


Unit 13: Organic Chemistry

Ms. Johnson
Prep Chemistry

Unit Learning Objectives: By the end of the unit students will be able to...

- (1) Name and draw hydrocarbons including alkanes, cycloalkanes, alkenes, cycloalkenes, and alkynes.
- (2) Match the structure with the correct name for molecules containing common functional groups including alkyl halides, alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, and amides.
- (3) Complete ester condensation reactions.

Monday	Tuesday	Wednesday	Thursday	Friday
May 16 Organic Chemistry Activity	17 alkanes Naming	18 alkenes	19 Benzene and alkynes	20 Functional groups
Work on Final Review →				
23 Esterification and Amino Acid Formation	24 Lab: Ester Synthesis	25 Review	26 Unit 13 Test Part 1	27 Unit 13 Test Part 2 HW packet Due
30 Final Review	31 Final Review	June 1 Final Review	2 Practice Multiple Choice Test ** After school Review Session**	3 Review of MC Test ** All Late work Due
6 AM Final Period 1 Final Period 2 Final	7 AM Final Period 3 Final Period 4 Final	8 Period 5 Final Period 6 Final	9 Last Day of School	10 Have a wonderful SUMMER! 

Organic Chemistry

Organic Chemistry is _____.

I. Hydrocarbons

– contain only _____ and _____

(1) Alkanes

– contain only **single** bonds

– called “saturated” hydrocarbons (contain maximum number of hydrogens for each carbon)

Unbranched Alkanes

Formula	Name	Structural Drawing	Lewis Structure
CH ₄	Methane	CH ₄	<pre> H H-C-H H </pre>
C ₂ H ₆	Ethane	CH ₃ CH ₃	<pre> H H H-C-C-H H H </pre>
C ₃ H ₈	Propane	CH ₃ CH ₂ CH ₃	<pre> H H H H-C-C-C-H H H H </pre>
C ₄ H ₁₀	Butane	CH ₃ CH ₂ CH ₂ CH ₃	<pre> H H H H H-C-C-C-C-H H H H H </pre>
C ₅ H ₁₂	Pentane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃	<pre> H H H H H H-C-C-C-C-C-H H H H H H </pre>
C ₆ H ₁₄	Hexane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<pre> H H H H H H H-C-C-C-C-C-C-H H H H H H H </pre>
C ₇ H ₁₆	Heptane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<pre> H H H H H H H H-C-C-C-C-C-C-C-H H H H H H H H </pre>
C ₈ H ₁₈	Octane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<pre> H H H H H H H H H-C-C-C-C-C-C-C-C-H H H H H H H H H </pre>
C ₉ H ₂₀	Nonane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<pre> H H H H H H H H H H-C-C-C-C-C-C-C-C-C-H H H H H H H H H H </pre>
C ₁₀ H ₂₂	Decane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	<pre> H H H H H H H H H H H-C-C-C-C-C-C-C-C-C-C-H H H H H H H H H H H </pre>

Branched Alkanes

– branched alkanes have alkyl groups attached to the main chain

– **main chain:** _____ Also called the _____.

– **alkyl group:** alkane missing one hydrogen so that it can bond to the main chain.

Common Alkyl Groups

Name	Drawing
Methyl	CH ₃ –
Ethyl	CH ₃ CH ₂ –
Propyl	CH ₃ CH ₂ CH ₂ –
Butyl	CH ₃ CH ₂ CH ₂ CH ₂ –

Naming Alkanes

(1) Identify the main chain.

(2) Number each carbon on the main chain. Begin at the end closest to the first alkyl group. If both ends are equally close to an alkyl group, begin numbering at the end closest to the longer alkyl group *or* at the end closest to the second alkyl group.

(3) Assign a number to each alkyl group based on the carbon number the alkyl group attaches to on the main chain. Name the alkyl groups in alphabetical order. If there is more than one of an alkyl group, use prefixes (ie. di, tri, tetra) to indicate how many of the alkyl groups there are. (Note: prefixes DO NOT affect alphabetization for the alkyl groups).

