Hydrocarbons – GCSE Chemistry

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1. Introduction

- In organic chemistry, the study of hydrocarbons is important for understanding all carbon compounds.
- They show how carbon and hydrogen combine to form the simplest organic structures, which later give rise to complex substances such as alcohols, acids, fuels, medicines, and plastics.
- In this blog, we'll study the two main classes of hydrocarbons — alkanes and alkenes — along with their important reactions and properties.

Uses of Hydrocarbons

- **Fuels** — in the form of petrol, diesel, and LPG for transport and cooking.
- Used in manufacturing medicines and cosmetic products.
- Provide energy through combustion in industries and power plants.
- Act as lubricants in engines and machinery.

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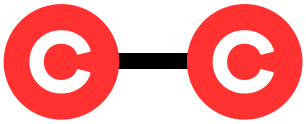
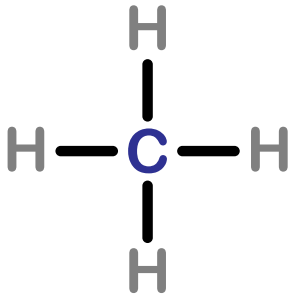
2. What are Hydrocarbons?

- Hydrocarbons are organic substances composed only of **carbon (C)** and **hydrogen (H)** atoms.
- Based on the type of bonding between carbon atoms, hydrocarbons are classified into two major categories:

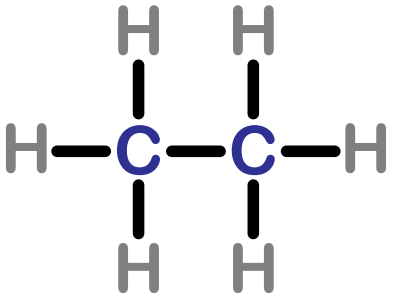
- **Alkanes –**
  - Alkanes are saturated hydrocarbons where each carbon forms four single covalent bonds.



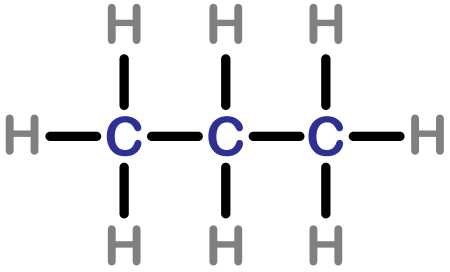
  - They are quite stable and unreactive, mainly reacting through combustion.
  - **Example:**



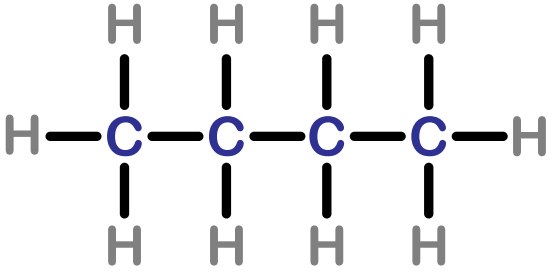
Methane



Ethane



Propane



Butane

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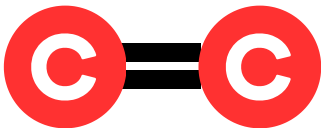
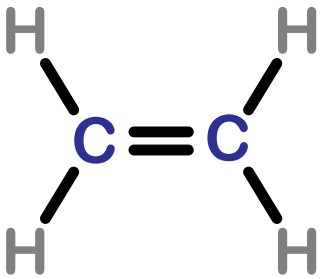
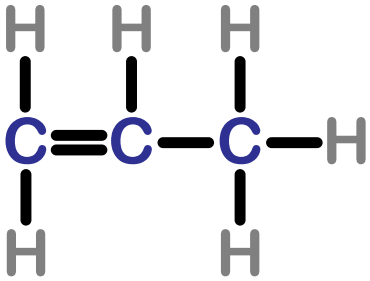
- **Alkanes –**
  - Alkenes are unsaturated hydrocarbons with one or more double bonds.



  - This double bond is their functional group and the reason for their higher reactivity.
  - **Example:**



Ethene



Propene

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3. Why are Alkanes saturated Hydrocarbons?

- Alkanes are called **saturated hydrocarbons** because each carbon atom forms only single bonds (**C–C**) and is bonded to the maximum number of hydrogen atoms possible.
- Since their carbon atoms are fully "saturated" with hydrogen, no more atoms can join unless a bond is broken.
- This is why alkanes are not very reactive and do not react with bromine water or undergo addition reactions.

