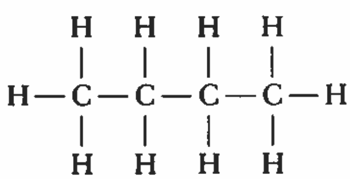
Naming Hydrocarbons

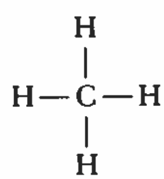
Hydrocarbons are compounds made up of carbon and hydrogen. Hydrocarbons called the alkanes are the simplest hydrocarbons. These compounds are named by using a prefix that tells the number of carbon atoms they contain and the root "ane."

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

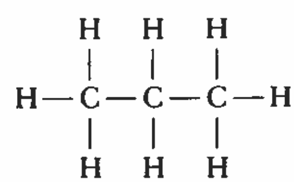
Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10



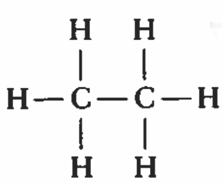
1. ______________________



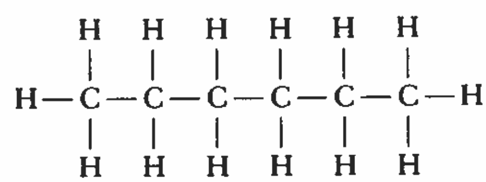
2. ______________________



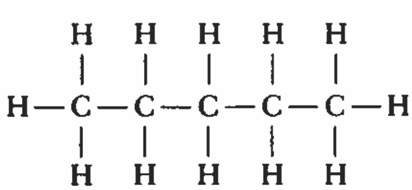
3. ______________________



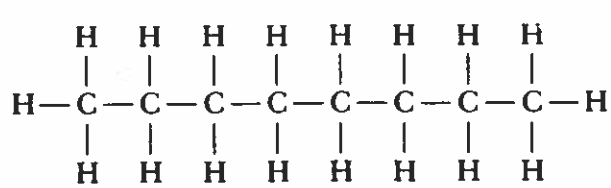
4. ______________________



5. ______________________



6. ______________________

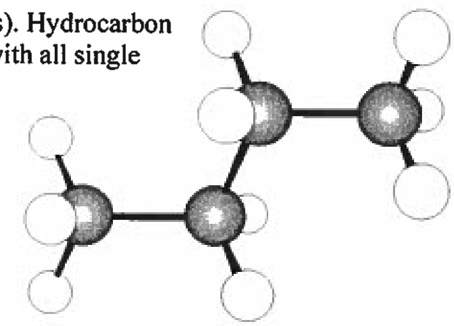


7. ______________________

Name ____________________

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} ______________________

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		______________

Chemistry: Form WS11.2.2A

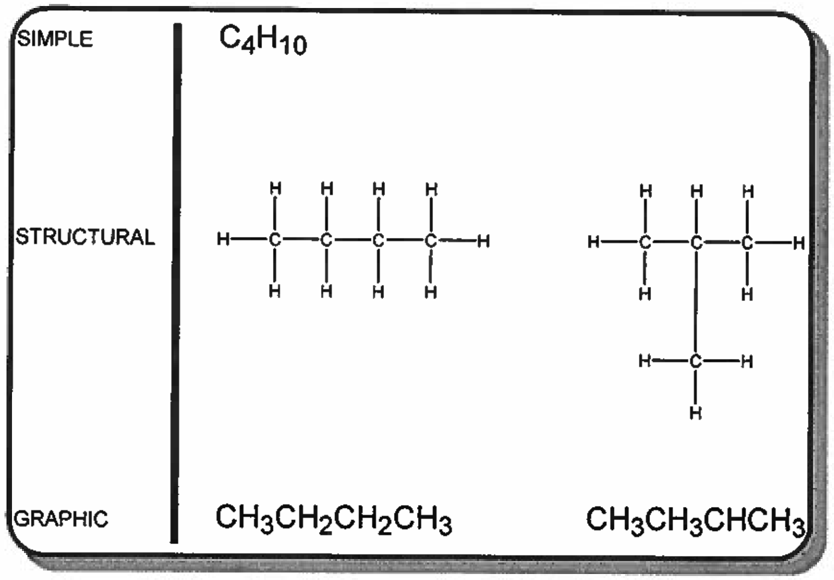
ORGANIC CHEMISTRY

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, 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. $CH_3CH_2CCH_3CH_3CH_2CH_3$

