Organic Chemistry

•Originally, organic substances were considered to be those carbon compounds that were extracted from living things, while inorganic ones were compounds that did not originate in living systems.

•An **organic compound** is defined as **a substance that contains the element carbon.**

•However, some compounds that contain carbon are considered to be inorganic. A better definition may be that **organic compounds have a carbon base, that carbon is the "backbone" of the compounds.**

Organic Chemistry

- **Organic chemistry:** the study of the structure, properties, composition, reactions, and preparation of carbon-based compounds.

- These compounds may contain any number of other elements, including H_2, N_2, O_2, the halogens, etc…
- Organic compounds are structurally diverse, and the range of application of organic compounds is enormous.

- They form the basis of, or are important constituents of many products (plastics, drugs, petrochemicals, food, explosives, paints, etc…) and, with very few exceptions, they form the basis of all earthly life processes.

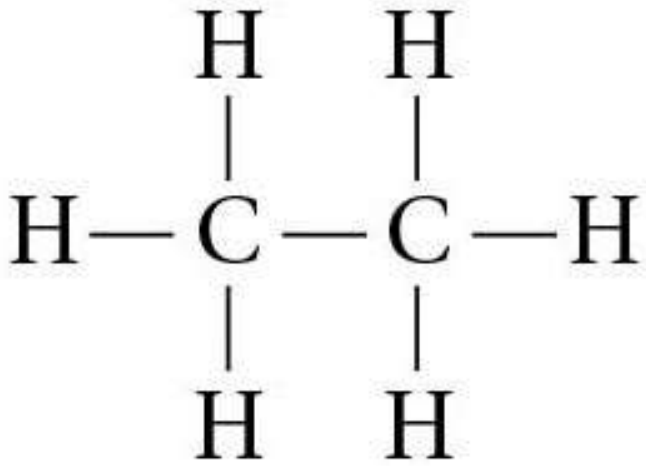
Carbon Bonding

- Many carbon-containing compounds exist because carbon forms strong bonds to itself and to many other elements.
  - Carbon can form a maximum of 4 bonds
  - Carbon can form one or more multiple bonds.
    - Sharing of more than one pair of electrons
- Carbon can form long chains of atoms better than any other atom
- Hydrocarbons

Hydrocarbons

Alkanes

- Hydrocarbons whose bonds are all single bonds are *saturated* because the have the max of 4 bonds. If they contain double or triple bonds they are *unsaturated*.
- Saturated hydrocarbons are called Alkanes. Long chains of carbon atoms held together by single bonds.



(a)

Alkanes

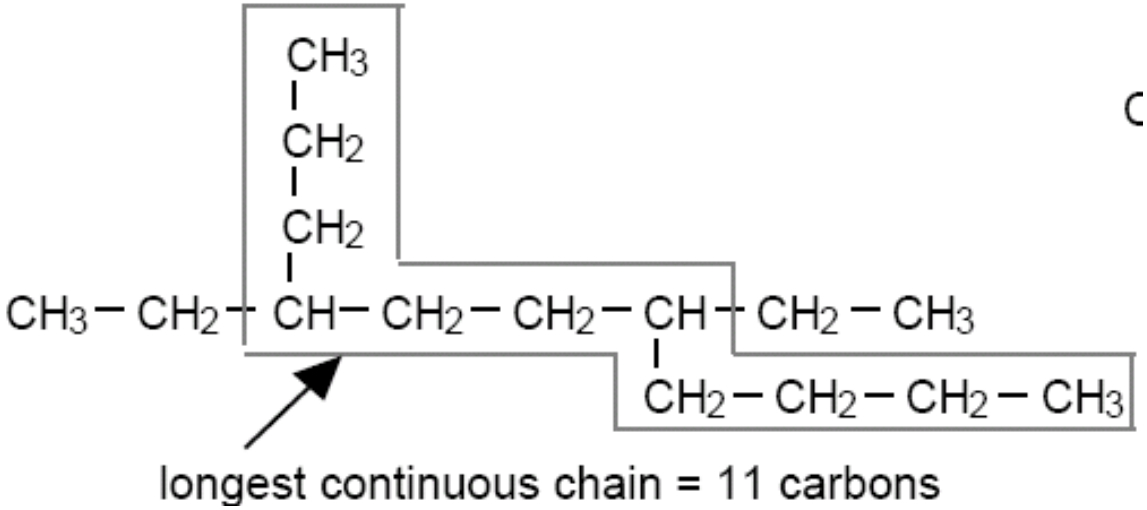
- Alkanes that form long strings or chains are called *normal*, *straight-chain* or *unbranched.*
- Carbon can join together to form short or long chains, they branch and they can form rings of many kinds, as well.
- How do you name these structures? There are rules…

