28. Carbon and its Compounds

- Diamond has a three-dimensional network of covalently bonded carbon atom. It is hard and colourless. It has high melting and boiling point and is a good conductor of heat but poor conductor of electricity.
- Graphite is soft, black, and slippery in nature and has a layered structure. It is a good conductor of electricity.
- Fullerenes contain carbon atoms arranged in closed structures similar to football.
- Charcoal, coke and carbon black are microcrystalline forms of carbon.
- The compounds of carbon can be classified as organic and inorganic.
- Carbon monoxide and carbon dioxide are two important inorganic compounds of carbon.
- Organic compounds of carbon are hydrocarbons and their derivatives.
- Hydrocarbons are classified as saturated and unsaturated. The saturated hydrocarbons contain carbon-carbon single bonds whereas the unsaturated hydrocarbons contain carbon-carbon multiple bonds.
- Isomers have same molecular formula but different structure.
- Some simple functional groups include halo-, hydroxyl-, carbonyl, carboxylic acid etc.
- Compounds containing the above functional groups exhibit characteristic properties and have important uses in our daily life.

Build Your Understanding

Tetravalency of carbon

Carbon atom (electron 2, 4)

Carbon atom can form four single covalent bonds e.g. CH₄ (Methane)

Tetra Covalency of Carbon

Carbon can form long chains of carbon atoms. This unique property of forming long chains is known as catenation

Allotrops of carbon

Carbon show three allotropic forms
- Diamond
- Graphite
- Fullerenes

Diamond
- High density 3.51 gcm⁻³
- M.P. 3500°C
- Do not conduct electricity but good conductor of heat

Uses
- For cutting and grinding hard material (glass)
- For making Jewellery
- Rock drilling
Graphite

- Density 2.2 g/cm³
- M.P. 3700°C (in vacuum)
- Good conductor of electricity

\[ \text{Graphite} \xrightarrow{\text{High atm Pressure, High Temperature}} \text{Diamond} \]

Uses

- used as lubricant in machines
- making electrodes in dry cells and electric arcs
- making pencil lead

Fullerenes

Fullerenes have closed structure like football so it is also known as Buckminster fullerenes $C_{60}$

Vapourized carbon $\xrightarrow{\text{Condensed}}$ Fullerenes

Hydrocarbons

Contain carbon and hydrogen only

| Saturated alkanes (paraffins) | Alkenes (Olefins) | Alkynes
|-----------------------------|------------------|------------------------------|
| \( C_nH_{2n+2} \)          | \( C_nH_{2n} \)   | \( C_nH_{2n-2} \)

Aliphatic hydrocarbons: Derived from the Greek word aleiphar meaning fat. They are derived from fat.

Acyclic: straight chain

Cyclic: form rings of carbon atoms

\[
\begin{align*}
CH_2 & \quad CH_2 \\
CH_2 & \quad CH_2
\end{align*}
\]

Aliphatic can be divided into: saturated and unsaturated hydrocarbons: Saturated hydrocarbon single bond in unsaturated multiple bonds (double and triple bonds)

IUPAC Nomenclature

For IUPAC naming, we must have idea about word root of carbon skeleton

<table>
<thead>
<tr>
<th>No. of Carbon atom</th>
<th>Word root</th>
<th>No. of Carbon atom</th>
<th>Word root</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>meth</td>
<td>5</td>
<td>pent</td>
</tr>
<tr>
<td>2</td>
<td>eth</td>
<td>6</td>
<td>hex</td>
</tr>
<tr>
<td>3</td>
<td>prop</td>
<td>7</td>
<td>hept</td>
</tr>
<tr>
<td>4</td>
<td>but</td>
<td>8</td>
<td>oct</td>
</tr>
</tbody>
</table>

Rules

1. Alkane (\( CH_4 \))
   Word root + ane $\rightarrow$ meth + ane $\rightarrow$ Methane

2. Alkene (\( C_2H_4 \))
   Word root + ene $\rightarrow$ eth + ene $\rightarrow$ ethene

3. Alkyne (\( C_2H_2 \))
   Word root + yne $\rightarrow$ eth + yne $\rightarrow$ ethyne

CH\(_3\)OH $\rightarrow$ Methane $\rightarrow$ replace ‘e’ by ol $\rightarrow$ Methanol

C\(_2\)H\(_5\)OH $\rightarrow$ Ethane $\rightarrow$ replace ‘e’ by ol $\rightarrow$ Ethanol

Alcohols: Synthesis of acetic acid, additive petrol, spirit

Aldehyde and ketones: As solvent, polish removes

Carboxylic acid: Ascorbic acid vitamin C citrus fruits.

4. Ketone
   For example O
   \[
   \begin{array}{c}
   \text{CH}_3 \\
   \text{CH}_3
   \end{array}
   \]
   Propane $\rightarrow$ replace ‘e’ by one $\rightarrow$ propanone

5. Carboxylic Acid.
   For example \( CH_3\text{COOH} \)
   Ethane $\rightarrow$ replace ‘e’ by oic acid $\rightarrow$ ethanoic acid

Functional groups

Functional groups is an atom or a group of atoms which is responsible for characteristic properties of a compound.
<table>
<thead>
<tr>
<th>Functional group</th>
<th>Class</th>
<th>General formula</th>
<th>Example</th>
<th>IUPAC Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>− C = C −</td>
<td>alkene</td>
<td>C_{n}H_{2n}</td>
<td>H_{2}C ≡ CH_{2}</td>
<td>Ethene</td>
</tr>
<tr>
<td>− C ≡ C −</td>
<td>alkyne</td>
<td>C_{n}H_{2n−2}</td>
<td>H_{2}C ≡ CH</td>
<td>Ethyne</td>
</tr>
<tr>
<td>− OH</td>
<td>alcohols</td>
<td>R − OH</td>
<td>CH_{3}OH</td>
<td>Methanol</td>
</tr>
<tr>
<td>− C − H</td>
<td>aldehydes</td>
<td>O − (R − C − H)</td>
<td>CH_{3}CHO</td>
<td>Ethanal</td>
</tr>
<tr>
<td>− C −</td>
<td>ketones</td>
<td>O − (R − C − R)</td>
<td>CH_{3}C − C − CH_{3}</td>
<td>Propanone</td>
</tr>
<tr>
<td>− C − OH</td>
<td>carboxylic acids</td>
<td>O − (R − C − OH)</td>
<td>CH_{3}COOH</td>
<td>Ethanoic Acid</td>
</tr>
<tr>
<td>− C − O −</td>
<td>esters</td>
<td>O − (R − C − OR)</td>
<td>CH_{3}COOC_{2}H_{5}</td>
<td>Ethyl ethanoate</td>
</tr>
</tbody>
</table>

**Stretch Yourself**

1. Methyl alcohol to harmful but ethylalcohol is not why?
2. Name the property of diamond which makes it brilliant when cut and polished.
3. Suppose in nature tetravalent of carbon is lost. What will happen then?

**Test Yourself**

1. Why diamond is used for cutting glass?
2. Explain the tetracovalency of carbon.
3. Carbon has a tendency to form long chain compounds. Why?
4. Write down possible isomers of C_{4}H_{10}.
5. Write down the IUPAC names of the following
   (i) CH_{3} − CH = CH_{2}
   (ii) CH_{3} − CH − CH_{3}
   (iii) CH_{3} − C − CH_{3}
   (iv) HCHO
   (v) CH_{3} − C ≡ C− H