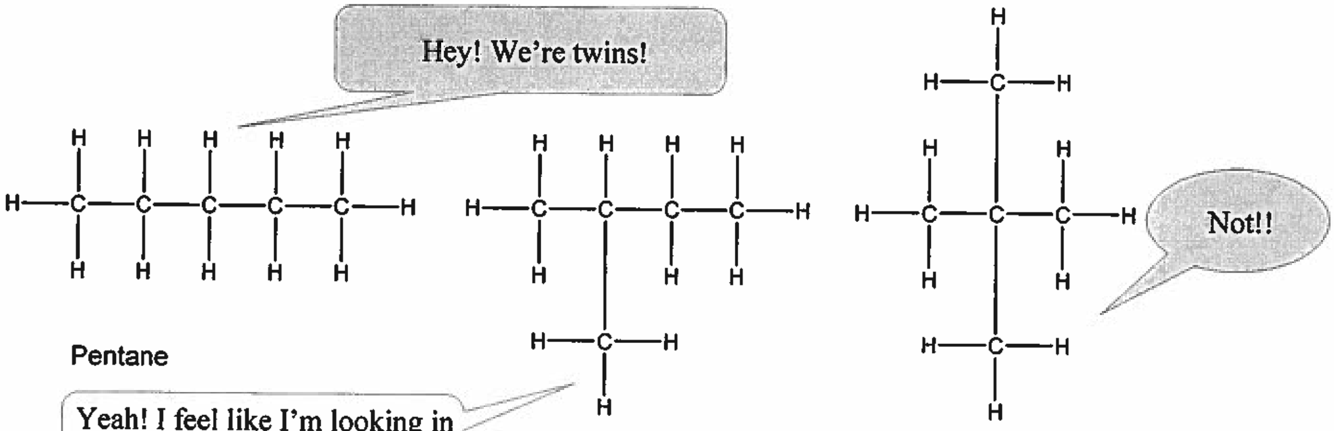
6. $CH_2CHCH_2CH_3$

Chemistry: Form WS11.2.1A Name ______________________

ORGANIC CHEMISTRY Date ______________ Period _____

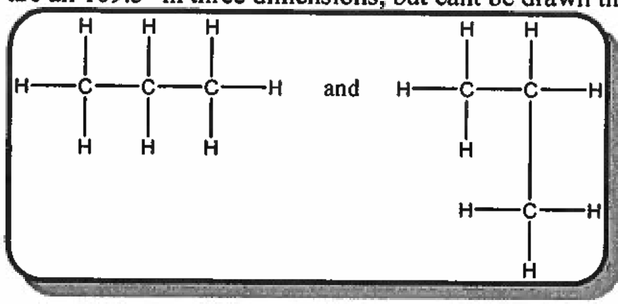
Isomers

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!

