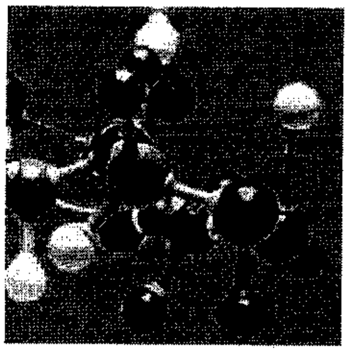
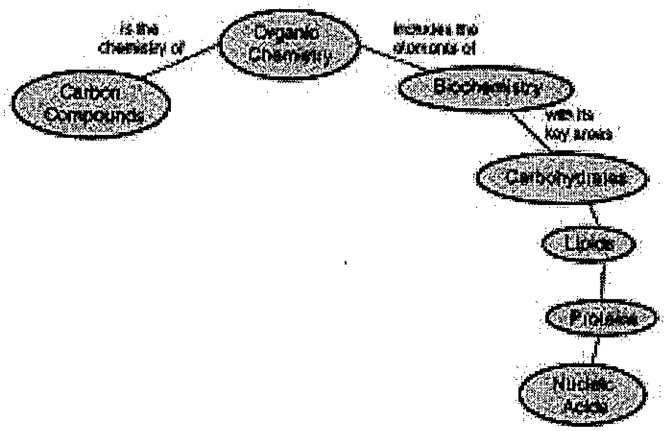
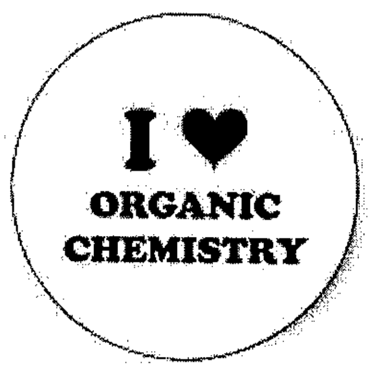
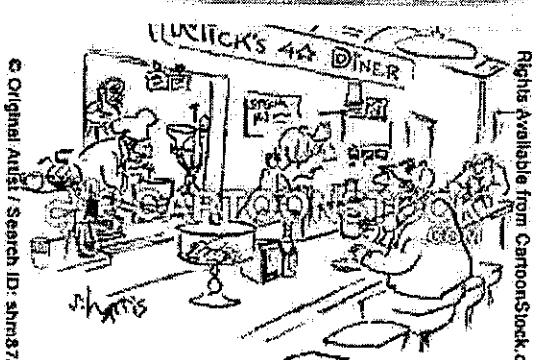
Organic Chemistry









"NICK MAJORED IN ORGANIC."

Chemistry: Form Ls11.1A

Name ______________________

ORGANIC CHEMISTRY

Date ______________ Period _____

Nature of Carbon and Hydrocarbons

Aim

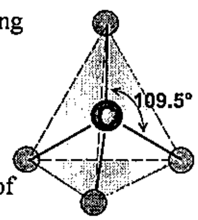
- to describe bonding in carbon and the type of compounds it typically forms

Notes

Nature of Carbon

★ Family - Group group 14
  - ☆ Metalloid - can bond with metals and nonmetals
  - ☆ Most active member of family
  - ☆ Electron configuration
    - ★ 4 valence electrons
    - ★ can bond with up to four elements at once

★ Bonding
  - ☆ forms compounds by covalent bonding
    - ★ single bond - one shared pair of electrons —C— (with bonds above and below)
      - ★ forms a regular tetrahedron



    - ★ double bond - two shared pairs of electrons >C=C<
    - ★ triple bond - three shared pairs of electrons —C≡C—
  - ☆ forms bonds with other elements or with other carbons
  - ☆ can form chains of carbon of unlimited length
    - ★ chains can be straight
    - ★ chains can be branched
    - ★ chains can be closed to form rings

★ The variety and complexity of carbon compounds is unlimited

Characteristics of organic compounds

- ★ Formed as a result almost exclusively of covalent bonding
- ★ Generally nonpolar
- ★ Generally insoluble in water
  - ★ usually soluble in nonpolar solvents (other organic compounds)
- ★ Nonelectrolytes except organic acids which are weak electrolytes
- ★ Have low melting points (due to weak intermolecular forces that hold them together)
- ★ Have slower reaction rates than inorganic compounds
  - ★ covalent bonds within organic molecules are strong
  - ★ activation energies are high
  - ★ catalysts are often used to increase reaction rates

Hydrocarbons

★ Definition - compounds composed of only hydrogen and carbon

★ Homologous series - group of organic compounds with similar properties and related structures (differ from each other by CH_2)
  - ☆ Aliphatic - hydrocarbon chains
    - ★ Saturated
      - ★ Definition - has no bonds that can be broken to add extra hydrogens
      - ★ called **Alkanes**
        - family of hydrocarbons with all single bonds
        - general formula C_nH_{2n+1}
        - named with suffix **"ANE"**
    - ★ Unsaturated - has double or triple bonds that can be broken to add more hydrogens
      - ★ **Alkenes**
        - family of hydrocarbons with one double bond
        - general formula C_nH2_n
        - named with suffix **"ENE"**
      - ★ **Alkynes**
        - family of hydrocarbons with one triple bond
        - general formula C_nH_{2n-2}
        - named with suffix **"YNE"**

Answer the questions below by circling the number of the correct response

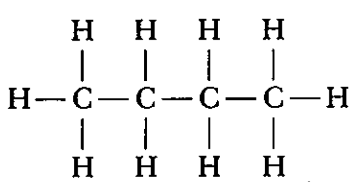
1. Which formula may represent an unsaturated hydrocarbon? (1) C_2H_6 (2) C_3H_6 (3) C_4H_{10} (4) C_5H_{12}
2. In an homologous series, the second member has the formula C_3H_6. What is the formula of the fourth member of this series. (1) C_4H_8 (2) C_4H_{10} (3) C_5H_{10} (4) C_5H_{12}
3. As the molecular mass of the compounds of the alkane series increases, their boiling point (1) decreases (2) increases (3) remains the same
4. Which represents an unsaturated hydrocarbon? (1) C_2H_4 (2) C_2H_6 (3) C_3H_8 (4) C_4H_{10}
5. Which is a saturated hydrocarbon? (1) C_3H_8 (2) C_6H_6 (3) C_2H_5OH (4) $C_2H_4O_2$
6. Which compound is a hydrocarbon? (1) R–CH_3 (2) R–OH (3) R–COOH (4) R–Cl
7. Which molecule contains a triple covalent bond? (1) C_2H_2 (2) C_2H_4 (3) C_3H_6 (4) C_3H_8
8. Which compound is a member of the alkane series? (1) C_2H_6 (2) C_3H_6 (3) C_4H_6 (4) C_6H_6
9. The general formula for the alkyne series is (1) C_nH_n (2) C_nH_{n-2} (3) C_nH_{2n} (4) C_nH_{2n-2}
10. Which is the formula of a saturated hydrocarbon? (1) C_2H_2 (2) C_2H_4 (3) C_5H_8 (4) C_5H_{12}
11. Which formula represents an unsaturated hydrocarbon? (1) C_3H_8 (2) C_3H_7Cl (3) C_3H_6 (4) CCl_4
12. The compound $CH_3CH_2CH_2CH_3$ belongs to the series that has the general formula (1) C_nH_{2n-2}, (2) C_nH_{2n+2}, (3) C_nH_{n-6}, (4) C_nH_{n+6}
13. Which molecule contains a triple covalent bond between adjacent carbon atoms? (1) C_2H_4 (2) C_2H_2 (3) C_3H_6 (4) C_3H_8
14. Each member of the alkane series differs from the preceding member by one additional carbon atom and (1) 1 hydrogen atom (2) 2 hydrogen atoms (3) 3 hydrogen atoms (4) 4 hydrogen atoms
15. Which formula represents a saturated hydrocarbon? (1) C_2H_2 (2) C_2H_4 (3) C_3H_6 (4) C_3H_8
16. Which formula represents a hydrocarbon with a double covalent bond? (1) CH_3Cl (2) C_2H_3Cl (3) C_2H_2 (4) C_2H_4
17. Organic compounds differ from inorganic compounds in that organic compounds generally have (1) high melting points and are electrolytes, (2) high melting points and are nonelectrolytes, (3) low melting points and are electrolytes, (4) low melting points and are nonelectrolytes
18. The compound C_2H_2 belongs to the series of hydrocarbons with the general formula (1) C_nH_n (2) $C_{2n}H_{2n}$ (3) C_nH_{2n-2} (4) $C_{2n}H_{2n-2}$
19. Which normal alkane has the highest boiling point at 1 atmosphere? (1) C_2H_4 (2) C_3H_6 (3) C_4H_8 (4) C_5H_{10}
20. Which element is composed of atoms that can form more than one covalent bond with each other? (1) hydrogen (2) helium (3) carbon (4) calcium

Naming Hydrocarbons

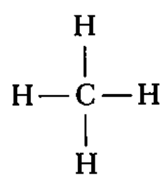
Hydrocarbons are compounds made up of carbon and hydrogen. Hydrocarbons called the alkanes are the simplest hydrocarbons. These compounds are named by using a prefix that tells the number of carbon atoms they contain and the root "ane."

Using the table below, name each of the alkanes that are shown.

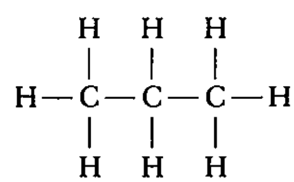
Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10



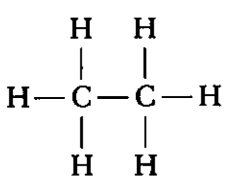
1. ______________________



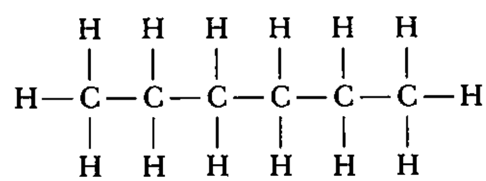
2. ______________________



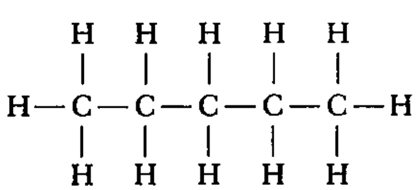
3. ______________________



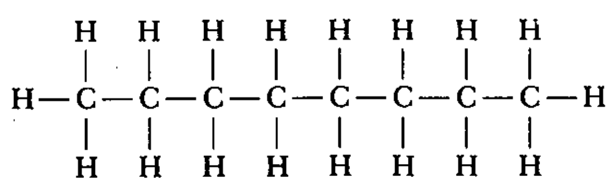
4. ______________________



5. ______________________



6. ______________________

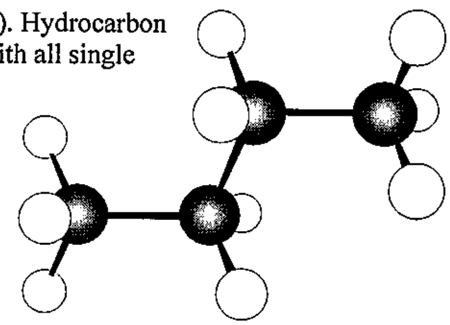


7. ______________________

Chemistry: Form WS11.1.2A	Name ____________________

ORGANIC CHEMISTRY	Date ______________ Period ____

Emphatically Aliphatic (the phattest molecules!)



