Organic Chemistry (Naming & Drawing)

A. Introduction

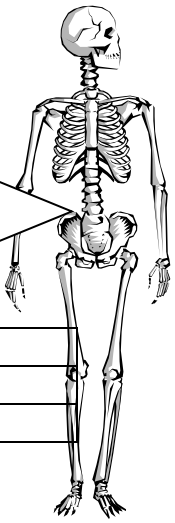
Organic Chemistry: the chemistry of _____ _____ except _____ **&** _____.

carbon compound = organic compound(O.C.)

Why OCs are so important in chemistry:

- we are _____ of them
- there are so many
- they are very useful to us

Common OCs: _____ ($C_6H_{12}O_6$), _____ ($C_{10}H_{14}N_2$), _____ ($[C_2F_4]_x$) ,



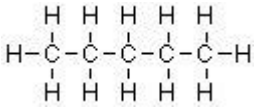
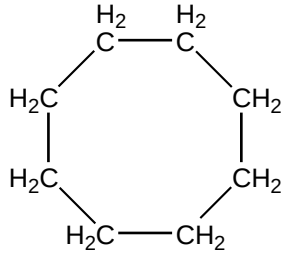
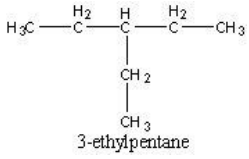
Carbon is called the "_____" of organic Chemistry

The Abundance of OCs

Compounds containing:	Abundance:
only C and H *(called _____)*	
C, H, and other atoms (i.e. O, N, Cl, etc.)	

Why so many types of hydrocarbons.....2 reasons:

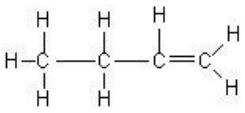
1. Carbon compounds are chains of carbon linked in:

- _____ _____ (linear): 
- _____ pattern(cyclic): 
- _____ (branched): 

3-ethylpentane

cyclooctane

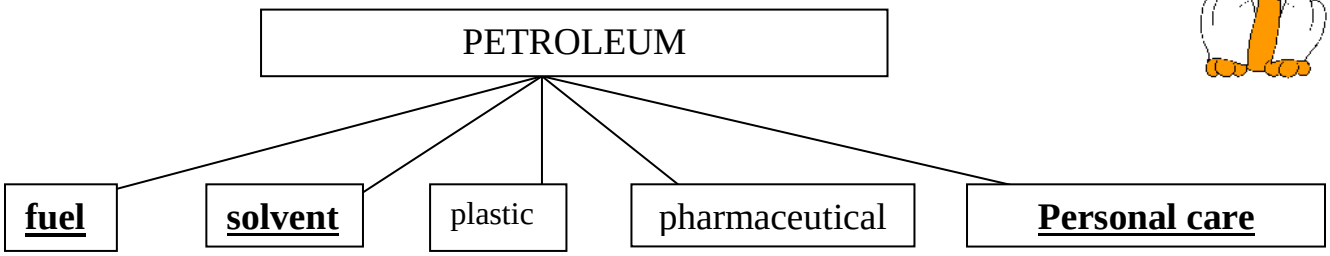
2. Carbon atoms may form _____, _____, or _____ bonds, each having _____ _____.

eg) this molecule has single and double C-C bonds: 

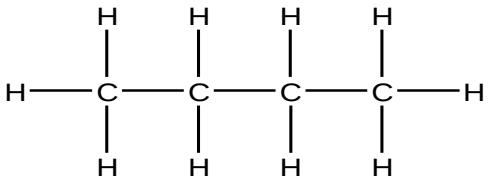
The Uses of OCs

Petroleum: "a **fossil fuel**" plant and animal remains trapped underground for hundreds of millions of years.

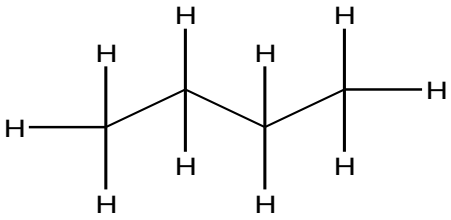
Using organic chemistry, many useful substances are derived from petroleum.



