

Organic Chem

Chapter 12 Alkanes

Organic chemistry is the study of carbon compounds. Carbon has several properties that are worth discussing:

- Tetravalent
- Always forms 4 bonds
- Can form multiple bonds (double like in ETHYLENE and triple like in ACETYLENE)
- Most commonly bonds with C, N, H, O
- Orbital is sp^3

One of the simplest carbon molecules is METHANE (CH_4)

Another simple one is ETHANE (C_2H_6)

The nature of organic molecules

- Organic molecules often contain H, N, and O in addition to C
- Organic molecules have specific 3-dimensional shapes
- Organic molecules contain polar covalent bonds when C bonds to an electronegative element on the right side of the periodic table.
- Organic molecules can also have partial charges (ex: chloromethane). + cations like to associate with the partial-negatives, and – anions like to associate with the partial-positives
- When C is bound to four atoms, the bonds are oriented toward the four corners of a regular tetrahedron, with C in the center.

Electronegativity Scale



12.2 Families of Organic Molecules and Functional Groups

The first four listed in the family list (Alkane, Alkene, Alkyne and Aromatic) are the hydrocarbons. These are organic compounds that contain only carbon and hydrogen.

- **ALKANE:** Have only single bonds and contain no functional groups. The absence of functional groups makes them nonreactive
- **ALKENES:** carbon-carbon double-bond functional group
- **ALKYNES:** carbon-carbon triple-bond functional group
- **AROMATIC:** 6-membered ring of C atoms with 3 alternating double bonds

The next four families have functional groups that contain only single bonds and have a carbon atom bonded to an electronegative atom

- **ALKYL HALIDES:** carbon-halogen bond
- **ALCOHOLS:** carbon-oxygen bond
- **ETHERS:** 2 carbons bonded to the same oxygen
- **AMINES:** carbon-nitrogen bond

The remaining families have functional groups that contain a carbon-oxygen double bond.

- **ALDEHYDES:**
- **KETONES**
- **CARBOXYLIC ACIDS:**
- **ANHYDRIDES**
- **ESTERS**
- **AMIDES**

12.3 Alkanes and their Isomers

Alkanes are hydrocarbons that contain only single bonds. The general rule for ALL hydrocarbons is that each carbon must be bonded to at least one other carbon. These carbon atoms bond together to form the backbone of the molecule and the hydrogens are on the periphery. The general formula for alkanes is C_nH_{2n+2} (n = number of carbons in the compound).

There are two ways in which some molecules can be formed. For example, C_4H_{10} can be formed as a straight-chain (all carbons are connected in a continuous line), or as a branched-chain (with the carbons branching off).

Compounds with the same formula but different structures are called ISOMERS (more specifically they are constitutional isomers). Note that a CONFORMER is the same molecule but just in a different shape...though at any given time most of the molecules are of the basic shape.)

As the number of carbon atoms goes up, so does the number of isomers. Note that different constitutional isomers, though they may have the same "formula", have completely different chemical compounds with different structures, physical properties and potentially different physiological properties.

Ex:

12.4 Drawing Chemical Structures

12.6 Naming Compounds/Alkanes

Prefix + Parent + Suffix

(where substituents are located) + (how many carbons) + (family name)

Note that compounds with 6 carbons or less have “trivial names” as well as “real names”. Also, an ALKYL GROUP is the part of an alkane that remains when one H is removed. These are the SUBSTITUENTS that are added on to chains.

Methyl:

Ethyl:

n-propyl:

Isopropyl:

n-Butyl:

sec-Butyl:

Isobutyl:

tert-Butyl:

Some Common Alkyl Groups

Methyl

Ethyl

n-propyl

Isopropyl

n-Butyl

sec-Butyl

Isobutyl

Steps in Naming Alkanes

Step 1: Name the main chain (the longest one you can make)

Step 2: Number the C atoms in the main chain

Step 3: Identify the branching substituents and number each

Step 4: Write the name as a single word.

- Use hyphens between numbers and words.
- Alphabetize substituents
- If 2 or more identical subs are present, use a prefix (di, tri, tetra)
- Aim for the lowest count (in regards to assigning # to subs)

12.7 Properties of Alkanes

- Odorless or mild odor
- Colorless
- Tasteless
- Nontoxic
- Nonpolar
- Insoluble in water
- Soluble in nonpolar organic solvents
- Less dense than water
- Flammable, otherwise not very reactive
- First four are gases at room temp and pressure
- Alkanes with 5-16 carbons are liquid
- Alkanes with 16+ carbons are low-melting, waxy solids
- Boiling and melting points for straight-chain alkanes goes up with size of compound