Aliphatic hydrocarbons are hydrocarbon chains (as opposed to hydrocarbon rings). Hydrocarbon chains can have single, double, or triple bonds between carbons. Hydrocarbons with all single bonds have no bonds that can be broken to expose extra bonding sites where additional hydrogen atoms can be added. As a result they are called **saturated.** The family of saturated hydrocarbons is called **Alkanes.** Alkanes have the general formula C_nH_{2n+2} and are named with suffix **"ANE"**. Octane (C_8H_{18}), the hydrocarbon found in gasoline, is an example. Unsaturated hydrocarbons have double or triple bonds. These bonds can be broken to add more hydrogens. The family of unsaturated hydrocarbons with one double bond is called **Alkenes.** Alkenes have the general formula C_nH_{2n} and are named with suffix **"ENE"**. Octene (C_8H_{16}) is an example. **Alkynes** are the family of unsaturated hydrocarbons with one triple bond. They have the general formula C_nH_{2n-2} and are named with suffix **"YNE** as in octyne (C_8H_{14}).

For each of the formulas below, draw a diagram, indicate whether it is saturated or unsaturated, and state whether it is an ALKANE, ALKENE or ALKYNE. (Remember, no rings; emphatically aliphatic!)

1. C_5H_{10} ____________________

2. $C_{12}H_{22}$ ____________________

3. CH_4 ____________________

4. C_9H_{20} ____________________

5. C_6H_{10} ____________________

6. C_3H_6 ____________________

7. C_2H_6 ____________________

8. C_7H_{12} ____________________

NAME:______________________________ DATE:_______SECTION______LAB______

We Are All Linked Together

Background:

Because of the very large number of organic compounds, chemists have found it convenient to classify these compounds into a series or classes. The basis of the system is the fact that the strength of the carbon-carbon bond is so great that, although in some reactions other elements or groups may be altered, the basic carbon skeleton of the molecule is not affected.

The four classes into which organic compounds are categorize, we will investigate on class. The aliphatic compounds, which consist of carbon atoms bonded together to form an open chain which may be straight or branched. As we shall see, the bond may be single, double, triple or a combinations of these.

Organic Nomenclature

A rational nomenclature system should do at least two things. First, it should indicate how the carbon atoms of a given compound are bonded together in a characteristic lattice of chains and rings. Second, it should identify and locate any functional groups present in the compound. Since hydrogen is such a common component of organic compounds, its amount and locations can be assumed from the tetravalency of carbon, and need not be specified in most cases.

The IUPAC nomenclature system is a set of logical rules devised and used by organic chemists to circumvent problems caused by arbitrary nomenclature. Knowing these rules and given a structural formula, one should be able to write a unique name for every distinct compound. Likewise, given a IUPAC name, one should be able to write a structural formula. In general, an IUPAC name will have three essential features:

- A root or base indicating a major chain or ring of carbon atoms found in the molecular structure.
- A suffix or other element(s) designating functional groups that may be present in the compound.
- Names of substituent groups, other than hydrogen, that completes the molecular structure.

Alkanes

Hydrocarbons having no double or triple bond functional groups are classified as **alkanes.** Although these hydrocarbons have no functional groups, they constitute the framework on which functional groups are located in other classes of compounds, and provide an ideal starting point for studying and naming organic compounds.

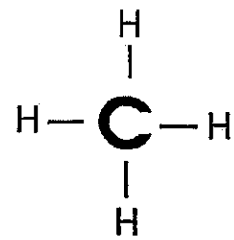
Table P in the CRT lists the IUPAC prefixes assigned to simple continuous-chain alkanes from C-1 to C-10. A common **"ane"** suffix identifies these compounds as alkanes. The names **methane** through **decane** should be memorized, since they constitute the root of many IUPAC names. Fortunately, common numerical prefixes are used in naming chains of five or more carbon atoms.

IUPAC Rules for Alkane Nomenclature

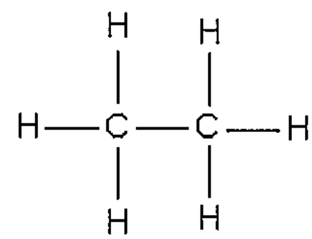
1. Find the longest continuous carbon chain.
2. Use the prefixes found in Table P to indicate the number of carbon atoms in the longest chain.
3. Use the suffix "ane" to indicate only single bonds between carbons.

Procedure using the rules for naming alkanes name or draw the following compounds.

1) ________________

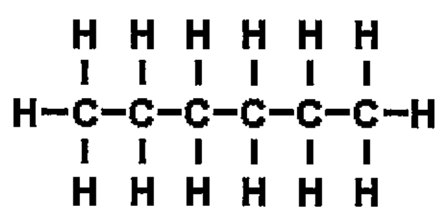


2) ________________



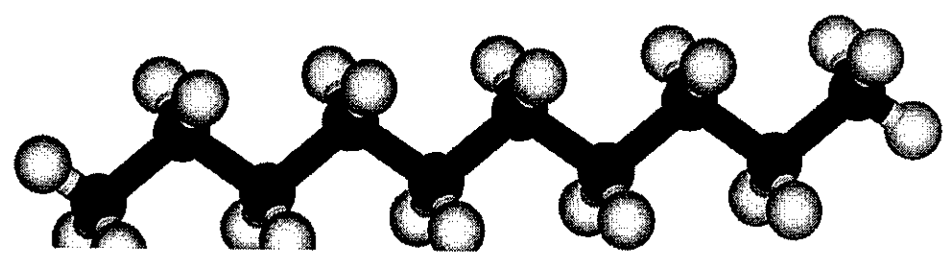
3) Propane:

4) ______________



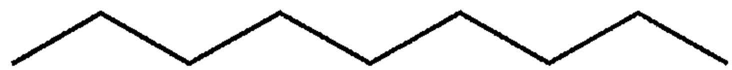
5) Octane:

6) ________________



6

7) ______________



Alkenes and Alkynes

Alkenes and alkynes are hydrocarbons which respectively have **carbon-carbon double bond** and **carbon-carbon triple bond** functional groups. These molecules are classified as unsaturated hydrocarbons due to the fact that the carbon chain appears to have missing spaces due to less hydrogen. Hence, alkanes are classified as saturated hydrocarbons because every spot on the chain is filled with hydrogen.

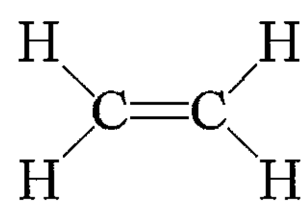
IUPAC Rules for Alkene Nomenclature

1. The ene suffix (ending) indicates an alkene.
2. The longest chain chosen for the root name must include <u>both carbon atoms of the double bond</u>.
3. The root chain must be numbered <u>from the end nearest a double bond carbon atom</u>. If the double bond is in the center of the chain, the nearest substituent rule is used to determine the end where numbering starts.
4. The smaller of the two numbers designating the carbon atoms of the double bond is used as the double bond locator.

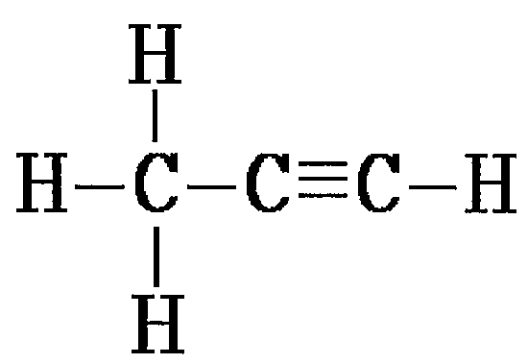
IUPAC Rules for Alkyne Nomenclature

The rules for naming alkynes are the same as for alkenes except the suffix used is yne instead of ene.

8) ______________



9) ______________

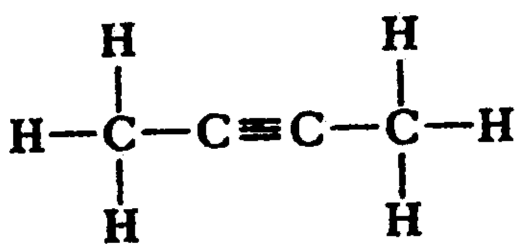


10) Ethyne:

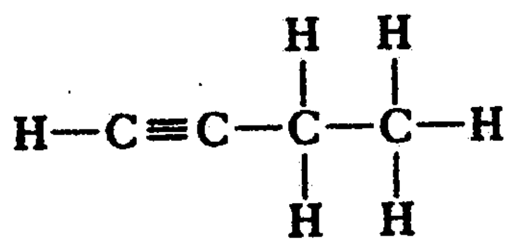
11) Propene:

Questions 12 through 14 are based on the following two molecules. These two molecules are isomers of each other.

A



B



12) Determine the molecular formula of both A and B. A:__________ B:____________

13) Based on your molecular formulas explain why these two molecules are isomers.

14) Using a number to indicate the position of the triple bond correct name each of these molecules.

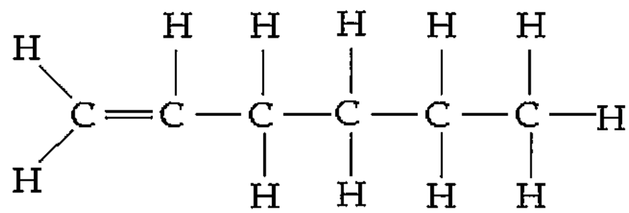
A:______________________ B:___________________________

15) In the boxes below draw the two isomers of pentene.

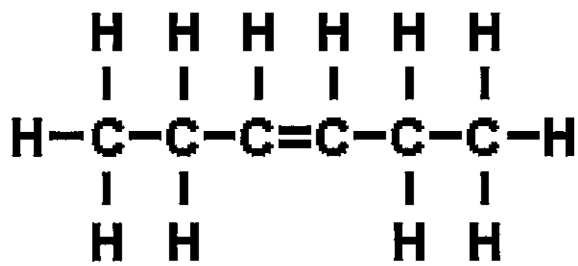
Use the following two molecules to answer questions 16 through 19.

16) Give the name of each.

