Introduction to

Organic Chemistry

Alkanes Bonding Alkenes Alkynes Isomers
Cyclic Branched Alkanes Alcohols Acids

Hydrogen HyperMedia

Organic Chemistry

- The study of carbon compounds.
- Carbon is a nonmetal with four valence electrons. It will share these valence electrons with other atoms to end up with *four* covalent bonds.
- There are currently around 15 million organic compounds compared to only 35 thousand inorganic compounds.
- Hydrocarbons are the simplest of all organic compounds. They contain only carbon and hydrogen atoms.

Reasons for the abundance of organic compounds:

- Carbon has 4 valence electrons and forms 4 covalent bonds.
- Carbon atoms can bond together with a single, double or triple covalent bond.
- Molecules can be straight chained, branched chain or rings.
- The same chemical formula can have many different structures.

Naming Hydrocarbons

Prefix tells you the number of carbon atoms.

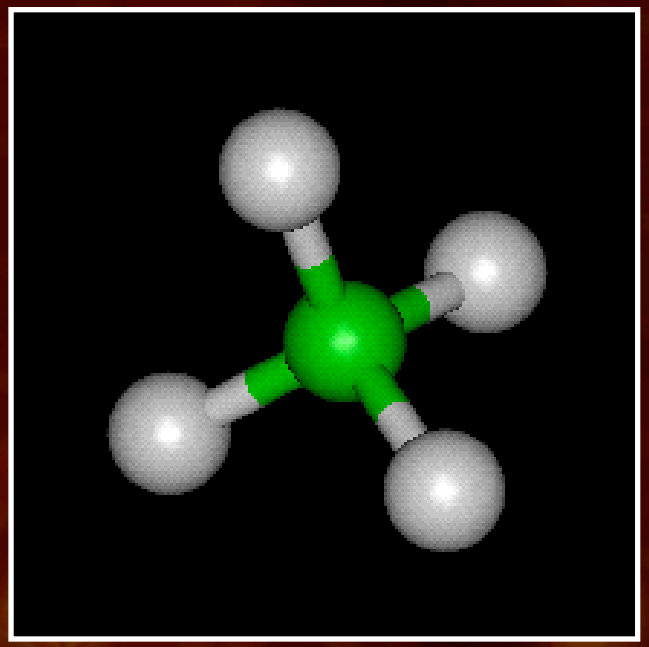
Meth - 1	Hex - 6
Eth - 2	Hept - 7
Prop - 3	Oct - 8
But - 4	Non - 9
Pent - 5	Dec - 10

Suffix is the type of bonding *between carbon*.

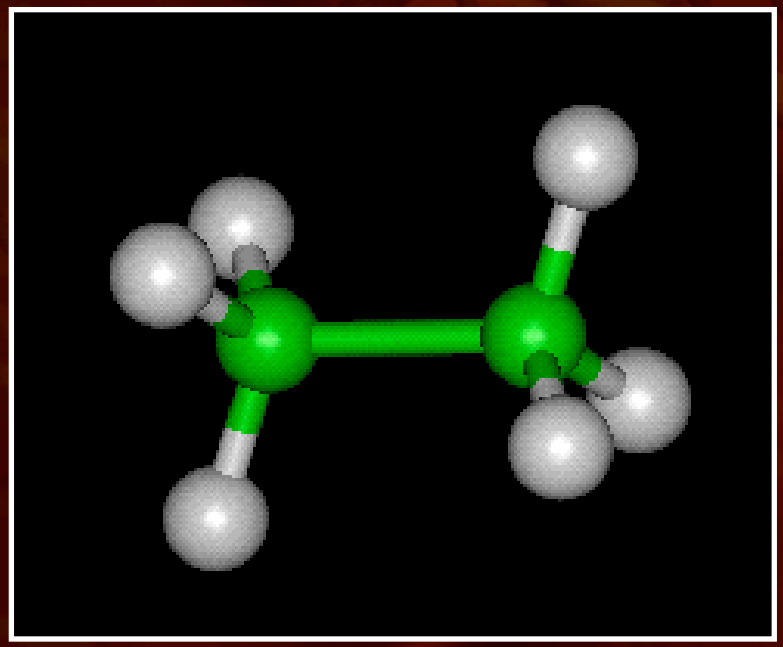
- ane all single bonds C–C
- ene one or more double bonds C=C
- yne one or more triple bonds C≡C

Alkanes

methane



ethane



Alkanes are hydrocarbons containing only single bonds. They are the simplest of all organic compounds.

Boiling Points of Alkanes

Natural Gases

- Methane -162˚C
- Ethane –89˚C
- Propane -42˚C
- Butane -1˚C
- Pentane 36˚C
- Hexane 68˚C

What is the relationship between b.p. and mass?

As mass increases so does b.p.

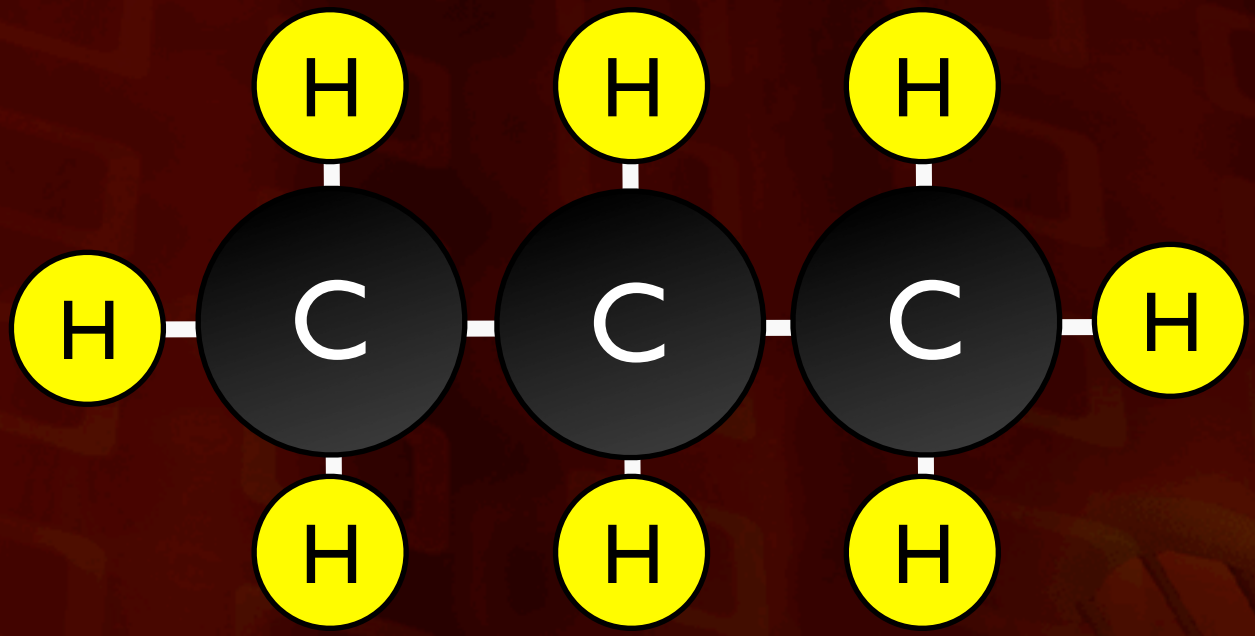
What happens when you burn an alkane like propane?

Propane and oxygen yields carbon dioxide and water

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Propane burns to produce carbon dioxide & water.

