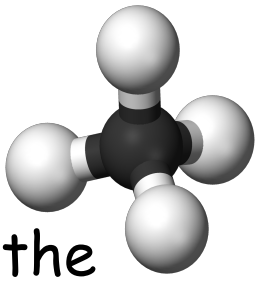
Hydrocarbons

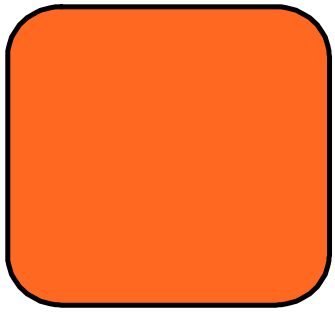


Organic Chemistry - includes the chemistry of almost all carbon compounds, regardless of their origin.

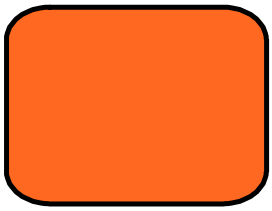
There are over a *million* organic compounds. The simplest compounds contain only carbon and hydrogen and are called hydrocarbons.

The 2 simplest hydrocarbons are methane and ethane.

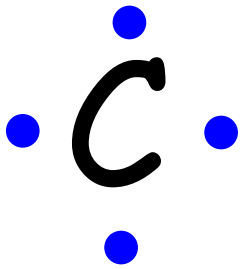
How many bonding pairs can carbon make?

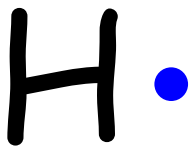


What about hydrogen?



So to make a molecular compound between carbon and hydrogen we need to make covalent bonds until we have full outer shells (octet rule).



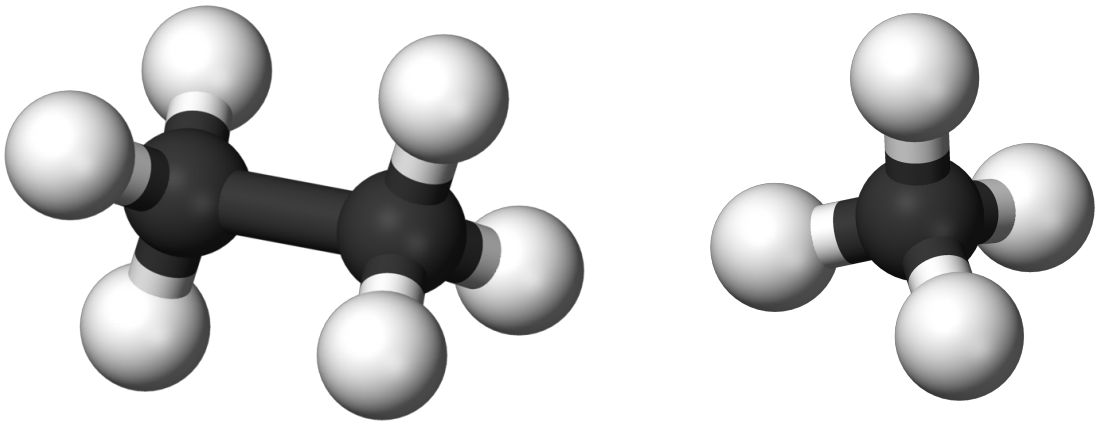


Because carbon has 4 valence electrons, a carbon atom always forms four covalent bonds.

Methane (CH_4)

Ethane (C_2H_6)

The ability of carbon to form stable carbon-carbon bonds is one reason that carbon can form so many different compounds.



Alkanes

Methane and ethane are examples of alkanes. An alkane is a hydrocarbon in which there are only *single covalent bonds*.

All carbon-carbon bonds are single bonds and all other bonds are carbon-hydrogen bonds.

The carbon atoms in an alkane can be arranged in a straight chain or in a chain that has branches.

Straight-Chain Alkanes

Looking at the following table (Pg. 695)

Table 22.1

The First Ten Straight-Chain Alkanes

Name	Molecular formula	Structural formula	Boiling point (°C)
Methane	CH_4	CH_4	−161.0
Ethane	C_2H_6	CH_3CH_3	−88.5
Propane	C_3H_8	$CH_3CH_2CH_3$	−42.0
Butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$	0.5
Pentane	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$	36.0
Hexane	C_6H_{14}	$CH_3CH_2CH_2CH_2CH_2CH_3$	68.7
Heptane	C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	98.5
Octane	C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	125.6
Nonane	C_9H_{20}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	150.7
Decane	$C_{10}H_{22}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	174.1

What patterns do you see?