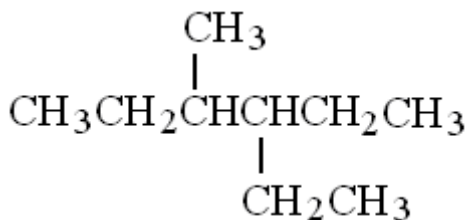
(4) Name the main chain based on the number of carbon atoms it contains.

Name the following alkanes

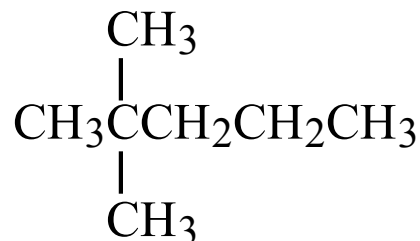
ex.



ex.



ex.



Drawing Alkanes

(1) Draw the main chain and number the carbons.

(2) Add the alkyl groups at the correct number on the main chain. Be sure the alkyl group attaches through a carbon that can bond. The alkyl groups may be drawn above or below the main chain.

(3) Fill in the missing hydrogen atoms so that each carbon has four bonds. A carbon is bonded to any carbon it is adjacent to and any alkyl group that is attached to it.

Draw the following alkanes

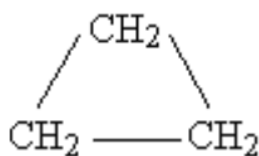
ex. 3-Ethyl-5-methylheptane

ex. 4,5-Diethyl-4-propylnonane

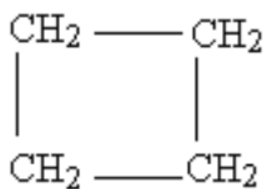
(2) Cycloalkanes

– the main chain forms a “circle”. The cycloalkane is named for the number of carbons in the “circle” with the prefix “cyclo”

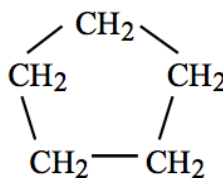
Cyclopropane



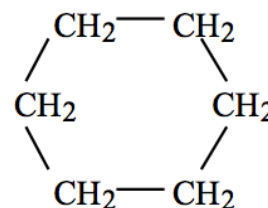
Cyclobutane



Cyclopentane



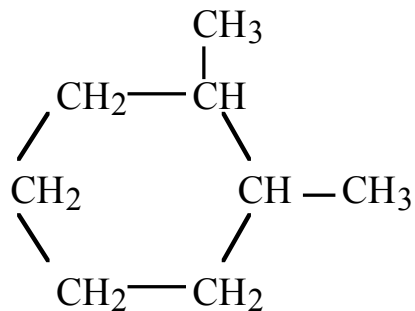
Cyclohexane



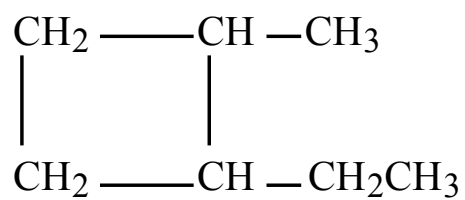
The cycloalkane is numbered so that the alkyl groups have the lowest numbers possible and so that the longer alkyl group is preferentially given a lower number.

Name the following Cycloalkanes

ex.



ex.



Draw the following Cycloalkanes

ex. 4-Methyl-1,3-dipropylcyclopentane

1,2,3-Trimethylcyclopropane

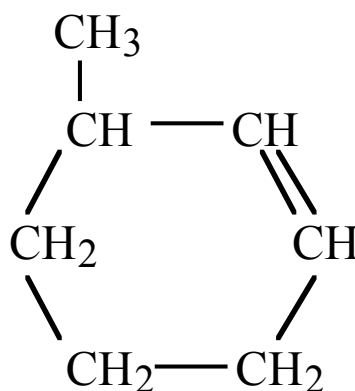
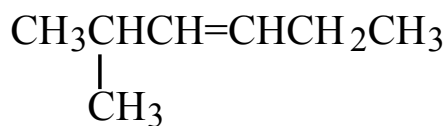
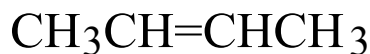
(3) Alkenes and cycloalkenes

- contain **double bonds** between carbon atoms
- General Formula for Alkenes: C_nH_{2n}
- Alkenes are called "unsaturated" hydrocarbons since they contain fewer hydrogen atoms for each atom of carbon. (ie an alkane with 15 carbon atoms has 32 hydrogen atoms and an alkene with 15 carbon atoms has 30 hydrogen atoms)