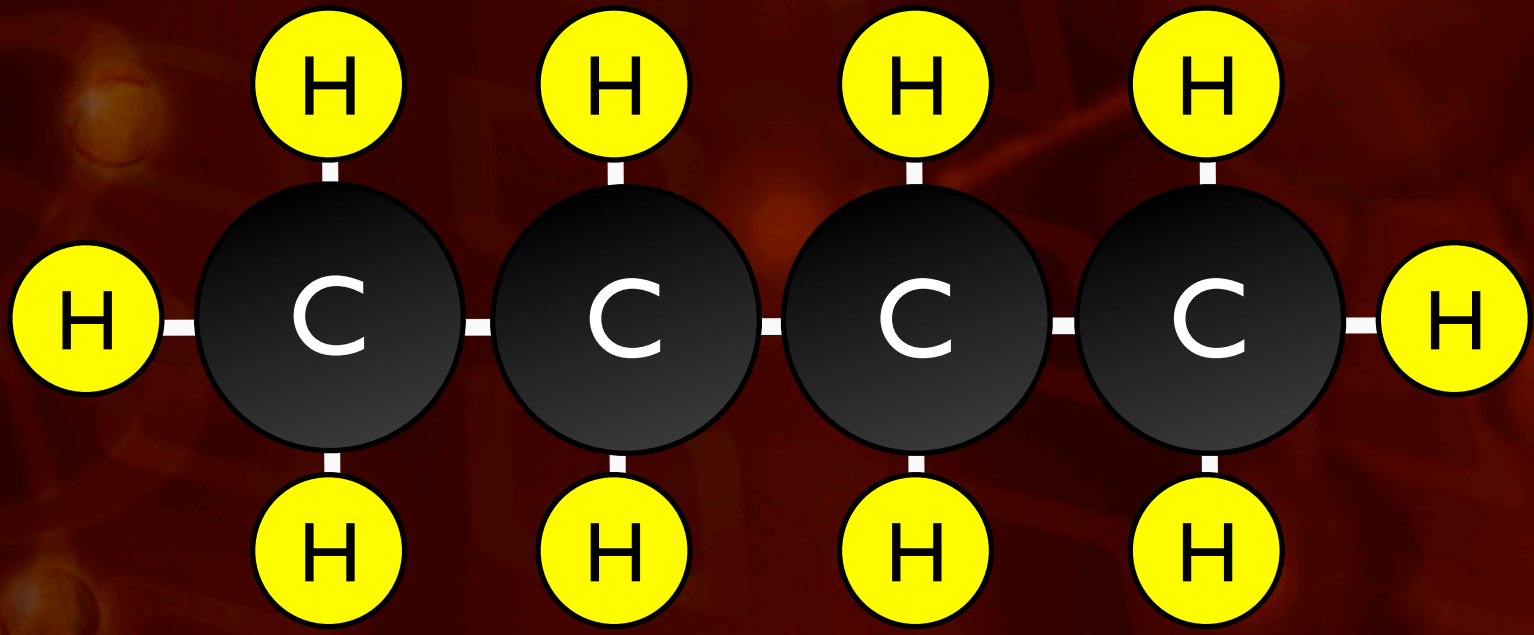
When burnt, all alkanes produce carbon dixoide and water.



PROPANE

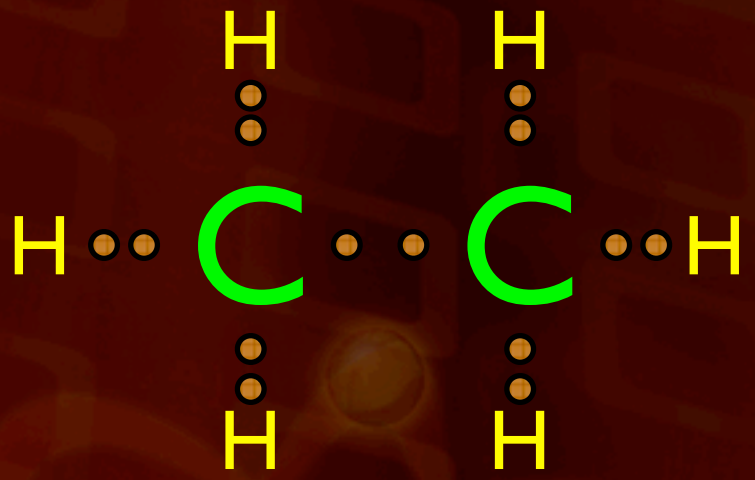
Alkanes are useful for fuels.

BUTANE



Types of Bonding

Single Covalent Bond

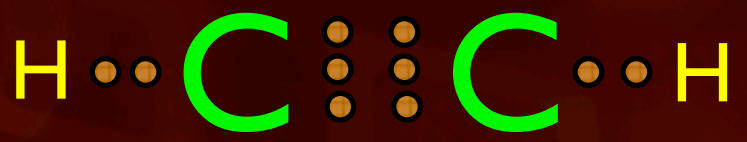


ethane

Double Covalent Bond

ethene

Triple Covalent Bond

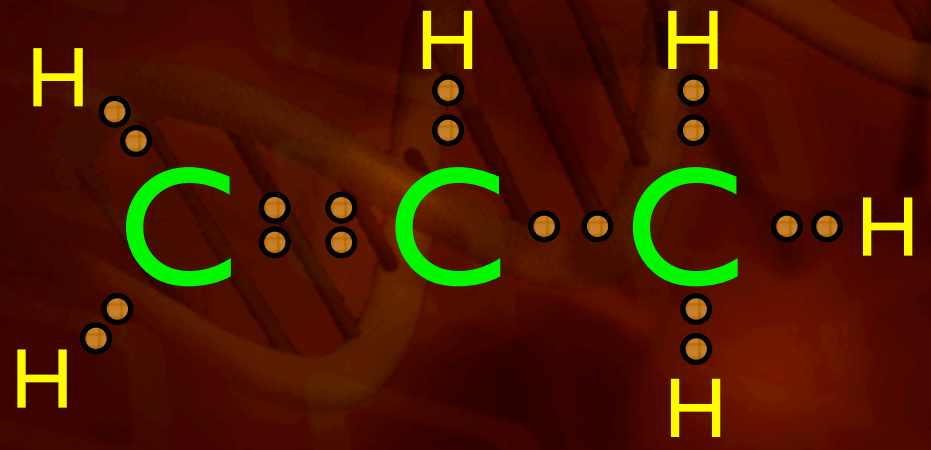


ethyne

Alkenes

ethene

propene



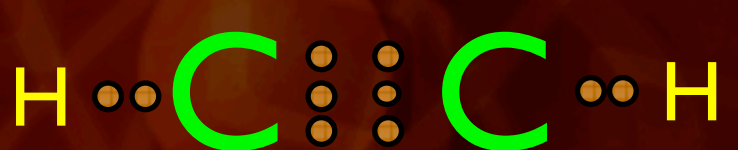
Alkenes are hydrocarbons containing one or more *double* bonds between carbon atoms. Because a double bond can break to add more hydrogen, alkenes are unsaturated.

Alkynes

Alkynes are hydrocarbons containing one or more *triple* bonds between carbon atoms.

Because a triple bond can break to add more hydrogen, alkynes (like alkenes) are also unsaturated.

ethyne



propyne

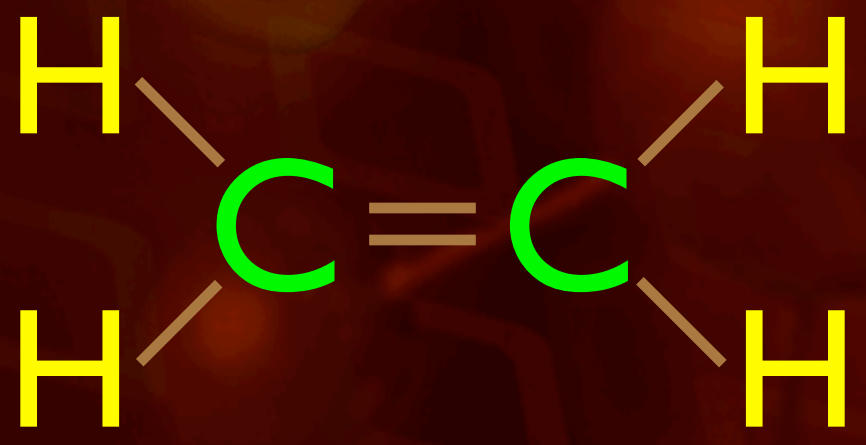
Structural Formulas

The structural formula shows the bonding between the atoms in a molecule.

