

Organic Chemistry 1450

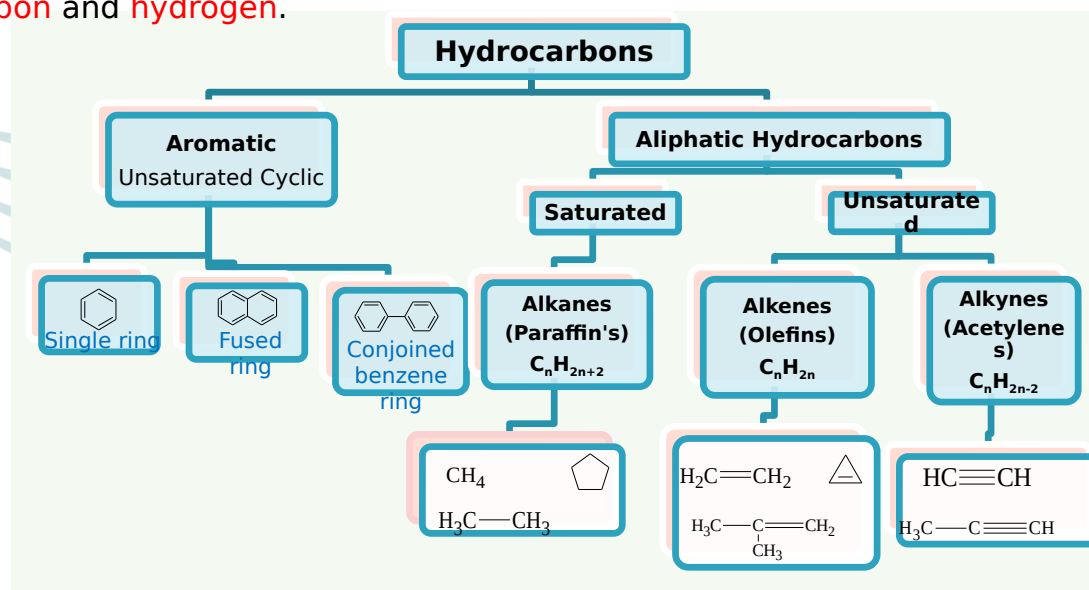
Chapter 3: Hydrocarbons- Alkanes

After this lecture, the student will be able to:

- ▶ **Illustrate the different forms of hydrocarbons and the saturation state of bonds**
- ▶ **Identify two possible arrangements of carbon atoms in an alkane**
- ▶ **Identify the IUPAK system in naming organic compounds**
- ▶ **Explain the IUPAK rules in naming hydrocarbons**

Hydrocarbons

- Hydrocarbons are Organic Compounds, which contain only the two elements carbon and hydrogen.



Properties of Hydrocarbons

- The electron pair in a carbon-hydrogen or a carbon-carbon bond is **shared almost equally** by the nuclei of the atoms forming the bond.
- Thus, **hydrocarbons** are **nonpolar** molecules.
 - ▢ The attractions between nonpolar molecules are weak **van der Waals forces**.
 - ▢ So, hydrocarbons with **low molar masses** tend to be **gases or liquids that boil at a low temperature**.

Recall the general rule “like dissolves like.”

- A nonpolar compound and a polar compound **will not form a solution.**
- For example, because **oil** is a mixture of hydrocarbons, **oil and water do not mix.**



- Because a **carbon atom forms four covalent bonds**, it can bond **not only to one or two other carbon atoms**, but also to three or even **four other carbons**, resulting in **branched chains**.
- In organic chemistry, branches on a hydrocarbon chain are discussed as if they were substituted for a hydrogen atom on the chain.
 - ▢ An atom or group of atoms that can take the place of a hydrogen atom on a parent hydrocarbon molecule is called a **substituent**.
 - ▢ **So, carbon atoms in a hydrocarbon can be arranged in a **straight** chain or in a chain that has **branches****

