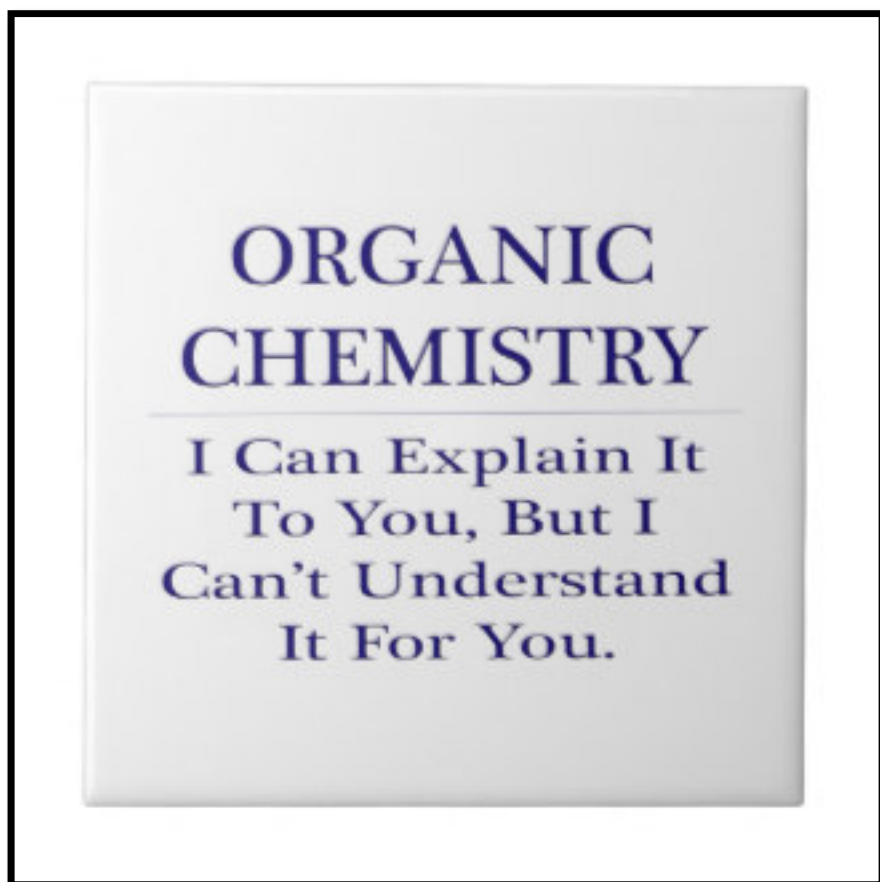


# Practice Packet

## Chapter 8:OrganicChemistry



## Chapter 8: Organic Chemistry

**Alkane** - a hydrocarbon containing only single covalent bonds - saturated hydrocarbon

**Alkyl group** - a hydrocarbon substituent, the methyl group (-CH<sub>3</sub>) is an alkyl group

**Alkenes** - a hydrocarbon containing one or more carbon-carbon double bonds

**Alkynes** - a hydrocarbon containing a carbon-carbon triple bond

**Alkyl halides** - a halocarbon in which one or more halogen atoms are attached to the carbon atoms

**Alcohol** - an organic compound having an -OH (hydroxyl) group

**Aldehyde** - an organic compound in which the carbon of the carbonyl group is joined to at least one hydrogen

**Addition reaction** - a reaction in which a substance is added at the double bond of an alkene or at the triple bond of an alkyne.

**Branched-chain alkane** - an alkane with one or more alkyl groups attached to the parent structure

**Carbonyl group** - a functional group having a carbon atom and an oxygen atom joined by a double bond

**Carboxylic acid** - an organic acid containing a carboxyl group

**Carboxyl group** - a functional group consisting of a carbonyl group attached to a hydroxyl group

**Condensed structural formula** - a structural formula that leaves out some bonds and/or atoms; the presence of these atoms or bonds is understood

**Ether** - an organic compound in which oxygen is bonded to two carbon groups

**Esters** - a derivative of a carboxylic acid in which the -OH of the carboxyl group has been replaced by the -OR from an alcohol.

**Esterification** - An ester is an organic compound where the hydrogen in the compound's carboxyl group is replaced with a hydrocarbon group.

**Fatty acids** - the name given to continuous-chain carboxylic acids that were first isolated from fats.

**Functional group** - a specific arrangement of atoms in an organic compound that is capable of characteristic chemical reactions

**Fermentation** - the production of ethanol from sugars by the action of yeast or bacteria

**Hydrocarbon** - contain only hydrogen and carbon

**Halocarbons** - any member of a class of organic compounds containing covalently bonded fluorine, chlorine, bromine or iodine

**Hydroxyl group** - the -OH functional groups present in alcohols.

**Homologous series** - a group of compounds in which there is a constant increment of change in molecular structure from one compound in the series to the next

**Isomers** - compounds that have the same molecular formula but different molecular structures

**Ketone** - an organic compound in which the carbon of the carbonyl group is joined to two other carbons

**Monomer** - a simple molecule that repeatedly combines to form a polymer

**Polymer** - a very large molecule formed by the covalent bonding of repeating small molecules, known as monomers

**Substituent** - an atom or group of atoms that can take the place of a hydrogen atom on a parent hydrocarbon

**Saturated compounds** - an organic compound in which all carbon atoms are joined by single covalent bonds

**Straight-chain alkanes** - a saturated hydrocarbon that contains any number of carbon atoms arranged one after the other

**Substitution reaction** - a common type of organic reaction, which involves the replacement of an atom or group of atoms by another atom or group of atoms

**Saponification** - the hydrolysis of fats or oils by a hot aqueous alkali-metal hydroxide, the making of soaps

**Unsaturated compounds** - an organic compound with one or more double or triple carbon-carbon bonds

# Organic Chemistry Introduction

•••  
8.1

## Objective:

What is a hydrocarbon and the properties of organic molecules?

How do we use table P and Q to write structural and molecular formulas for hydrocarbons?

## Organic versus Hydrocarbon

- **Organic** molecules must have the element C.
- **Hydrocarbons** can only have the elements H and C.
- Therefore hydrocarbons are organic but not all organic compounds are hydrocarbons:
  - $\text{CH}_4$  is a hydrocarbon and is organic
  - $\text{CCl}_4$  is organic but not a hydrocarbon
  - $\text{O}_2$  is neither organic nor a hydrocarbon

## Organic molecules

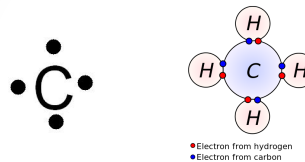
- Found in fossil fuels, plants and animals.
- Examples include gasoline, oil, kerosene, butane, propane...

## Hydrocarbon Properties

- Mostly insoluble
- Non-electrolytes (do not conduct electricity)
- React very slowly
- As size increases, the melting point and boiling point of the hydrocarbons increase.
- Small hydrocarbons may be gases and large hydrocarbons may be solids at room temperature.

## Carbon

- Remember carbon has four valence electrons. Therefore carbon will bond four times to achieve an octet.



- Each bond shown shares two electrons. One from C and one from H.

## Organic molecules

- Sometimes double and triple bond will be needed to fulfill all octets.



- A double bond shares four electrons.
- A triple bond shares six electrons.

## Organic Molecules

- All single bonded hydrocarbons are in the same family known as alkanes.
- All double bonded hydrocarbons are in the same family known as alkenes.
- All triple bonded hydrocarbons are in the same family known as alkynes.
- Refer to table Q

**Table Q**  
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	$\text{C}_n\text{H}_{2n+2}$	ethane	$\begin{array}{c} \text{H} & \text{H} \\   &   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   &   \\ \text{H} & \text{H} \end{array}$
alkenes	$\text{C}_n\text{H}_{2n}$	ethene	$\begin{array}{c} \text{H} & & \text{H} \\ & \backslash & / \\ & \text{C}=\text{C} \\ & / & \backslash \\ \text{H} & & \text{H} \end{array}$
alkynes	$\text{C}_n\text{H}_{2n-2}$	ethyne	$\text{H}-\text{C}\equiv\text{C}-\text{H}$

Note:  $n$  = number of carbon atoms

## Organic Molecules

- Notice the picture shows you the number of bonds.
- Table Q also shows that if you know how many carbon atoms are present in a molecule and what type of bonds it has, you can CALCULATE the number of hydrogen atoms using the general formula. But drawing it out might be easier.

## Organic Molecules

**Table P**  
Organic Prefixes

Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Table P shows prefixes to determine how many Carbon atoms a compound has.

## Give the prefix for the following:



Eth



Prop



But



Pent



Hex



Hept



Oct



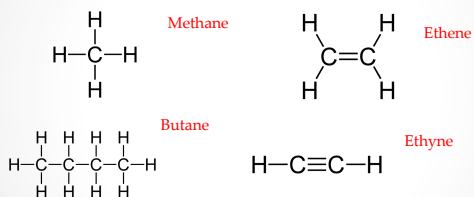
Non



Dec

## Organic Compounds

- Putting P and Q together we can name simple hydrocarbons:



## Saturation

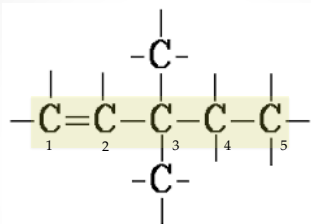
- Compounds like fats that are saturated have many hydrogen atoms. This requires single bonds. **Alkanes are saturated with single bonds.**
- Compounds that are unsaturated have double and triple bonds, therefore, they have less hydrogen atoms. **Alkenes and alkynes are unsaturated.**

## Branched Hydrocarbons

Video 8.2

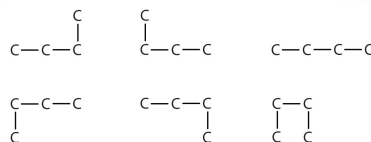
## Branched hydrocarbons

- When naming branched hydrocarbons, name the longest continuous chain and use that as the 'last name.' Making sure the multiple bond is part of that chain. Then name the shorter chains, specifying the position of each branch. Also make sure that your branches are numbered as low as possible.



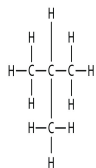
3,3 dimethyl 1 pentene

## Branched hydrocarbons

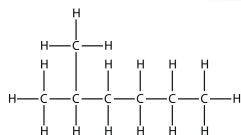


These are all just butane!!!

## Branched hydrocarbons



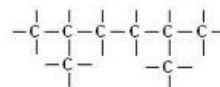
2 methyl propane



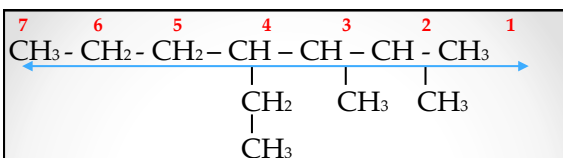
2 methyl hexane

The little branches are known as alkyl groups which is why they have a "yl" ending.