Ethene

C_2H_4

Chemical Formula



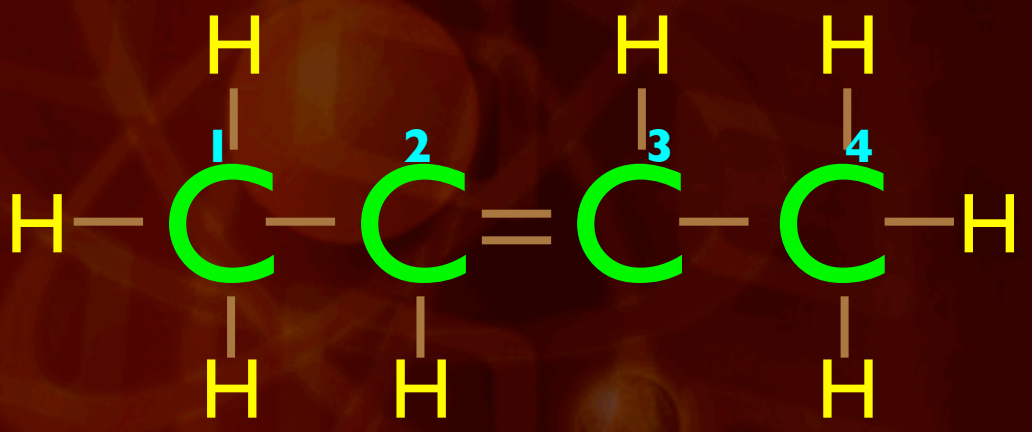
Structural Formula

Naming Alkenes & Alkynes

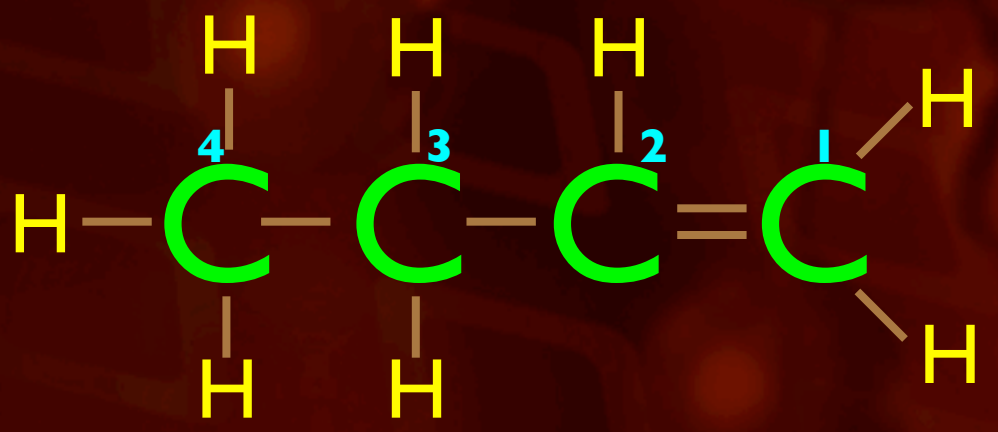
When naming alkenes and alkynes use a number in front of the name to tell where the double or triple bond are located. When doing so, number left to right or right to left, whichever gives you the smallest number.

Use a dash between the number and the name.

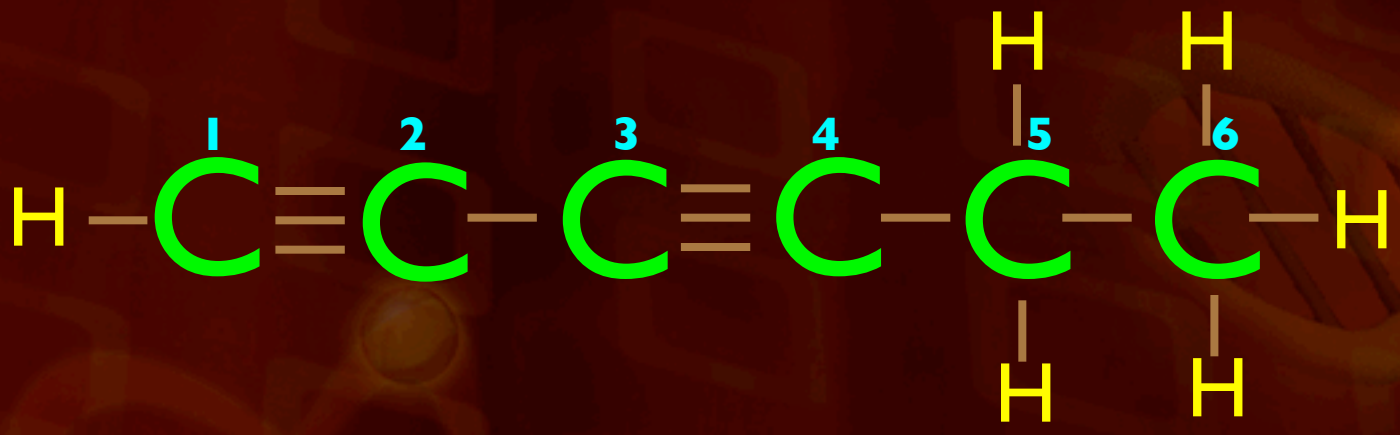
2-butene



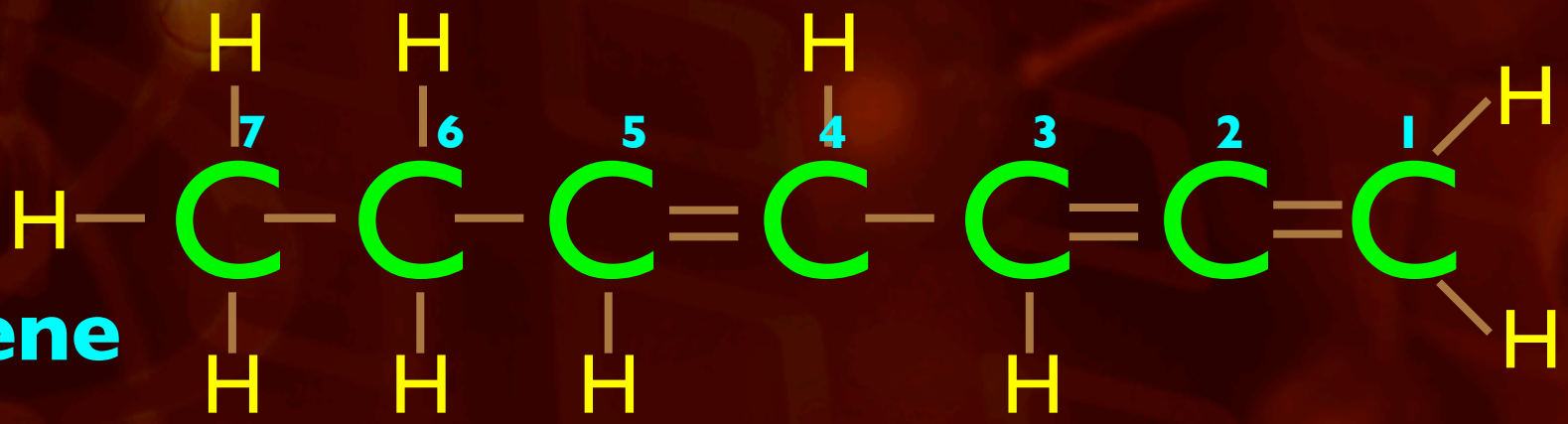
1-butene



Name these structural formulas:



1,3-hexyne

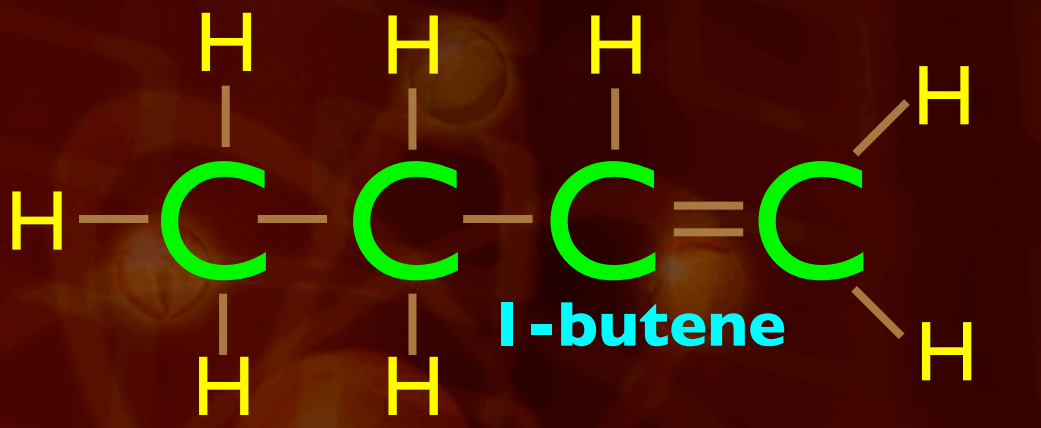


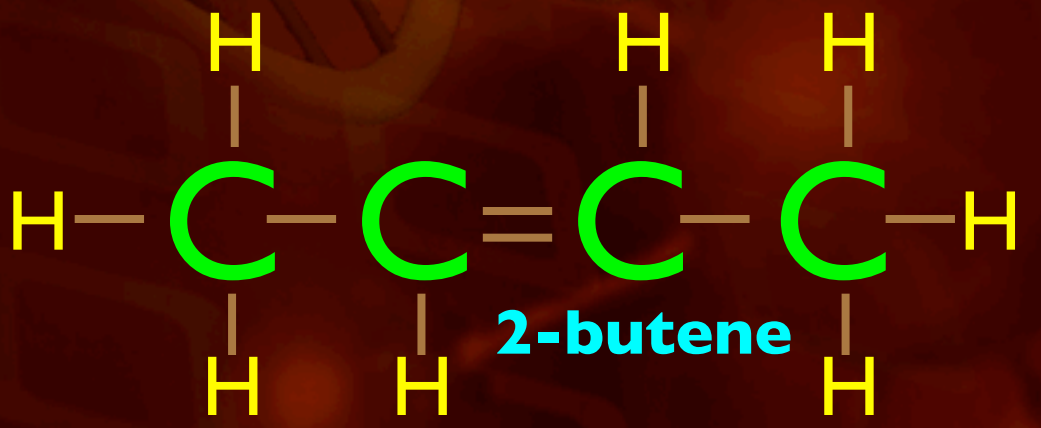
1,2,4-heptene

Isomers

Isomers are organic compounds that have different structural formulas but share the same chemical formula.

The alkenes 1-butene and 2-butene are isomers since they share the same chemical formula.



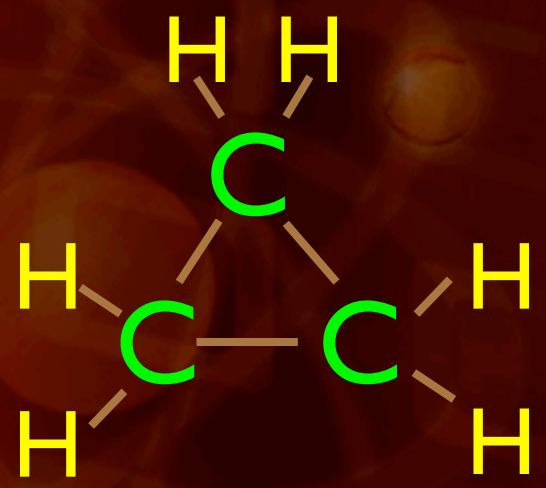


Chemical Forumula: C_4H_8

Question: Would 3-butene also be an isomer?
No. 3-butene doesn't exist (it would be 1-butene).

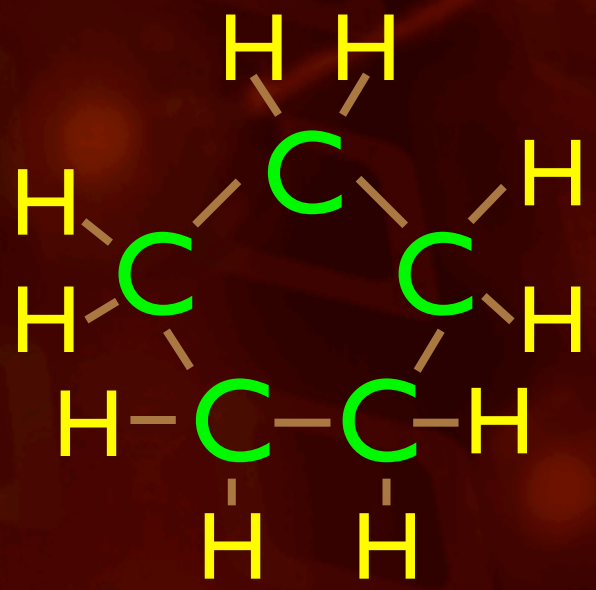
Cyclic Hydrocarbons

Cyclic (also known as Ring) hydrocarbons are joined together to form a ring.
When naming these compounds use the prefix cyclo- at the beginning of the name.



cyclopropane

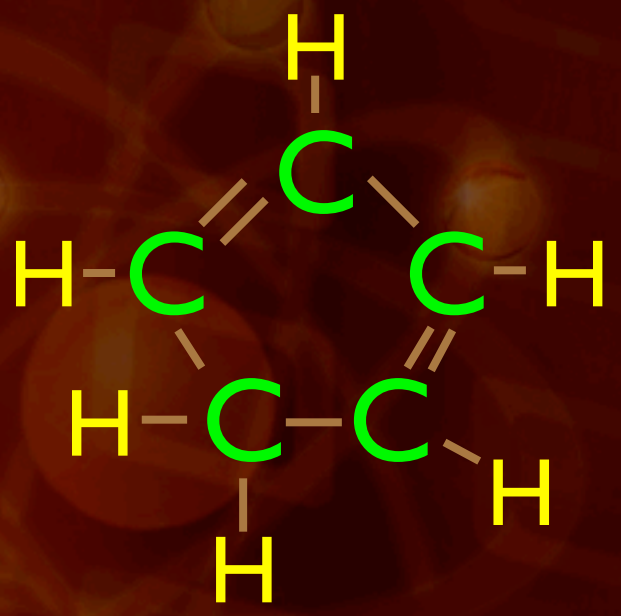
cyclopentane



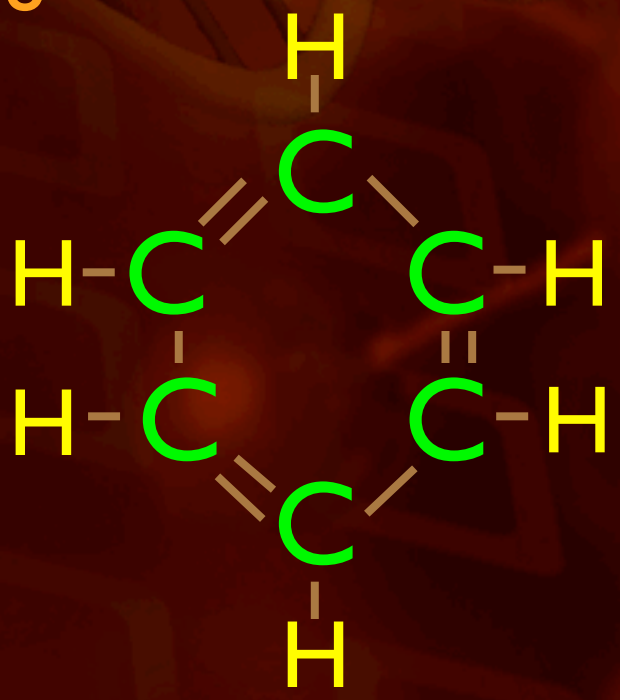
Naming Cyclic Alkenes

When naming cyclic hydrocarbons with two or more double bonds, start with a carbon with a double bond and count clockwise or counter-clockwise - whichever gives you the smallest set of numbers.

