Is a finite resource
- It is possible to separate the substances in the mixture by physical methods including fractional distillation:
    - The oil is heated in the fractionating column and the oil evaporates and condenses at a number of different temperatures.
    - The many hydrocarbons in crude oil can be separated into fractions each of which contains molecules with a similar number of carbon atoms
    - The fractionating column works continuously, heated crude oil is piped in at the bottom. The vaporised oil rises up the column and the various fractions are constantly tapped off at the different levels where they condense.
    - The fractions can be processed to produce fuels and feedstock for the petrochemical industry.
- Most of the compounds in crude oil consist of molecules made up of hydrogen and carbon (hydrocarbons). Most of these saturated hydrocarbons are alkanes, which have the general formula C_nH_{2n+2}

uses of different fractions:

- There are many uses of each fraction obtained from the fractional distillation of crude oil, such as...
    - Refinery gas for bottled gas for heating and cooking
    - Gasoline fraction for fuel (petrol) in cars
    - Naphtha fraction for making chemicals
    - Kerosene/paraffin fraction for jet fuel
    - Diesel oil/gas oil for fuel in diesel engines
    - Fuel oil fraction for fuel for ships and home heating systems
    - Lubricating fraction for lubricants, waxes and polishes
    - Bitumen for making roads

Properties of hydrocarbons

- Some properties of hydrocarbons depend on the size of their molecules. These properties influence their use as fuels.
- Shorter the molecules, the less viscous it is. (more runny) The longer the molecules, the more viscous it is.
- The shorter the molecules, the lower the temperature at which that fraction vaporises or condenses – and the lower its boiling point.

- The shorter the molecules – the more flammable it is.

Cracking and alkenes

- Hydrocarbons can be cracked to produce smaller, more useful molecules. This process involved heating the hydrocarbons to vaporise them.

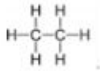
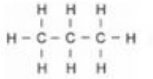
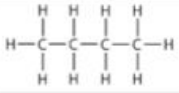
The vapours are:

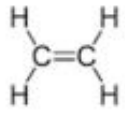
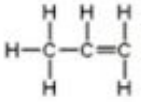
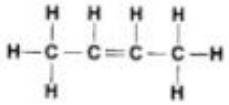
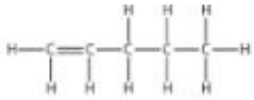
  - Either passed over a hot catalyst
  - Mixed with steam and heated to a very high temperature so that thermal decomposition reactions can occur.

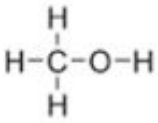
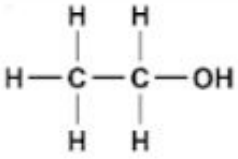
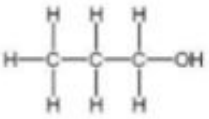
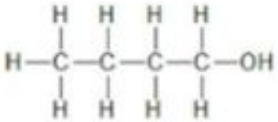
- The products of cracking include alkanes and unsaturated hydrocarbons called alkenes. Alkenes have the general formula C_nH_{2n}

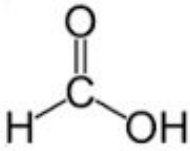
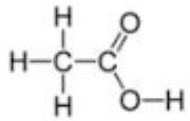
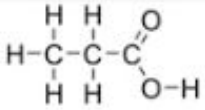
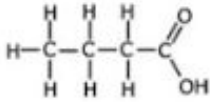
functional groups and homologous series

- Prefixes (beginning of the name)
  - remember the first 4 prefixes using MEPB Monkeys Eat Peanut Butter
  - Any compound with 1 carbon has the prefix of: Meth-
  - 2 carbons: Eth-
  - 3 carbons: Prop-
  - 4 carbons: But-
- The suffix of any compound refers to the functional group
  - Alkanes – ane (C-C // C-H) e.g. ethane
  - Alkenes – ene (C=C) e.g. ethene
  - Alcohols – ol (OH) e.g. ethanol
  - Carboxylic acids – anoic acid (-COOH) e.g. ethanoic acid

alkane	structural formula	displayed formula
methane	CH_4	
ethane	CH_3CH_3	
propane	$CH_3CH_2CH_3$	
butane	$CH_3CH_2CH_2CH_3$	

ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	
pentene	C_5H_{10}	

methanol	CH_3OH	
ethanol	C_2H_5OH	
propanol	C_3H_7OH	
butanol	C_4H_9OH	

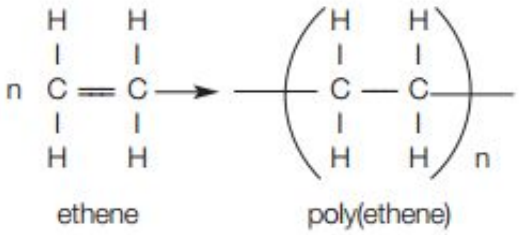
methanoic acid	CHOOH	
ethanoic acid	CH_3COOH	
propanoic acid	C_2H_5COOH	
butanoic acid	C_3H_7COOH	

reactions

- functional groups determine the reactions of organic compounds
- combustion of alkanes: alkane + oxygen → carbon dioxide + water
- addition reactions of alkenes: the molecule added splits and is added to one carbon from the C=C bond, leading to a C-C bond being formed instead
    - alkene + hydrogen → alkane
    - alkene + bromine → dibromoalkane
    - alkene + water → alcohol (H added to one carbon, OH to the other)
- oxidation reactions of alcohols: alcohol + oxidising agent (contains oxygen) → carboxylic acid

Addition polymerisation

- Alkenes can be used to make polymers such as poly(ethene) and poly(propene) by addition polymerisation. In this reaction, many small molecules (monomers) join together to create very large molecules (polymers). For example:



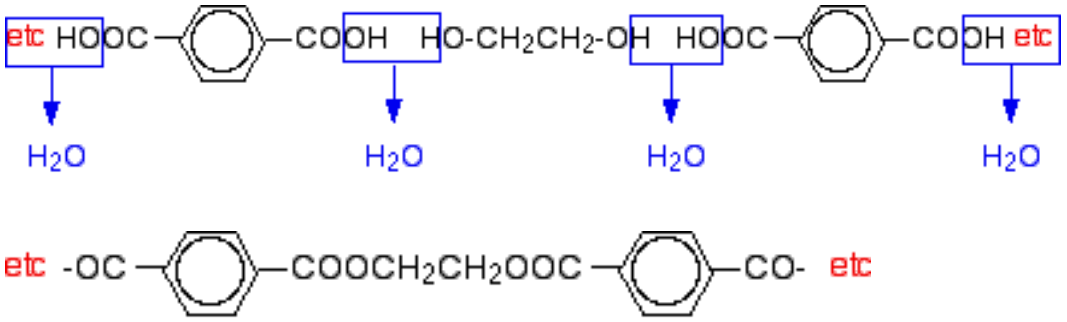
- The repeat unit has the same atoms as the monomer because no other molecule is formed in the reaction

Condensation polymerisation

Condensation polymerisation involves the reaction of two different functional groups to form one long molecule by the removal of a small molecule, such as water H_2O

- **Functional groups that react to form condensation polymers include alcohol + carboxylic acid -> polyester // amine + carboxylic acid -> polyamide OR amino acid -> protein**
- **A monomer must have at least 2 functional groups, if the 2 functional groups are different only one type of monomer needs to be used. If the 2 functional groups are the same, then 2 monomers must be used, with the other monomer having a different 2 functional groups (e.g. one monomer with 2x carboxylic acid groups and one with 2x alcohol)**
- **How to find a repeat unit: look for a chunk that involves each functional group only once**

This is an example of a polyester:



DNA (deoxyribonucleic acid) and other naturally occurring polymers

- Is a large molecule essential for life
- Encodes genetic instructions for the development and functioning of living organisms and viruses
- Most molecules are two polymer chains, made from four different monomers called nucleotides, in the form of a double helix
- Other naturally occurring polymers important for life…
    - Proteins (monomer= amino acid)
    - starch (monomer= glucose)
    - cellulose (monomer= glucose)