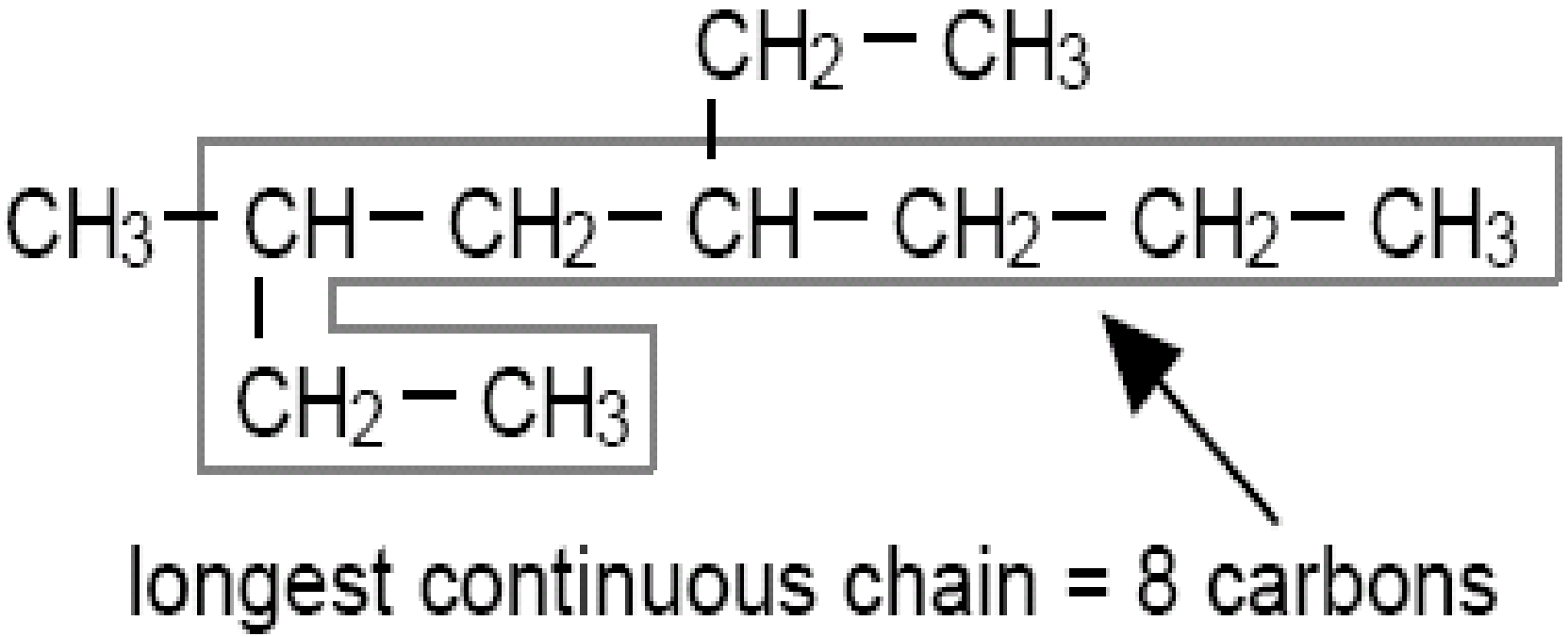
IUPAC rules for naming more complicated Alkanes

A system for naming organic compounds has been developed by the *International Union of Pure and Applied Chemists (IUPAC)*. The system is accepted and used throughout the world.

Rule 1

- Find the longest carbon chain, this will be the parent chain.