You must always start numbering *towards* a double bond.



1,3-cyclopentene



1,3,5-cyclohexene

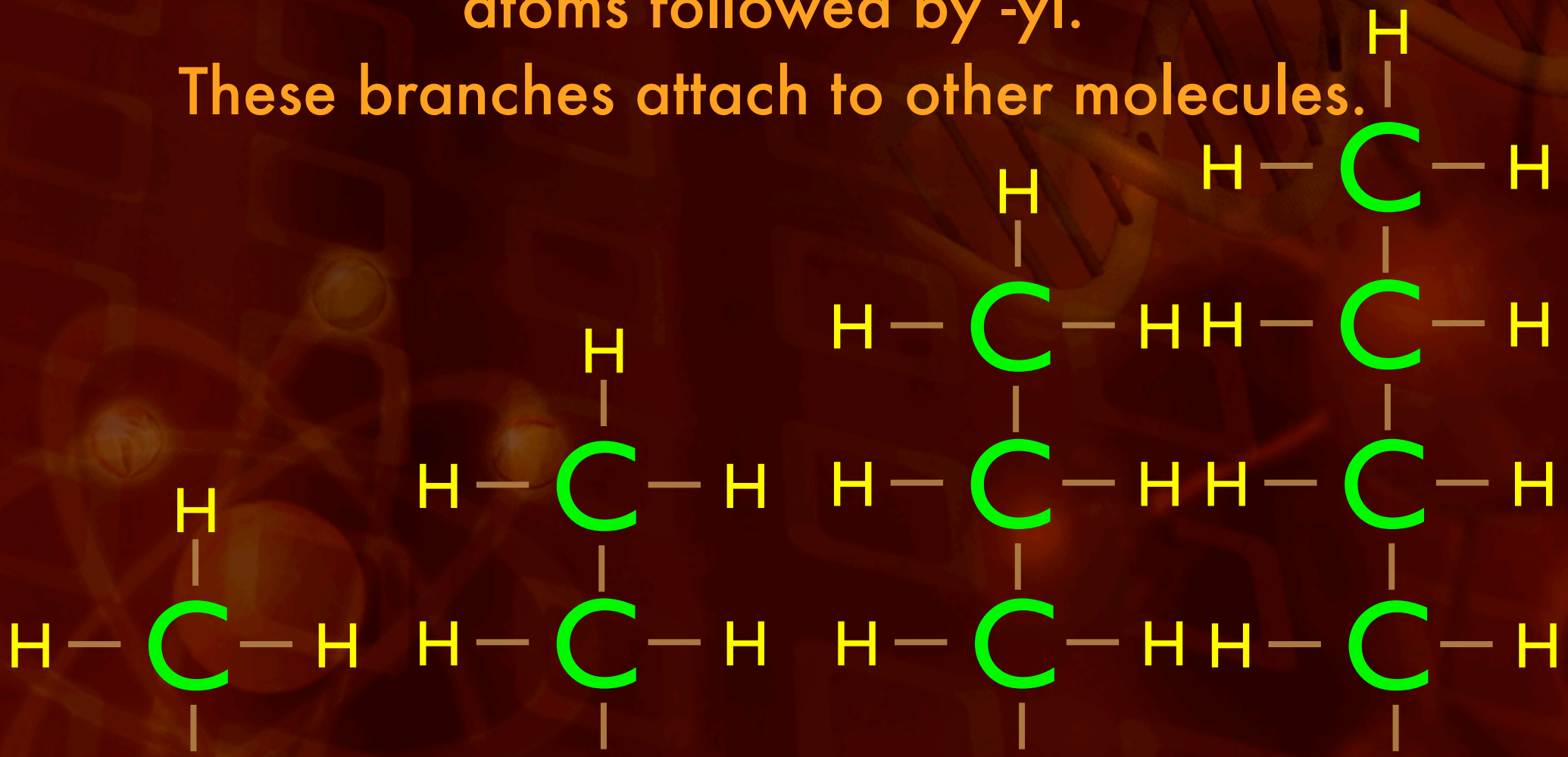
Draw the following:

1) octane
2) 2-butyne
3) cyclobutane
4) 2-pentyne
5) propane
6) 1,3-cycloheptene
7) 3-heptene
8) 1,3,5-cyclohexene
9) ethyne
10) 1,2-propene

Branched Chain Alkanes

Branches are named for the number of Carbon atoms followed by -yl.

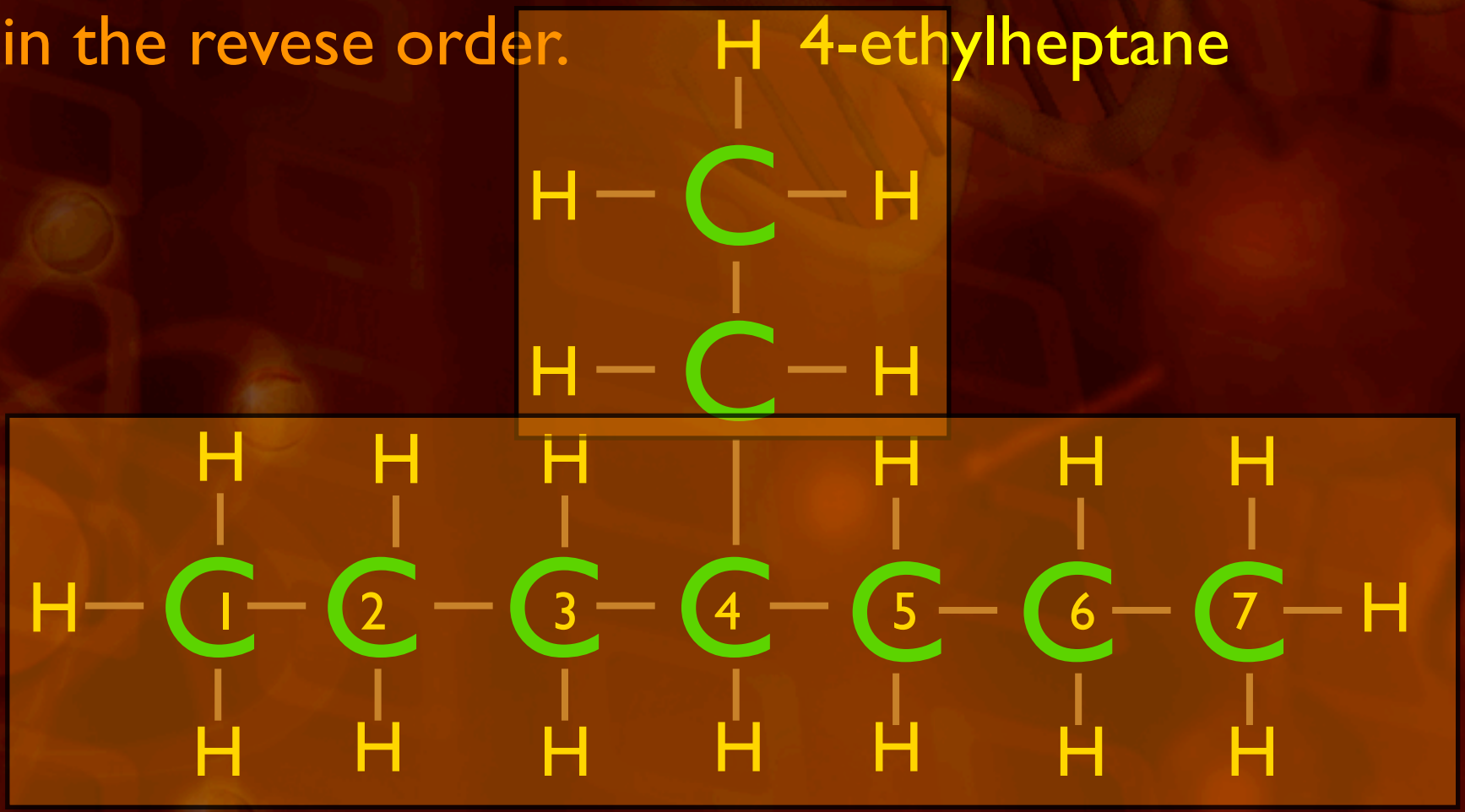
These branches attach to other molecules.