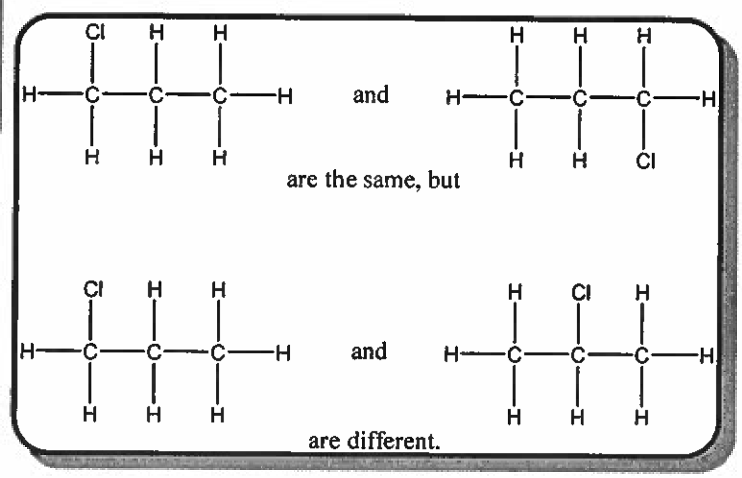


Pentane 2-methyl butane 2,2-dimethyl propane

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

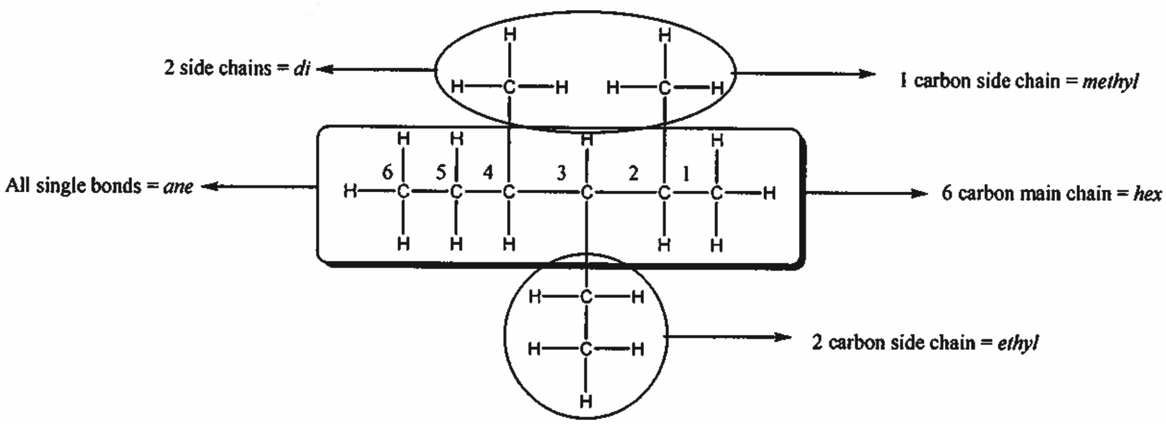
Name ______________________________

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

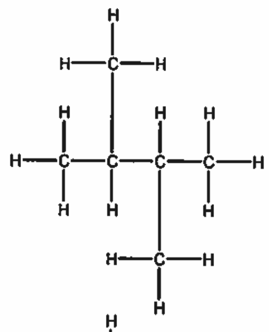
Following these rules, the compound $CH_2CHCHCH_2$ would be named 1,3-butadiene. The "a" is added just to make it pronounceable. Draw the picture to check. You will see there are 4 carbons (*but*) and two (*di*) double bonds (*ene*). The double bonds are located between the first and second carbon (*1*)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

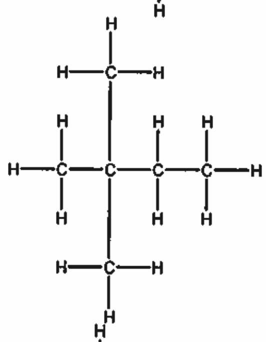
$CH_3CH_3CCH_3CH_3$ is called 2,2-dimethyl propane. The longest chain is three carbons long (*prop*). There are two (*di*) one carbon (*methyl*) side chains. Both side chains are attached to the middle or second carbon (*2*). Because there is no place else to attach these side chains, the compound can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

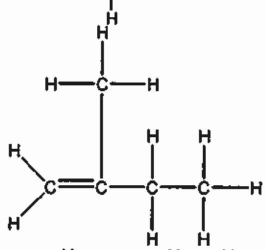
Continue ☞

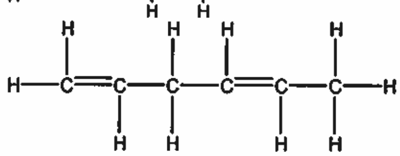
Name the hydrocarbons below based on your reading and on your knowledge of chemistry.