A)________________



B)________________



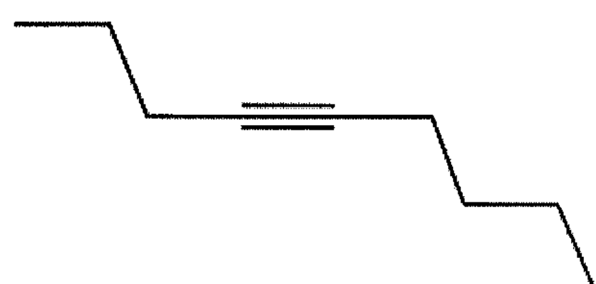
17) Explain in terms of molecular formulas and structure why these two molecules are isomers of each other.

18) In the space below draw a third isomer of hexene and correctly name it.

19) Explain and show why it is not correct to use the name 5-hexene.

20) 3-Heptyne:

21) ________________



22) ____________________

Reflection:

A) Describe the difference between alkane, alkene, and alkyne. Use the terms saturated and unsaturated in your answer.

B) In your own words define the term isomer.

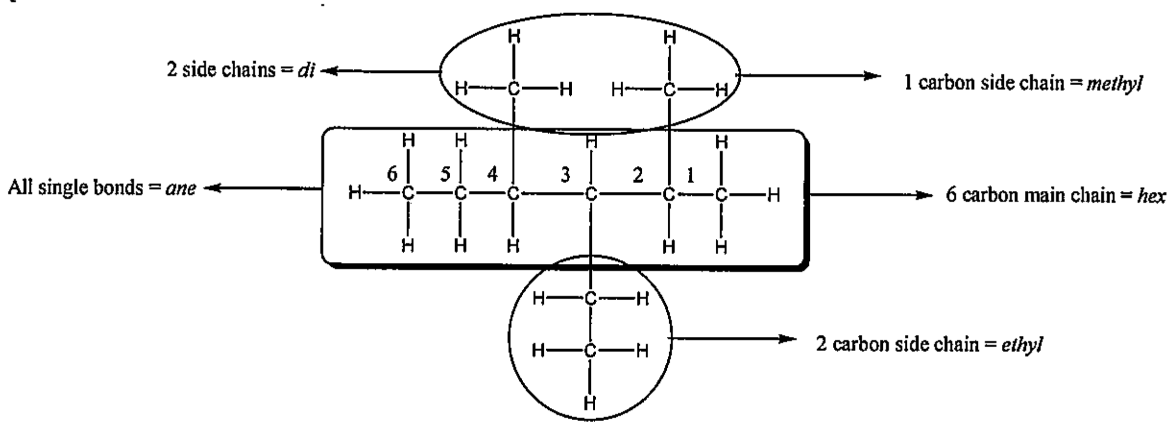
Name ______________________

Date ______________ Period _____

Naming Hydrocarbons

Hydrocarbons are named based on the family they are in (alkane, alkene, or alkyne), the length of the longest or main chain, the length of any shorter or side chains, and the location and number of any side chains or points of unsaturation. The family is shown by the suffixes *ane*, *ene*, and *yne*. As shown in the table to the right, the number of carbons in a main chain or side chain is shown by prefixes such as *meth*, and *eth*, while the number of side chains or points of unsaturation are shown by prefixes such as *di*, and *tri*. The location of any of these is determined by numbering the carbons in such a way that the lowest possible numbers are used. For example, C=C–C–C and C–C–C=C (shown without the hydrogens) are both 1-butene, because the double bond is between the first and second carbon, while C–C=C–C is 2-butene. Numbering starts at the end closest to the double bond. Side chains are listed in alphabetical order by prefix. See the example below.

Number	Prefix			
	Carbons in Main Chain	Carbons in side chain	Number of side chains or groups	Location of side chains or groups
1	meth	methyl	-	1
2	eth	ethyl	di	2
3	prop	propyl	tri	3
4	but	butyl	tetra	4
5	pent	pentyl	penta	5
6	hex	hexyl	hexa	6
7	hept	heptyl	hepta	7
8	oct	octyl	octa	8
9	non	nonyl	nona	9
10	dec	decyl	deca	10



3-ethyl 2,4-dimethylhexane

- side chains in alphabetical order
- numbering from left for smallest total

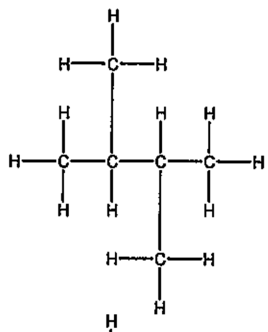
Following these rules, the compound $CH_2CHCHCH_2$ would be named 1,3-butadiene. The "a" is added just to make it pronounceable. Draw the picture to check. You will see there are 4 carbons (*but*) and two (*di*) double bonds (*ene*). The double bonds are located between the first and second carbon (*1*) and between the third and fourth carbon (*3*).

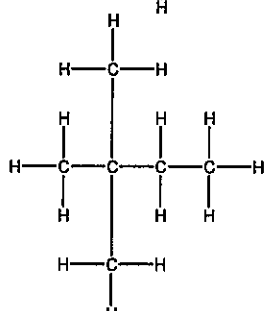
$CH_3CH_3CCH_3CH_3$ is called 2,2-dimethyl propane. The longest chain is three carbons long (*prop*). There are two (*di*) one carbon (*methyl*) side chains. Both side chains are attached to the middle or second carbon (*2*). Because there is no place else to attach these side chains, the compound can simply be called dimethylpropane. Draw the picture! Check it out!!

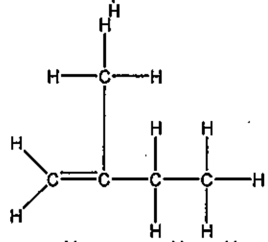
Continue ☞

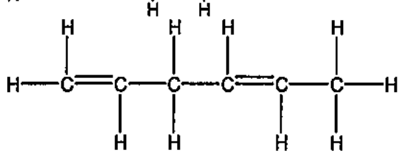
Name the hydrocarbons below based on your reading and on your knowledge of chemistry.

1. $CH_3CH_2CH_2CH_2CH_2CH_2CH_3$ .... ______________________

2.  .... ______________________

3.  .... ______________________

4.  .... ______________________

5.  .... ______________________

6. $CHCCH_2CH_2CH_2CH_2CH_2CH_3$ .... ______________________

7. $CH_3CH_2CH_2CH_2CH_2CH_2CCH_3CH_3CH_3$ .... ______________________

8. C_2H_2 .... ______________________

9. C_3H_8 .... ______________________

10. $CHCCCCH_3$ .... ______________________

NAME:______________________________ DATE:_______SECTION________LAB______

Don't Mess With My Group

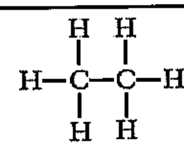
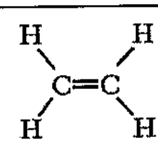
Background:

The study of organic chemistry is simplified by the fact that organic compounds can be classified into groups having related structures and properties. Such groups are called homologous series. Let's look at the molecular formula for methane, ethane and propane: CH_4, C_2H_6, and C_3H_8. We notice that the difference between methane and ethane is a CH_2 group, and the difference between ethane and propane is also a CH_2 group. Chemical formula used for a series of compounds that differ from each other by a constant unit is called **general formula**. Such a series is called the homologous series, while its members are called homologs. The members of a homologous series have similar molecular structures, and they also have similar chemical properties.

The general formula for any member of a homologous series uses n is an integer representing the number of carbon atoms in the molecule.

Some common general formulas are found in Table Q of the CRT.

Table Q
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	C_nH_{2n+2}	ethane	
alkenes	C_nH_{2n}	ethene	
alkynes	C_nH_{2n-2}	ethyne	H—C≡C—H

n = number of carbon atoms

Where pentane an alkane would have n=5, hence the molecular formula would be $C_5H_{2(5)+2}$ or C_5H_{12}.

Questions:

1) Determine the molecular formula for a molecular of butane. __________

2) Determine the molecular formula for a molecular of hexene. _________

3) A molecule has a molecular formula of C_3H_6. To which class of hydrocarbon does it belong?

____

4) Determine the molecular formula for a molecule of octyne. ________

5) Which of the following molecules is an alkane?
(1) C_6H_{10}
(2) C_6H_{12}
(3) C_7H_{14}
(4) C_7H_{16}

6) Which of the following molecules is unsaturated?
(1) C_3H_8
(2) C4H8
(3) C_4H_{10}
(4) C_5H_{12}
Use the following information to answer questions 7 through 10.

A hydrocarbon has 9 carbon atoms. It is a member of the alkene series.

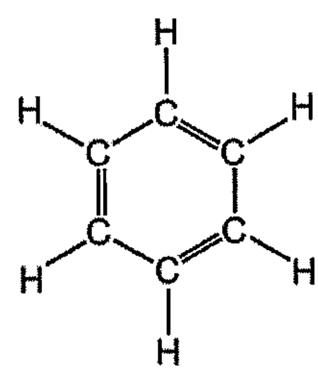
7) Determine the molecule's molecular formula. __________

8) In the space below draw and name a correct structural formula for your formula.

9) In the space below draw and name an isomer of the molecule you drew in question 8.

10) Are your drawn molecules saturated or unsaturated. Explain.

Use the following information to answer questions 11 through 15.



Aromatics, so called because of their distinctive perfumed smell, are substances derived from crude oil and, in small quantities, from coal. Aromatics are hydrocarbons, organic compounds that consist exclusively of the elements carbon and hydrogen – without which life would not be possible on Earth.

The main aromatics are benzene (shown to the right), toluene and the xylenes; they are used as starting materials for a wide range of consumer products.

Many items taken for granted in our everyday lives rely on products made by the aromatics industry, with benefits like durability, safety, comfort and lightweight design. Aromatics are used to make products for areas as diverse as medicine, hygiene, transport, telecommunications, fashion and sports.

Aromatics have a general formula of: C_nH_{2n-6}

11) Based on the diagram determine benzene's molecular formula.________

12) Toluene is a benzene derivative with 7 carbon atoms. Determine toluene's molecular formula.

____

13) Toluene's IUPAC name is methyl benzene. Based on its name and formula draw the structural formula for toluene.

14) Ethyl benzene has 8 carbon atoms, determine its molecular formula. ___________

15) Xylene also has 8 carbon atoms, determine its molecular formula. ___________

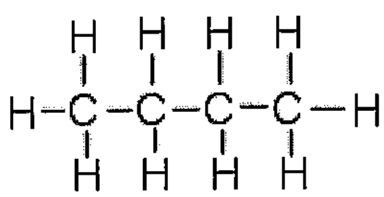
16) Draw the structural formula for ethyl benzene and xylene (1,4 dimethyl benzene) and explain why they are isomers of each other.