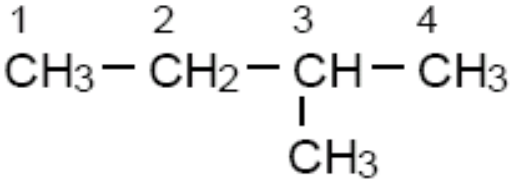



CH2 – CH3
CH3 – CH – CH2 – CH – CH2 – CH2 – CH3
CH2 – CH3
longest continuous chain = 8 carbons

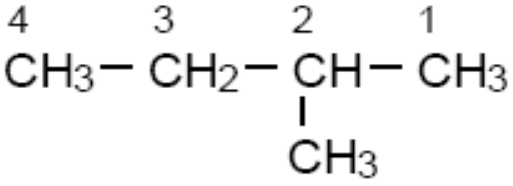
Rule 2

- The name of the parent compound is modified by noting what alkyl groups are attached to the chain. Number the longest chain so that the alkyl group(s) will be on the lowest numbered carbons.

- Note in the molecules shown below, that the longest chain should be numbered from right to left in order to give the carbon which is bonded to the methyl group the lowest possible numb...



Incorrect Numbering



Correct Numbering

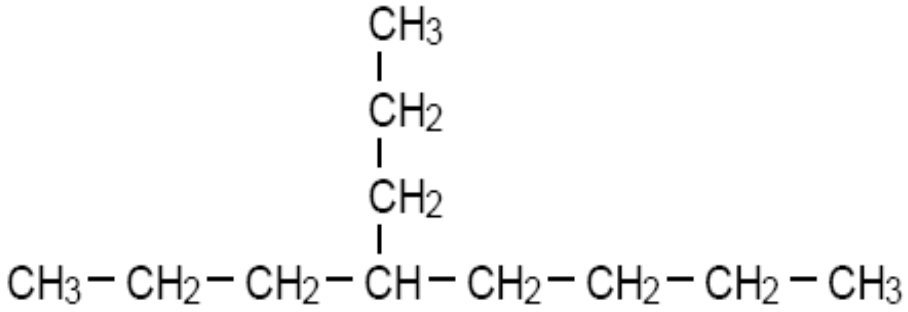
The correct name of this compound is **2-methylbutane**. The "2-" indicates that the methyl group is attached to the second carbon in the longest chain. Note that the name of the alkyl group is added to that of the parent compound (butane) to form one word, and that hyphens are used to separate numbers from alphabetical parts of the name.

Depending on where the hydrogen atom is removed, the bonding site on some alkyl groups can change position. This would change the way in which the alkyl group bonds to the parent compound. For example, notice the two alkyl groups shown below. Both are composed of three-carbon chains, but the bonding site differs:

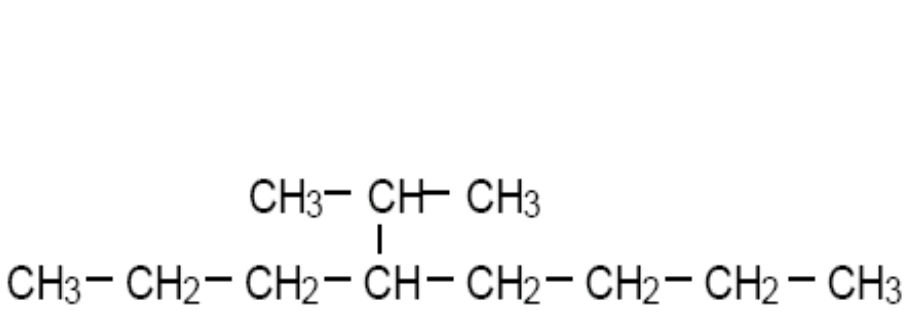
end carbon bonded

middle carbon bonded

The compound on the left below has a propyl group attached to the parent compound which is octane. The compound on the right has an isopropyl group attached to the parent compound (octane). Note that all carbons in the molecules have four bonds.