## Branched hydrocarbons



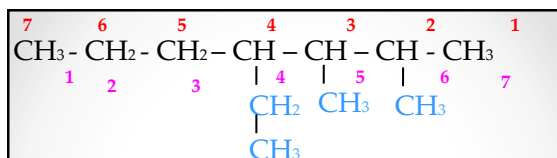
2,5 dimethyl hexane



Find the longest continuous chain of carbons. This is the parent chain. Look at all bonds between carbons to determine type of hydrocarbon. Count from the side with the alkyl groups

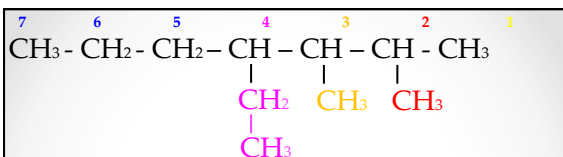
All single bonds so ending is... **ane**.

There are 7 continuous carbons, so the parent chain is **heptane**



Number the carbons in the main sequence starting with the end that will give the **alkyl groups** the smallest #.

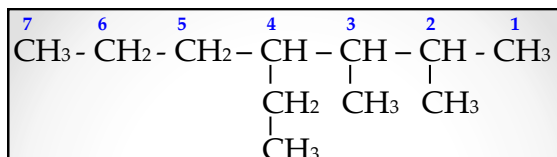
The chain is numbered from right to left because it gives the attached groups the lowest possible number



Add numbers to the names of the groups to identify their positions on the chain. These are prefixes with a "yl" ending.

In this ex. the positions are:

**2 - methyl, 3 - methyl, 4 - ethyl**



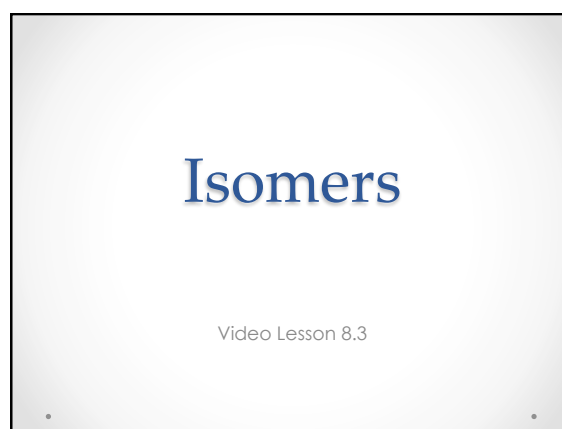
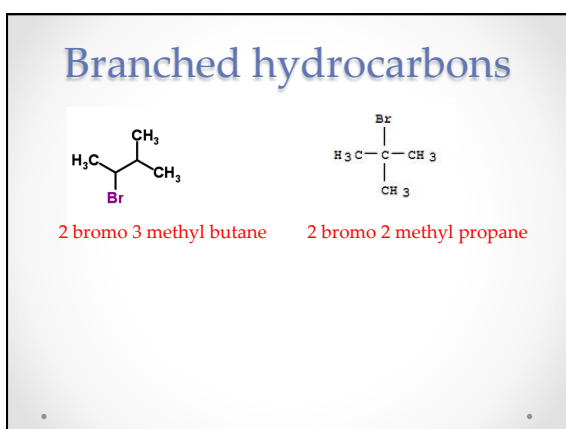
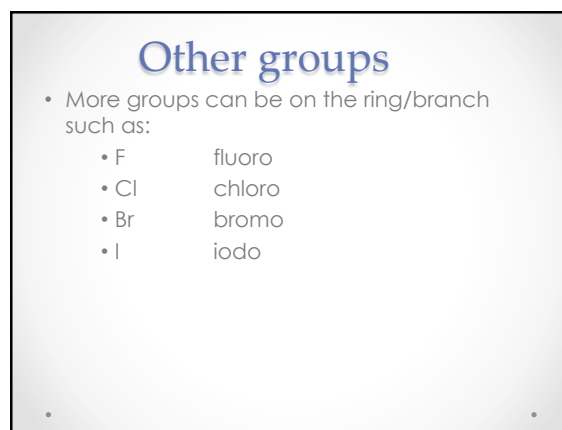
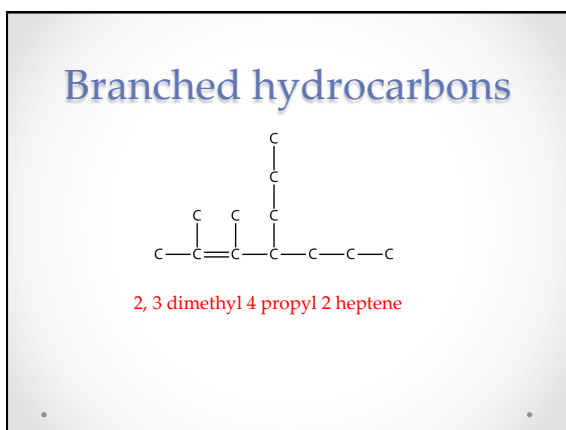
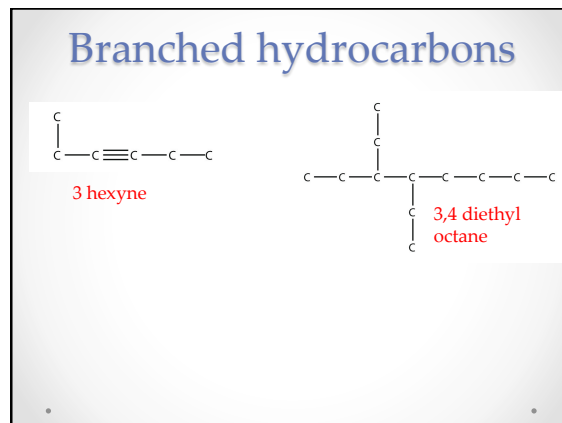
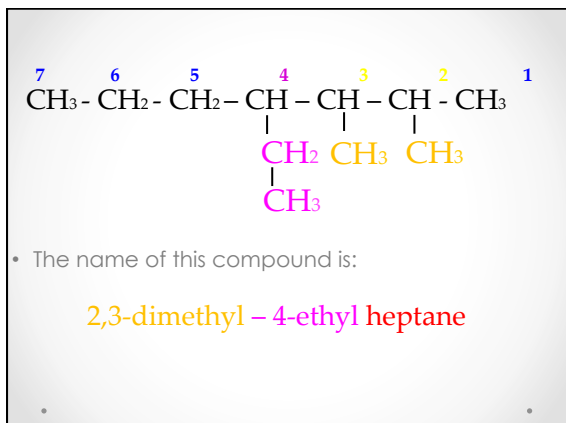
Use prefixes to indicate the appearance of a group more than once in the structure. And list them in alpha order

**Di = twice**

**Tri = three times**

**Tetra = four times**

**Penta = five times**





## Objectives

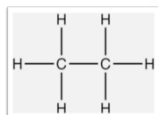
- Identify structural isomers.

## Isomers

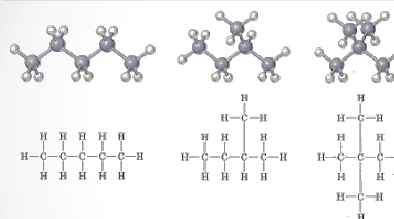
- Isomers are compounds that have the same simple molecular formula, but different structures.

## Formulas

- Molecular Formula: shows the number of atoms of each element in a compound.
- Structural Formula: diagram of the molecular shape of a compound.
- Condensed Structural Formula: each carbon is written separately followed by atoms bonded to it.



## The Three Isomers of Pentane, $\text{C}_5\text{H}_{12}$



pentane

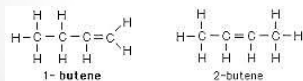
2 methyl butane

2,2 - dimethyl propane

## Isomers

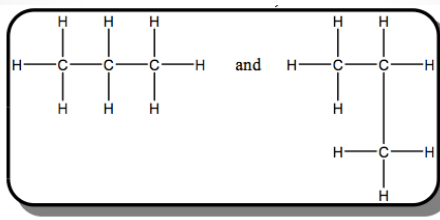
- Isomers have the same molecular formula but rearranged in a different structure with different properties.

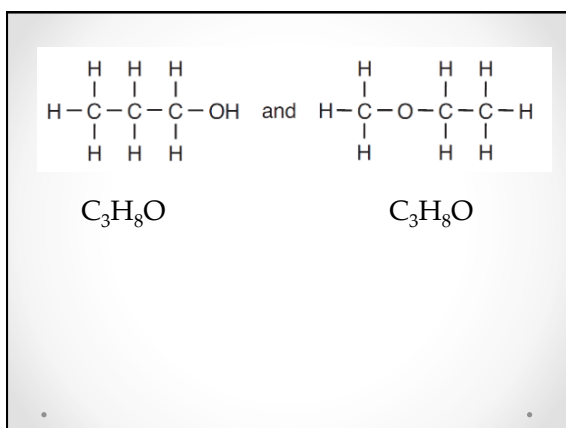
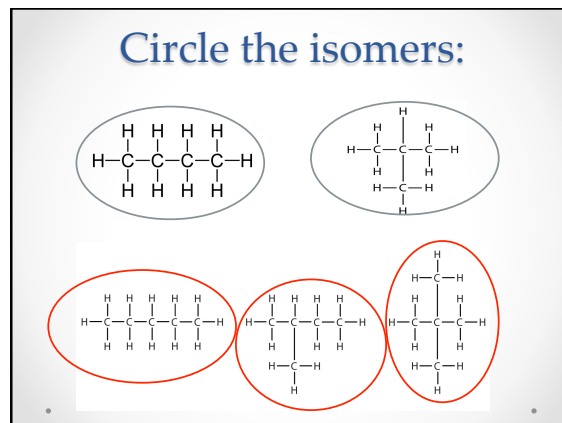
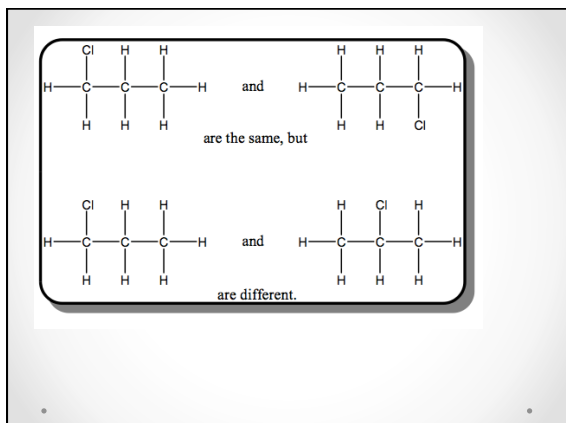
- Draw two isomers of butene:



- Why not 3-butene?

## Not Isomers





**Functional groups**

...

Video 8.4

**Objective:**

How do we use Table R to recognize structural and molecular formulas for organic molecules containing functional groups?