NAME:______________________________ DATE:_______SECTION_______LAB_______

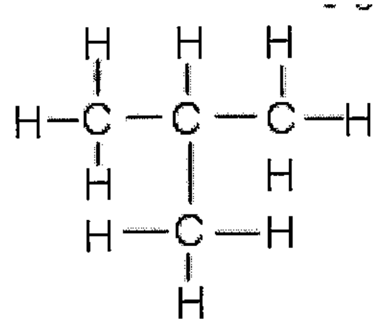
Opening a New Branch

Background:

One of the reasons organic chemistry has a wide variety of molecules is due to carbon's ability to make branched chains. Below is an example, butane which is a straight chain alkane and 2-methyl propane a branched alkane. Notice both compounds have the same molecular formula (C_4H_{10}) but a different structural formula. These are isomers of each other. Since they are isomers of each other they have different properties and hence need different names.



Butane



2 methyl propane

IUPAC Rules for Alkane Nomenclature:

1) Find and name the longest continuous carbon chain.
2) Identify and name the functional groups attached to this chain.
3) Number the chain consecutively, starting at the end nearest a substituent group.
4) Designate the location of each substituent group by an appropriate number and name.
5) Assemble the name, listing groups in alphabetical order.
6) The prefixes di, tri, tetra etc., used to designate several groups of the same kind, are not considered when alphabetizing.

Some functional groups which can hang off the longest continuous chain:

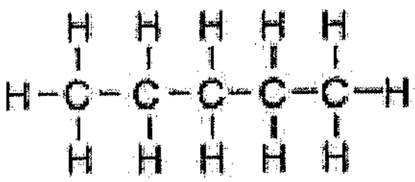
CH_3- methyl
CH_3CH_2- ethyl
$CH_3CH_2CH_2$- propyl
$CH_3CH_2CH_2CH_2$- butyl
$CH_3CH_2CH_2CH_2CH_2$- pentyl

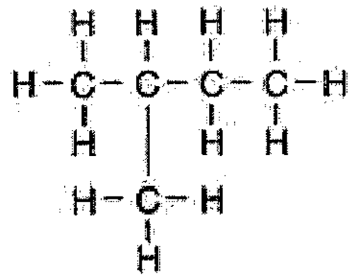
2-Methy propane name is derived from the longest continuous chain being 3 carbons in a row with all carbons connected by a single bond. Hence propane. The group not on main chain is only composed of one carbon hence the use of the methyl group. The number 2 is used to show the methyl group is on the 2nd carbon of the longest continuous chain.

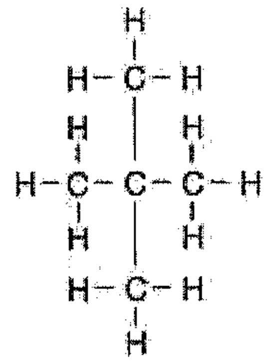
Procedure:

Name or draw the following compounds.

1) Below are the 3 isomers of C_5H_{12}. Name each isomer.



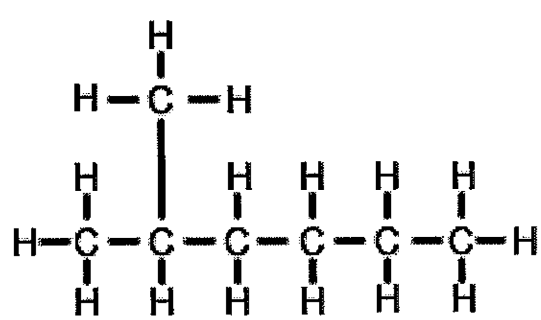




A)________________ B)________________ C)________________

2) Use the space below to draw and name the 5 isomers of C_6H_{14}.

Use the following compound to answer questions 3 through 6.



3) Determine the name of the compound.

____

4) Determine the molecular formula.

____

5) Determine the name of the straight chain alkane which the given molecule is an isomer.

____

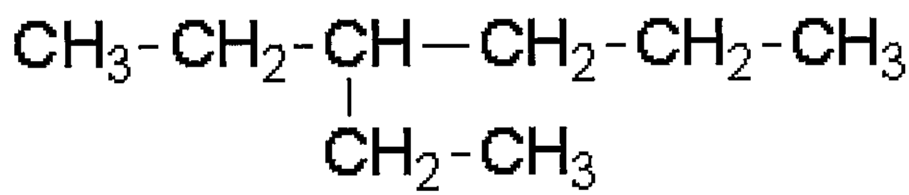
6) Draw and name another branched alkane which is an isomer of the given compound.

7) Draw the structural formula for 3,3-Dimethylpentane.

8) Draw the structural formula for 3,3-Dimethylpentane.

9) Draw the structural formula for 2,3,4-Trimethylpentane.

10) Determine the name of the following compound.



____

<u>Reflection:</u> Describe the rules you used to name/draw branched alkanes.

STRUCTURE OF HYDROCARBONS

Name ____________________

Draw the structure of the compounds below.

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

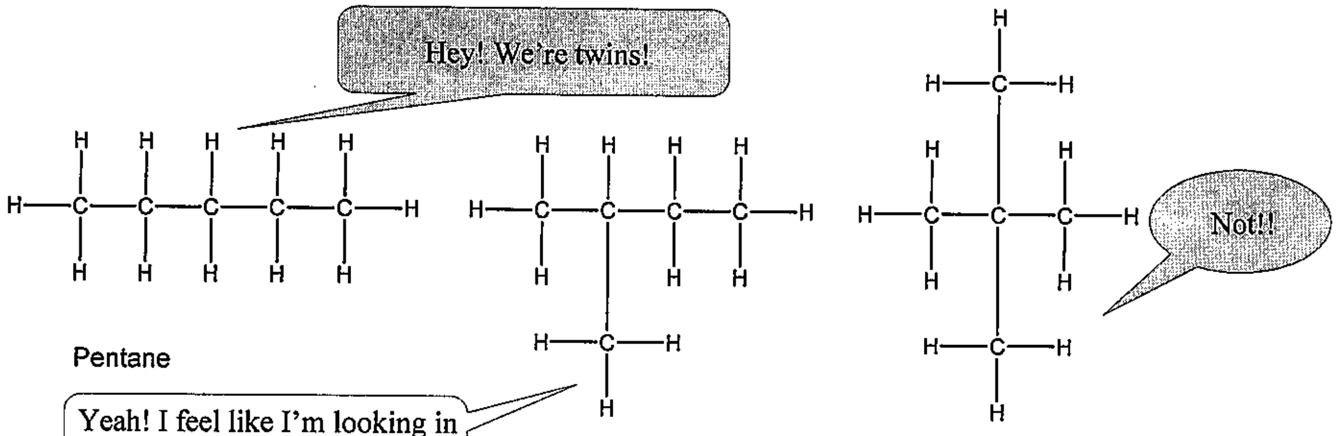
Name ____________________

ORGANIC CHEMISTRY

Date ______________ Period _____

Isomers

Isomers are compounds that have the same simple formula, but different structures. Below are three isomers of C_5H_{12}. They don't look like the same compound, because they're not!

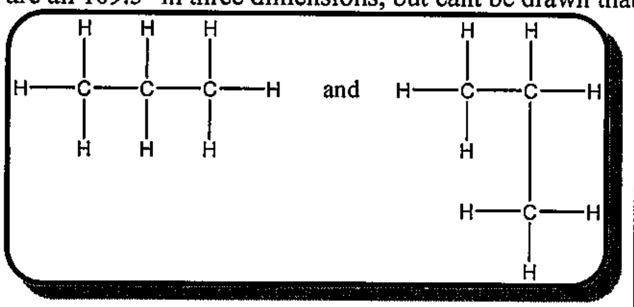


Pentane

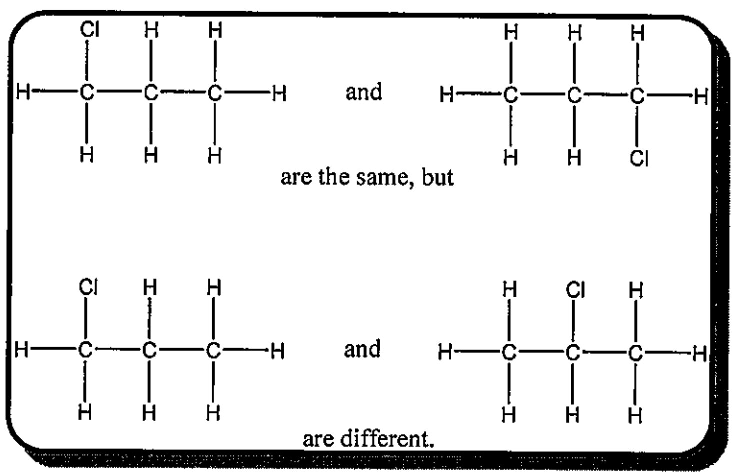
2-methyl butane

2,2-dimethyl propane

The tricky part of recognizing isomers comes from the fact that on paper, all the bond angles are multiples of 90° while in three dimensions the bond angles are all 109.5°. On paper the following two structures for C_3H_8 look different, but they're not. The carbons in the drawing at the left appear to be at 180° to each other while the ones at the right appear to be at 90°. In fact, they are all 109.5° in three dimensions, but cant be drawn that way on paper.



Other structures may look different, but if they can be flipped and superimposed on top of each other, they are the same. See the drawing below.



In order for two compounds to be isomers, they must have the same simple formula, and they must be truly different. Looking different on paper is not enough!!

Answer the questions below based on the reading above, and on your knowledge of chemistry.

1. Draw the isomers for C_4H_{10}.

Continue ☞

2. Draw the isomers of C_4H_9Cl.

3. Draw the isomers of $C_5H_{11}Cl$.

4. Draw the isomers of C_4H_8.

5. Draw the isomers of C_4H_6.

6. Draw the isomers of C_2H_6O

Structural Formulas

Draw the structural formula and then write the name for each of the following compounds.