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 __________ Class __________

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

2. 1,1-dibromopropane

3. 1,4-hexadiene

4. chloroethane

5. 1,2-dibromopropane

6. nitrobenzene

Name ______________________________

REVIEW ACTIVITY Chapter 24

Writing Structural Formulas for Organic Compounds (continued)

7. 2-nitromethylbenzene

9. 3-methylpentane

8. 1-chloro-4-ethylhexane

10. 1,2-dinitrobenzene

STRUCTURE OF HYDROCARBONS

Name ____________________

Draw the structure of the compounds below.

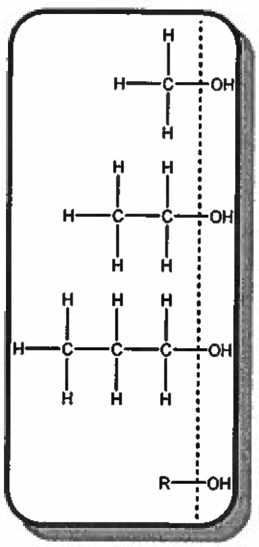
1. ethane
2. propene
3. 2-butene
4. methane
5. ethyne
6. 3, 3-dimethyl pentane
7. 2, 3-dimethyl pentane
8. n-butyne

Chemistry: Form WS11.3.2A — Name ______________________

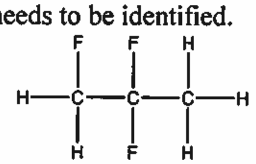
ORGANIC CHEMISTRY — Date ______________ Period ____

Naming Substituted Hydrocarbons

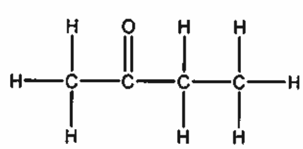
A substituted hydrocarbon is a hydrocarbon with an element other than hydrogen attached somewhere along the hydrocarbon chain. It is named in a similar fashion to a hydrocarbon. This can be illustrated with alcohols as an example. The compounds pictured to the lower left are alcohols. They look like 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



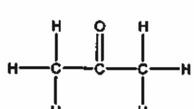
2-butanone

Table R
Organic Functional Groups

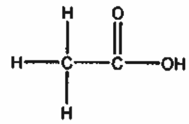
Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	—F (fluoro-) —Cl (chloro-) —Br (bromo-) —I (iodo-)	*R*—*X* (*X* represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	—OH	*R*—OH	$CH_3CH_2CH_2OH$ 1-propanol
ether	—O—	*R*—O—*R'*	$CH_3OCH_2CH_3$ methyl ethyl ether
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. $CH_3CH_2CHOHCH_3$ .... ______________________________

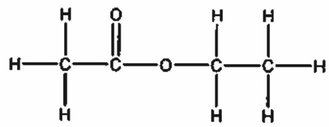
2.  .... ______________________________

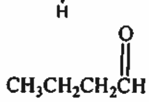
Continue ☞

3.  .... ____________________

4. $CH_3CH_2CH_2OCH_2CH_3$ .... ____________________

5. CH_3OCH_3 .... ____________________

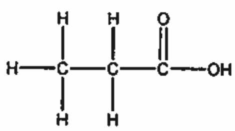
6.  .... ____________________

7.  .... ____________________

8. $CH_3CH_2CH_2CHOHCH_2CH_2CH_2CH_3$ .... ____________________

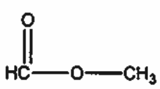
9. CH_3CHO .... ____________________

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 __________

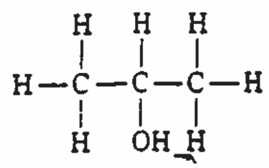
CHAPTER 24 REVIEW ACTIVITY

Text Reference: Section 24-17

Classifying Organic Compounds by Functional Group

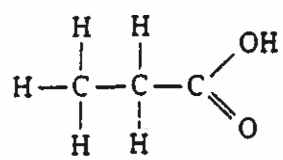
Classifying each of the following organic compounds as one of the following: primary alcohol, secondary alcohol, tertiary alcohol, aldehyde, ketone, ether, carboxylic acid, or ester.