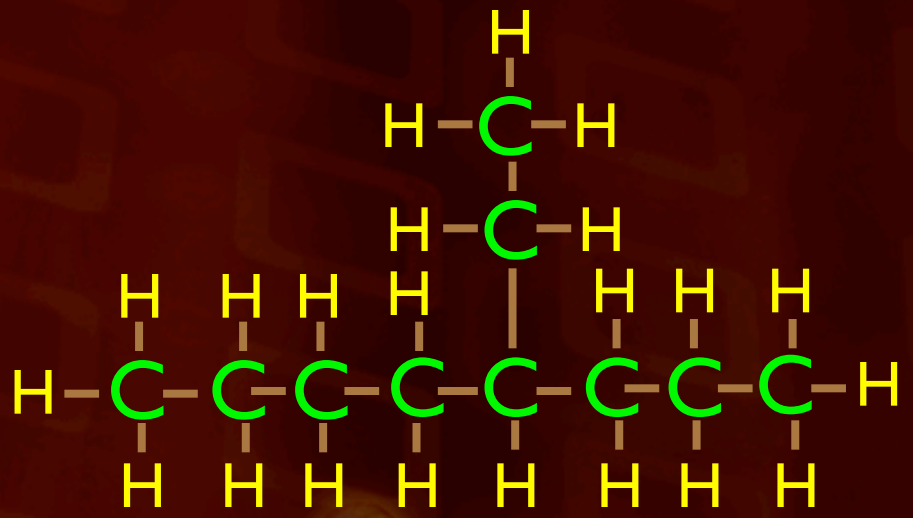
Methyl Ethyl Propyl Butyl

Branched Chain Alkanes

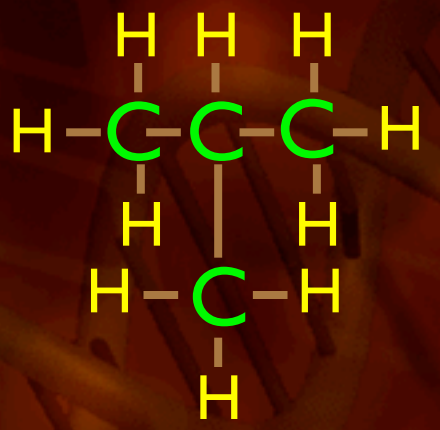
1. Determine which is the main (longest) chain. heptane
2. Determine the name of the branch. ethyl
3. Determine which carbon the branch is attached to. 4
4. Name in the revese order. 4-ethylheptane