Hydrocarbons (Alkanes) name

- [illegible]

Names and Formulas of Alkyl Groups

Alkyl groups are named by removing the *-ane* ending from the parent hydrocarbon name and adding *-yl*; General formula C_nH_{2n+1}

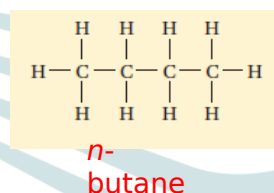
Alkane - H = Alkyl group; Alkane - ane + yl = Alkyl

<u>Formula</u>	<u>Name</u>	<u>Formula</u>	<u>Name</u>
CH_3-	methyl	$CH_3CH_2CH_2CH_2-$	butyl
CH_3CH_2-	ethyl	$(CH_3)_2CHCH_2-$	isobutyl
$CH_3CH_2CH_2-$	propyl	$CH_3CH_2CH(CH_3)-$	<i>sec</i> -butyl
$(CH_3)_2CH-$	isopropyl	$(CH_3)_3C-$	<i>tert</i> -butyl

Alkyl Group

nomenclature

- For **four-carbon alkyl group**, there are **four different butyl groups**.
 - The **butyl** and **sec-butyl** groups are based on **n-butane**.
 - The **isobutyl** and **tert-butyl** groups come from **isobutane**.



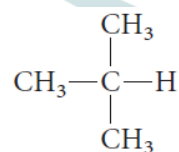
butyl

and

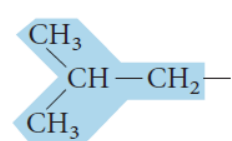


sec-butyl

(or 1-methylpropyl)



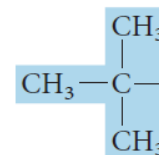
isobutane



isobutyl

(or 2-methylpropyl)

and

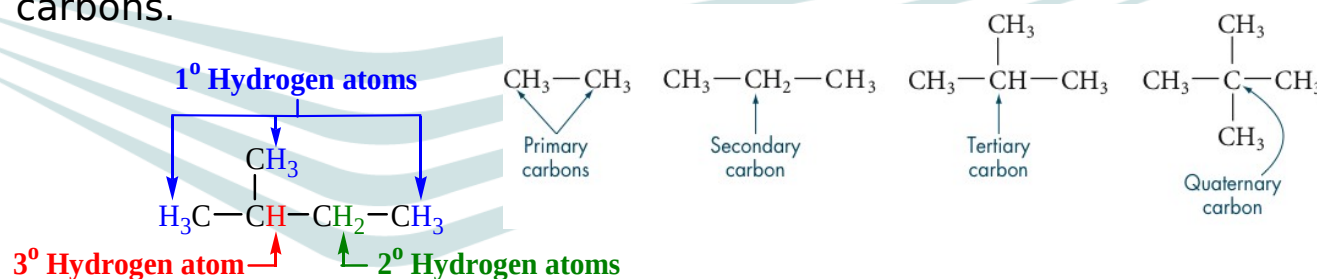


tert-butyl

(or 1,1-dimethylethyl)

Classes of Carbons and Hydrogen

- A **primary (1°) carbon** is one that is bonded to only one other carbon.
- A **secondary (2°) carbon** is one that is bonded to two other carbons.
- A **tertiary (3°) carbon** is one that is bonded to three other carbons.



- **Hydrogens** are also referred to as **1°, 2°, or 3°** according to the type of carbon they are bonded to.

IUPAC Rules for Naming Alkanes



- ▶ Select the longest continuous chain of carbon atoms as the parent compound.
- ▶ Number the carbon atoms in the parent carbon chain starting from the end closest to the first carbon atom that has an alkyl or other group.
- ▶ Name the alkyl group and designate the position on the parent carbon chain by a number.
- ▶ When the same alkyl group branch chain occurs more than once, indicate this repetition by a prefix (*di-*, *tri-*, *tetra-*, and so forth).
- ▶ When several different alkyl groups are attached to the parent compound, list them in alphabetical order.