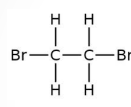
**TAKE OUT TABLE R!!!!**

**Table R  
Organic Functional Groups**

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	-F (fluoro) -Cl (chloro) -Br (bromo) -I (iodo)	R-X (X represents any halogen)	CH <sub>3</sub> CHClCH <sub>3</sub> 2-chloropropane
alcohol	-OH	R-OH	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH 1-propanol
ether	-O-	R-O-R'	CH <sub>3</sub> OCH <sub>2</sub> CH <sub>3</sub> methyl ethyl ether
aldehyde	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R-C-H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> C(=O)H propanal
ketone	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R-C-R'} \end{array}$	CH <sub>3</sub> COCH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> 2-pentanone
organic acid	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-OH} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R-C-OH} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> C(=O)OH propanoic acid
ester	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-O-} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R-C-O-R'} \end{array}$	CH <sub>3</sub> COOCH <sub>2</sub> CH <sub>3</sub> methyl propanoate
amine	$\begin{array}{c} \text{R} \\   \\ \text{-N-} \end{array}$	$\begin{array}{c} \text{R} \\   \\ \text{R-N-R'} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> 1-propanamine
amide	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-NH} \end{array}$	$\begin{array}{c} \text{O} \text{ R} \\ \parallel \   \\ \text{R-C-NH} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> C(=O)NH <sub>2</sub> propanamide

Note: R represents a bonded atom or group of atoms.

## Halides




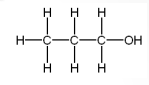
1, 2 dibromo ethane

- Have one of the halogens as a branched group. Names as we did in the previous lessons.

halide (halocarbon)	-F (fluoro-) -Cl (chloro-) -Br (bromo-) -I (iodo-)	R-X (X represents any halogen)	CH <sub>3</sub> CHClCH <sub>3</sub> 2-chloropropane
---------------------	---	-----------------------------------	--

## Alcohol




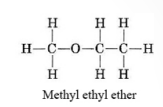


- Suffix: -ol
- Flammable, soluble

alcohol	-OH	R-OH	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH 1-propanol
---------	-----	------	--

## Ether



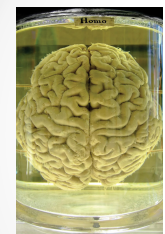


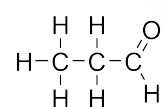
Methyl ethyl ether

- Name small chain, large chain, suffix: -ether
- Anesthetic, soluble

ether	-O-	R-O-R'	CH <sub>3</sub> OCH <sub>2</sub> CH <sub>3</sub> methyl ethyl ether
-------	-----	--------	--

## Aldehyde




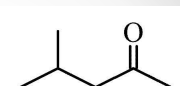


- Suffix: -al
- Soluble, reactive

aldehyde	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R-C-H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> C(=O)H propanal
----------	---	--	--

## Ketone






- Suffix: -one
- Somewhat soluble, needs at least 3 carbons

ketone	$\begin{array}{c} \text{O} \\ \parallel \\ \text{-C-} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R-C-R'} \end{array}$	CH <sub>3</sub> C(=O)CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> 2-pentanone
--------	--	---	---

## acids



$$\begin{array}{c}
 \text{H} & \text{H} & & \text{O} \\
 | & | & & || \\
 \text{H}-\text{C}-\text{C}-\text{C} & & & \\
 | & | & & | \\
 \text{H} & \text{H} & & \text{O}-\text{H}
 \end{array}$$


- Suffix: -anoic acid
- Also known as carboxylic acids: weak acids/ **weak electrolytes**

organic acid	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\    \\ \text{CH}_3\text{CH}_2\text{C}-\text{OH} \\ \text{propanoic acid} \end{array}$
--------------	--	--	--

## Esters

$$\begin{array}{c}
 \text{H} & \text{H} & & \text{O} \\
 | & | & & || \\
 \text{H}-\text{C}-\text{C}-\text{C} & & & \\
 | & | & & | \\
 \text{H} & \text{H} & & \text{O}-\text{C}-\text{H}
 \end{array}$$

- Name chain adjacent to double bonded O last, Suffix: -anoate
- Smells great (perfumes, foods)



ester	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{O}- \end{array}$	$\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{O}-\text{R}' \end{array}$	$\begin{array}{c} \text{O} \\    \\ \text{CH}_3\text{CH}_2\text{C}-\text{OCH}_3 \\ \text{methyl propanoate} \end{array}$
-------	--	---	--

## Amine

Nitrogen is present

$\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{CH}_3$

- Prefix: amino-
- Basic, used in dyes, found in proteins: DNA

amine	$\begin{array}{c}   \\ -\text{N}- \end{array}$	$\begin{array}{c} \text{R}' \\   \\ \text{R}-\text{N}-\text{R}'' \end{array}$	$\begin{array}{c} \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \\ \text{1-propanamine} \end{array}$
-------	--	---	---

## Amine


### Amino Acid Structure

$$\begin{array}{c}
 \text{H} & & \text{H} & & \text{O} \\
 | & & | & & || \\
 \text{H}-\text{N} & - & \text{C} & - & \text{C}-\text{OH} \\
 \text{Amino} & & & & \text{Carboxyl} \\
 \text{Group} & & & & \text{Group} \\
 & & | & & \\
 & & \text{R} & & \\
 & & \text{Side Chain} & &
 \end{array}$$

©Nutrientsreview.com

## Amide

$$\begin{array}{c}
 \text{O} \\
 || \\
 \text{CH}_3\text{CH}_2\text{C}-\text{NH}_2
 \end{array}$$





- Suffix: -amide
- Used in dyes

amide	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{NH} \end{array}$	$\begin{array}{c} \text{O} & \text{R}' \\    &   \\ \text{R}-\text{C} & -\text{NH} \end{array}$	$\begin{array}{c} \text{O} \\    \\ \text{CH}_3\text{CH}_2\text{C}-\text{NH}_2 \\ \text{propanamide} \end{array}$
-------	--	---	---

## Polymers

- Long Carbon chains
- $(\text{C}_2\text{H}_4)_n$
- Used in all plastics, runner, nylons...


# Organic Reactions

Video Lesson 8.5

## Objectives

- Describe and classify different types of organic reactions.

## 7 Types of Organic Reactions

1. Combustion
2. Substitution
3. Addition
4. Esterification
5. Saponification
6. Fermentation
7. Polymerization

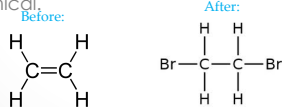
## Combustion

- An alkane is burned in the presence of oxygen to produce water and carbon dioxide ( $O_2$  is always a reactant!)



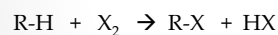
## Addition

- Similar to synthesis reactions: **one product forms**
- $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$
- Notice the first compound is **unsaturated**. The bond breaks to allow new Bromine atoms into the chemical.



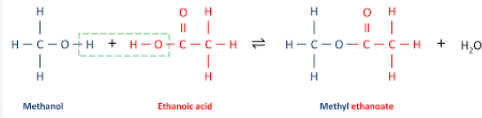
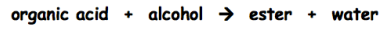
## Substitution

- 1 or more hydrogen atom in a SATURATED ALKANE is replaced by another atom/group



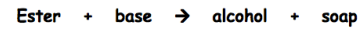
Alkane    Halogen    Halocarbon    Hydrogen halide

## Esterification



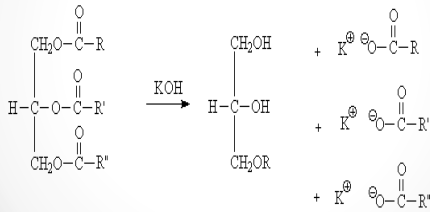
## Saponification

- Making soap



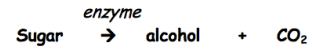
## Saponification

Saponification: Bases added to fats yield glycerol and soap. Look for large molecules and bases!



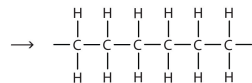
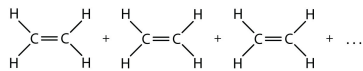
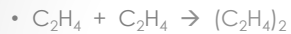
## Fermentation

- The production of alcohol (ethanol)



## Polymerization

- Formation of large molecules called polymers



# Chapter 8: Organic Chemistry

# of Carbon	Alkane	Alkene	Alkyne
1	Methane $\text{C}_1\text{H}_4$		
2	Ethane $\text{C}_2\text{H}_6$	Ethene $\text{C}_2\text{H}_4$	Ethyne $\text{C}_2\text{H}_2$
3			
4			
5			
6			
7			
8			
9			
10			

## Chapter 8: Organic Chemistry

---

### Video 8.1 Hydrocarbons

1. How many carbon atoms are in each compound?

a. Methane \_\_\_\_\_

b. Ethane \_\_\_\_\_

c. Ethene \_\_\_\_\_

d. Pentane \_\_\_\_\_

e. Propene \_\_\_\_\_

f. Hexane \_\_\_\_\_

g. Ethyne \_\_\_\_\_

h. Propane \_\_\_\_\_

i. Heptane \_\_\_\_\_

j. Octane \_\_\_\_\_

k. Decane \_\_\_\_\_

l. Butyne \_\_\_\_\_

m. Butane \_\_\_\_\_

n. Propyne \_\_\_\_\_

o. Butene \_\_\_\_\_

2. For each compound fill in each blank:

	Number of Carbon atoms	Series	Formula
a. Methane	_____	_____	_____
b. Butane	_____	_____	_____
c. Propyne	_____	_____	_____
d. Pentane	_____	_____	_____
e. Octane	_____	_____	_____
f. Heptene	_____	_____	_____
g. Propene	_____	_____	_____
h. Butyne	_____	_____	_____
i. Decane	_____	_____	_____
j. Nonane	_____	_____	_____
k. Heptane	_____	_____	_____
l. Ethyne	_____	_____	_____
m. Hexyne	_____	_____	_____
n. Ethane	_____	_____	_____
o. Propane	_____	_____	_____
p. Decene	_____	_____	_____
q. Octyne	_____	_____	_____

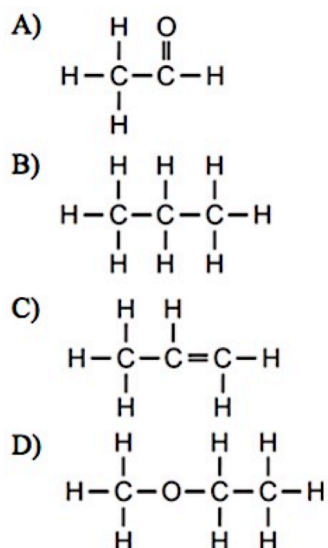
3. How many times does carbon bond and why?



Answer the following questions.