1.



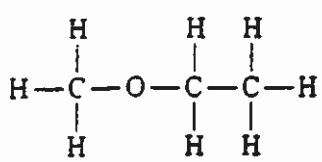
1. ______________________

2.



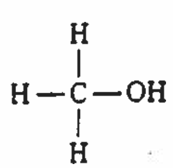
2. ______________________

3.



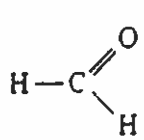
3. ______________________

4.



4. ______________________

5.



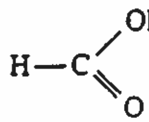
5. ______________________

14

Name ____

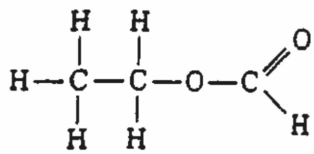
Classifying Organic Compounds by Functional Group (continued)

6.



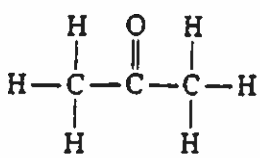
6. ____________________

7.



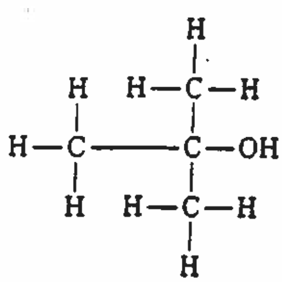
7. ____________________

8.



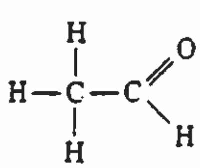
8. ____________________

9.



9. ____________________

10.



10. ____________________

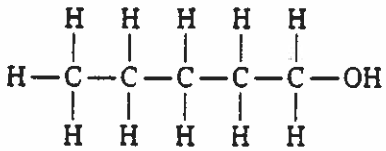
15

Name ______________________ Date ____________ Class ____________

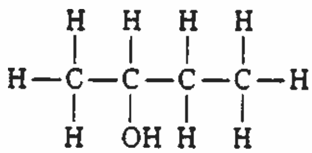
CHAPTER 24 REVIEW ACTIVITY   Text Reference: Section 24-17

Naming Organic Compounds That Contain Functional Groups

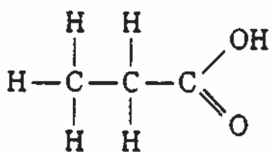
Use the IUPAC system of nomenclature to name each of the following compounds.

1.


1. ______________________

2.


2. ______________________

3.


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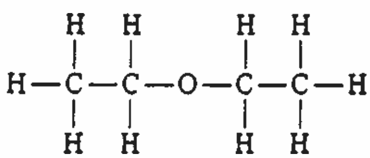

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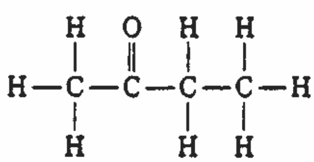

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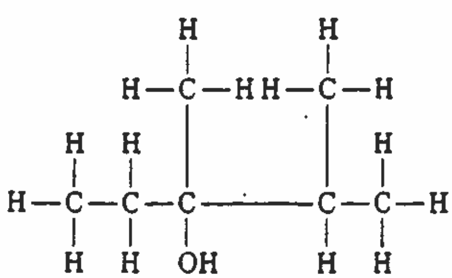
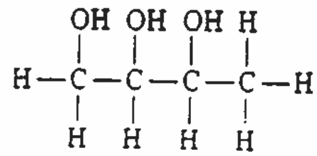


6. ______________________

Naming Organic Compounds That Contain Functional Groups (continued)

7. 