A group of compounds forms a **homologous series** if there is a constant change in molecular structure from one compound to the next.

The homologous series for alkanes would then be C_nH_{2n+2}

Using the model kits to build structures

Draw the following: 

Build the following: 

How many covalent bonds are there? How does this connect to the homologous series of alkanes?

Why are 3-D models a more accurate representation of organic molecules than 2-D models?

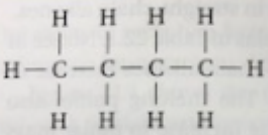
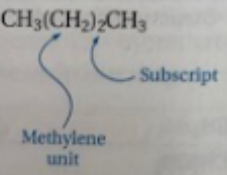
What is butane used for?

There are many different ways scientists describe different compounds.

Taking a look at table 22.2 on pg. 696

Table 22.2

Formulas for Butane

Formula	Description
C_4H_{10}	Molecular formula
	Complete structural formula
$CH_3-CH_2-CH_2-CH_3$	Condensed structural formula; C — H bonds understood
$CH_3CH_2CH_2CH_3$	Condensed structural formula; C — H and — C — C — bonds understood
	Condensed structural formula; all bonds understood; parentheses indicate CH_2 units are linked together in a continuous chain (the — CH_2 — unit is called a methylene group); subscript 2 to the right of parenthesis indicates two methylene groups are linked together
C—C—C—C	Carbon skeleton; all hydrogens and C — H bonds understood
	Line-angle formula; all carbons and hydrogens understood; carbon atoms are located at each intersection and at the ends of lines

Practice

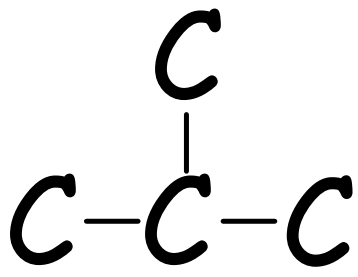
Draw complete structural formulas for the straight-chain alkanes that have three and six carbons.

Branched-Chain Alkanes

Branched chains and other hydrocarbons do not always have carbon atoms bonded in straight chains.

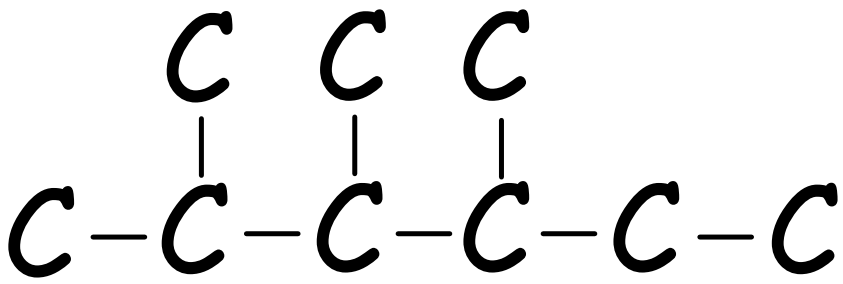
Because a carbon atoms has 4 covalent bonds, it can bond to many other carbon atoms creating branched chains.

An atom or group of atoms that can take the place of a hydrogen atom on a parent hydrocarbon molecule is called a **substituent**. The parent alkane in a hydrocarbon is the longest continuous chain of carbon.



Which is the parent alkane?

What is the name of the parent alkane?



Which is the substituent?

A hydrocarbon substituent is called an **alkyl group**. An alkyl group can be one carbon or several carbons long.

They are named by removing the *-ane* ending from the parent hydrocarbon name and adding *-yl*. An alkane group with one or more alkyl groups is called a **branched-chain alkane**.

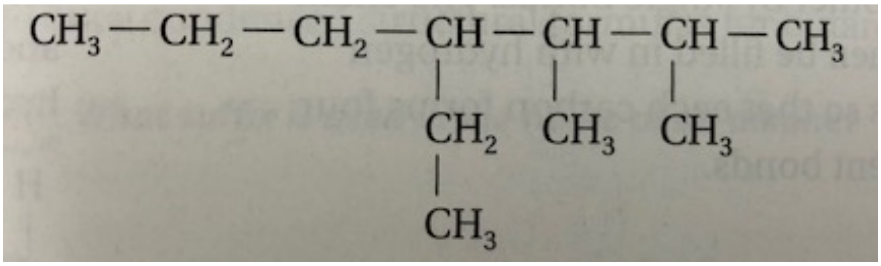
So, methane --> methyl
ethane --> ethyl
propane -->

An alkane with one or more alkyl groups is called a **branch-chain alkane**.