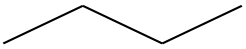
5 Ways to represent butane



Full structure



Half skeleton structure



Skeleton structure

CH_3-CH_2-CH_2-CH_3 or $CH_3CH_2CH_2CH_3$

Condensed structure

C_4H_{10}

Molecular formula

B. Hydrocarbons (only C and H)

3 main groups of hydrocarbons: alkanes, alkenes, alkynes.

Type 1. ALKANES

- contain only single C-C bonds (also called _____ hydrocarbons)
- are divided into: _____, _____, and **cyclic** alkanes types.

Definition: If an atom is _____, it is bonded to the maximum number of other atoms (for C this is 4 other atoms, since the valence of C = 4)

a) NAMING LINEAR ALKANES

# of C in chain	Prefix	Suffix	Name	Molecular formula	Mnemonic
1	meth-	ane	***methane***	**CH_4**	
2	eth-	ane			
3	prop-	ane			
4	but-	ane			
5	pent-	ane			
6	hex-	ane			
7	hept-	ane			
8	oct-	ane			
9	non-	ane			
10	dec-	ane			
etc…					

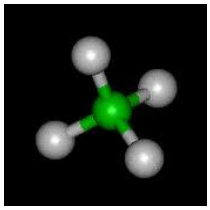
(**notice**; **General formula** = C_nH_{2n+2})

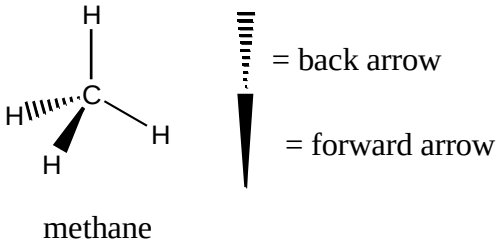
ii) GEOMTERY:

On paper, bonds on carbon atoms are all at _____ _____ BUT bond angles are actually = **109.5 °.**

The bonds are actually arranged in the shape of a 4 cornered pyramid. (*tetra* hedron) (4 sides)

eg) CH_4





methane

b) SUBSTITUTED ALKANES

These are alkanes with _____, and the branches are _____themselves.

To make a branch (alkyl group):

alkyl group

Alkane		Branch form
C_2H_6	Remove a Hydrogen →	- C_2H_5
ethane		ethyl

i) NAMING AND DRAWING:

original alkane	alkane name	branch form	branch name
CH_4	methane	$–CH_3$	
CH_3CH_3	ethane	$–CH_2CH_3$	
$CH_3CH_2CH_3$	propane	$–CH_2CH_2CH_3$	
$CH_3CH_2CH_2CH_3$	butane	$–CH_2CH_2CH_2CH_3$	

Molecule name:

Steps

1. Find the _____ _____ carbon chain.
2. _____ the carbons in the chain, starting at end _____ to the _____ /substitution and find the number where substitution is.
3. name the branch
4. put together the name as follows: (# of the substituted C) – (branch name) (name of longest chain)

always dashes between #'s and words

eg) $CH_3–\underset{\displaystyle CH_2 \\ \displaystyle CH_2 \\ \displaystyle CH_3}{\underset{|}{CH}}–CH_2–CH_2–CH_2–CH_2–CH_3$

1. longest chain has ____carbons ∴ chain name = **(_____)**

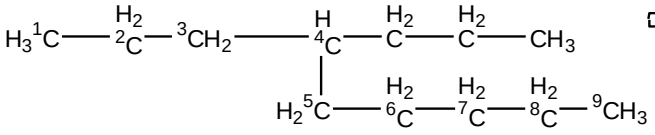
2. substitution is at Carbon # **(_____)**