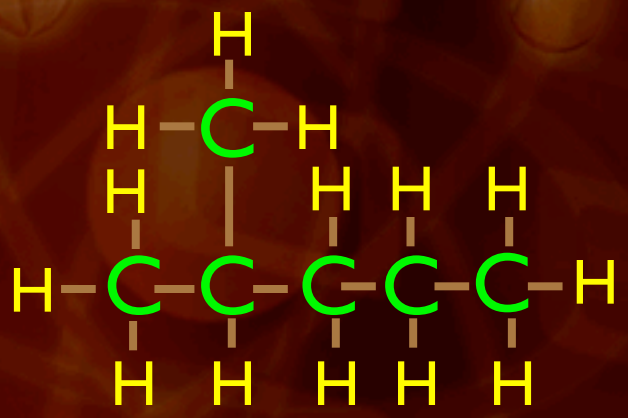
Name these branched alkanes



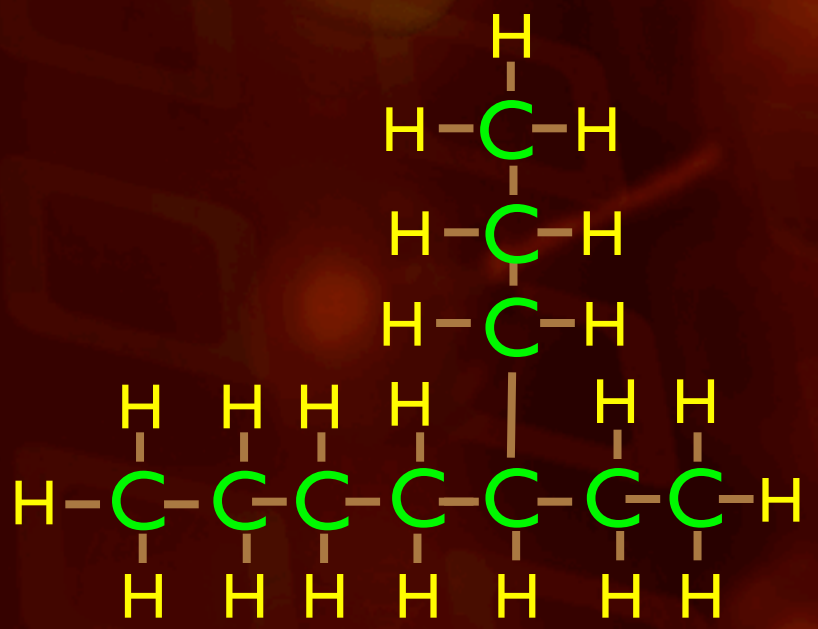
4-ethyloctane



2-methylpropane



2-methylpentane

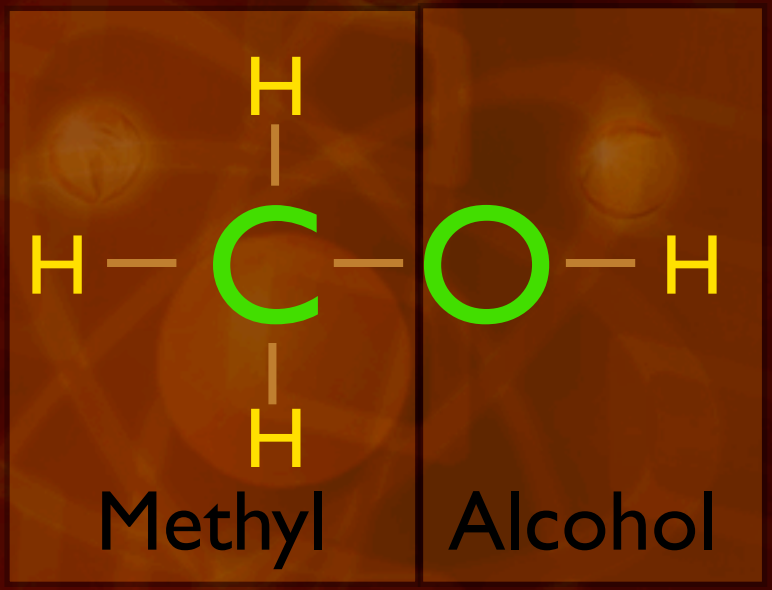


4-ethyloctane

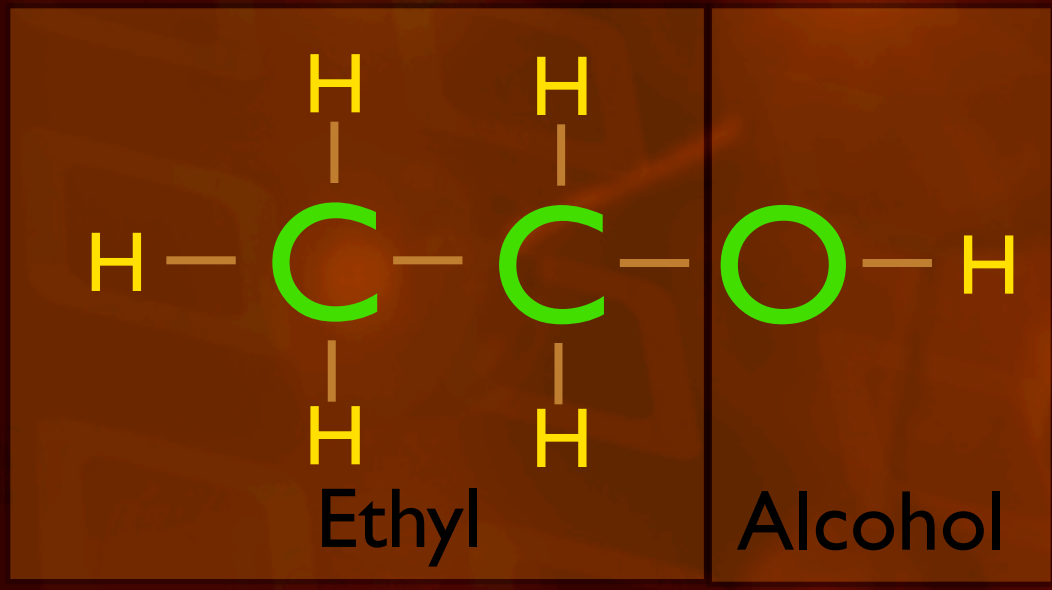
Alcohols

Alcohols are *substituted hydrocarbons in which one or more hydrogen atoms have been replaced with a hydroxyl group (-OH).

*Another element has replaced hydrogen.



aka Methanol



aka Ethanol

Alcohols

The alcohol that is found in all alcoholic beverages is ethyl alcohol (ethanol). Ethanol, and all other alcohols, are highly flammable and are used as fuels. Like hydrocarbons, when burned alcohols produce carbon dioxide and water.

Ethyl Alcohol + Oxygen → Carbon Dioxide + Water

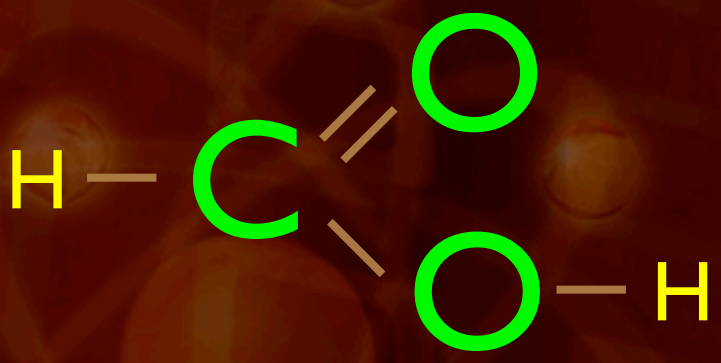
$$CH_5COH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Acids

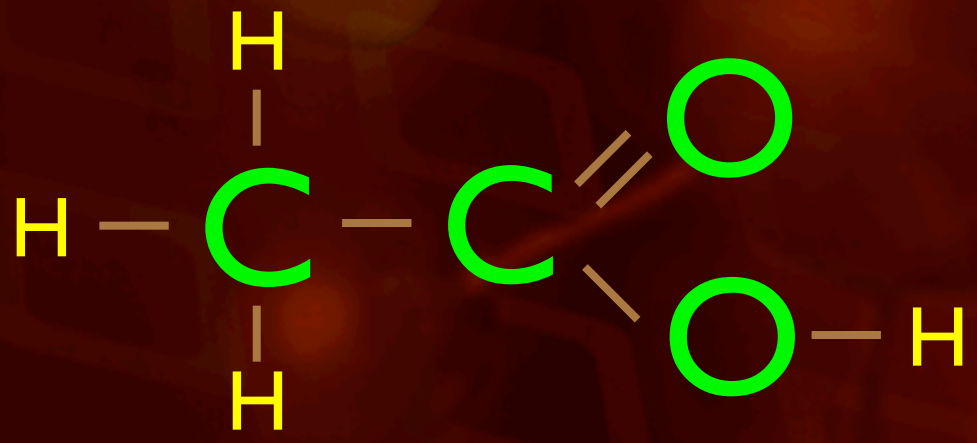
Acids are organic compounds that form when an alcohol is oxidized.

alcohol + diatomic oxygen → acid + water

Acids contain the structure of COOH.