Nomenclature of Alkanes

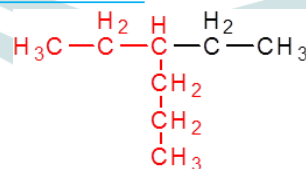
- o The older unsystematic names, (**Common names**).
- o The **IUPAC names**.

IUPAC: International Union of Pure & Appplied Chemistry

The IUPAC

Rules

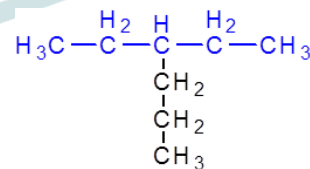
- 1) Select the parent structure; **the longest continuous chain**



Ethylhexan

The **longest continuous chain** is **not** necessarily **straight**.

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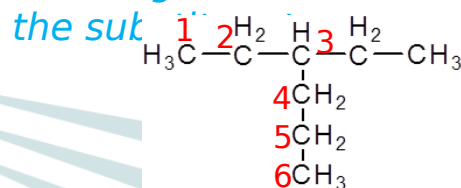


Propylpentan

X

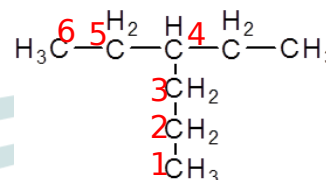
Nomenclature of Alkanes

- 2) **Number** the carbons in the parent chain
starting from the end which gives the lowest number for
the substituent.



3-Ethylhexane

not



4-Ethylhexane

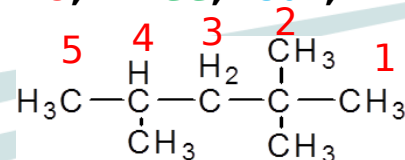
To name the compound;

- 1) The position of the substituent on the parent carbon chain by a number.
- 2) The number is followed by a hyphen
- 3) The combined name of the substituent (ethyl).
- 4) The parent carbon chain (hexane).

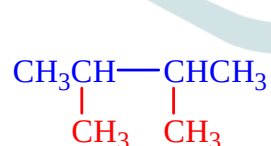
3-Ethyl hexane

Nomenclature of Alkanes

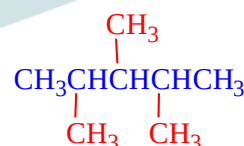
- 3) If the **same alkyl substituent** occurs more than once on the parent carbon chain, the prefixes **di-**, **tri-**, **tetra-**, **penta-**, and so on are used to indicate **two**, **three**, **four**, **five**, and so on.



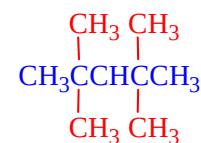
2,2,4Trimethylpentane



2,3-Dimethylbutane



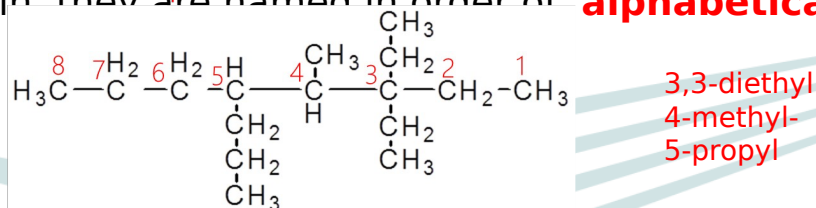
2,3,4-Trimethylpentane



2,2,4,4-Tetramethylpentane

Nomenclature of Alkanes

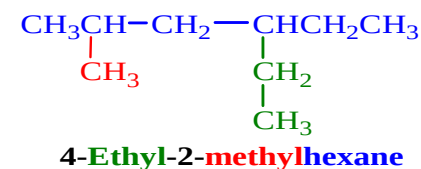
4) If **different alkyl substituents** are attached on the parent carbon chain, they are named in order of **alphabetical order**.