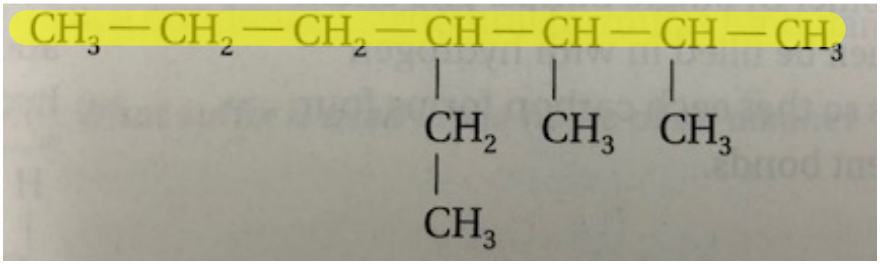
The name of the branched-chain alkane is based on the name of the longest continuous carbon chain.

IUPAC Rules for naming branch-chain alkanes

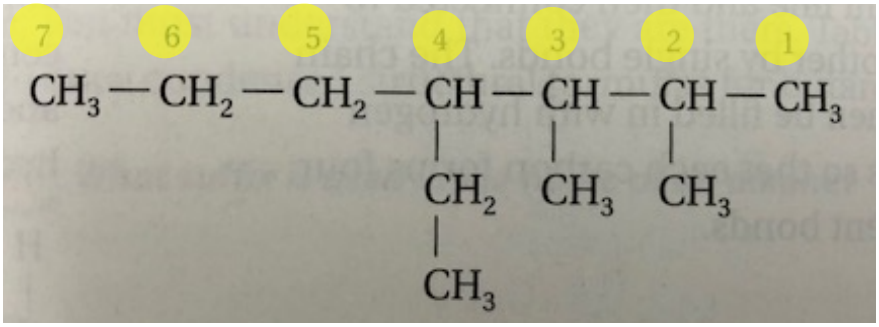
Example:



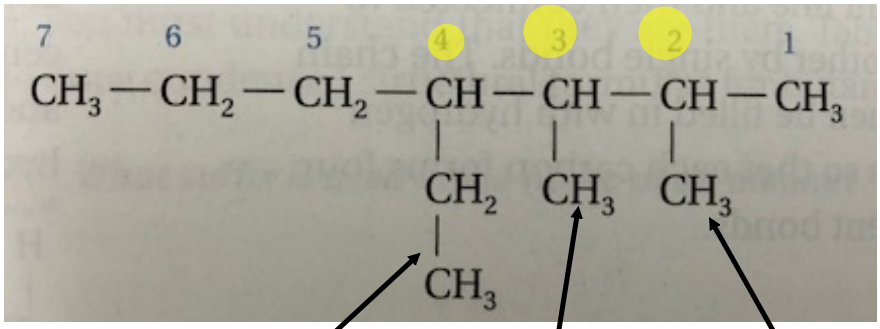
1. Find the longest chain of carbons. This makes your parent structure. In this case it would be



2. Number the carbons in the main chain sequence. Start at the end that will give the groups attached to the chain the smallest sequence.



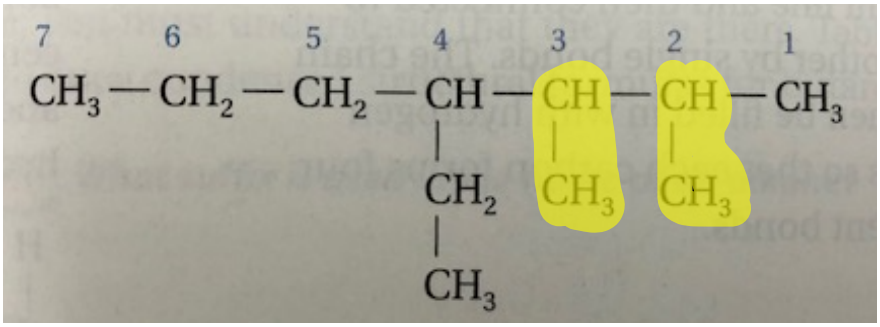
3. Add the numbers from step 2 to the names of the substituent groups.