Naming Alkenes

- (1) Identify the main chain containing the double bond.
- (2) Number each carbon on the main chain so that the carbon number of the double bond is the lowest. The double bond takes priority over alkyl groups. For cycloalkenes, the double bond is always numbered such that it is placed between carbons 1 and 2.
- (3) Assign a number to each alkyl group and name the alkyl groups in alphabetical order. If there is more than one of an alkyl group, use prefixes (ie. di, tri, tetra) to indicate the number.
- (4) Name the main chain based on the number of carbons it contains and change the ending to "ene". Indicated the position of the double bond with the carbon number the double bond comes after. (For cycloalkenes, the number 1 is not written in the name)

Name the following alkenes



Drawing Alkenes

- (1) Draw the main chain and number the carbons. Add the double bond at the indicated carbon of the main chain. For cycloalkanes, the double bond is always between carbons one and two.
- (2) Add the alkyl groups at the correct number on the main chain.
- (3) Fill in the missing hydrogen atoms (each carbon has four bonds). The double bond accounts for two bonds.

Draw the following alkenes

ex. 4-Methyl-2-pentene

ex. 4-Ethyl-3,5-Dimethyl-2-hexene

ex. 3-methylcycloheptene

Alkynes

- Contain triple bonds between carbon atoms
- General formula for alkynes: C_nH_{2n-2}

Naming Alkynes

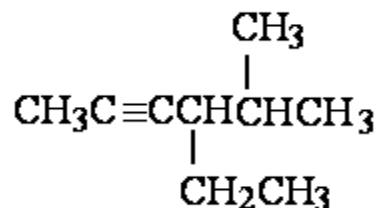
- (1) Identify the main chain containing the triple bond.
- (2) Number each carbon on the main chain so that the carbon number of the triple bond is the lowest. The triple bond takes priority over alkyl groups.
- (3) Assign a number to each alkyl group and name the alkyl groups in alphabetical order. If there is more than one of an alkyl group, use prefixes (ie. di, tri, tetra) to indicate the number.
- (4) Name the main chain based on the number of carbons it contains and change the ending to "yne". Indicate the position of the triple bond with the carbon number the triple bond comes after.

Name the following alkynes

ex.



ex.



Drawing Alkynes

- (1) Draw the main chain and number the carbons. Add the triple bond at the indicated carbon of the main chain.
- (2) Add the alkyl groups at the correct number on the main chain.
- (3) Fill in the missing hydrogen atoms (each carbon has four bonds). The triple bond accounts for three bonds.

Draw the following alkynes

ex. 3,5-Dimethyl-1-heptyne

ex. 4-Ethyl-5-methyl-2-nonyne

II. Functional Groups

Naming Organic Compounds with functional groups

- (1) Identify the functional group.
- (2) Number each carbon on the main chain containing the functional group so that the carbon number of the functional group is the lowest.
- (3) Assign a number to each alkyl group and name the alkyl groups in alphabetical order. If there is more than one of an alkyl group, use prefixes (ie. di, tri, tetra) to indicate the number.
- (4) Name the functional group with the appropriate ending.