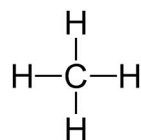
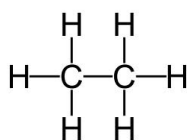
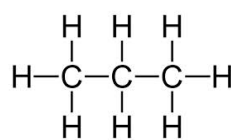
- \_\_\_ All organic compounds must contain:
  - hydrogen
  - nitrogen
  - carbon
  - oxygen
- \_\_\_ Which element is composed of atoms that can form more than one covalent bond (with one another)?
  - hydrogen
  - helium
  - carbon
  - calcium
- \_\_\_ What is the total number of valence electrons in a carbon atom in the ground state
  - 12
  - 2
  - 6
  - 4
- \_\_\_ Which property is generally characteristic of an organic compound?
  - low melting point
  - high melting point
  - mainly polar
  - mainly nonpolar
- \_\_\_ In general, which property do organic compounds share?
  - high melting points
  - high electrical conductivity
  - readily soluble in water
  - slow reaction rate
- \_\_\_ A hydrocarbon molecule containing one triple bond is classified as an:
  - alkene
  - alkane
  - alkyne
  - alkadiene
- \_\_\_ What is the total number of hydrogen atoms in a molecule of butane?
  - 10
  - 6
  - 8
  - 4
- \_\_\_ By how many carbon atoms does each member of a homologous series differ from the previous member?
  - 1
  - 2
  - 3
  - 4
- \_\_\_ Which of the following is a saturated hydrocarbon?
  - ethene
  - ethyne
  - propene
  - propane

10. \_\_\_ Which compound is a member of the same homologous series as  $C_3H_6$ ?
1.  $C_2H_4$
  2.  $C_2H_6$
  3.  $C_3H_4$
  4.  $C_3H_8$
11. \_\_\_ Which hydrocarbon is a member of the series with the general formul  $C_nH_{2nR_2}$ ?
1. ethyne
  2. ethane
  3. butane
  4. benzene
12. \_\_\_ Which compound belongs to the alkene series?
1.  $C_2H_2$
  2.  $C_2H_4$
  3.  $C_6H_6$
  4.  $C_6H_{14}$
13. \_\_\_ Which type of bond occurs in a saturated hydrocarbon molecule?
1. single covalent
  2. double covalent
  3. triple covalent
  4. ionic
14. \_\_\_ In which group could the hydrocarbons all belong to the same homologous series?
1.  $C_2H_2, C_2H_4, C_2H_6$
  2.  $C_2H_4, C_3H_4, C_4H_8$
  3.  $C_2H_4, C_2H_6, C_3H_6$
  4.  $C_2H_4, C_3H_6, C_4H_8$
15. \_\_\_ Which formula represents butane?
1.  $CH_3CH_3$
  2.  $CH_3CH_2CH_3$
  3.  $CH_3CH_2CH_2CH_3$
  4.  $CH_3CH_2CH_2CH_2CH_3$
16. \_\_\_ Which formula represents an unsaturated hydrocarbon?

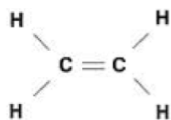
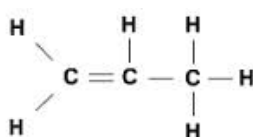
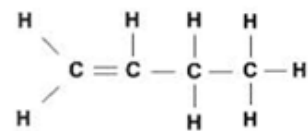


**Video Lesson 8.1**

**Background:** Structural formulas show the arrangement of the atoms within the molecules as far as which atoms are bonded to which and whether single, double or triple bonds are used.

*Figure 1:***Structural formulas for alkanes:***methane**ethane**propane*

1. Using Tables P and Q in your reference table, draw the structural formula for the following alkanes. **Name each compound.**

*Figure 2:***Structural Formulas for Alkenes***ethene**propene**butene*

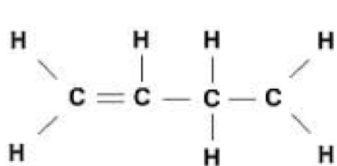
- Based upon Figure 2 and your knowledge of alkenes, why does the compound methene not exist?
- Why do the carbon atoms with the double bond contain 1 less Hydrogen atoms than carbon atoms that contains a single bond?

3. Using Tables P and Q, draw the structural formula for the following alkenes. Name each compound.

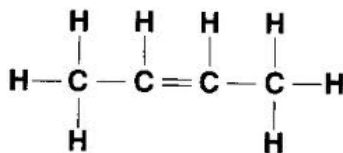


When naming alkenes you must give the location of the double bond in the name when there are more than 3 carbon atoms in the compound. You do this by numbering the carbon atoms and stating which number carbon the double bond is on. You can number the carbon atoms *from left to right* or *right to left* which ever gives the double bond the lowest possible numbered location. This is because compounds are not stationary in the "real world" and are therefore constantly moving. See Figure 3 below.

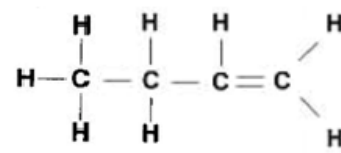
Figure 3:



1-butene

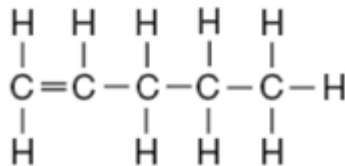
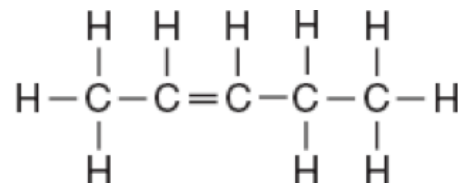
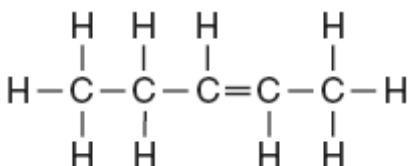


2-butene



1-butene

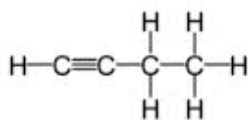
1. Using Figure 3 and reference tables P & Q name the following compounds:



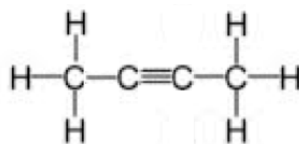
Drawing structural formulas for alkynes is exactly the same as alkenes except they contain a triple bond instead of a double bond.

Figure 4:

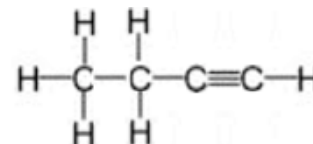
**Structural Formulas for alkynes**



1- butyne



2-butyne

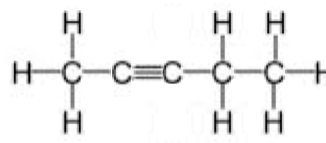
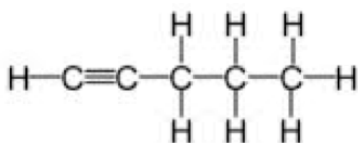


1-butyne

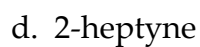
1. Why do the carbons with the triple bond contain no bonded hydrogen atoms?
2. Using Reference Tables P and Q, draw the structural formula for the following alkynes. Name each compound.



3. Name the following compounds:



**Practice: Draw the structural formula for the following compounds:**

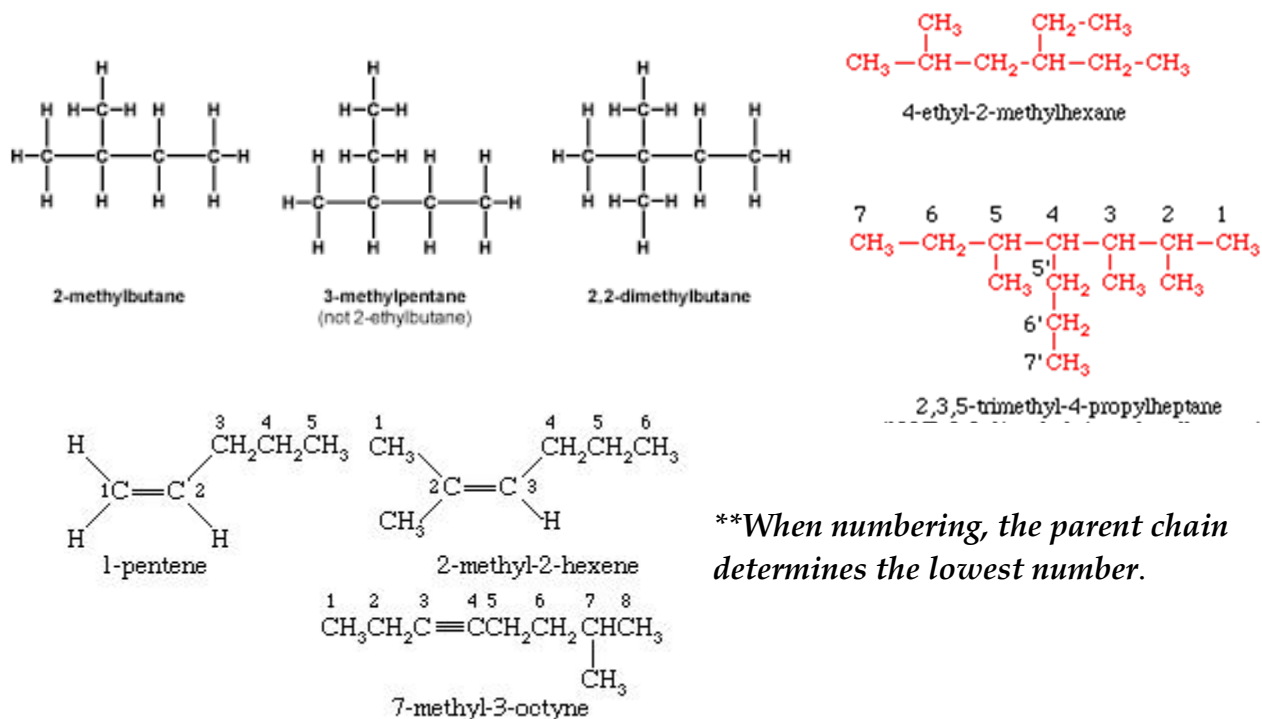


**Video Lesson 8.2**

Chemists use a system developed by the IUPAC (International Union of Pure and Applied Chemistry) system for naming isomers.

1. Identify the longest *continuous* carbon chain. This chain is called the parent chain and forms the basis for the name of the hydrocarbon.
2. Identify all of the substituents (groups branching from the parent chain). The substituents are named using the proper prefix (meth-, eth-, etc) and a -yl ending.
3. Number the carbons of the parent chain from the end that gives the substituents the lowest numbers.
4. If the same substituent occurs more than once, the location of each point on which the substituent occurs is given. In addition, the number of times the substituent group occurs is indicated by a prefix (di, tri, tetra, etc.).
5. If there are two or more different substituents they are listed in alphabetical order using the base name (ignore the prefixes).

The following examples will illustrate this:



Draw the structural formula for 3-ethyl-5-methyl-3-heptene.