Propyl group attached to an 8-carbon chain

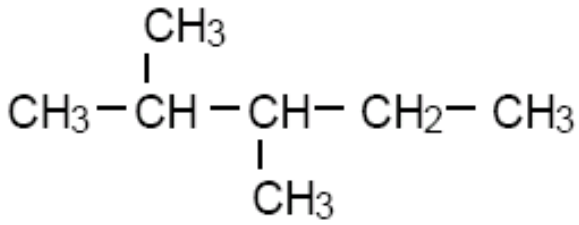


Isopropyl group attached to an 8-carbon chain

Rule 3

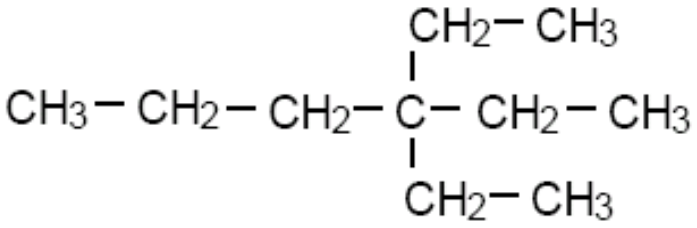
- When the same alkyl group occurs more than once in a molecule, the numbers of the carbons to which they are attached are all included in the name. The number of the carbon is repeated as many times as the group appears. The number of repeating alkyl groups is indicated in the name by the use of Greek prefixes for 2, 3, 4, 5, etc. (di, tri, tetra, penta, etc.).

To better understand step 3, study the following examples.



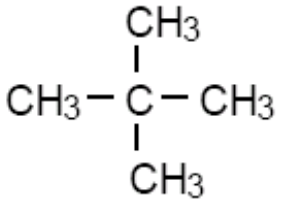
is called 2,3-dimethylpentane

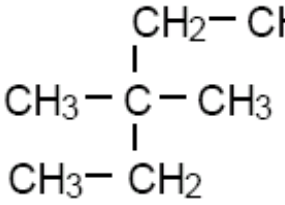
Note that numbers used in the name are separated from each other by commas, and note that the numbers are separated from the rest of the name with a hyphen.

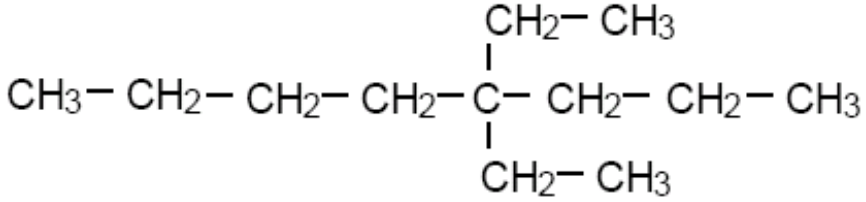


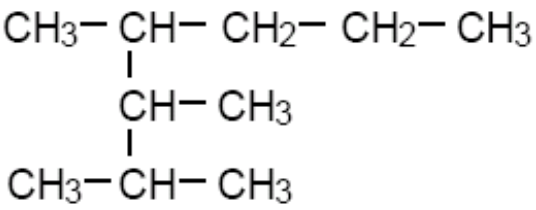
is called 3,3-diethylhexane

Problem 6. Name the four molecules whose structures are drawn below.

a. 

b. 

c. 

d. 

a. 2,2-dimethylpropane

b. 3,3-dimethylpentane

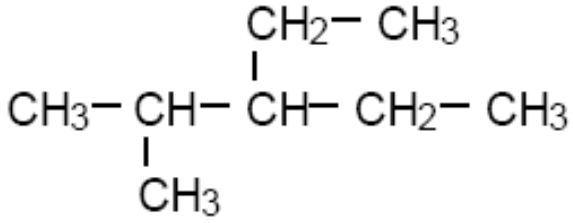
c. 4,4-diethyloctane

d. 2,3,4-trimethylheptane

Rule 4

If there are two or more different kinds of alkyl groups attached to the parent chain, name them in **alphabetical order.**

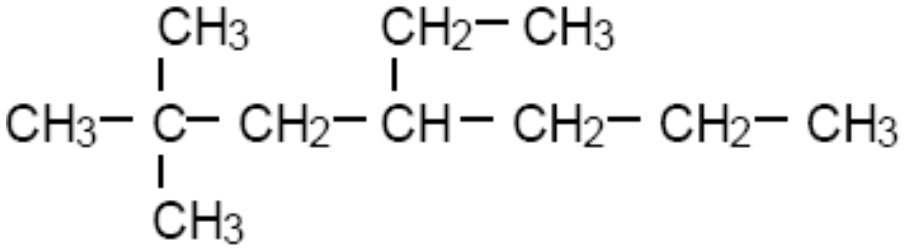
For example:



is called 3-ethyl-2-methylpentane

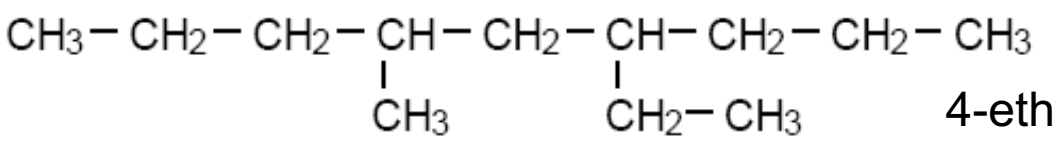
It is NOT called 2-methyl-3-ethylpentane

However, when you are determining the alphabetical order, **do not** consider any Greek prefixes that are being used. For example:

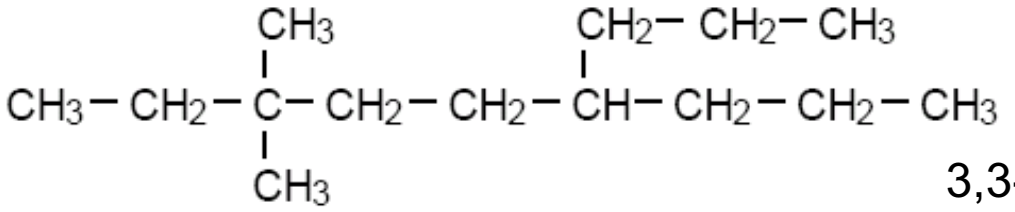


is called 4-ethyl-2,2-dimethylheptane

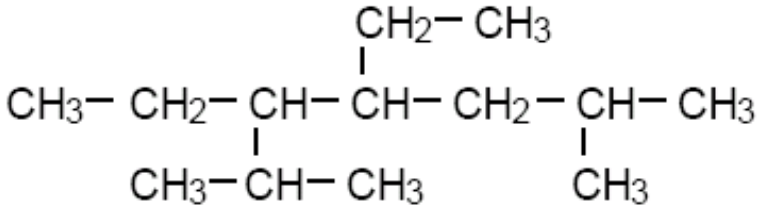
It is NOT called 2,2-dimethyl-4-ethylheptane

a. 

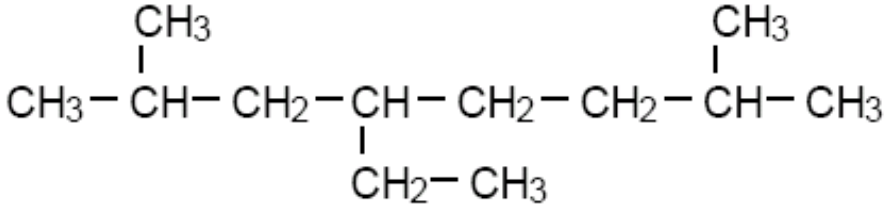
4-ethyl-6-methylnonane

b. 

3,3-dimethyl-6-propylnonane

c. 

4-ethyl-5-isopropyl-2-methylheptane

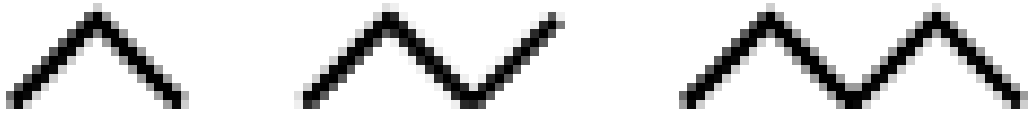
d. 

4-ethyl-2,7-dimethyloctane

Line drawing shorthand

Although non-cyclic alkanes are called straight-chain alkanes they are technically made of kinked chains. This is reflected in the line-drawing method. Each ending point and bend in the line represents one carbon atom and each short line represents one single carbon-carbon bond. Every carbon is assumed to be surrounded with a maximum number of hydrogen atoms unless shown otherwise.

Propane *butane* *pentane*



Summary

To put the finishing touches on the name of an alkane, keep the following points in mind:

(a) hyphens are used to separate numbers from names of substituents.

(b) numbers are separated from each other by commas.

(c) the last alkyl group to be named is prefixed to the name of the parent alkane, forming one word.

(d) the suffix "-ane" indicates that the molecule is an alkane.