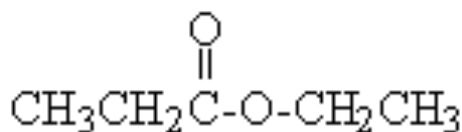
Functional Group	Structure	Ending	Example	Applications
Alkane	$R-R$ R= any alkyl group	“ane”	$CH_3CH_2CH_2CH_2CH_3$ Pentane	
Alkene	$R=R$	“ene”	$CH_3CH=CHCH_2CH_2CH_3$ 2-hexane	
Alkyne	$R\equiv R$	“yne”	$CH_3C\equiv CCH_3$ 2-butyne	
Alkyl Halide	$R-X$ X= F, Cl, Br, I fluoro, chloro, bromo, iodo	depends on main chain	$\begin{array}{cccccccc} & Cl & & F & & & & \\ & & & & & & & \\ CH_3 & -CH & -CH & -CH & -CH & -CH_2 & -CH_3 \\ & & & & & & \\ & & I & & Br & & \end{array}$ 5-bromo-2-chloro-4-fluoro-3- idoheptane	
Alcohol	$R-OH$	“ol”	$\begin{array}{c} OH \\ \\ CH_3CHCH_3 \end{array}$ 2-propanol	
Ether	R_1-O-R_2	“ether”	$CH_3CH_2-O-CH_2CH_2CH_3$ Ethyl propyl ether	
Aldehyde	$\begin{array}{c} O \\ \\ R-C-H \end{array}$	“al”	$\begin{array}{c} O \\ \\ CH_3CH_2CH \end{array}$ propanal	
Ketone	$\begin{array}{c} O \\ \\ R_1-C-R_2 \end{array}$	“one”	$\begin{array}{c} O \\ \\ CH_3CCH_2CH_2CH_3 \end{array}$ 2-pentanone	
Carboxylic Acid	$\begin{array}{c} O \\ \\ R-C-OH \end{array}$	“oic acid”	$\begin{array}{c} O \\ \\ CH_3C-OH \end{array}$ ethanoic acid	
Ester	$\begin{array}{c} O \\ \\ R_2-C-O-R_1 \end{array}$	“oate”	$\begin{array}{c} O \\ \\ CH_3CH_2C-O-CH_3 \end{array}$ methyl propanoate	
Amine	$R-NH_2$ $NH_2 = \text{amino}$	depends on main chain	$\begin{array}{c} NH_2 \\ \\ CH_3CHCH_2CH_3 \end{array}$ 2-aminobutane	
Amide	$\begin{array}{c} O \\ \\ R-C-NH_2 \end{array}$	“amide”	$\begin{array}{c} O \\ \\ CH_3CH_2CH_2C-NH_2 \end{array}$ butanamide	

ex. Classify each compound and match with the correct name below

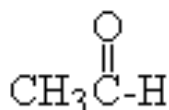
(1)



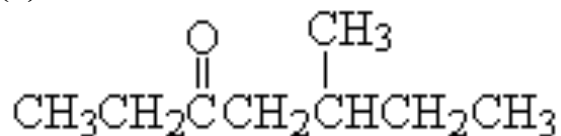
(2)



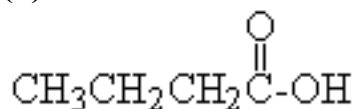
(3)



(4)



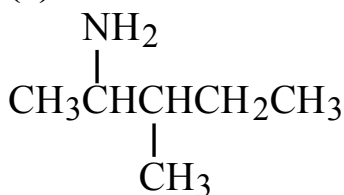
(5)



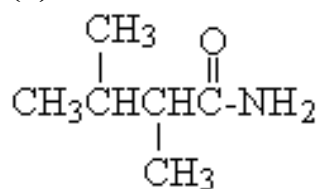
(6)



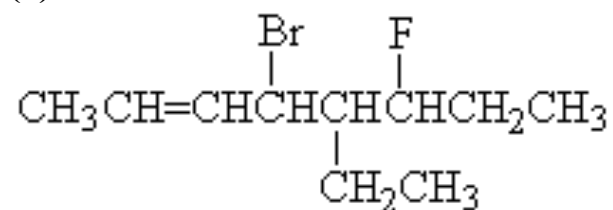
(7)



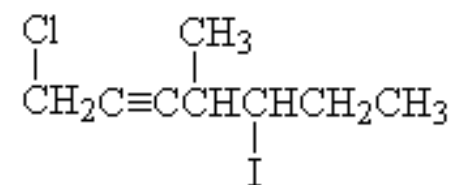
(8)



(9)



(10)



- (a) 2-amino-3-methylpentane
 (b) butanoic acid
 (c) 1-chloro-5-iodo-4-methyl-2-heptyne
 (d) ethyl propanoate
 (e) 5-methyl-3-heptanone