**Structure of Hydrocarbons**

1. ethane	5. ethyne
2. propene	6. 3,3-dimethyl pentane
3. 2-butene	7. 2,3 -dimethyl pentane
4. methane	8. 2-butyne



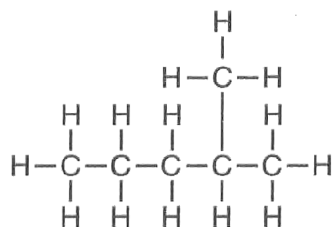


## Organic Structural Formulas

1. Which element is present in all organic compounds?

- 1) carbon                      2) hydrogen  
3) nitrogen                    4) oxygen

2. What is the IUPAC name of the organic compound that has the formula shown below?



- 1) 1,1-dimethylbutane  
2) 2-methylpentane  
3) hexane  
4) 4-methylpentane

3. Which formula represents 2-butene?

- 1) 
$$\begin{array}{ccccccc}
 & \text{H} & \text{H} & \text{H} & \text{H} & & \\
 & | & | & | & | & & \\
 \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} & & & & & & \\
 | & | & | & | & & & \\
 \text{H} & \text{H} & \text{H} & \text{H} & & & 
 \end{array}$$
- 2) 
$$\begin{array}{ccccccc}
 & \text{H} & & \text{H} & & \text{H} & \\
 & \diagdown & & \diagup & & \diagdown & \\
 & \text{C}=\text{C}-\text{C}=\text{C} & & & & & \\
 & \diagup & & \diagdown & & \diagup & \\
 & \text{H} & & & & \text{H} & 
 \end{array}$$
- 3) 
$$\begin{array}{ccccccc}
 & \text{H} & & \text{H} & & \text{H} & \\
 & \diagdown & & \diagup & & \diagdown & \\
 & \text{C}=\text{C}-\text{C}-\text{C}-\text{H} & & & & & \\
 & \diagup & & | & & | & \\
 & \text{H} & & \text{H} & & \text{H} & 
 \end{array}$$
- 4) 
$$\begin{array}{ccccccc}
 & \text{H} & & & & \text{H} & \\
 & | & & & & | & \\
 \text{H}-\text{C}-\text{C}=\text{C}-\text{C}-\text{H} & & & & & & \\
 | & | & | & | & & | & \\
 \text{H} & \text{H} & \text{H} & \text{H} & & \text{H} & 
 \end{array}$$

4. Which formula represents propyne?

- 1) C<sub>3</sub>H<sub>4</sub>                      2) C<sub>3</sub>H<sub>6</sub>  
3) C<sub>5</sub>H<sub>8</sub>                      4) C<sub>5</sub>H<sub>10</sub>

5. Which structural formula represents 2-pentyne?

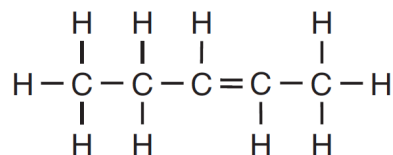
- 1) 
$$\begin{array}{ccccccc}
 & \text{H} & \text{H} & \text{H} & \text{H} & & \\
 & | & | & | & | & & \\
 \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} & & & & & & \\
 | & | & | & | & & & \\
 \text{H} & \text{H} & \text{H}-\text{C}-\text{H} & \text{H} & & & \\
 & & | & & & & \\
 & & \text{H} & & & & 
 \end{array}$$
- 2) 
$$\begin{array}{ccccccc}
 & & & & \text{H} & & \\
 & & & & | & & \\
 & & & & \text{H}-\text{C}-\text{H} & & \\
 & & & & | & & \\
 & & & & \text{H} & & \\
 & & & & | & & \\
 & & & & \text{H}-\text{C}-\text{H} & & \\
 & & & & | & & \\
 & & & & \text{H} & & \\
 & & & & | & & \\
 & & & & \text{H}-\text{C}-\text{H} & & \\
 & & & & | & & \\
 & & & & \text{H} & & 
 \end{array}$$
- 3) 
$$\begin{array}{ccccccc}
 & \text{H} & & \text{H} & \text{H} & \text{H} & \\
 & | & & | & | & | & \\
 \text{H}-\text{C}-\text{C}=\text{C}-\text{C}-\text{C}-\text{H} & & & & & & \\
 | & | & & | & | & | & \\
 \text{H} & \text{H} & & \text{H} & \text{H} & \text{H} & 
 \end{array}$$
- 4) 
$$\begin{array}{ccccccc}
 & \text{H} & & & \text{H} & \text{H} & \\
 & | & & & | & | & \\
 \text{H}-\text{C}-\text{C}\equiv\text{C}-\text{C}-\text{C}-\text{H} & & & & & & \\
 | & & & | & | & & \\
 \text{H} & & & \text{H} & \text{H} & & 
 \end{array}$$

6. Which structural formula is *incorrect*?

- 1) 
$$\begin{array}{ccc}
 & \text{H} & \\
 & | & \\
 \text{H}-\text{C}-\text{Cl} & & \\
 & | & \\
 & \text{H} & 
 \end{array}$$
- 2) 
$$\begin{array}{ccc}
 \text{H} & & \text{H} \\
 & \diagdown & / \\
 & \text{C}=\text{C} & \\
 & / & \diagdown \\
 \text{H} & & \text{H}
 \end{array}$$
- 3) 
$$\begin{array}{ccc}
 & \text{O} & \\
 & || & \\
 \text{H}-\text{C}-\text{OH} & & 
 \end{array}$$
- 4) 
$$\begin{array}{ccccccc}
 & & \text{H} & & \text{H} & & \\
 & & | & & | & & \\
 \text{H} & & \text{C}=\text{C}-\text{C}-\text{H} & & & & \\
 & & | & & | & & \\
 & & \text{H} & & \text{H} & & 
 \end{array}$$

7. In the space below, draw a structural formula for a molecule of 2,2,4-trimethylpentane.

8. Given the formula representing a compound:



What is a chemical name of this compound?

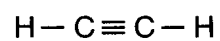
- 1) 2-pentene                      2) 2-pentyne  
3) 3-pentene                    4) 3-pentyne

---

9. Which condensed structural formula represents an unsaturated compound?

- 1)  $\text{CH}_3\text{CHCHCH}_3$
- 2)  $\text{CH}_3\text{CH}_2\text{CH}_3$
- 3)  $\text{CH}_3\text{CH}_3$
- 4)  $\text{CH}_4$

10. Given the structural formula for ethyne:



What is the total number of electrons shared between the carbon atoms?

- 1) 6
  - 2) 2
  - 3) 3
  - 4) 4
-

# Chapter 8 Organic Chemistry

## Video Lesson 8.3: Isomers

1. Record the Structural formula, molecular formula, and condensed formula for the following:

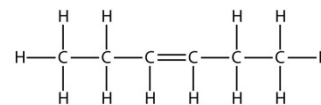
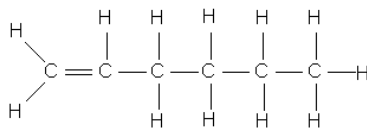
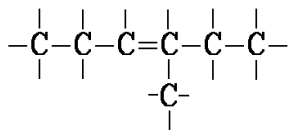
Name	Structural	Molecular	Condensed
2, 3-dimethyl butane			
2, 2-dimethyl butane			
2-heptyne			
3-hexene			
2-methyl 1-pentene			

2. Were any of the above isomers? Explain your answer. \_\_\_\_\_

\_\_\_\_\_

3. Draw an isomer of 2-heptyne below. Give the name of your isomer: \_\_\_\_\_

4. Name the following and identify the isomers.



\_\_\_\_\_

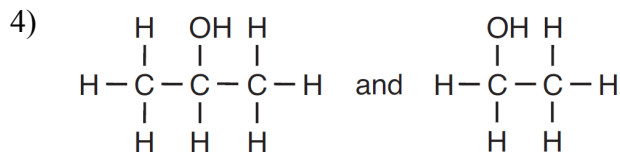
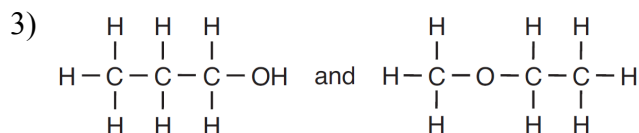
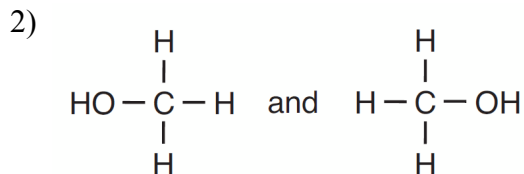
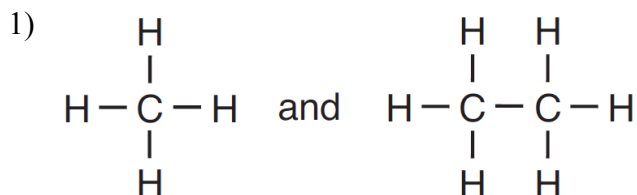
\_\_\_\_\_

\_\_\_\_\_

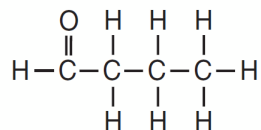
5. Which of the hydrocarbons in the table above were saturated?

## Isomers 8.3

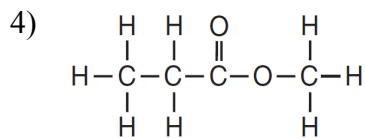
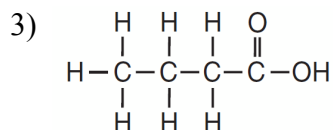
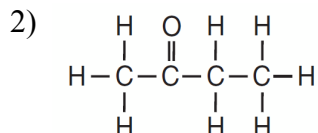
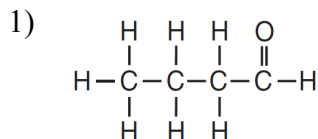
1. Which formulas represent compounds that are isomers of each other?



2. Given a formula representing a compound:



Which formula represents an isomer of this compound?



3. The two isomers of butane have different

- 1) formula masses
- 2) empirical formulas
- 3) molecular formulas
- 4) structural formulas

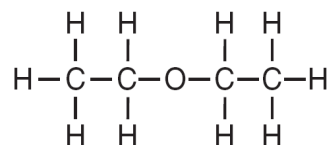
4. The isomers butane and methylpropane differ in their

- 1) molecular formulas
- 2) structural formulas
- 3) total number of atoms per molecule
- 4) total number of bonds per molecule

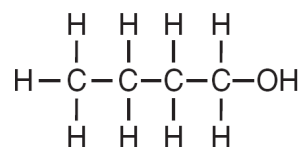
5. Which two compounds are isomers of each other?