4. Why are Alkenes unsaturated Hydrocarbons?

- Alkenes are called **unsaturated hydrocarbons** because they contain at least one double bond (**C=C**) between carbon atoms.
- The double bond means that more atoms can join the molecule without breaking existing single bonds.
- This makes alkenes more reactive than alkanes.
- They react with bromine water, which turns from orange to colorless, and can undergo addition reactions.

5. How do Alkenes react with Bromine?

- The reaction in which an alkene reacts with bromine is called an addition reaction.
- The double bond in the carbon molecule breaks, and each carbon atom bonds to one bromine atom, forming a saturated compound.
- This happens because alkenes are more reactive due to their double bond, which easily opens to add new atoms.

Example:

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$$\underset{\text{(Ethene)}}{C_2H_4} + \underset{\text{(Bromine)}}{Br_2} \rightarrow \underset{\text{(1,2-Dibromoethane)}}{C_2H_4Br_2}$$

6. How does Bromine Water Test distinguish Alkanes and Alkenes?

- Bromine water test is a simple way to distinguish between alkanes and alkenes.
- Bromine water is orange-brown in color.

Working / Procedure:

- Take two test tubes — one with an alkane and one with an alkene.
- Add a few drops of bromine water to each test tube.
- Gently shake or stir both tubes.

Result:

For Alkanes:

- Do not react with bromine water because they are saturated hydrocarbons.
- The orange color stays the same.

For Alkenes:

- Undergo an addition reaction with bromine water because they are unsaturated hydrocarbons.
- The orange color turns colorless.

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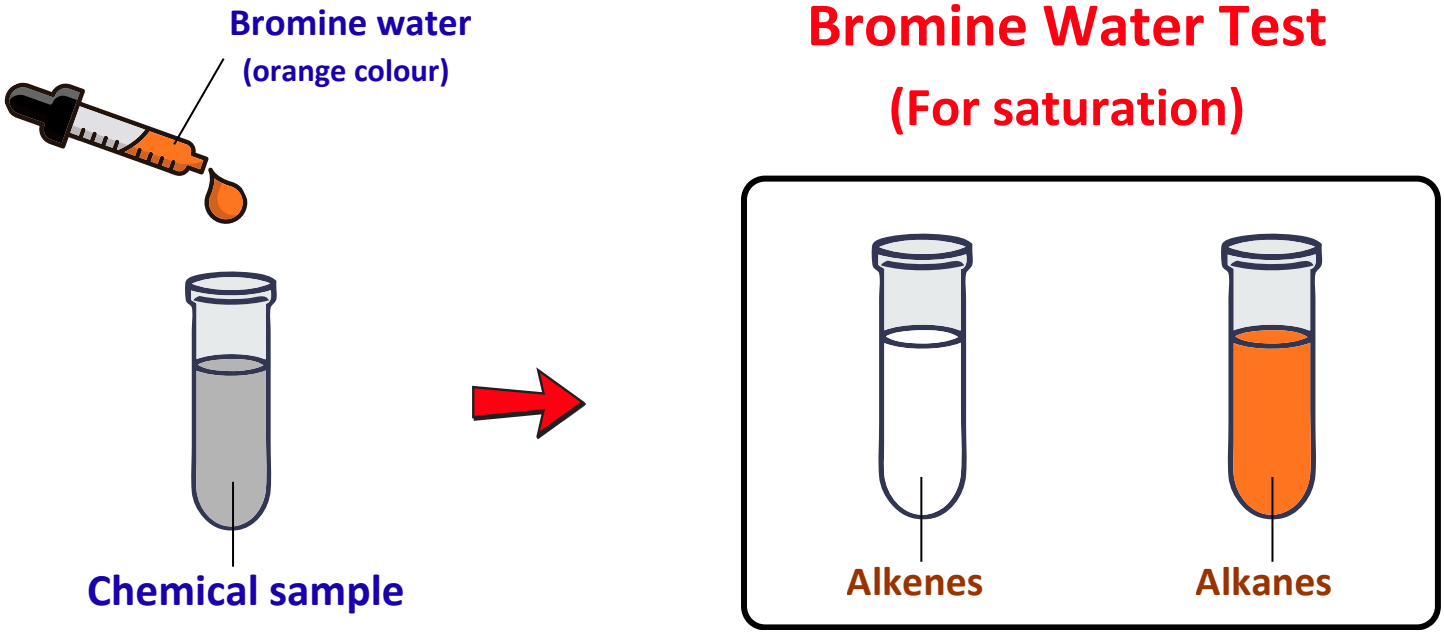
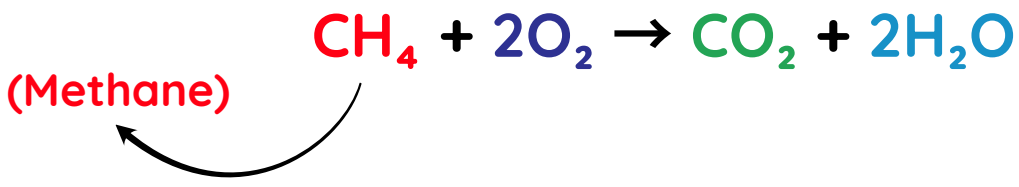