4-ethyl 3-methyl 2-methyl

4. Use prefixes to indicate the appearance of the same group more than once in the structural formula.

Common prefixes
- di (twice)
- tri (three times)
- tetra (four times)
- penta (five times)



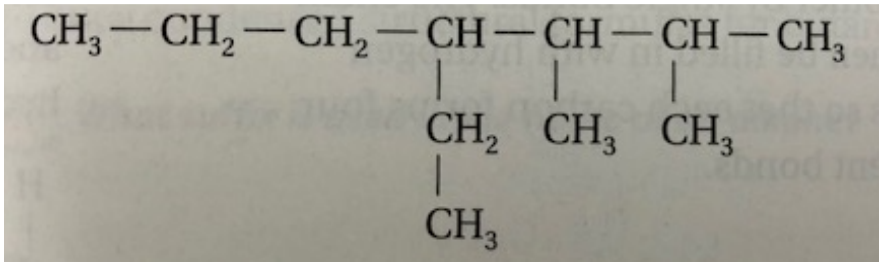
This example has 2 methyl substituents... so we will use *dimethyl* as part of the complete name.

5. List the names of the alkyl substituents in alphabetical order.

   *Ignore the prefixes when alphabetizing

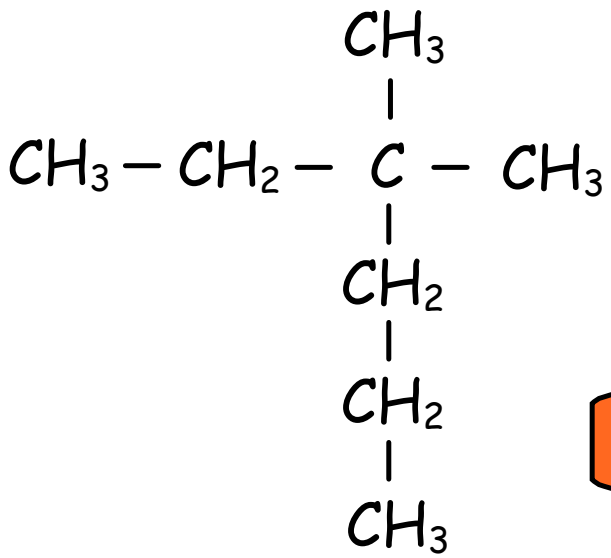
4-ethyl will be listed before 2-methyl and 3-methyl (the methyl groups will be combined to 2,3-dimethyl in the name)

6. Use proper punctuation
   - commas separate numbers
   - hyphens separate number and words
   - no spaces in the name



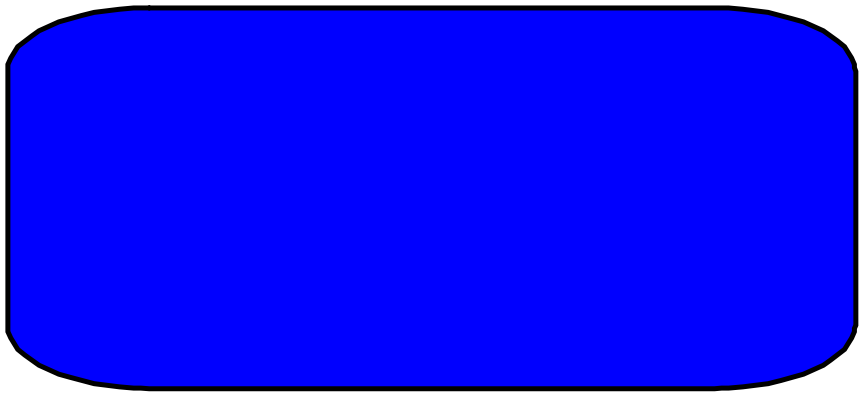
Practice

Name this compound using the IUPAC system. Notice that the longest chain is not written in a straight line.



Practice

The compound 2,2,4-trimethylpentane (commonly called isooctane) is found in gasoline. Draw a complete structural formula for isooctane.



- Read the "Careers in Chemistry" section on the top of page 701.

- Work on questions #1-11 on pages 697-701