- 1)  $\text{CH}_3\text{CH}_2\text{COOH}$  and  $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- 2)  $\text{CH}_3\text{CH}_2\text{CHO}$  and  $\text{CH}_3\text{COCH}_3$
- 3)  $\text{CH}_3\text{CHBrCH}_3$  and  $\text{CH}_2\text{BrCHBrCH}_3$
- 4)  $\text{CH}_3\text{CHOHCH}_3$  and  $\text{CH}_3\text{CHOHCH}_2\text{OH}$

6. Given the formulas for two compounds:



*and*



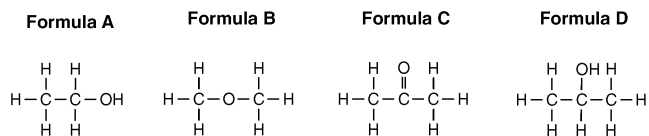
These compounds differ in

- 1) gram-formula mass
- 2) molecular formula
- 3) percent composition by mass
- 4) physical properties at STP

7. Two substances have different physical and chemical properties. Both substances have molecules that contain two carbon atoms, one oxygen atom, and six hydrogen atoms. These two substances must be

- 1) isomers of each other
- 2) isotopes of each other
- 3) the same compound
- 4) the same hydrocarbon

8. Given the structural formulas:



Which two formulas represent compounds that are isomers of each other?

- |                          |                          |
|--------------------------|--------------------------|
| 1) <i>A</i> and <i>B</i> | 2) <i>A</i> and <i>C</i> |
| 3) <i>B</i> and <i>D</i> | 4) <i>C</i> and <i>D</i> |

9. The compounds  $\text{CH}_3\text{OCH}_3$  and  $\text{CH}_3\text{CH}_2\text{OH}$  are isomers of each other. These two compounds must have the same

- 1) density
- 2) reactivity
- 3) melting point
- 4) molecular formula

10. Which pair of compounds are isomers?

- 1)  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$
- 2)  $\text{P}_2\text{O}_5$  and  $\text{P}_4\text{O}_{10}$
- 3)  $\text{HCOOH}$  and  $\text{CH}_3\text{COOH}$
- 4)  $\text{CH}_3\text{OCH}_3$  and  $\text{C}_2\text{H}_5\text{OH}$

## Chapter 8: Organic Chemistry

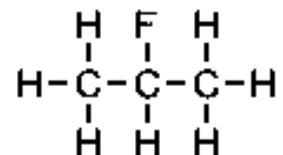
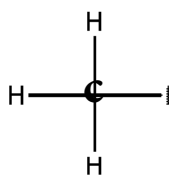
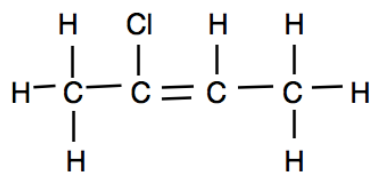
### Video Lesson 8.4: Functional Groups

For the following compounds, determine the family and draw the compound:

Name	Family	Structural Formula	Condensed Formula
Butanoic acid			
Methanal			
Butanamide			
3-iodo octane			
Methyl pentanoate			
Ethanol			
2-heptanone			
Diethyl ether			
2-pentanol			
Ethanoic acid			
2-propanamine			
Hexanal			
Ethyl methanoate			

Practice Organic Chemistry

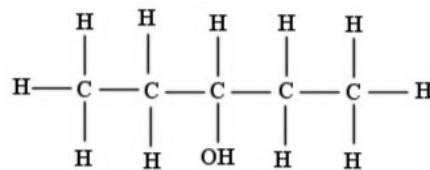
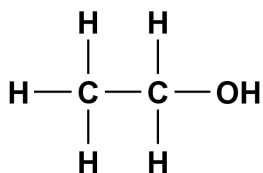
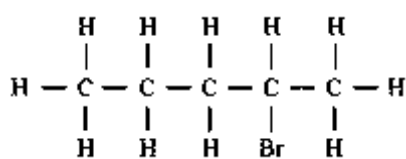
Classify each of the following structural formulas and write each name.



\_\_\_\_\_

\_\_\_\_\_

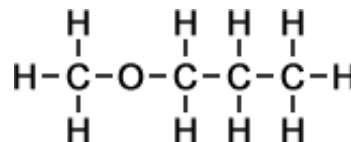
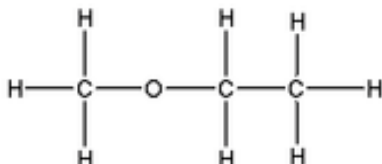
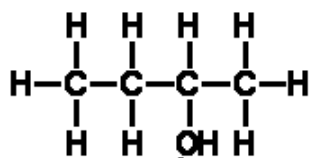
\_\_\_\_\_



\_\_\_\_\_

\_\_\_\_\_

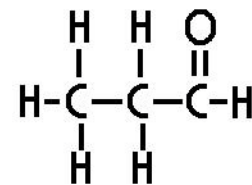
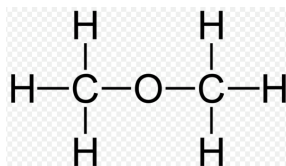
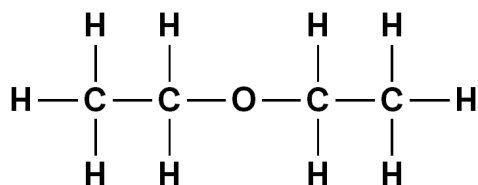
\_\_\_\_\_



\_\_\_\_\_

\_\_\_\_\_

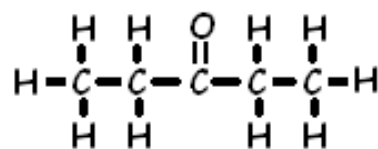
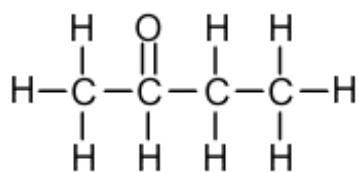
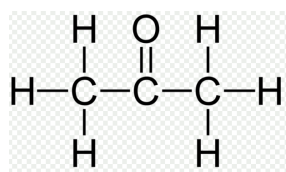
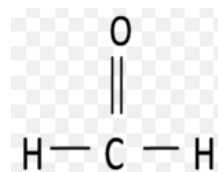
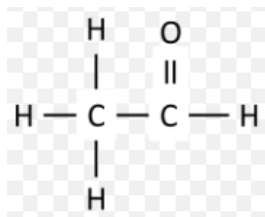
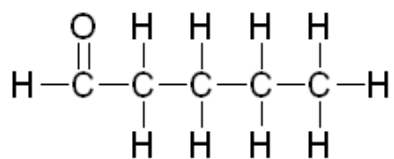
\_\_\_\_\_



\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



*Classify each name and draw the structural formula*

2 hexanol

ethyl methyl ether

3 heptanol

2 hexanone

butanal

2 pentanone



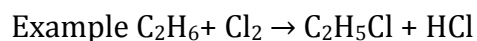
**Video Lesson 8.5:**Organic Reactions

**Combustion:** Many organic compounds react with excess oxygen to form carbon dioxide and water. On Table I of your reference, the first 6 reactions are combustion reactions. Write a balance reaction for the combustion of:

1. Ethane:

2. Pentane:

**Substitution:** Saturated hydrocarbons(ALKANES) may replace a hydrogen atom in the molecule with another element usually a halogen.



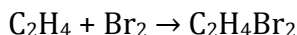
Draw the structural formulas for the above reaction:

Name the product  $C_2H_5Cl$ \_\_\_\_\_

Write a balanced reaction for the substitution of bromine onto propane.

Draw the structure of and name two possible halocarbon isomers formed in the above reaction.

**Addition:** Unsaturated hydrocarbons (ALKENES or(ALKYNES) can add a atom of hydrogen or of a halogen at the site of a double or triple bond. When hydrogen is added, the process is called HYDROGENATION. When a halogen is added, the process is called HALOGENATION.



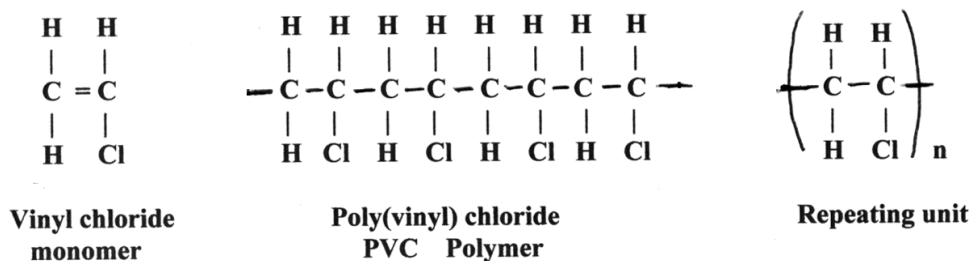
Name the product\_\_\_\_\_

Now write structural formulas for the addition of  $Cl_2$  onto 2 butene. Name the product. Notice that, unlike substitution, only one product is possible!

When hydrogen is added to propene, what is the name of the new hydrocarbon thae forms?Write a balanced equation to illustrate this reaction.

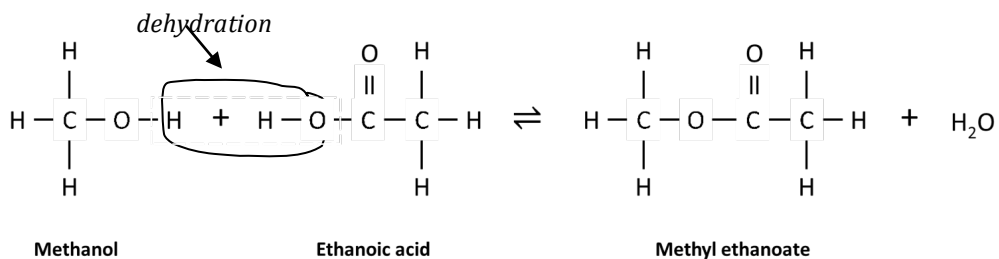
<http://mintzchemistry.weebly.com>

**Polymerization:** Large molecules can form when individual units of molecules (*monomers*) are chained together to form a *polymer*. If the individual monomer is an unsaturated hydrocarbon, **addition polymerization** may occur as the double (or triple) bond is "broken open" and a chain is formed: (

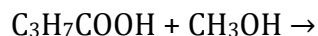
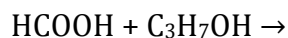
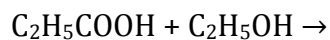


**Esterification:** Esters are compounds which have pleasant odors. They are formed by the reaction between organic acids and alcohols.

Ethanoic acid and methanol will react to form methyl ethanoate. The structural formulas for this reaction are shown below.



Now draw the structures, determine the products and name each reactant and organic product in the following esterification reactions:

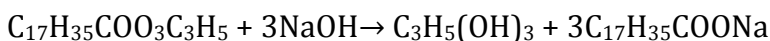


**Fermentation:** In the fermentation process, enzymes found in living things, such as yeast, convert carbohydrates usually sugar into carbon dioxide and alcohol.

Glucose( $C_6H_{12}O_6$ ) is fermented in the presence of the enzyme *zymase* in yeast to form ethanol and carbon dioxide. Write a balanced equation to represent this reaction:

**Saponification:** The hydrolysis of fats by basis is saponification or *soap-making*. This process was made "famous" by a scene from the (movie "Fight(Club)". The main(characters in the film steal human fat from a liposuction clinic and react it with lye (NaOH) to form soap.

The reaction looks like this:(



The presence of the Na and the NaOH makes this reaction very recognizable!  
Occasionally, KOH is used instead of NaOH....