Compound	Structural Formula	Name
1. C_2H_2		______
2. C_3H_6		______
3. C_4H_{10}		______
4. C_5H_8		______
5. CH_4		______
6. C_6H_6		______
7. C_3H_7Cl		______
8. C_7H_{14}		______
9. C_4H_6		______
10. C_2H_6		______

Name ______________________

Date ____________ Period ____

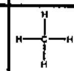
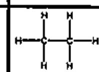
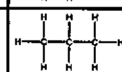
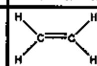
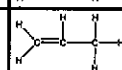
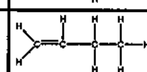
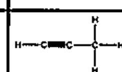
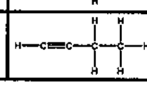
Structural Formulas and Isomers

Aim

- to interpret organic formulas

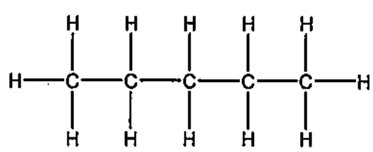
Notes

Types of formulas

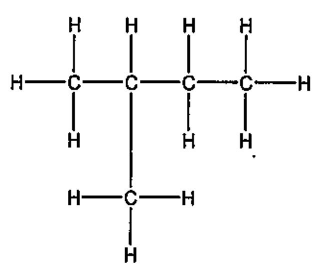
Type of Compound	Simple formula	Structural formula	Graphic formula
Alkanes	CH_4		CH_4
	C_2H_6		CH_3CH_3
	C_3H_8		$CH_3CH_2CH_3$
Alkenes	C_2H_4		CH_2CH_2
	C_3H_6		CH_2CHCH_3
	C_4H_8		$CH_2CHCH_2CH_3$
Alkynes	C_2H_2	H—C≡C—H	CHCH
	C_3H_4		$CHCCH_3$
	C_4H_6		$CHCCH_2CH_3$

- Isomers - compounds with the same simple formula but different structures

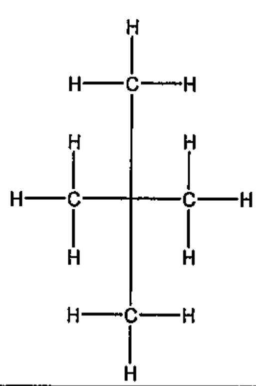
C_5H_{12}



Pentane



2-methyl butane



2,2-dimethyl propane

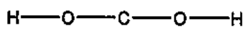
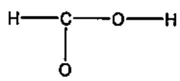
- structures must actually be different (looking different on paper is not always enough)
- branches of different isomers are attached on non-equivalent carbons

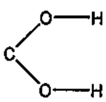
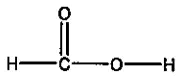
Answer the questions below by circling the number of the correct response

1. The compounds $CH_3CH_2OCH_2CH_3$ and $CH_3CH_2CH_2CH_2OH$ are (1) hydrocarbons (2) isomers (3) allotropes (4) carbohydrates

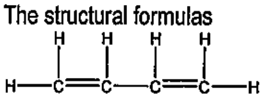
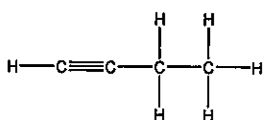
2. The compound C_4H_9OH is an isomer of (1) $C_3H_7COCH_3$ (2) $CH_3COOC_2H_5$ (3) $C_2H_5OC_2H_5$ (4) CH_3COOH

3. If a compound has a molecular formula of CH_2O_2, then its structural formula must be

(1)  (3) 

(2)  (4) 

4. The structural formulas

 and 

represent molecules which both are (1) halogen addition products (2) unsaturated hydrocarbons (3) members of alkynes (4) isomers of butane

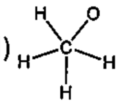
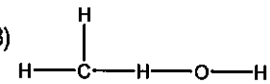
5. Compounds which have the same molecular formula but different molecular structures are called (1) isomers (2) allotropes (3) isotopes (4) homologs

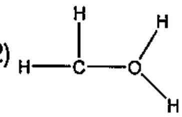
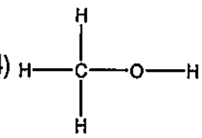
6. Which compound is an isomer of CH_3CH_2OH? (1) CH_3CHO (2) CH_3COCH_3 (3) CH_3OCH_3 (4) CH_3CH_2COOH

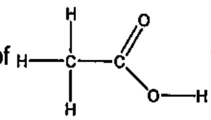
7. Which compound is an isomer of CH_3COOCH_3? (1) CH_3OCH_3 (2) CH_3COCH_3 (3) CH_3CH_2COOH (4) $CH_3CH_2CH_2OH$

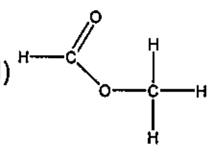
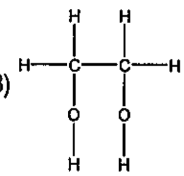
8. Which compound is an isomer of CH_3COOH? (1) $HCOOCH_3$ (2) CH_3CH_2COOH (3)CH_3CH_2OH (4) CH_3COOCH_3

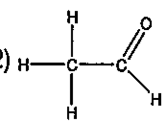
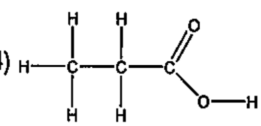
9. Which is the correct structural formula of a compound whose molecular formula is CH_4O?

(1)  (3) 

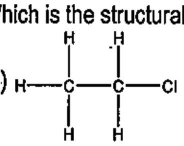
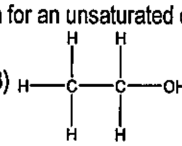
(2)  (4) 

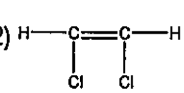
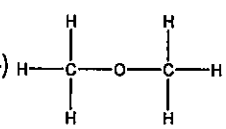
10. Which compound is an isomer of  ?

(1)  (3) 

(2)  (4) 

11. Which is the structural formula for an unsaturated compound?

(1)  (3) 

(2)  (4) 

Naming Hydrocarbons and Substituted Hydrocarbons

Aim

- to apply the IUPAC rules for naming organic compounds

Notes

Naming hydrocarbons

★ family: alkane, alkene, or alkyne - use suffix ANE, ENE, or YNE

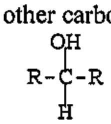
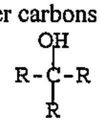
★ Length of chain, length of side chain, number of side chains or functional groups, location of side chains or functional groups - use prefixes

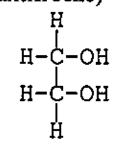
Number	Prefix			
	Carbons in Main Chain	Carbons in side chain	Number of side chains or groups	Location of side chains or groups
1	meth	methyl	-	1
2	eth	ethyl	di	2
3	prop	propyl	tri	3
4	but	butyl	tetra	4
5	pent	pentyl	penta	5
6	hex	hexyl	hexa	6
7	hept	heptyl	hepta	7
8	oct	octyl	octa	8
9	non	nonyl	nona	9
10	dec	decyl	deca	10

Substituted hydrocarbons

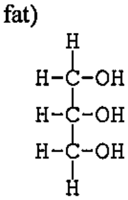
★ Halogenated hydrocarbons - prefix in name
- ☆ fluorine = fluoro; chlorine = chloro; bromine = bromo; iodine = iodo

example: $CH_3CH_2CHClCH_2CH_3$ (3-chlorobutane)

★ Alcohols
- ☆ general formula: R-OH
- ☆ suffix: ol
- ☆ monohydroxy alcohols: one -OH
  - ★ primary alcohols: the -OH is attached to one end of a hydrocarbon chain
    - ★ general formula: $R\text{-}CH_2OH$
    - ★ example: $CH_3CH_2CH_2OH$ (propanol)
  - ★ secondary alcohols: the OH is attached to a carbon that is attached to two other carbons
    - ★ general formula: 
    - ★ example: $CH_3CHOHCH_3$ (2-propanol)
  - ★ tertiary alcohols: the OH is attached to a carbon that is attached to three other carbons
    - ★ general formula: 
    - ★ example: $CH_3CH_3COHCH_3$ (tertiary butanol or 2 methyl-2 propanol)
  - ★ important monohydroxy alcohols
    - ★ ethanol - beverage alcohol
    - ★ 2-propanol - rubbing alcohol
- ☆ dihydroxy alcohols (glycols): with two -OH groups
  - ★ example: ethylene glycol or 1,2 ethanediol (active ingredient in antifreeze)



- ☆ trihydroxy (trihydric) alcohols: with three -OH groups
  - ★ example: glycerol or 1,2,3 propanetriol (product of digestion of fat)



★ Aldehydes - produced by oxidation of primary alcohols
- ☆ $2CH_3OH + O_2 \rightarrow 2H\text{-}CHO + 2H_2O$
- ☆ general formula: R-CHO
- ☆ suffix: al
- ☆ example: CH_3CH_2CHO (propanal)
- ☆ important aldehydes: methanal - formaldehyde

★ Ketones - produced by the oxidation of secondary alcohols
- ☆ general formula: RCOR
- ☆ suffix: one
- ☆ example: CH_3COCH_3 (propanone)
- ☆ important ketones: propanone - (acetone, dimethyl ketone)

★ Acids
- ☆ general formula: RCOOH
- ☆ suffix: oic acid
- ☆ example: CH_3CH_2COOH (propanoic acid)
- ☆ important acids: ethanoic acid-acetic acid (vinegar)

★ Ethers - produced by dehydration synthesis of two primary alcohols [$R\text{-}OH + HO\text{-}R \rightarrow R\text{-}O\text{-}R + H_2O$]
- ☆ general formula: R-O-R
- ☆ example: diethyl ether ($C_2H_5OC_2H_5$) or ethoxyethane
  - ★ use: anesthetic and solvent

★ Esters R–COOR (fragrances)
- ☆ example: CH_3COOCH_3 methyl methanoate

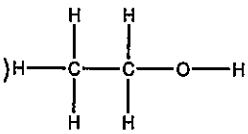
★ Amines - derivatives of ammonia

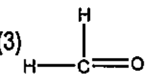
★ Amino acids $R\text{–}C(NH_2)COOH$

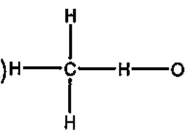
★ Amides - dehydration synthesis of amino acids

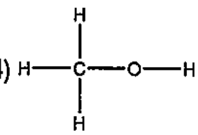
Answer the questions below by circling the number of the correct response

1. Which is the correct structural formula for methanol?

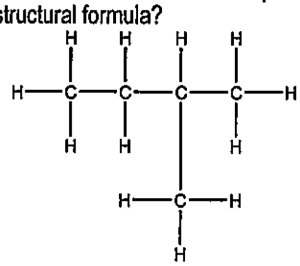
(1) 

(3) 

(2) 

(4) 

2. What is the correct I.U.C. name of the compound represented by the following structural formula?

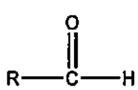


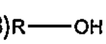
(1) n-pentane (3) 2-methylbutane
(2) isobutane (4) n-butane

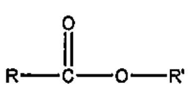
3. Which is an isomer of 2,2-dimethylpropane?
(1) ethane (3) n-pentane
(2) propane (4) n-butane

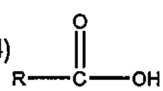
4. Which molecule contains four carbon atoms?
(1) ethane (3) methane
(2) butane (4) propane

5. The general formula of organic acids can be represented as

(1) 

(3) 

(2) 

(4) 

