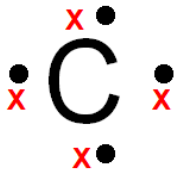
Organic Chemistry

Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds. Most organic compounds contain carbon and hydrogen, but they may also include any number of other elements (e.g., nitrogen, oxygen, halogens, phosphorus, silicon, sulfur).

- Organic compounds are the primary constituents of all living organisms.
- Carbon is able to form 4 covalent bonds (4 valence electrons) with other carbon or other elements.



Hydrocarbons are organic compounds that consist of only Carbon and Hydrogen atoms.

Characteristics of Organic Compounds

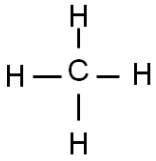
1- Presence of carbon.
2- They are nonpolar compounds – they do not dissolve in polar solvents like water.

*remember the rule – "likes dissolve likes"

3- They have low melting and boiling points.
4- They react slower than ionic compounds – due to strong covalent bonds between atoms.

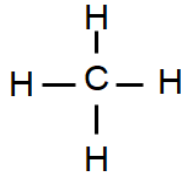
Structural Formulas

- Carbon is found in the center.
- The short line – represents a pair of electrons.

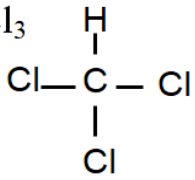


Draw the structures for each organic:

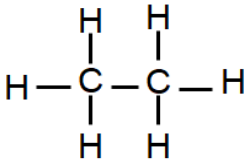
1. Methane: CH_4



2. Chloroform: $CHCl_3$



3. Ethane: C_2H_6



Remember: Carbon has **4** bonding sites.

Chemical Bonding

Lewis Theory of Chemical Bonding

- An atom can be viewed as a positively charged 'Kernel'. The kernel consists of the **nucleus** (which contains protons and neutrons) and the **inner electrons**. These inner electrons are tightly bound to the nucleus and play a crucial role in defining the atom's chemical properties.
- The outer shell can accommodate a maximum of **eight** electrons only.
- **Octet Rule**: Lewis proposed that atoms tend to gain, lose, or share electrons to achieve a stable electron configuration with eight electrons in their outermost shell (except for hydrogen and helium, which aim for a duet, or two electrons in their outermost shell). This is known as the octet rule.
- Only the electrons present in the outer shell, also known as the **valence electrons**, take part in the formation of chemical bonds. Gilbert Lewis used specific notations, better known as Lewis symbols, to represent these valence electrons.

Types of Chemical Bonds

Chemical bonds are the forces that hold atoms together in compounds. There are several types of chemical bonds, and they can be broadly categorized:

1. **Ionic Bonds:**
    - Formed between a metal and a non-metal.
    - Involves the transfer of electrons from the metal atom to the non-metal atom.
    - Results in the formation of ions with opposite charges (cation and anion).
    - Examples include the bond between sodium (Na^+) and chlorine (Cl^-) in sodium chloride (NaCl).

2. Covalent Bonds:

- Formed between non-metal atoms.
- Involves the sharing of electrons between atoms to achieve a stable electron configuration.
- Can be single, double, or triple bonds, depending on the number of electron pairs shared.
- Examples include the single bond in hydrogen gas (H_2), the double bond in oxygen gas (O_2), and the triple bond in nitrogen gas (N_2).

Single	Double	Triple
Forms when two atoms share one pair of valence electrons (total of two electrons).	Forms when two atoms share two pairs of valence electrons (total of four electrons).	Forms when two atoms share three pairs of valence electrons (total of six electrons).
Bond Type: A single bond is a sigma (σ) bond,.	Bond Type: Consists of one sigma (σ) bond and one pi (π) bond.	Bond Type: Consists of one sigma (σ) bond and two pi (π) bonds.
Represented by a single dash for example; Hydrogen molecule (H_2): H-H Fluorine molecule (F_2): F-F Hydrochloric acid(HCl): H-Cl	Represented by a double dash or an equal sign for example; Oxygen molecule (O_2): O=O Carbon dioxide (CO_2): O=C=O	Represented by a triple dash (e.g., N ≡ N) for Example: Nitrogen molecule (N_2): N ≡ N

3. Metallic Bonds:

- Found in metals.
- Involves of several of delocalized electrons moving freely among positively charged metal ions.
- Provides metals with their characteristic properties like conductivity and malleability.
- Examples include the metallic bonds in copper (Cu) or iron (Fe).

4. Polar Bonds:

- Occur when there is an uneven sharing of electrons between two atoms.
- The atom with a higher electronegativity attracts the shared electrons more strongly, leading to partial charges.
- Water (H_2O) is an example, where the oxygen atom is more electronegative than the hydrogen atoms.

5. Hydrogen Bonds:

- A type of weak bond that occurs between a hydrogen atom bonded to a highly electronegative atom (e.g., oxygen, nitrogen, or fluorine) and another electronegative atom in a different molecule.
- Important in biological systems and contribute to the properties of substances.

Types Of Compounds

1. **Saturated Compounds:**
   - Saturated compounds are characterized by carbon-carbon single bonds (C-C) and carbon-hydrogen single bonds (C-H) in their molecular structures.
   - All carbon atoms in the hydrocarbon chain are bonded to the maximum number of hydrogen atoms possible.
   - Saturated hydrocarbons are also known as alkanes.
   - Examples include methane (CH_4), ethane (C_2H_6), and propane (C_3H_8).

2. **Unsaturated Compounds:**
   - Unsaturated compounds contain one or more carbon-carbon multiple bonds, such as double bonds (C=C) or triple bonds (C≡C).
   - Due to the presence of multiple bonds, these compounds have fewer hydrogen atoms compared to saturated compounds.
   - Unsaturated hydrocarbons include alkenes (containing double bonds) and alkynes (containing triple bonds).
   - Examples of unsaturated compounds include ethene (C_2H_4), propene (C_3H_6), and acetylene (C_2H_2).

In summary, the key difference lies in the type of carbon-carbon bonds present in the hydrocarbon chain. Saturated compounds have only single bonds, while unsaturated compounds have at least one multiple bond (double or triple bond) between carbon atoms.