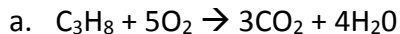
## Chapter 8: Organic Chemistry

---

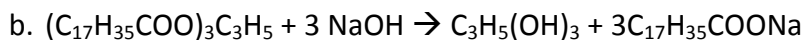
### Video Lesson 8.5: Organic Reactions

#### Match the reaction to its name:

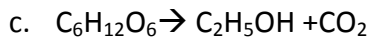
\_\_\_ 1. Addition



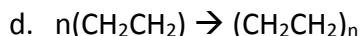
\_\_\_ 2. Substitution



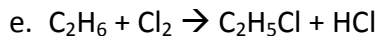
\_\_\_ 3. Combustion



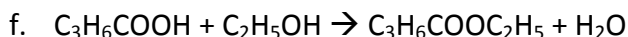
\_\_\_ 4. Polymerization



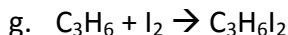
\_\_\_ 6. Fermentation



\_\_\_ 7. Esterification



\_\_\_ 8. Saponification



#### Name the reaction:

9. A saturated alkane reacts with fluorine

\_\_\_\_\_

10. Small alkene chains connect to form larger alkane chains

\_\_\_\_\_

11. Sugar is decomposed to form an alcohol

\_\_\_\_\_

12. An unsaturated hydrocarbon reacts with bromine

\_\_\_\_\_

13. An alcohol and an organic acid are reacted

\_\_\_\_\_

14. A base is added to a fat molecule to form a soap

\_\_\_\_\_

15. Hydrocarbons are burned in the presence of oxygen

\_\_\_\_\_

Draw all organic reactants and products. Then name and give the formula for the missing substance in the reaction. Give the reaction type.



Rxn: \_\_\_\_\_



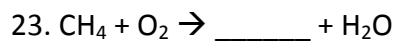
Rxn: \_\_\_\_\_



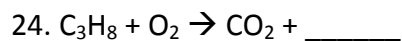
Rxn: \_\_\_\_\_



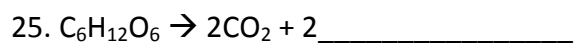
Rxn: \_\_\_\_\_



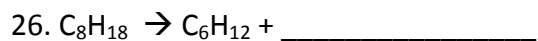
Rxn: \_\_\_\_\_



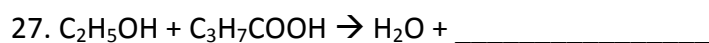
Rxn: \_\_\_\_\_



Rxn: \_\_\_\_\_



Rxn: \_\_\_\_\_



Rxn: \_\_\_\_\_



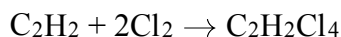
Rxn: \_\_\_\_\_

## 8.5 Organic Reactions

1. Which formula represents the product of the addition reaction between ethene and chlorine, Cl<sub>2</sub>?

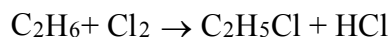
- 1)  $\begin{array}{c} \text{Cl} \quad \text{Cl} \\ | \quad | \\ \text{Cl}-\text{C}-\text{C}-\text{Cl} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$       2)  $\begin{array}{c} \text{Cl} \quad \text{Cl} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$
- 3)  $\begin{array}{c} \text{Cl} \quad \text{Cl} \\ | \quad | \\ \text{H}-\text{C}=\text{C}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$       4)  $\begin{array}{c} \text{Cl} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$

2. Given the balanced equation for an organic reaction:



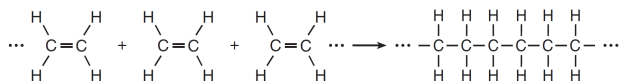
This reaction is best classified as

- 1) addition                      2) esterification  
3) fermentation              4) substitution
3. Given the equation:



This reaction is best described as

- 1) addition involving a saturated hydrocarbon  
2) addition involving an unsaturated hydrocarbon  
3) substitution involving a saturated hydrocarbon  
4) substitution involving an unsaturated hydrocarbon
4. Given the equation:



Which type of reaction is represented by this equation?

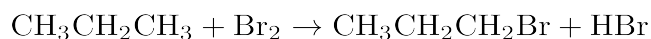
- 1) combustion                  2) esterification  
3) polymerization              4) substitution
5. The reaction that joins thousands of small, identical molecules to form one very long molecule is called
- 1) esterification                  2) fermentation  
3) polymerization              4) substitution

6. Given the reaction:



This reaction is an example of

- 1) fermentation                  2) saponification  
3) hydrogenation                4) esterification
7. When butane burns in an excess of oxygen, the principal products are
- 1) CO<sub>2</sub> and H<sub>2</sub>O                2) CO<sub>2</sub> and H<sub>2</sub>  
3) CO and H<sub>2</sub>O                4) CO and H<sub>2</sub>
8. Which reaction results in the production of soap?
- 1) esterification                  2) fermentation  
3) polymerization                4) saponification
9. Which formula correctly represents the product of an addition reaction between ethene and chlorine?
- 1) CH<sub>2</sub>Cl<sub>2</sub>                        2) CH<sub>3</sub>Cl  
3) C<sub>2</sub>H<sub>4</sub>Cl<sub>2</sub>                       4) C<sub>2</sub>H<sub>3</sub>Cl
10. Given the balanced equation representing a reaction:

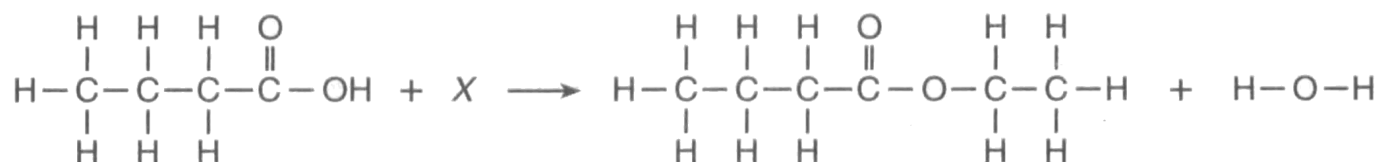


This organic reaction is best classified as

- 1) an addition reaction  
2) an esterification reaction  
3) a polymerization reaction  
4) a substitution reaction
11. Which type of reaction is represented by the equation below?
- Note:** n and n are very large numbers equal to about 2000.
- $$n \left( \begin{array}{c} \text{H} \quad \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{H} \end{array} \right) \rightarrow \left( \begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ -\text{C} - \text{C}- \\ | \quad | \\ \text{H} \quad \text{H} \end{array} \right)_n$$
- 1) esterification                  2) fermentation  
3) saponification                4) polymerization
12. Which reaction produces ethanol?
- 1) combustion                    2) esterification  
3) fermentation                 4) polymerization

Base your answers to questions 13 and 14 on the following information.

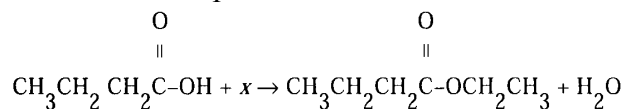
The equation below represents the reaction between butanoic acid and an unidentified reactant,  $X$ .



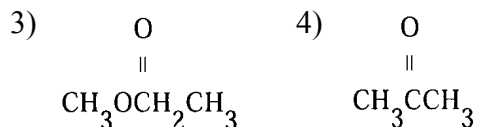
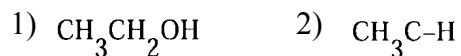
13 Draw a structural formula for the unidentified reactant,  $X$ , in the equation.

14. Identify the type of organic reaction represented by the equation.

15. Given the incomplete reaction:



Which compound is represented by  $x$ ?



16. What are the two main products of a fermentation reaction?

- 1) ethanol and carbon dioxide
- 2) ethanol and water
- 3) sugar and carbon dioxide
- 4) sugar and water

17. Which reaction best represents the complete combustion of ethene?

- 1)  $\text{C}_2\text{H}_4 + \text{HCl} \rightarrow \text{C}_2\text{H}_5\text{Cl}$
- 2)  $\text{C}_2\text{H}_4 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2$
- 3)  $\text{C}_2\text{H}_4 + 3 \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2\text{O}$
- 4)  $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH}$

## Organic Review

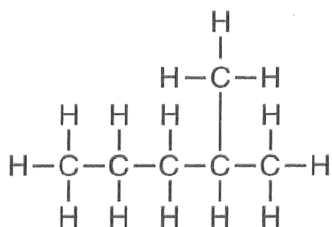
1. Which compound is a saturated hydrocarbon?

- A) propanal                      B) propane  
C) propene                        D) propyne

2. Which compound is a member of the same homologous series as  $C_3H_8$ ?

- A)  $CH_4$                             B)  $C_4H_8$   
C)  $C_5H_8$                         D)  $C_5H_{10}$

3. What is the IUPAC name of the organic compound that has the formula shown below?



- A) 1,1-dimethylbutane  
B) 2-methylpentane  
C) hexane  
D) 4-methylpentane

4. Hydrocarbons are compounds that contain

- A) carbon, only  
B) carbon and hydrogen, only  
C) carbon, hydrogen, and oxygen, only  
D) carbon, hydrogen, oxygen, and nitrogen, only

5. A molecule of a compound contains a total of 10 hydrogen atoms and has the general formula  $C_nH_{2n+2}$ .

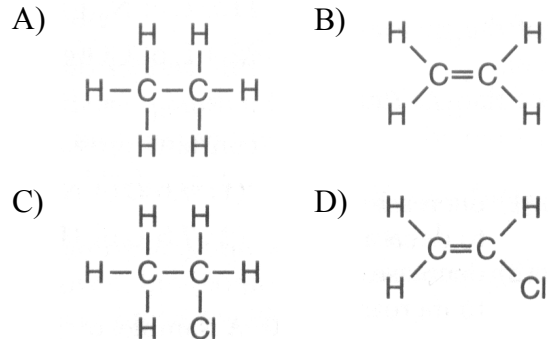
Which prefix is used in the name of this compound?

- A) but-    B) dec-    C) oct-    D) pent-

6. Which compound is a saturated hydrocarbon?

- A)  $CH_2CH_2$                       B)  $CH_3CH_3$   
C)  $CH_3CHO$                       D)  $CH_3CH_2OH$

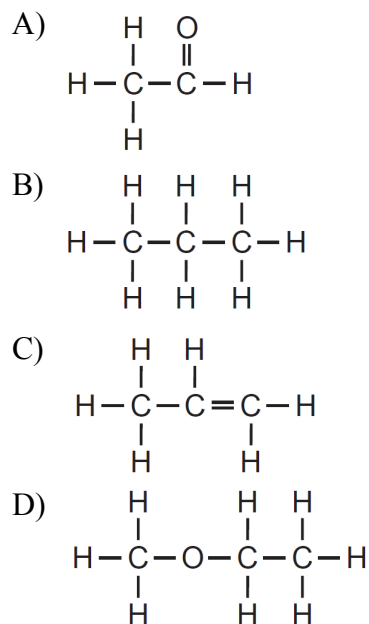
7. Which formula represents an unsaturated hydrocarbon?