6. How many carbon atoms are contained in an ethyl group?
(1) 1 (3) 3
(2) 2 (4) 4

7. Which is an isomer of 2-chloropropane?
(1) butane (3) 1-chlorobutane
(3) propane (4) 1-chloropropane

8. Which is an ester? (1) CH_3OH (2) CH_3COOH (3) CH_3OCH_3
(4) CH_3COOCH_3

9. The compound $CH_3CH_2COOCH_3$ is an example of
(1) an ester (3) an acid
(2) an alcohol (4) a polymer

10. The formula of methanoic acid is
(1) HCHO (3) CH_3OH
(2) HCOOH (4) $HCOOCH_3$

11. Which is the formula for ethanoic acid?
(1) CH_3COOH (3) CH_3CH_2COOH
(2) CH_3CH_2OH (4) $CH_3CH_2CH_2OH$

12. The compound CH_3COOCH_3 is classified as
(1) an acid (3) an ester
(2) an alcohol (4) a hydrocarbon

13. Which formula represents an organic acid?
(1) CH_3COOH (3) CH_3OCH_3
(2) CH_3OH (4) CH_3COOCH_3

14. The compound methanal, HCHO, is an example of an
(1) ether (3) alcohol
(2) aldehyde (4) acid

15. What could be the name of a compound that has the general formula R-OH?
(1) methanol (3) methyl methanoate
(2) methane (4) methanoic acid

16. Which organic compound is a ketone?
(1) CH_3OH (3) CH_3COOH
(2) CH_3COCH_3 (4) CH_3COOCH_3

Chemistry: Form WS11.2.2A

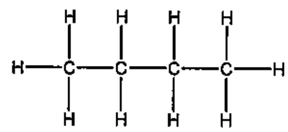
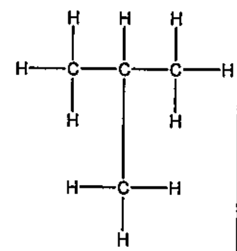
ORGANIC CHEMISTRY

Name ______________________

Date ________________ Period _____

Condensed Structural Formulas

Structural formulas are cumbersome to write, but simple formulas don't convey enough information. Graphic formulas or condensed structural formulas are a good compromise. In a condensed structural formula, each carbon in a chain is written in order along with the number of hydrogens attached to it. Remember that every carbon always has four bonds. End carbons always have three bonding sites for elements other than carbon, while carbons in the middle of a chain, since they are attached to a carbon on each side, have only two bonding sites for elements other than carbon. In the formula $CH_3CH_3CHCH_3$, it is obvious there is a branch because there are three end carbons, and the middle carbon has only one hydrogen, so it must be attached to the three other carbons.

SIMPLE	C_4H_{10}	
STRUCTURAL		
GRAPHIC	$CH_3CH_2CH_2CH_3$	$CH_3CH_3CHCH_3$

Simple, Structural, and Graphic Formulas

Based on the reading above and on your knowledge of chemistry, draw the structural and graphic formulas for each of the simple formulas below. Make sure to draw all the iosmers.

1. C_2H_4

2. C_3H_8O

3. C_3H_4

Based on the reading above and on your knowledge of chemistry, draw the structural formulas for each of the graphic formulas below.

4. CH_3COOH

5. $CH_3CH_2CCH_3CH_3CH_2CH_3$

6. $CH_2CHCH_2CH_3$

Name ______________________ Date __________ Class __________

CHAPTER 24 REVIEW ACTIVITY

Text Reference: Section 24-10

Writing Structural Formulas for Organic Compounds

In the space below each of the following IUPAC names, write a structural formula for the compound.

1. ethane

4. chloroethane

2. 1,1-dibromopropane

5. 1,2-dibromopropane

3. 1,4-hexadiene

6. nitrobenzene

Writing Structural Formulas for Organic Compounds (continued)

7. 2-nitromethylbenzene

9. 3-methylpentane

8. 1-chloro-4-ethylhexane

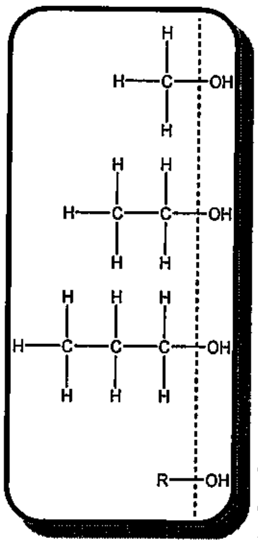
10. 1,2-dinitrobenzene

Name ______________________

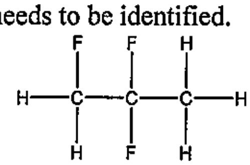
Date ________________ Period ______

Naming Substituted Hydrocarbons

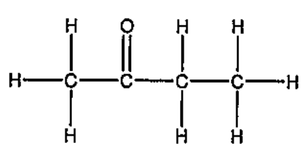
A substituted hydrocarbon is a hydrocarbon with an element other than hydrogen attached somewhere along the hydrocarbon chain. It is named in a similar fashion to a hydrocarbon. This can be illustrated with alcohols as an example. The compounds pictured to the lower left are alcohols. They look like alkanes with –OH at one end where a hydrogen would have been. The –OH is called a functional group. The rest of the molecule is called a residue (R). The general formula for alcohols is R–OH. CH_3OH, the first alcohol pictured to the left is formed by substituting an –OH group for hydrogen on methane (CH_4). As a result, it is called 1-methan*ol*. The suffix *ol* shows that it is an alcohol. The root *methan* comes from methane. The number 1 shows the location of the –OH. The next alcohol in the series, CH_3CH_2OH, formed from ethane, is called 1-ethanol. $CH_3CH_2CH_2OH$ is 1-propanol.



The alcohols and several other classes of substituted hydrocarbons are found in *Table R*. The root is determined by counting the number of carbons in the chain. For halides, the substitution is identified with a prefix. For the remaining substitutions, a suffix is used. (See *Table R*.) As with all hydrocarbons, the number and location of groups needs to be identified.



1,2,2-trifluoropropane



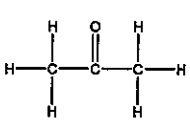
2-butanone

Table R
Organic Functional Groups

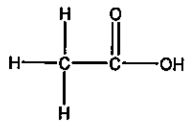
Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	—F (fluoro-) —Cl (chloro-) —Br (bromo-) —I (iodo-)	*R*—*X* (*X* represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	—OH	*R*—OH	$CH_3CH_2CH_2OH$ 1-propanol
ether	—O—	*R*—O—*R'*	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde	—C(=O)—H	*R*—C(=O)—H	$CH_3CH_2C(=O)—H$ propanal
ketone	—C(=O)—	*R*—C(=O)—*R'*	$CH_3C(=O)CH_2CH_2CH_3$ 2-pentanone
organic acid	—C(=O)—OH	*R*—C(=O)—OH	$CH_3CH_2C(=O)—OH$ propanoic acid
ester	—C(=O)—O—	*R*—C(=O)—O—*R'*	$CH_3CH_2C(=O)OCH_3$ methyl propanoate
amine	—N(—)—	*R*—N(*R'*)—*R''*	$CH_3CH_2CH_2NH_2$ 1-propanamine
amide	—C(=O)—NH(—)	*R*—C(=O)—NH(*R'*)	$CH_3CH_2C(=O)—NH_2$ propanamide

Name the following compounds using the rules for naming hydrocarbons and by referring to the reading and *Table R* above.

1. $CH_3CH_2CHOHCH_3$ .... ______________________

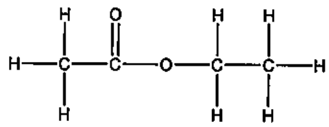
2.  .... ______________________

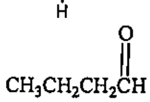
Continue ☞

3.  .... ______________________

4. $CH_3CH_2CH_2OCH_2CH_3$ .... ______________________

5. CH_3OCH_3 .... ______________________

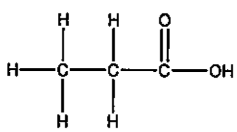
6.  .... ______________________

7.  .... ______________________

8. $CH_3CH_2CH_2CHOHCH_2CH_2CH_2CH_3$ .... ______________________

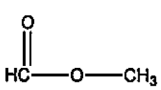
9. CH_3CHO .... ______________________

10. $CH_3CH_2COOCH_2CH_2CH_2CH_3$ .... ______________________

11.  .... ______________________

12. CCl_4 .... ______________________

13. CF_2CH_2 .... ______________________

14.  .... ______________________

15. $CH_3CH_2OCH_2CH_3$ .... ______________________

16. $CH_3CH_2CH_2CH_2CH_2CH_2OH$ .... ______________________

17. $CH_3CH_2CHOH\,CH_2CH_2CH_3$ .... ______________________

18. $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CHO$ .... ______________________

19. $CH_3CH_2CHBrCH_2CH_2CH_2CH_2CH_3$ .... ______________________

20. $CH_3CHNH_2CH_2CH_3$ .... ______________________

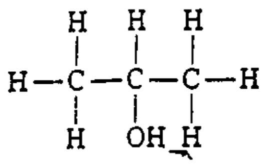
Name ______________________ Date __________ Class __________

CHAPTER 24 REVIEW ACTIVITY

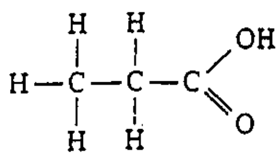
Text Reference: Section 24-17

Classifying Organic Compounds by Functional Group

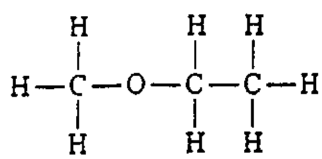
Classifying each of the following organic compounds as one of the following: primary alcohol, secondary alcohol, tertiary alcohol, aldehyde, ketone, ether, carboxylic acid, or ester.

1. 

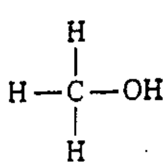
1. ______________________

2. 

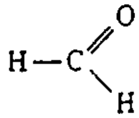
2. ______________________

3. 

3. ______________________

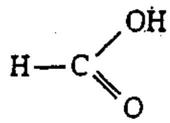
4. 

4. ______________________

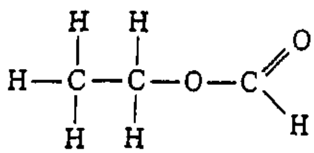
5. 

5. ______________________

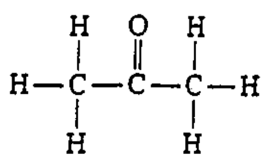
Classifying Organic Compounds by Functional Group (continued)

6. 

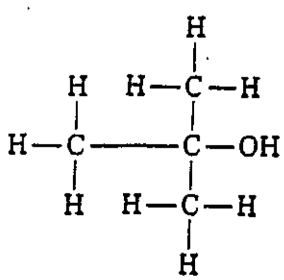
6. ______________________

7. 

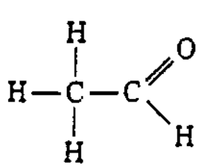
7. ______________________

8. 

8. ______________________

9. 

9. ______________________

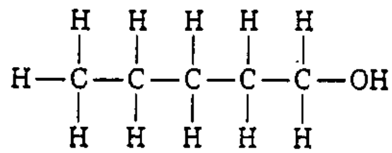
10. 

