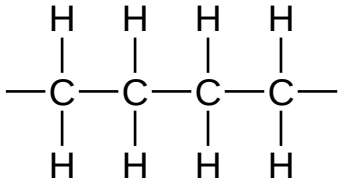
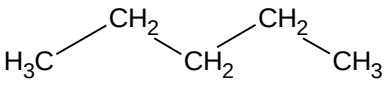
Organic Chemistry

The study of carbon-containing *molecules* and their properties

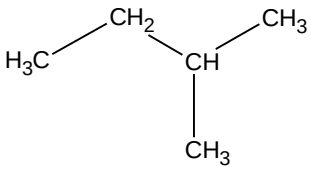
- Since carbon has four valence electrons, it can form up to four bonds
- This allows for a carbon "backbone" to form in molecules and is the reason for the huge variety of carbon-based molecules, i.e.:



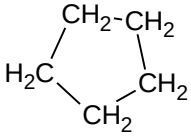
- Organic molecules can vary in size from 1 - 10,000 + carbon atoms
- Shapes of molecules can be:



Straight

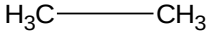


Branched

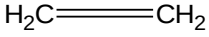


cyclical

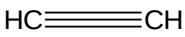
- carbon can form single, double, or triple bonds, e.g.:



Single



Double



Triple

- *Structural Isomers* – molecules that have the same chemical formula, but different structure
- *Alkyl group* – one or more carbons that branch off the carbon backbone

General Rules for Naming Organic Molecules

Organic molecules can have three different parts to their names:

1. prefix – indicates the *name* and *position* of the branch(es) on the *parent* (longest) carbon chain.

2. root – indicates the number of carbon atoms in the *parent* carbon chain.

Root	# of C atoms
meth -	1
eth -	2
prop(a) -	3
but(a) -	4
pent(a) -	5
hex(a) -	6
hept(a) -	7
oct(a) -	8
non(a) -	9
dec(a) -	10

3. suffix – ending part of name, identifies the type of organic molecule.

Alkanes – Saturated Hydrocarbons

- Contain only single bonds between carbons (saturated hydrocarbons)
- non-polar molecules with weak intermolecular forces
- low water solubility
- generally low boiling points, that increase as the molecule gets larger
- generally unreactive (they do not react with acids, bases, or oxidizing agents)
- good fuel sources because they undergo complete combustion. Smaller alkanes are more combustible.

Naming Alkanes

1. Identify the *parent* chain. This is the longest chain of carbon atoms. Note: If there is more than one possible way to arrange the parent chain, the simplest method is used.

2. *Identify all branches* connected to the parent chain.

3. *Number the carbons* in the parent chain. If there are branches, start from the side that allows branches to have the lowest possible position numbers. If two or more groups are tied for the lowest number, the group that comes first alphabetically gets priority.

4. *Name the branch(es)* based on the number of carbons it contains and note its position number. Branch names always end in *– yl*.

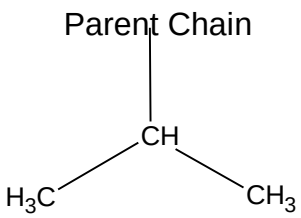
5. *Write the prefix*, include the position number of each branch (list branches in *alphabetical* order). More than one of each type of branch is shown by adding di-, tri-etc. in front of the branch's name. NOTE: di-, tri- etc., does not count in the alphabetizing of the name.
   Separate numbers with commas, and number from a word with a hyphen.

6. *Write the root* (depends on the number of carbons in parent chain)

7. *Write the suffix* –ane.