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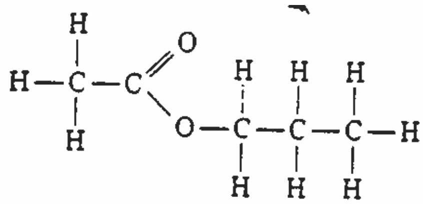
8. 

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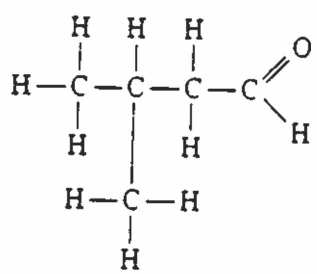
9. 

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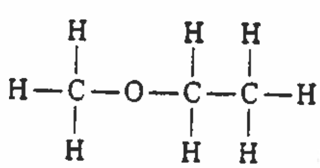
10. 

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 __________

Writing Structural 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

Name ______________________________

REVIEW ACTIVITY Chapter 24

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

7. heptanal

9. 2-butanol

8. ethanoic acid

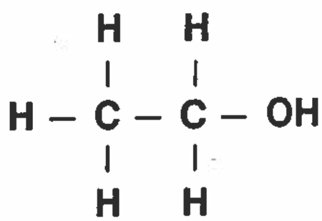
10. 1,3-propanediol

Name ______________________

NAMING OTHER ORGANIC COMPOUNDS

Name the compounds below.

1.



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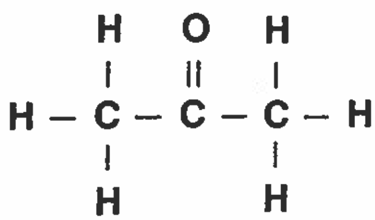

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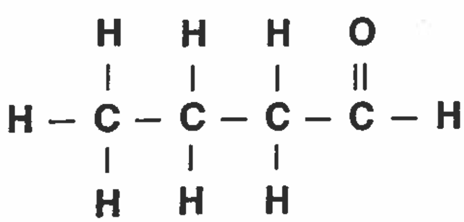

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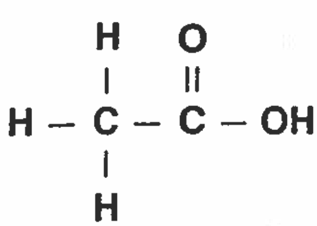

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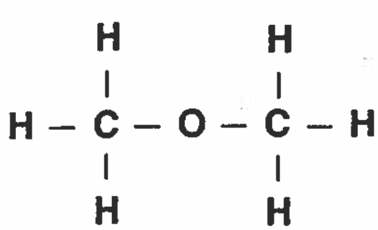

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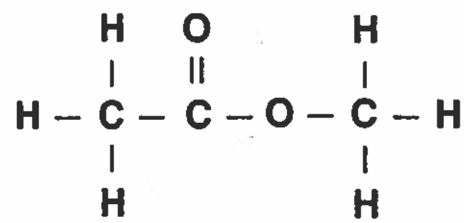

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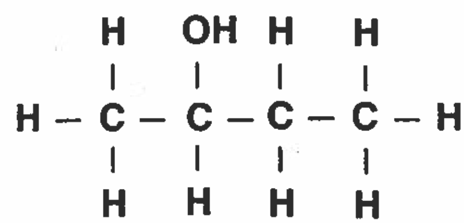

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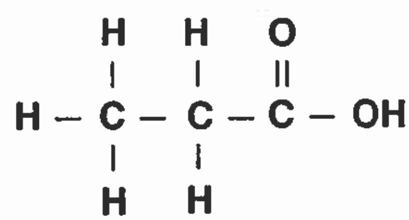

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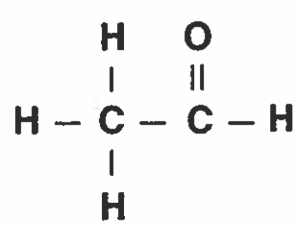

