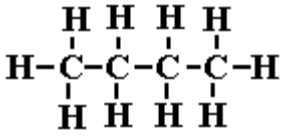
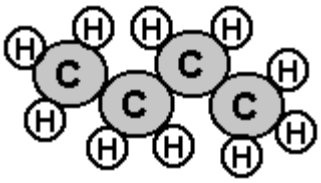
(1) C_4H_{10} (2) $CH_3-CH_2-CH_2-CH_3$ (3)  or 	**butane**

A brief guide to the structure and nomenclature of alkanes

C_nH_{2n+2} n =	1	2	3	4	5	6	7	8	9	10
formula of alkane	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	C_7H_{16}	C_8H_{18}	C_9H_{20}	$C_{10}H_{22}$
name of alkane	methane	ethane	propane	butane	pentane	hexane	heptane	octane	nonane	decane

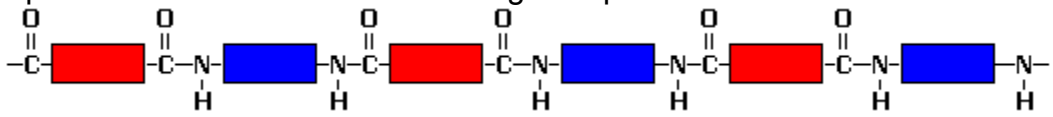
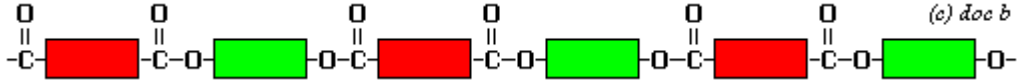
- The primary suffix name is based on the longest carbon chain and ending in **-ane**.
  - **1** carbon, **methane**; **2** carbons, **ethane**; **3** carbons in chain, **propane**; **4** carbons in chain, **butane**. After these four preserved 'old trivial' names, the name is 'numerically' systematic e.g. C_5 carbon chain **pentane**; C_6 chain **hexane**, C_7 chain **heptane**, C_8 chain **octane**, C_9 chain **nonane**, C_{10} chain **decane etc**.
- **The table above lists the molecular formula and names of the first ten linear alkanes (the term linear applies to butane onwards)**
- If all the carbon atoms of the molecule are in **one continuous chain**, it is referred to as unbranched or **linear**.
  - E.g. pentane $CH_3-CH_2-CH_2-CH_2-CH_3$ is **linear** or unbranched.
- If another chain of carbon atoms starts out of the main carbon chain, it is referred to as **branching**, giving rise to 'branched' alkane, one with a **side-chain**.

$$CH_3-CH_2-\underset{\displaystyle CH_2-CH_3}{\underset{|}{CH}}-CH_2-CH_3$$

  - E.g. 3-ethylpentane is **branched**, because it has an 'ethyl branch' from the 3rd carbon atom in the main chain.
  - The longest continuous chain of 5 carbon atoms forms the basis of the name.
  - The 3- denotes the position of the carbon chain branch i.e. the lowest number possible for the start of the side-chain.
- The **positions of the substituent alkyl groups** (side chains or 'branches') are **denoted by using the lowest possible number**(s)
  - e.g. 2, 3 etc. for the associated carbon atoms in the main chain, where the 1st carbon atom in the chain is considered as C atom 1.
- If there is more than one 'type' of substituent e.g. using the prefixes: methyl... and ethyl.... etc., they are written out in alphabetical order (BUT di, tri are ignored in using this rule).

Condensation polymerisation

Involves linking lots of small monomer molecules together by eliminating a small molecule. This is often water from two different monomers, a H from one monomer, and an OH from the other, the 'spare bonds' then link up to form the polymer chain.

