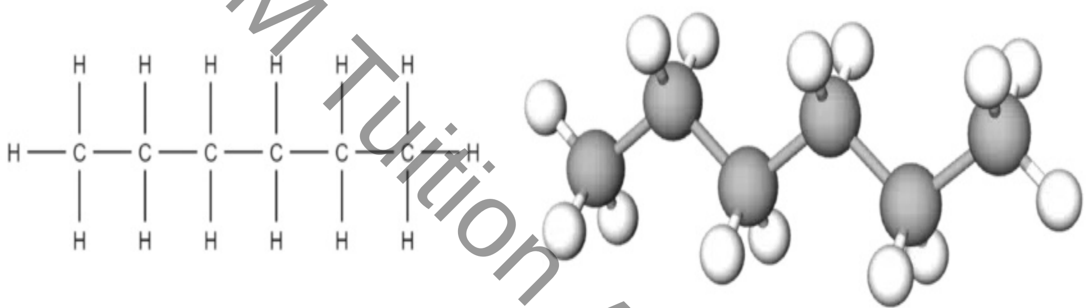
Hydrocarbons

- A hydrocarbon is a molecule that is made up of hydrogen and carbon only.
  - They consist of chains of carbon atoms bonded together, with hydrogen atoms bonded to each carbon atom.
  - The structures of hydrocarbons are governed by **bonding** of the **carbon atoms**. They are able to form up to **four bonds** with other atoms.

- Hydrocarbons come in a wide range of forms, of varying complexity.
- Hydrocarbon compounds can be divided up into different **homologous series**. A homologous series (also known as a family) is a group of molecules that have **similar properties** and all share a **general formula**.
- The most simple homologous series are the **alkanes**.



Left: A 2D Representation of a Hydrocarbon. Right: A 3D computer model of a hydrocarbon (carbon atoms are in grey, hydrogen in white)

Alkanes

- **The general formula for alkanes is C_nH_{2n+2}. Alkanes** are part of a homologous series, which means that they are part of a series of compounds with the same general formula and have similar reactions.
- **Using the general formula.** The general formula for alkanes is **C_nH_{2n+2}**. We can use the general formula to work out the number of carbon atoms given the number of hydrogen atoms and vice versa.

- **Alkanes have single carbon-carbon bonds (C-C).** Alkanes are the simplest type of hydrocarbon. All of the carbon-carbon bonds they contain are **single** covalent bonds, which means that they are **saturated** compounds (ie no double bonds are present).
- **Methane is an example of an alkane.** The first member of the alkane family is **methane**, which has one carbon and four hydrogen atoms. The next three members in order are ethane (2 carbons), propane (3 carbons) and butane (4 carbons).

- **Finding the number of carbon atoms.** You can deduce the number of carbon atoms in any organic compound using the stem of its name:

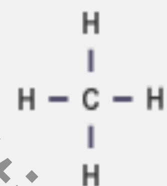
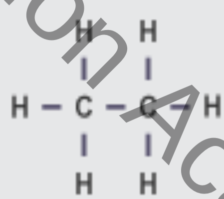
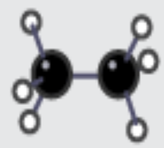
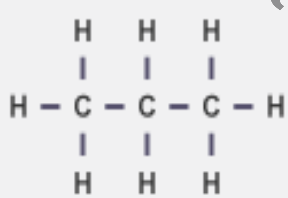
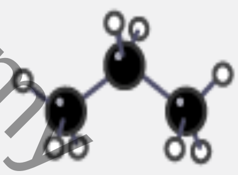
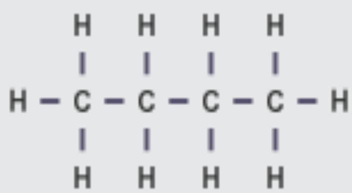
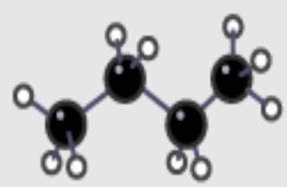
Methane = meth = 1 carbon atom

Ethane = eth = 2 carbon atoms

Propane= prop = 3 carbon atoms

Butane= but = 4 carbon atoms

Pentane = pent = 5 carbon atoms

Alkane	Molecular formula	Structural formula	Ball-and-stick model
Methane	CH_4		
Ethane	C_2H_6		
Propane	C_3H_8		
Butane	C_4H_{10}		

Hydrocarbon Properties

- **Composition of Hydrocarbons:** They are made up of hydrogen and carbon.
- **Hydrocarbon are determined by molecule size.** The properties of hydrocarbons can be influenced by the **length** of the carbon chain. The three major properties that are affected are the boiling point, viscosity and flammability.
- **A homologous series is a family of hydrocarbons**. In a **homologous series**, the members of the family will share the same chemical properties of hydrocarbon due to having the same functional group.

- **The boiling point increases with increasing molecular size.** As the length of the carbon chain increases, the **higher** the boiling point will be. Longer chain hydrocarbons are less volatile, so they do not evaporate as easily.
- **The viscosity increases with increasing molecular size.** As the length of the carbon chain increases, the **more viscous** the hydrocarbon will be. A shorter hydrocarbon chain will be more 'runny' than a longer hydrocarbon chain.
- **The flammability decreases with increasing molecular size.** As the length of the carbon chain increases, the **less flammable** the hydrocarbon will be. Longer chain hydrocarbons are more difficult to ignite as compared to shorter chain hydrocarbons.
- **Explaining the reasons for the trends in properties.** Larger hydrocarbon molecules have more weak intermolecular forces compared to shorter hydrocarbon chains. Therefore larger chains will:

1. Require more energy to separate the molecules so have higher boiling points.
2. Have stronger forces which attract them together, so they are more viscous.
3. Have higher boiling points so they are harder to evaporate and react with oxygen.

Uses of Hydrocarbons

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Number of C atoms	State	Major Uses
1-4	gas	heating and cooking fuel
5-7	liquids, (low boiling)	solvents, gasoline
6-18	liquids	gasoline
12-24	liquids	jet fuel; camp stove fuel
18-50	liquids, (high boiling)	diesel fuel, lubricants, heating oil
50+	solids	petroleum jelly, paraffin wax

Combustion of Fossil Fuels

- When fossil fuels undergo **combustion** (burning) they release energy. This is useful for things like heating our homes, powering our cars, and generating electricity.

- The combustion of fossil fuels also creates pollution and contributes to global warming.

Complete Combustion

- Most fuels contain carbon and hydrogen, and during combustion, they react with oxygen.
    - The hydrogen atoms are oxidised to form water (H2O)
    - The carbon atoms are fully oxidised to carbon dioxide (CO2)
- This type of combustion, where all the fuel burns and fully reacts with oxygen, is called **complete combustion**. During the complete combustion of hydrocarbon fuels, only carbon dioxide and water are produced. Therefore, if carbon dioxide forms, we can tell that complete combustion has taken place.

- Complete combustion produces a lot of energy and is the ideal way to burn fossil fuels

- For example, let's look at the combustion of methane, a hydrocarbon found in natural gas:

Methane + Oxygen —-> Carbon dioxide + Water

CH4 + 2O2 —-> CO2 + 2H2O

- The carbon and hydrogen atoms in methane combine with oxygen to form carbon dioxide and water. However, there needs to be enough oxygen present for complete combustion to take place.