Naming Branches

IF a branch is connected to the parent chain by a non-terminal carbon (i.e., a carbon that is in the middle of the branch), it must be identified in the branch name. For example, the branch below would be named:



…(propan-2-yl)…

Cyclical Alkanes

Form when two ends of hydrocarbon chains join to form a ring
The parent chain is always the ring

Naming Cycloalkanes

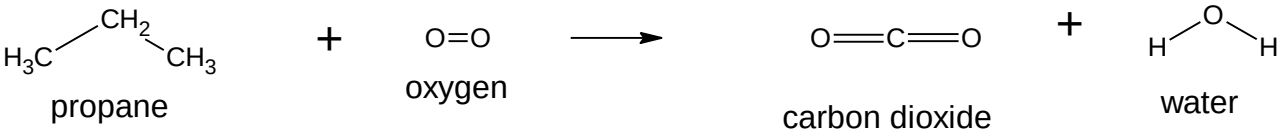
1. *Identify the branches*
2. *Number carbons in ring* in either direction so that branches have the *lowest* possible position numbers
3. *write prefix* (as above for alkanes). Note if there is only one substituent group or branch, a position number is NOT included
4. *write the root -cyclo-* plus name for the number of carbons in ring
5. *write the suffix –ane*

Reactions of Alkanes

Combustion Reactions

Combustion reactions involve the reaction of an alkane with oxygen to produce carbon dioxide and water.

Example:

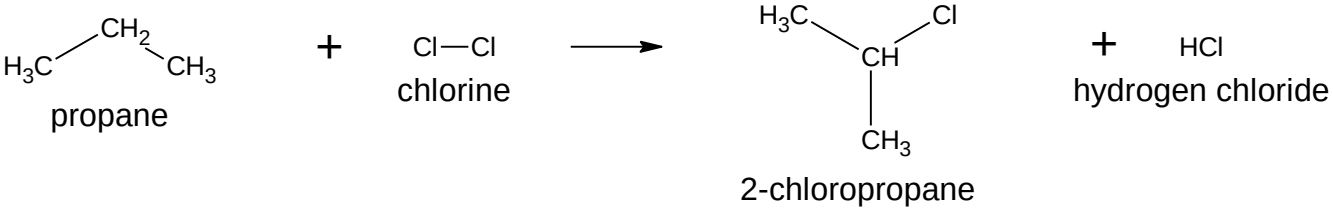


***note that the reaction above is unbalanced, and is using structural diagrams to show the reaction*

Substitution Reactions

Substitution reactions involve the replacement of one or more hydrogen atom(s) by a substituent group

Example:



Alkyl Halides (Haloalkanes)

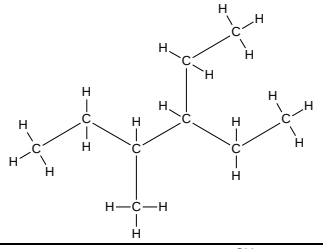
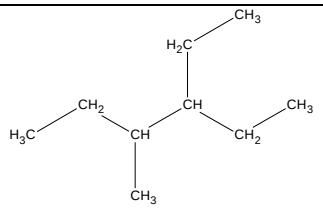
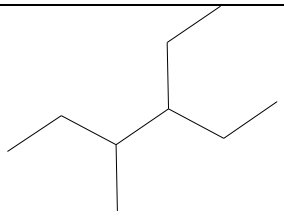
- *Substituent group* – an atom or group of atoms that replaces a hydrogen in an organic molecule
- alkyl halides have a substituent halogen (F, Cl, Br, I).
- form by a substitution reaction in an alkane
- bond between halogens and carbon is polar, causing the molecule to be polar
- stronger intermolecular forces
- higher boiling points
- mostly unreactive

Naming Alkyl Halides

1. same rules for alkanes
2. use prefix fluoro-, chloro-, bromo-, or iodo- with a position number

Representing Organic Molecules

Organic molecules can be represented in different ways.

Name	3-ethyl-4-methyl hexane
Chemical formula	C_9H_{20}
Structural diagram	
Condensed Structural Diagram	
Line Diagram	
Condensed Formula	$CH_3CH_2CH(CH_3)CH(CH_2CH_3)CH_2CH_3$