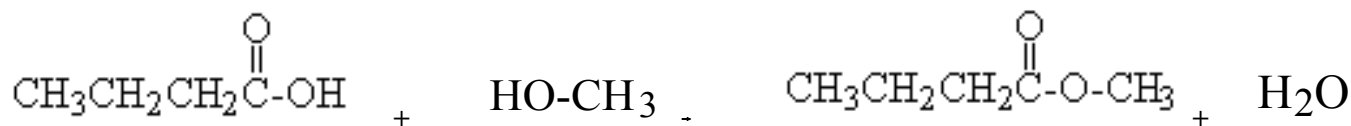
- (f) 2,3-dimethyl butanamide
 (g) ethanal
 (h) 4-bromo-5-ethyl-6-fluoro-2-octene
 (i) methyl propyl ether
 (j) 2-butanol

Ester Condensation Reactions (Esterification or Ester Synthesis Reaction)

Esters can be produced from the reaction of a carboxylic acid with an alcohol. The "OH" from the carboxylic acid and the "H" from the alcohol combine together to make water. The remaining parts of each molecule join to produce an ester.

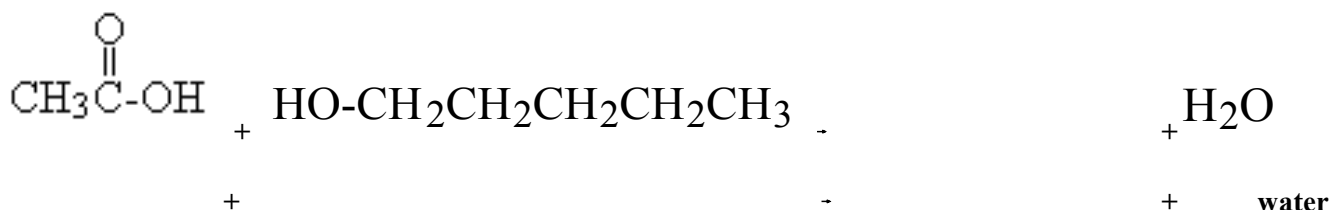


ex.



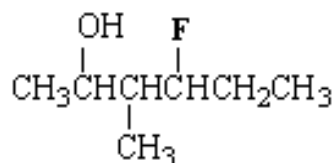
butanoic acid + methanol → methyl butanoate + water

ex. Complete the following ester synthesis reaction:

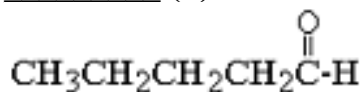


Review: Organic Compounds

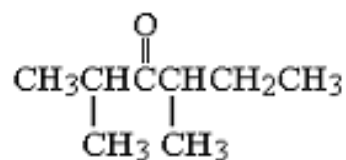
_____ (a)



_____ (b)

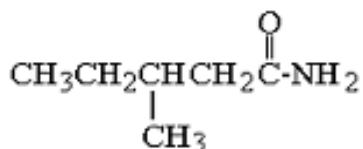


_____ (c)

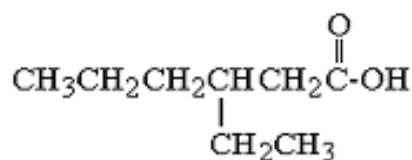


_____ (d)

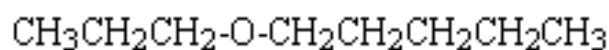
_____ (f)



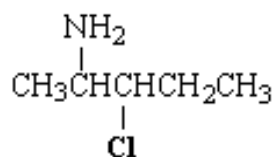
_____ (g)



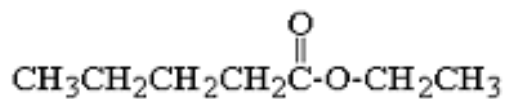
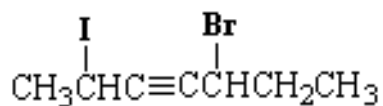
_____ (h)



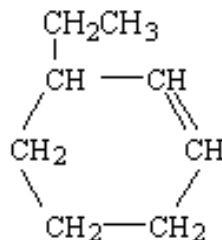
_____ (i)



_____ (e)



_____ (j)



(1) Pentyl propyl ether

(2) 4-fluoro-3-methyl-2-hexanol

(3) pentanal

(4) 3-ethylcyclohexene

(5) 3-ethylhexanoic acid

(6) 3-methylpentanamide

(7) 2,4-dimethyl-3-hexanone

(8) 2-amino-3-chloropentane

(9) 5-bromo-2-iodo-3-heptyne

(10) ethyl pentanoate