3,3-diethyl-4-methyl-5-propyloctane

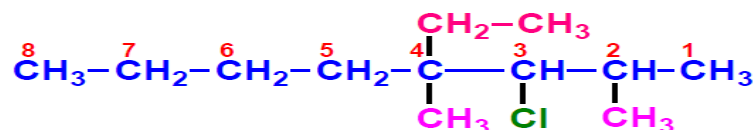
Note that

- Each substituent is given a number corresponding to its location on the longest chain.
- The substituent groups are listed alphabetically.



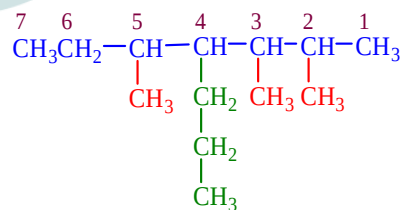
Nomenclature of Alkanes

5) When **two substituent** are present on the same carbon, **use the number twice**



3-chloro-4-ethyl-2,4-dimethyloctane

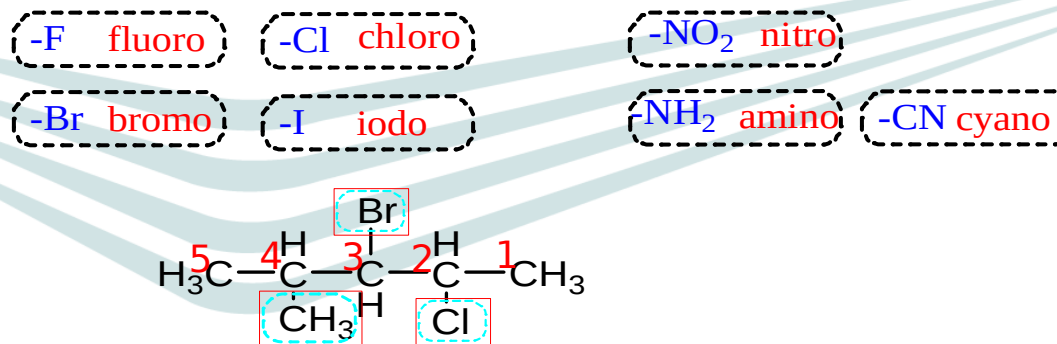
6) When two chains of equal length compete for selection as the parent chain, **choose the chain with the greater number of substituents**



2,3,5-Trimethyl-4-n-propylheptane

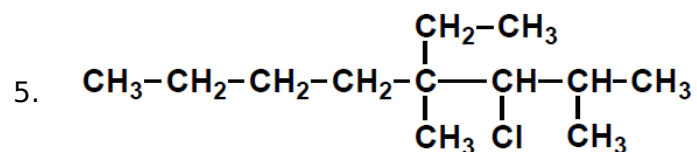
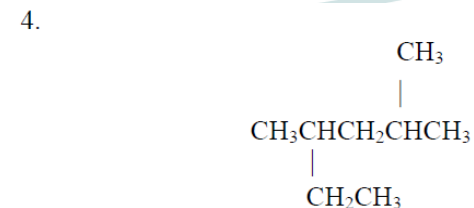
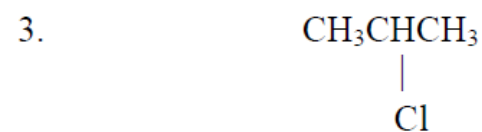
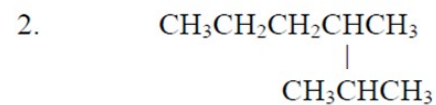
Nomenclature of Alkanes

7) If substituents other than alky groups are also presents on the parent carbon chain; **all substituents are named alphabetically**



3-bromo-2-chloro-4-methylpentane

H.W Name each compound shown below using the IUPAC system:



6. Draw the structural formula for 2,2,4-trimethylpentane, or isooctane?