10. ______________________

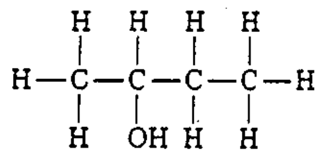
Name ______________________ Date ____________ Class ____________

Naming Organic Compounds That Contain Functional Groups

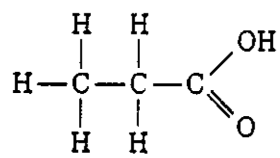
Use the IUPAC system of nomenclature to name each of the following compounds.

1.


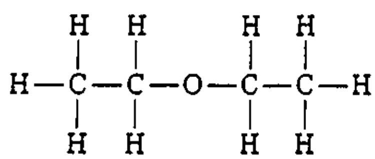
1. ____________________

2.


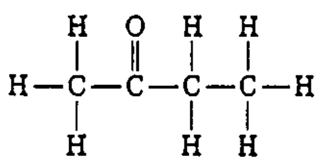
2. ____________________

3.


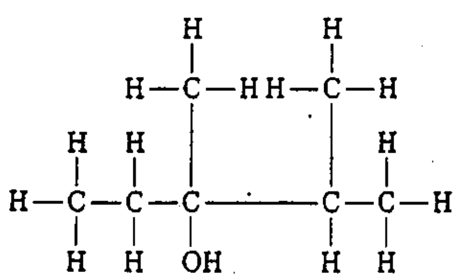
3. ____________________

4.


4. ____________________

5.


5. ____________________

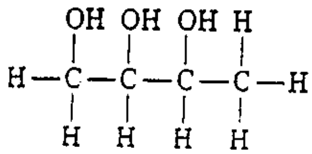
6.


6. ____________________

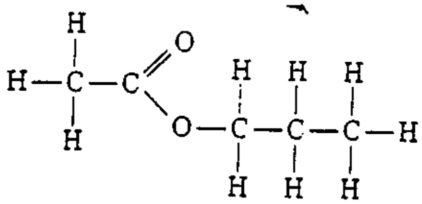
Name ____

REVIEW ACTIVITY Chapter 24

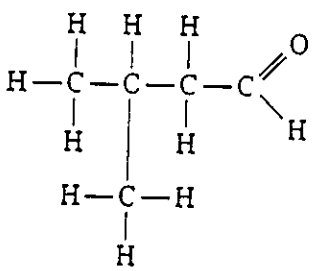
Naming Organic Compounds That Contain Functional Groups (continued)

7. 

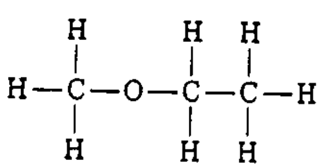
7. ______________________

8. 

8. ______________________

9. 

9. ______________________

10. 

10. ______________________

FUNCTIONAL GROUPS

Name ______________________

Classify each of the organic compounds below as an alcohol, carboxylic acid, aldehyde, ketone, ether or ester, and draw its structural formula.

1. CH_3COOH	6. $CH_3CH(OH)CH_3$
2. CH_3COCH_3	7. CH_3CH_2COOH
3. CH_3CH_2OH	8. $CH_3CH_2COOCH_3$
4. $CH_3CH_2OCH_3$	9. $CH_3CH_2COCH_3$
5. CH_3CH_2CHO	10. CH_3OCH_3

Name ______________________ Date __________ Class __________

CHAPTER 24 REVIEW ACTIVITY

Text Reference: Section 24-17

Writing Structual Formulas for Organic Compounds That Contain Functional Groups

In the space below each of the following IUPAC names, write a structural formula for the compound.

1. ethanol

2. 2-pentanone

3. 3-methylpentanoic acid

4. 3-ethyl-3-hexanol

5. ethyl butyl ether

6. methyl propanoate

Writing Structural Formulas for Organic Compounds That Contain Functional Groups (continued)

7. heptanal

9. 2-butanol

8. ethanoic acid

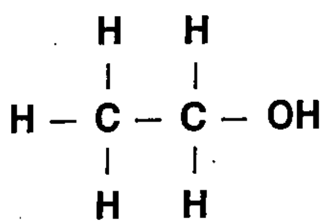
10. 1,3-propanediol

Name ____________________

NAMING OTHER ORGANIC COMPOUNDS

Name the compounds below.

1.



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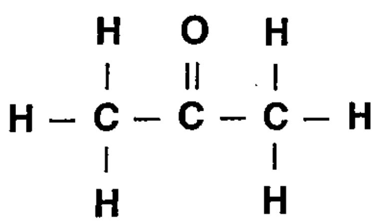

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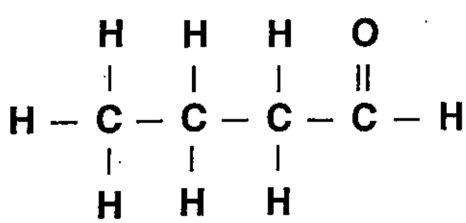

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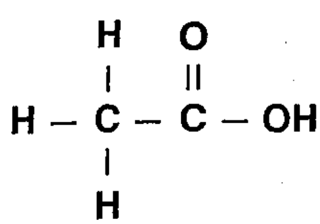

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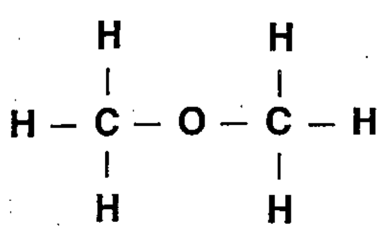

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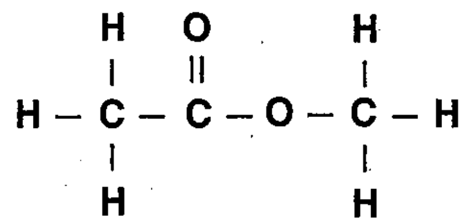

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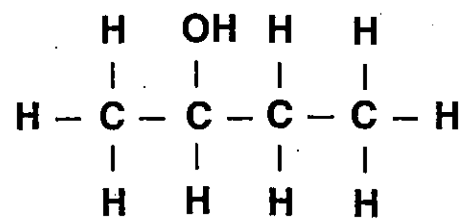

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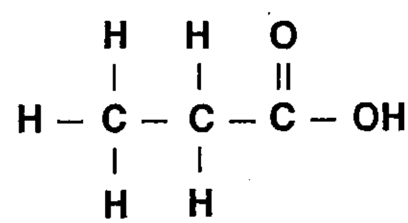

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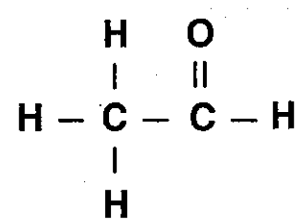

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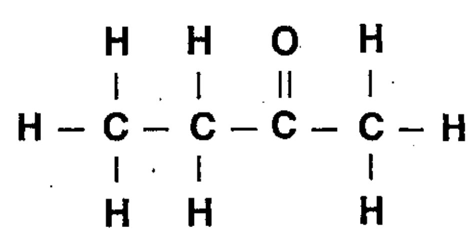


STRUCTURES OF OTHER ORGANIC COMPOUNDS

Name ____________________

Draw the structures of the compounds below.

1. butanoic acid	6. methylmethanoate (methyl formate)
2. methanal	7. 3-pentanol
3. methanol	8. methanoic acid (formic acid)
4. butanone	9. propanal
5. diethyl ether	10. 2-pentanone

Chemistry: Form WS11.4.1A Name ____________________

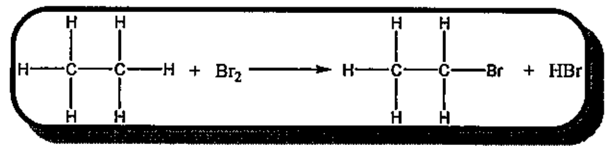
ORGANIC CHEMISTRY Date ______________ Period _____

Understanding Organic Reactions

Hydrocarbons participate in a variety of chemical reactions. Some are described below.

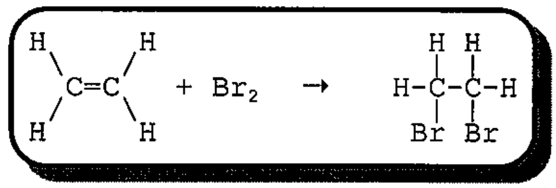
Combustion. Fossil fuels such as the gasoline used in automobiles or the propane used in gas barbecues are hydrocarbons. When they burn, they release carbon dioxide and water. ($C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$). Of course, when there is insufficient oxygen, as in an automobile engine, the carbon does not oxidize completely, and carbon monoxide and water forms. ($2C_8H_{18} + 17O_2 \rightarrow 16CO + 18H_2O$). That is why automobile exhaust contains carbon monoxide.

Substitution. Saturated hydrocarbons have all their bonding sites filled with hydrogen. The only way to attach any other elements to the carbon chain of a saturated hydrocarbon is to replace the hydrogen. The replacement of the hydrogen with another element is called substitution. The diagram to the right shows halogen substitution.



ethane + bromine → 1-bromoethane + hydrogen bromide

Addition. When there is a point of unsaturation, it is possible to add elements to the hydrocarbon chain at that point without removing any hydrogens. This is called addition. Unsaturated bonds are more reactive than saturated bonds and alkynes are even more reactive than alkenes, so additon of halogens occurs at room temperature. Addition of hydrogen to an alkene or an alkyne (or other carbon compounds with double or triple bonds) is called hydrogenation. It is the processed used to make margarine from vegetable oil.



ethene + bromine → 1,2 -dibromoethane

Fermentation. Beverage alcohol is formed by yeast. It forms as a result of the enzymatic breakdown of organic molecules during anaerobic respiration. It is called fermentation.

$$C_6H_{12}O_6 \xrightarrow{zymase} 2C_2H_5OH + 2CO_2$$

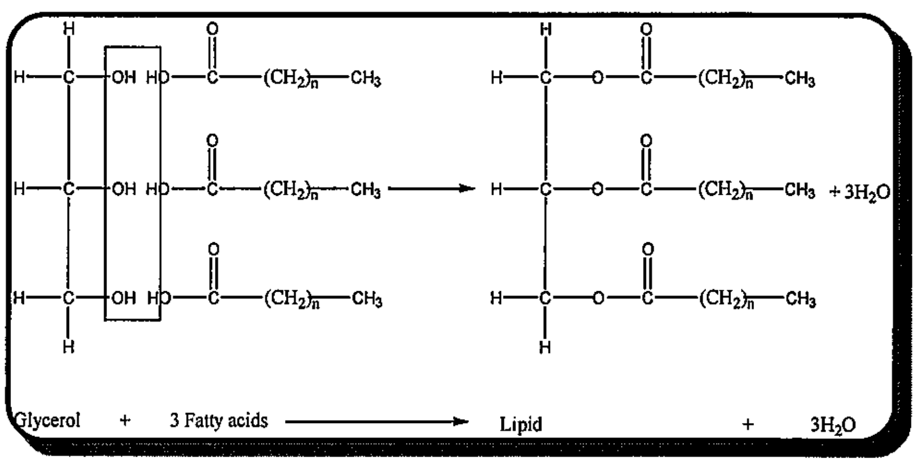
glucose → ethanol + carbon dioxide

Esterification. Esterification is the formation of esters (RCOOR). Esters form from a reaction between an organic acid and an alcohol. The alcohol and acid join by dehydration synthesis. The reaction looks similar to an acid base neutralization. Esters are responsible for fruit flavorings and aromas of flowers. They are synthesized as artificial flavors. Lipids (fats and oils) are formed by esterification of glycerol (1,2,3-propanetriol) by fatty acids (long chain organic acids)

$$ROH + RCOOH \rightarrow RCOOR + H_2O$$

Alcohol + Acid → Ester + Water

Saponification. Saponification is the hydrolysis of fats by bases. When sodium hydroxide reacts with a fat it produces organic salts called soaps plus glycerol as a byproduct. The reaction looks much like the reverse of the formation of the fat, except that the fatty acid becomes a sodium salt [$Na^+ \ CH_3(CH_2)_nCOO^-$].