8. Which formula represents an unsaturated hydrocarbon?

- A)  $C_5H_{12}$                             B)  $C_6H_{14}$   
C)  $C_7H_{16}$                             D)  $C_8H_{14}$

9. Which formula represents an unsaturated hydrocarbon?

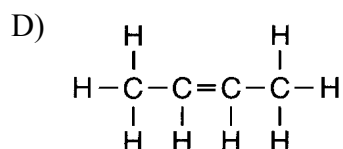
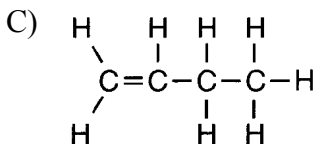
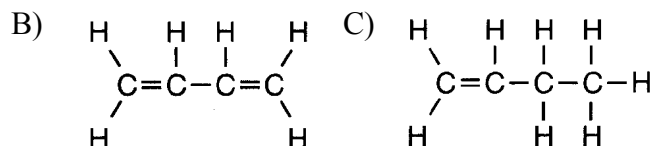
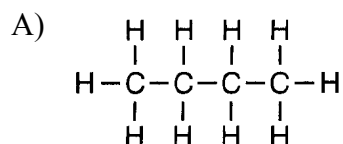


10. A straight-chain hydrocarbon that has only one double bond in each molecule has the general formula

- A)  $C_nH_{2n-6}$                       B)  $C_nH_{2n-2}$   
C)  $C_nH_{2n}$                         D)  $C_nH_{2n+2}$



11. Which formula represents 2-butene?



12. A carbon-carbon triple bond is found in a molecule of

- A) butane                      B) butanone  
C) butene                      D) butyne

13. Which compound is an alkyne?

- A)  $\text{C}_2\text{H}_2$                       B)  $\text{C}_2\text{H}_4$   
C)  $\text{C}_4\text{H}_8$                       D)  $\text{C}_4\text{H}_{10}$

14. Which general formula represents the compound  $\text{CH}_3\text{CH}_2\text{CCH}$ ?

- A)  $\text{C}_n\text{H}_n$                       B)  $\text{C}_n\text{H}_{2n}$   
C)  $\text{C}_n\text{H}_{2n-2}$                   D)  $\text{C}_n\text{H}_{2n+2}$

15. Which compound is an unsaturated hydrocarbon?

- A) hexanal                      B) hexane  
C) hexanoic acid              D) hexyne

16. Which element is present in all organic compounds?

- A) carbon                      B) hydrogen  
C) nitrogen                      D) oxygen

17. Butanal and butanone have different chemical and physical properties primarily because of differences in their

- A) functional groups  
B) molecular masses  
C) molecular formulas  
D) number of carbon atoms per molecule

18. Ethanol and dimethyl ether have different chemical and physical properties because they have different

- A) functional groups  
B) molecular masses  
C) numbers of covalent bonds  
D) percent compositions by mass

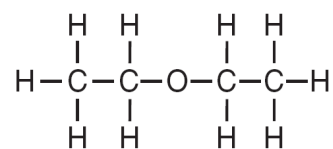
19. Which two compounds have the same molecular formula but different chemical and physical properties?

- A)  $\text{CH}_3\text{CH}_2\text{Cl}$  and  $\text{CH}_3\text{CH}_2\text{Br}$   
B)  $\text{CH}_3\text{CHCH}_2$  and  $\text{CH}_3\text{CH}_2\text{CH}_3$   
C)  $\text{CH}_3\text{CHO}$  and  $\text{CH}_3\text{COCH}_3$   
D)  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{OCH}_3$

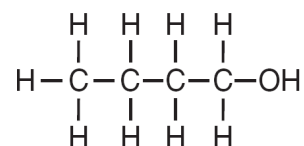
20. The isomers butane and methylpropane differ in their

- A) molecular formulas  
B) structural formulas  
C) total number of atoms per molecule  
D) total number of bonds per molecule

21. Given the formulas for two compounds:



and

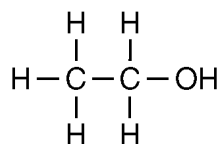


These compounds differ in

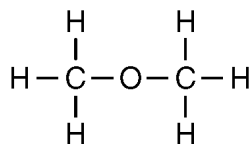
- A) gram-formula mass  
B) molecular formula  
C) percent composition by mass  
D) physical properties at STP

22. Given the structural formulas:

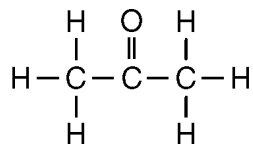
**Formula A**



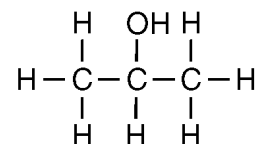
**Formula B**



**Formula C**



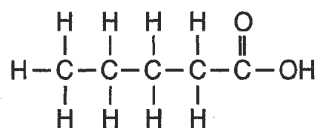
**Formula D**



Which two formulas represent compounds that are isomers of each other?

- A) *A* and *B*      B) *A* and *C*      C) *B* and *D*      D) *C* and *D*

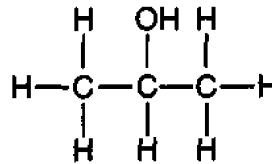
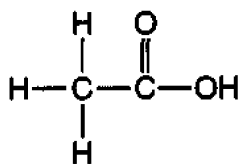
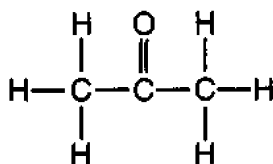
23. Given the formula for an organic compound:



This compound is classified as an

- A) aldehyde      B) amine  
C) ester      D) organic acid
24. What is the total number of carbon atoms in a molecule of ethanoic acid?  
A) 1      B) 2      C) 3      D) 4

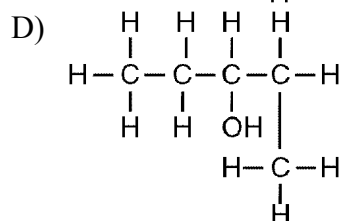
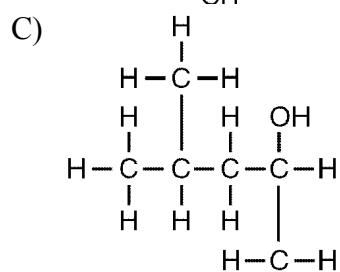
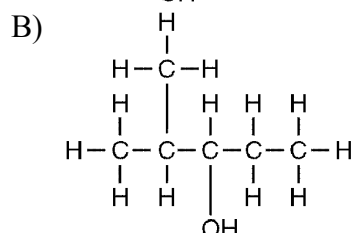
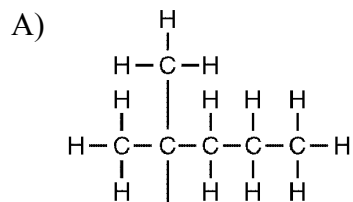
25. Given the three organic structural formulas shown below:



Which organic compound classes are represented by these structural formulas, as shown from left to right?

- A) ester, organic acid, ketone      B) ester, aldehyde, organic acid  
C) ketone, aldehyde, alcohol      D) ketone, organic acid, alcohol

26. Which structural formula is correct for 2-methyl-3-pentanol?



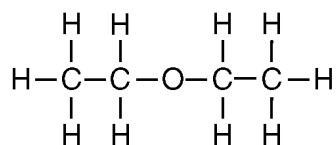
27. What is the total number of pairs of electrons shared between the carbon atom and the oxygen atom in a molecule of methanal?

- A) 1    B) 2    C) 3    D) 4

28. The reaction between an organic acid and an alcohol produces

- A) an aldehyde            B) a ketone  
C) an ether                D) an ester

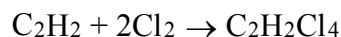
29. Given the structural formula:



The compound represented by this formula can be classified as an

- A) organic acid            B) ether  
C) ester                    D) aldehyde

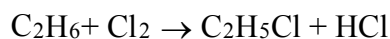
30. Given the balanced equation for an organic reaction:



This reaction is best classified as

- A) addition                B) esterification  
C) fermentation          D) substitution

31. Given the equation:



This reaction is best described as

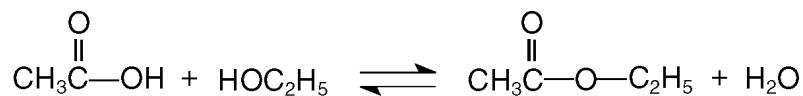
- A) addition involving a saturated hydrocarbon  
B) addition involving an unsaturated hydrocarbon  
C) substitution involving a saturated hydrocarbon  
D) substitution involving an unsaturated hydrocarbon

32. The reaction that joins thousands of small, identical molecules to form one very long molecule is called

- A) esterification          B) fermentation  
C) polymerization        D) substitution

---

33. Given the reaction:



This reaction is an example of

- A) fermentation    B) saponification    C) hydrogenation    D) esterification
- 

34. What are the two main products of a fermentation reaction?

- A) ethanol and carbon dioxide  
B) ethanol and water  
C) sugar and carbon dioxide  
D) sugar and water

35. Which reaction results in the production of soap?

- A) esterification    B) fermentation  
C) polymerization    D) saponification

Base your answers to questions **36** through **38** on the information below.

Gasoline is a mixture composed primarily of hydrocarbons such as isooctane, which is also known as 2,2,4-trimethylpentane.

Gasoline is assigned a number called an octane rating. Gasoline with an octane rating of 87 performs the same as a mixture that consists of 87% isooctane and 13% heptane.

An alternative fuel, E-85, can be used in some automobiles. This fuel is a mixture of 85% ethanol and 15% gasoline.

36. In the space below, draw a structural formula for a molecule of 2,2,4-trimethylpentane.

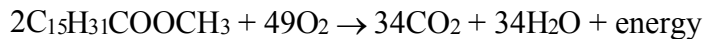
37. State the octane rating of a gasoline sample that performs the same as a mixture consisting of 92% isooctane and 8% heptane.

38. Identify the functional group in a molecule of ethanol in the alternative fuel E-85.

---

Base your answers to questions **39** through **43** on the information below.

Biodiesel is an alternative fuel for vehicles that use petroleum diesel. Biodiesel is produced by reacting vegetable oil with CH<sub>3</sub>OH. Methyl palmitate, C<sub>15</sub>H<sub>31</sub>COOCH<sub>3</sub>, a compound found in biodiesel, is made from soybean oil. One reaction of methyl palmitate with oxygen is represented by the balanced equation below.



39. Identify the type of organic reaction represented by the balanced equation.
40. Identify the class of organic compounds to which methyl palmitate belongs.
41. Explain, in terms of *both* atoms and molecular structure, why there is no isomer of CH<sub>3</sub>OH.
42. Write the IUPAC name for the compound that reacts with vegetable oil to produce biodiesel.
43. State evidence from the balanced equation that indicates the reaction is exothermic.