- **Nylon (a polyamide)** is formed by **condensation polymerisation**, the structure of nylon represented below where the rectangles represent the rest of the carbon chains in each unit.
-  (3 units etc.)
- This is the same linkage (-CO-NH-) that is found in linked amino acids in naturally occurring macromolecules called proteins, where it is called the 'peptide' linkage.
  - Nylon-6,6 $-\left(NH-(CH_2)_6-NH-CO-(CH_2)_4-CO\right)_n-$
- **Terylene (a polyester)** is formed by **condensation polymerisation** and the structure of Terylene represented as
-  (3 units etc.)
- This is the same kind of 'ester linkage' (-COOC-) found in fats which are combination of long chain fatty carboxylic acids and glycerol (alcohol with 3 -OH groups, a 'triol').
- **Terylene (polyester) and nylon are good for making 'artificial' or 'man-made' fibres** used in the clothing and rope industries.
  - In the manufacturing process the polymer chains are made to line up.
  - This greatly increases the intermolecular forces between the 'aligned' polymer molecules and strong fibre strands of the plastic can be made.

Three problems associated with using and disposing of Polymers or Plastics

1. **Polymers or plastics cannot be easily broken down by micro-organisms** i.e. most, at the moment, **most are NOT biodegradable** (non-biodegradable) which leads to waste disposal problems and 'non-rotting' litter around the environment.
   - Land-fill sites are getting full and recycling isn't as easy as it may seem.
   - Incineration i.e. using waste plastic as fuel must be very efficient to avoid any other pollution problem.
2. **Can we burn waste plastic?**
   - When **plastic materials burn** they can **produce highly toxic gases** such as carbon monoxide, hydrogen cyanide and hydrogen chloride (particularly from PVC and other plastics containing chlorine and nitrogen).
   - The toxic fumes cause deaths in house fires and controversial problems with alleged inefficient waste incinerators as they will definitely cause environmental problems if burned on waste tips!
3. **How can we recycle plastics? What ways are used to recycle plastics?**
   - It is **difficult to recycle plastics** because of separation into the various types of polymer and their different physical properties. BUT this should not prevent us from trying and it would be beneficial to prolong the life of the finite crude oil reserves AND reduce pollution and space in land-fill sites.
   - There are problems in trying to sort out the different plastics into useful categories, they are not easy separate, and you can't just use any old mixture of polymers.

        - At the moment, a lot may have to be sorted by hand - lack of automation makes the sorting more costly.
    - However, people are coming up with ideas. A company in Scarborough, England, is collecting waste plastic. This is shredded and compressed into porous pads and used for good 'underground' drainage layers for footpaths, golf greens and sand bunkers etc. and has a good working life because the material isn't biodegradable!
    - Clear soft drink bottles are made from PET (polyethene/polyethylene terephthalate) which can be recycled as fibre-fill for pillows and carpets.
        - This saves 90% of the energy costs compared to the original manufacturing process.
        - Energy costs are a big economic recycling factor; it's not just about making naturally occurring resources like oil last longer.
        - However, it takes about 20,000 drinks bottles to make a tonne of recycled PET.
    - **New plastics** are being developed which are **more biodegradable** or can be **recycled**, so will the paper bag and cardboard package make a comeback? (in Ireland you have to bring your own bag or buy one, and not necessarily a plastic one!), this isn't a recycling process BUT it does reduce environmental pollution.
    - In 1988 Australia issued bank notes made from **recycled poly(propene)**. These plastic notes apparently have the advantage of being more difficult to forge and they last longer.
        - Waste **poly(propene)**/polypropylene can be ground up and recycled to make pipes, compost bins and flower pots
    - Other ideas include making more durable plastic bags that can be used many times for shopping.
    - Ideally some recycled thermoplastics and scrap material from a plastic product manufacturing process, can be heated and remoulded in the same process or another product.
    - It is possible in some cases to break the plastic material down with heat (a sort of 'cracking' into smaller organic hydrocarbon molecules that can act as chemical feedstock like oil, from which you can make other valuable products including plastics.
        - Less green, but useful purpose is to use scrap plastic as a fuel, but complete incineration is not always easy to be efficient.
    - All of these will slow down the rate at which valuable oil-petroleum deposits are depleted - the latter are finite, so we should make the best use of them.

air chemically coal compounds crust distillation evaporating flammable fossil fractional fuels gas greater higher hydrocarbons less mixture molecules organisms physical pressure sedimentary similar temperatures two unchanged viscous

(1) Crude oil is extracted from the Earth's _____. It was formed from the remains of marine _____ which lived millions of years ago. The _____ fuels _____, oil and natural _____ have formed by the action of heat and _____ over millions of years, in the absence of