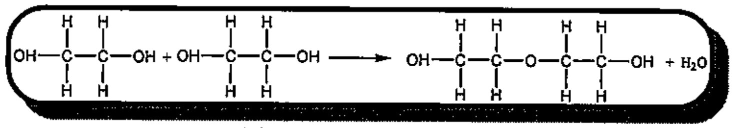


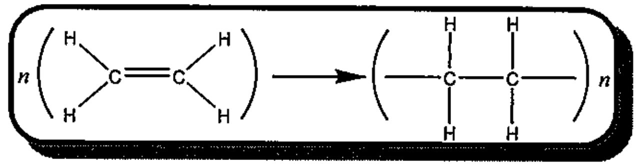
Formation of fat by esterification

Continue ☞

40

Polymerization. Polymerization is the formation of large molecules from repeating units of smaller ones. A polymer is a large molecule formed from many smaller, repeating units or *monomers.* Polymers can form by ***condensation*** – joining monomers by dehydration synthesis. Condensation polymers must have at least two functional groups. The process can be repeated to form long chain polymers. Examples include silicones, polyesters, polyamides, phenolic plastics, and nylons. ***Addition polymerization*** involves opening up double and triple bonds of unsaturated hydrocarbons. Examples include vinyl plastics - polyethylene and polystyrene.


Polymerization by condensation


Addition polymerization

Answer the questions below based on the reading above and on your knowledge of chemistry.

1. What forms from the complete combustion of a hydrocarbon? ______________________________

2. A hydrocarbon reacts with fluorine. Under which conditions will substitution occur, and under which conditions will addition occur? ______________________________

3. What is butylpentanoate? How does it form? ______________________________

4. How is soap made? ______________________________

5. What is the process of joining many small molecules into larger molecules is called? ______________________________

6. Teflon, a common non-stick cooking surface, is a polymer of tetrafluoroethene. Draw a structural formula of tetrafluoroethene. Then show the result of the reaction using structural formulas. What type of polymerization is this?

Chemistry: Form Ls11.4A Name ______________________

ORGANIC CHEMISTRY Date ______________ Period _____

Organic Reactions

Aim

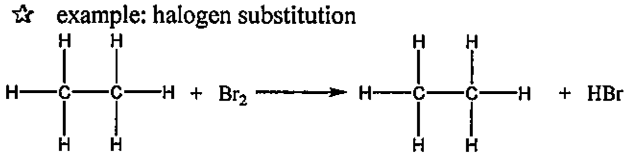
- to describe common reactions of organic compounds

Notes

Some reactions of hydrocarbons

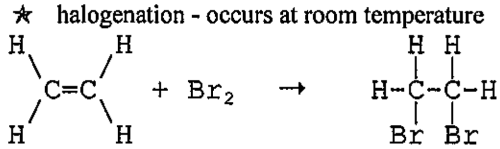
★ Combustion - burning
- ☆ with sufficient oxygen → CO_2 and water
  - ★ example: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
- ☆ with insufficient oxygen → CO and water
  - ★ example: $2C_3H_8 + 7O_2 \rightarrow 6CO + 8H_2O$

★ Substitution - replacement of hydrogen in saturated hydrocarbons
- ☆ example: halogen substitution



eth
ane + bromine → monobromoethane + hydrogen bromide

★ Addition
- ☆ Definition = Adding two or more atoms to carbon at a point of unsaturation
- ☆ Characteristics
  - ★ take place more easily than substitutions
  - ★ unsaturated bonds are more reactive than saturated bonds and alkynes are more reactive than alkenes
  - ★ results in the formation of a single product
- ☆ Examples
  - ★ halogenation - occurs at room temperature



- ☆ Hydrogenation
  - ★ Definition - addition of hydrogen to an alkene or an alkyne (or other carbon compounds with double or triple bonds)

★ Fermentation - enzymatic breakdown of organic molecules during anaerobic respiration

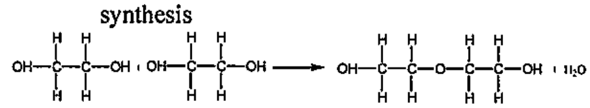
$$C_6H_{12}O_6 \xrightarrow{zymase} 2C_2H_5OH + 2CO_2$$

glucose → ethanol + carbon dioxide

★ Esterification - formation of esters
- ☆ General formula: RCOOR
- ☆ Formation: ROH + RCOOH → RCOOR + H_2O
- ☆ importance:
  - ★ fruit flavorings and aromas
  - ★ lipids are formed by esterification of glycerol by fatty acids

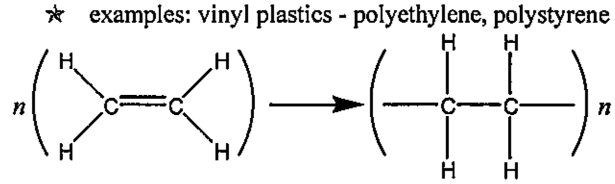
★ Saponification - hydrolysis of fats by bases
- ☆ produces organic salts called soaps
- ☆ forms glycerol as a byproduct

★ Polymerization - formation of large molecules from repeating units of smaller ones
- ☆ Polymer - large molecule formed from many smaller, repeating units or *monomers*
- ☆ Condensation - joining monomers by dehydration synthesis



monomer monomer dimer

  - ★ condensation polymers must have at least two functional groups
  - ★ the process can be repeated to form long chain polymers
  - ★ examples: silicones, polyesters, polyamides, phenolic plastics, and nylons
- ☆ Addition polymerization - involves opening up double and triple bonds of unsaturated hydrocarbons
  - ★ examples: vinyl plastics - polyethylene, polystyrene



ethylene monomer polyethylene

Answer the questions below by circling the number of the correct response

1. One of the products produced by the reaction between CH_3COOH and CH_3OH is
(1) HOH (3) HCOOH
(2) H_2SO_4 (4) CH_3CH_2OH

2. A fermentation reaction and a sponification reaction are similar in that they both can produce
(1) an ester (3) an acid
(2) an alcohol (4) a soap

3. The product of a reaction between a hydrocarbon and chlorine was 1,2-dichloropropane. The hydrocarbon must have been
(1) C_5H_{10} (3) C_3H_6
(2) C_2H_4 (4) C_4H_8

4. The product of a reaction between a hydrocarbon and chlorine was 1,2-dichloropropane. The hydrocarbon must have been
(1) C_5H_{10} (3) C_3H_6
(2) C_2H_4 (4) C_4H_8

5. The reaction $C_3H_6 + H_2 \rightarrow C_3H_8$ is an example of
(1) substitution (3) polymerization
(2) addition (4) esterification

6. The reaction $C_2H_4 + H_2 \rightarrow C_2H_6$ is an example of
(1) addition (3) saponification
(2) substitution (4) esterification

7. A reaction between an acid and an alcohol produces an ester and
(1) carbon dioxide (3) glycerol
(2) water (4) ethanol

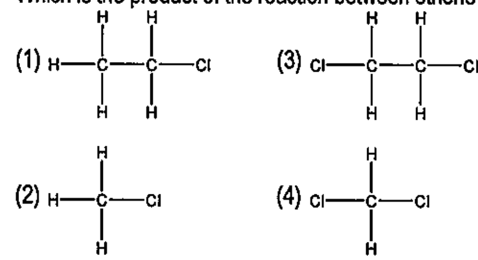
8. The fermentation of $C_6H_{12}O_6$ will produce carbon dioxide and
(1) a polymer (3) an ester
(2) a soap (4) an alcohol

9. The reaction: $C_4H_8 + Cl_2 \rightarrow C_4H_8Cl_2$ is an example of
(1) substitution (3) polymerization
(2) addition (4) fermentation

10. A reaction between CH_3COOH and an alcohol produced water and an ester CH_3COOCH_3. Which alcohol was used in the reaction?
(1) CH_3OH (3) C_3H_7OH
(2) C_2H_5OH (4) C_4H_9OH

11. The hydrolysis of fat by a base is called
(1) saponification (3) polymerization
(2) esterification (4) neutralization

12. Which is the product of the reaction between ethene and chlorine?



13. Which equation represents an esterification reaction?
(1) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + CO_2$
(2) $C_5H_{10} + H_2 \rightarrow C_5H_{12}$
(3) $C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$
(4) $HCOOH + CH_3OH \rightarrow HCOOCH_3 + HOH$

14. In a condensation polymerization, a product always formed is
(1) water (3) oxygen
(2) hydrogen (4) carbon dioxide

15. The organic reaction,
$HCOOH + CH_3CH_2CH_2CH_2OH \rightarrow HCOOCH_2CH_2CH_2CH_3 + HOH$,
is an example of
(1) fermentation (3) polymerization
(2) esterification (4) saponification

16. Which compound will undergo a substitution reaction with chlorine?
(1) CH_4 (3) C_3H_6
(2) C_2H_4 (4) C_4H_8

17. The reaction represented by the equation $nC_2H_4 \rightarrow (\text{-}C_2H_4\text{-})_n$ is called
(1) saponification (3) esterification
(2) fermentation (4) polymerization

18. Which organic reaction involves the bonding of monomers by a dehydration process?
(1) substitution (3) addition polymerization
(2) oxidation (4) condensation polymerization

19. The reaction $CH_3OH + HCOOH \rightarrow HCOOCH_3 + H_2O$ is an example of
(1) hydrogenation (3) esterification
(2) polymerization (4) addition

20. The reaction $C_4H_{10} + Br_2 \rightarrow C_4H_9Br + HBr$ is an example of
(1) substitution (3) fermentation
(2) addition (4) polymerization