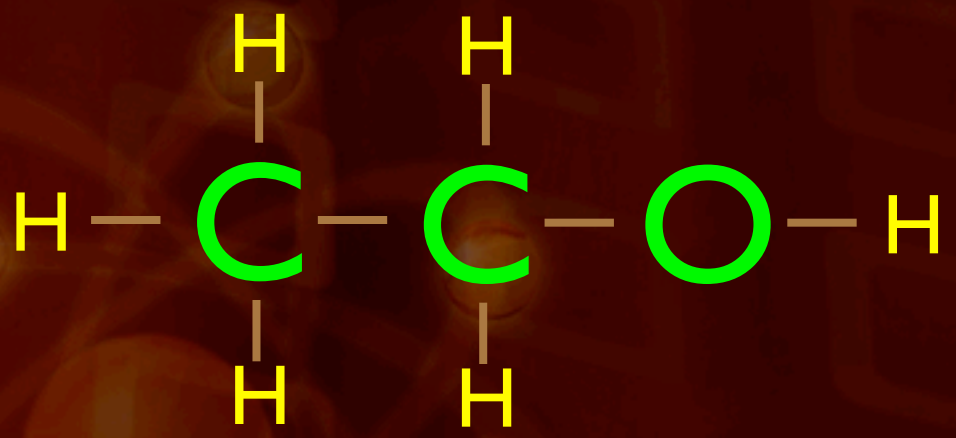
Methanoic acid



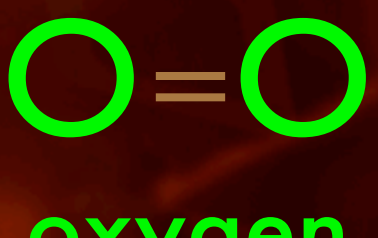
Ethanoic acid

Formation of Acids

alcohol + diatomic oxygen → acid + water



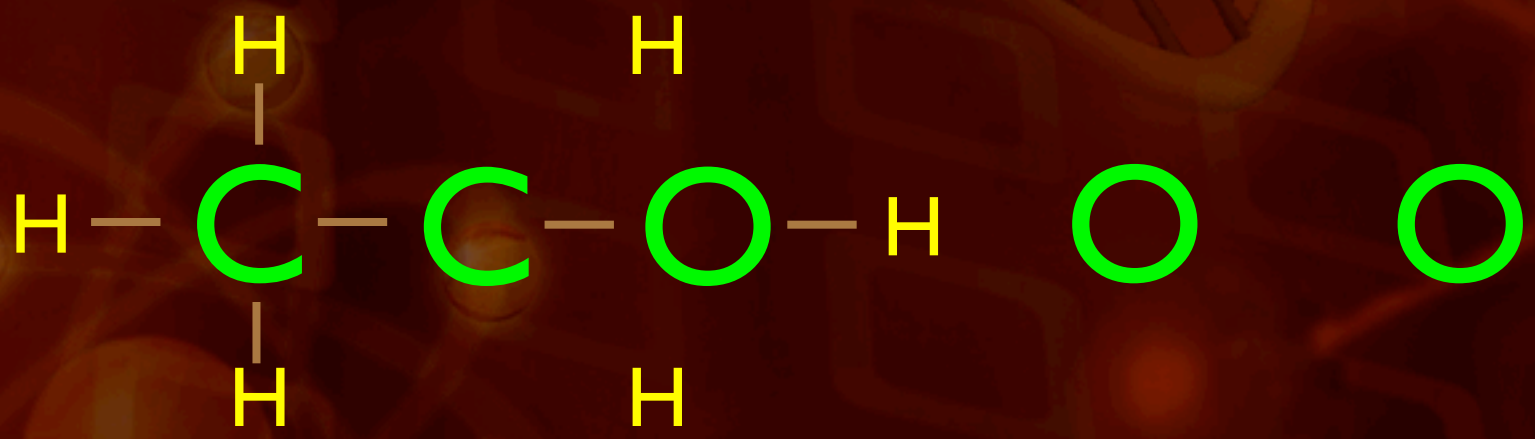
ethanol



oxygen

Formation of Acids

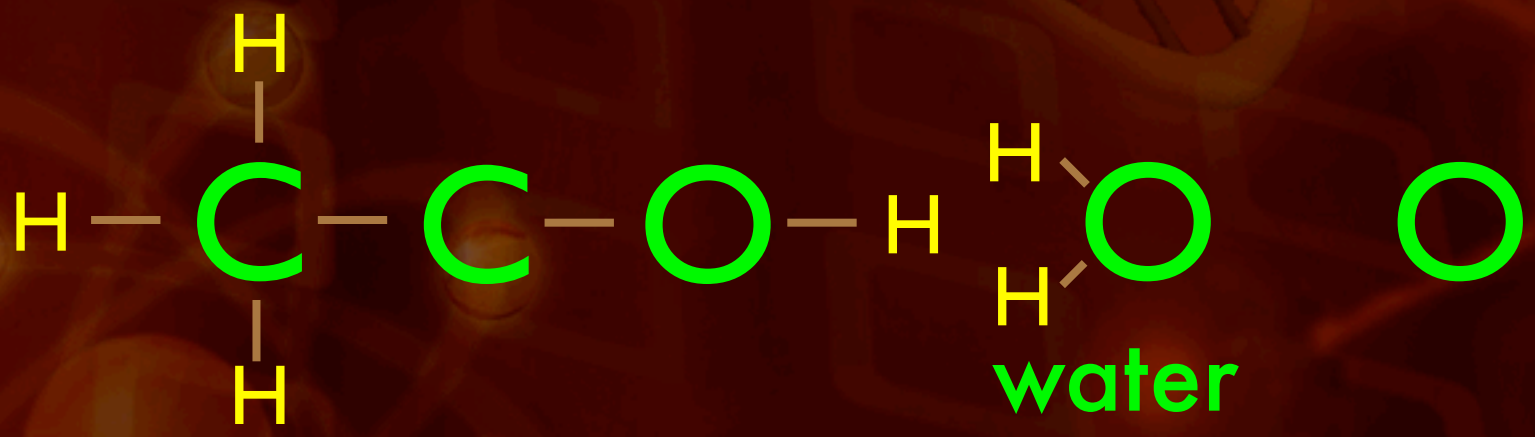
alcohol + diatomic oxygen → acid + water



Double bond between oxygen breaks.
Single bonds between H and C break.

Formation of Acids

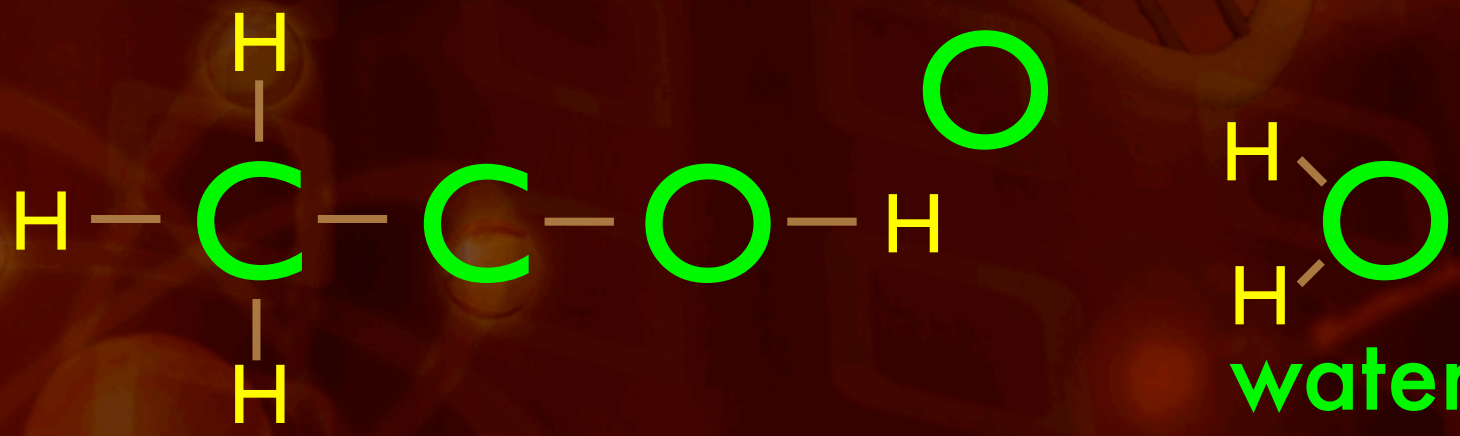
alcohol + diatomic oxygen → acid + water



Free oxygen and free hydrogen combine to form water.

Formation of Acids

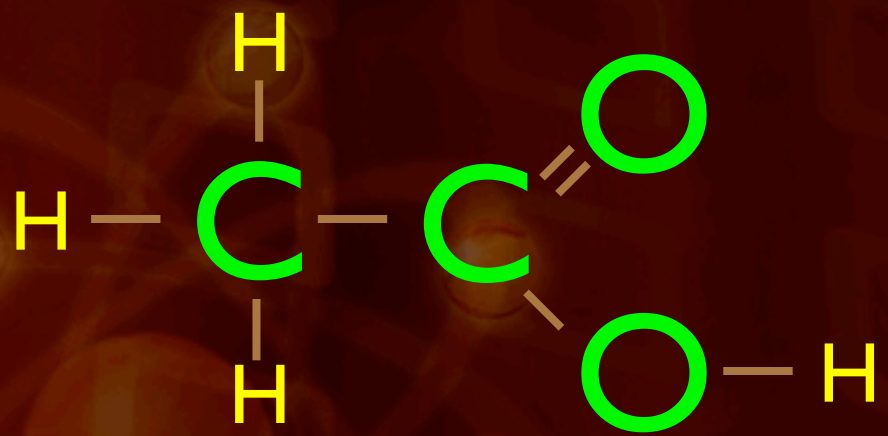
alcohol + diatomic oxygen → acid + water



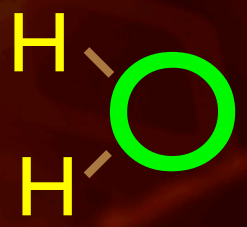
Both oxygen and carbon need a double bond.

Formation of Acids

alcohol + diatomic oxygen → acid + water



Ethanoic acid



water

Rerun

Naming Acids

The name of an acid is derived from the name of the alcohol. The "l" at the end of the alcohol's name is replaced with "ic".

ALCOHOL	ACID
Methanol	Methanoic acid
Ethanol	Ethanoic acid
Propanol	Propanoic acid
Butanol	Butanoic acid
Pentanol	Pentanoic acid