7. How do Hydrocarbons undergo combustion?

- Both alkanes and alkenes burn in oxygen in a reaction called combustion.
- This reaction releases energy as heat and light, which is why hydrocarbons are widely used as fuels.

1. Complete Combustion:

- Hydrocarbons burn completely when there is enough oxygen.
- In this process, the carbon and hydrogen atoms are oxidised, forming carbon dioxide (CO_2) and water (H_2O).
- Example:



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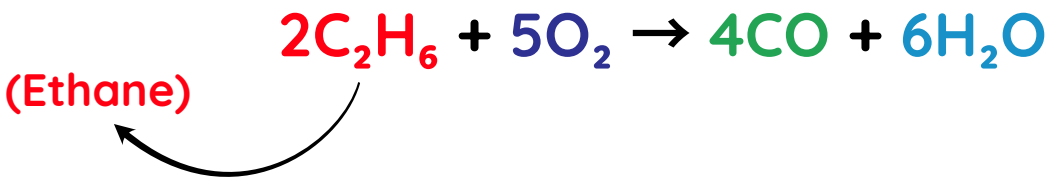
2. Incomplete Combustion:

- Hydrocarbons burn incompletely when there is not enough oxygen.
- In this process, carbon monoxide (CO) is formed instead of carbon dioxide (CO_2).
- Example:



8. FAQs

1. What are Hydrocarbons?

- Hydrocarbons are compounds made only of carbon and hydrogen atoms.
- They are the basic fuels like methane and petrol.
- **Example:** CH_4 is the simplest hydrocarbon.

2. Why are Alkanes saturated Hydrocarbons?

- Alkanes contain only single bonds between carbon atoms.
- This means no more atoms can be added, so they are called saturated.
- **Example:** Ethane (C_2H_6).

3. Why are Alkenes unsaturated Hydrocarbons?

- Alkenes contain a C=C double bond, which can open and add more atoms. Because they are not fully bonded with hydrogen, they are unsaturated.
- **Example:** Ethene (C_2H_4).

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4. How do Alkenes react with Bromine?

The double bond in alkenes breaks open during the reaction. Bromine atoms add across the double bond, forming a colourless product.

5. How does Bromine Water Test distinguish Alkanes and Alkenes?

- Alkenes decolourise brown bromine water because they react with it.
- Alkanes do not react, so the brown colour stays the same.

6. How do Hydrocarbons undergo combustion?

Hydrocarbons burn in oxygen to form carbon dioxide and water. This reaction releases heat energy, which is why fuels are useful.

7. Why do Alkanes burn with a clean flame?

Alkanes burn completely when oxygen is enough. This produces a blue, clean flame with no smoke.

8. Why do Alkenes burn with a smoky flame?

Alkenes burn less completely because of their double bond. This forms carbon particles, which give a yellow, smoky flame.

9. What is the general formula of Alkanes?

Alkanes follow the formula $\mathbf{C_nH_{2n+2}}$. This fits all single-bonded hydrocarbons like methane and ethane.

10. What is the general formula of Alkenes?

Alkenes follow the formula $\mathbf{C_nH_{2n}}$. This matches hydrocarbons with one double bond such as ethene and propene.