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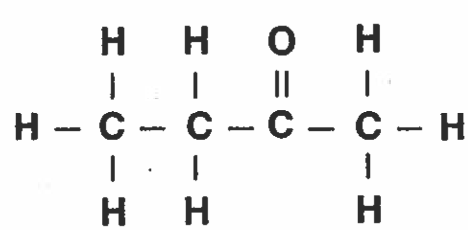


STRUCTURES OF OTHER ORGANIC COMPOUNDS

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 ______________________

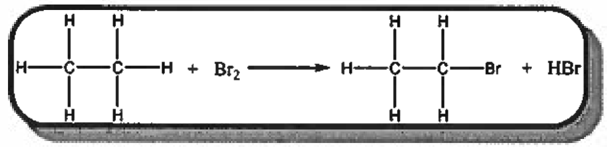
ORGANIC CHEMISTRY | Date ______________ Period _____

Understanding Organic Reactions

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

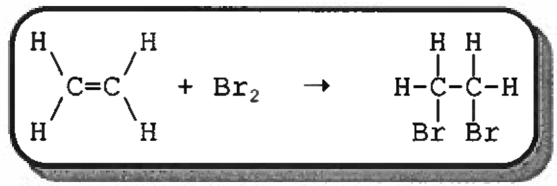
Combustion. Fossil fuels such as the gasoline used in automobiles or the propane used in gas barbecues are hydrocarbons. When they burn, they release carbon dioxide and water. ($C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$). Of course, when there is insufficient oxygen, as in an automobile engine, the carbon 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.

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

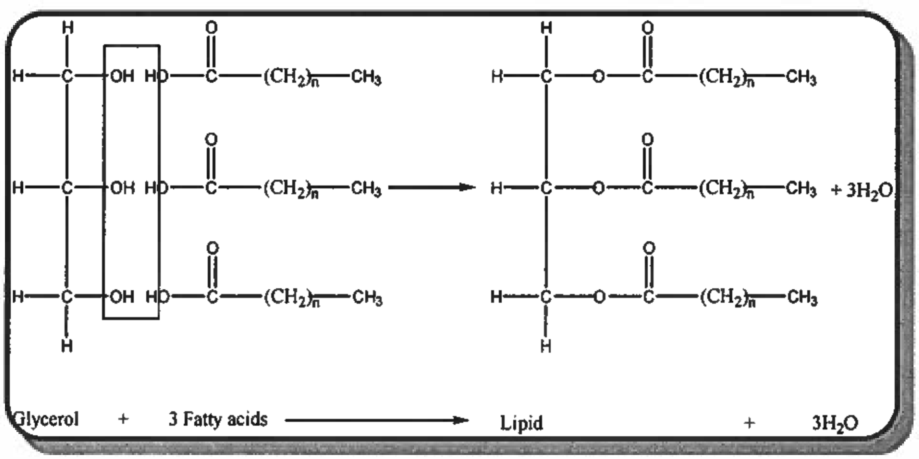
glucose → ethanol + carbon dioxide

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

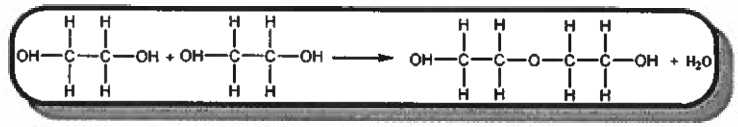
Saponification. Saponification is the hydrolysis of fats by bases. When sodium hydroxide reacts with a fat it produces organic salts called soaps plus glycerol as a byproduct. The reaction looks much like the reverse of the formation of the fat, except that the fatty acid becomes a sodium salt [$Na^+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

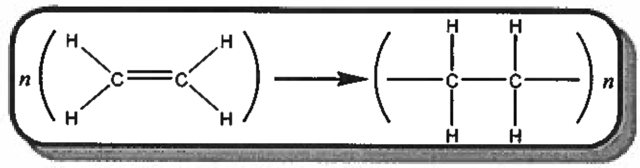


Formation of fat by esterification

Continue ☞

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?