3. Branch name = **(_____)**

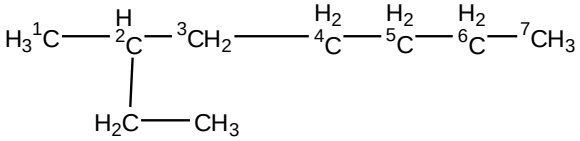
4. Name = (# of the substituted C) – (branch name) – (name of longest chain)

_____

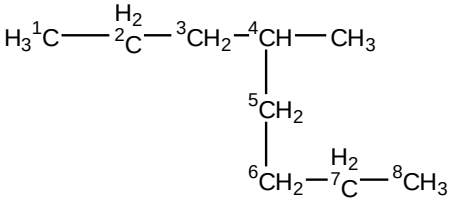
Practice



⇒ _____



⇒ _____

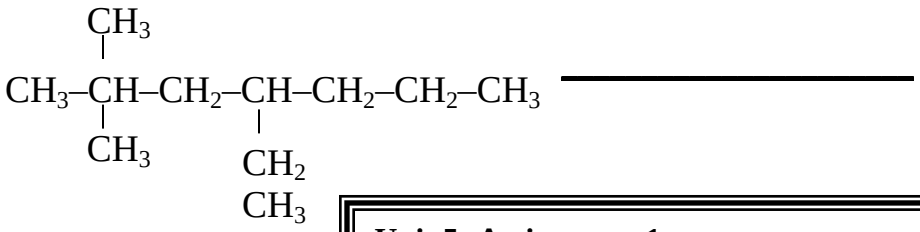


⇒ _____

Notes:

- If a molecule has _____ _____, list them in _____order
- If an alkyl group is _____:
  - list each carbon number where the _____ group is attached separated by _____ and…
  - prefix the repeated group name with di, tri, tetra, etc.. to show how many are attached.

Find the mistake in the drawing below. Correct it, and then name the compound.



_____

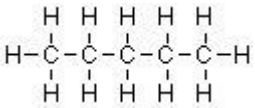
Unit 5: Assignment 1
- # P.361 #1, 4
- P.370 #7(a,b,f,g,h), 8, 9, 10(c,d), 11

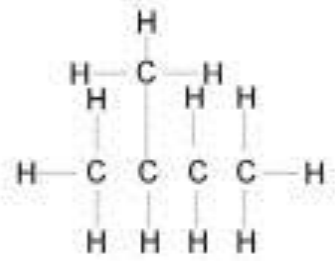
- **ALWAYS** include both name & drawing

ii) <u>STUCTURAL ISOMERS:</u>

Compounds which have the _____ _____ _____ but a _____ arrangement of atoms.

eg1) **<u>linear</u>** & **<u>branched</u>** C_5H_{12}

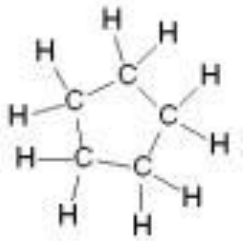




c) Type 2 . <u>CYCLOALKANES</u>

These are hydrocarbon chains which connect "head-to-tail" (in a _____)

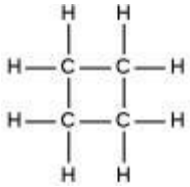
eg)



i) NAMING CYCLOALKANES

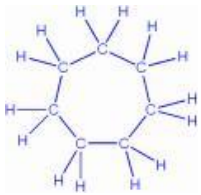
Simply add the word "_____" before the name of the _____.

eg1)



4 carbons = _____ ∴ _____

eg2)



7 carbons = _____ ∴ _____

Unit 5: Assignment 2
P.372 #5(a,d,e), 6, 7, 8, 10
- **ALWAYS** include both name & drawing

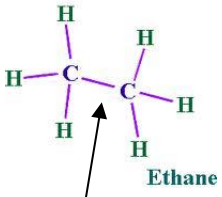
Type 3. ALKENES

- contain C=C double bonds
- ∴ are _____

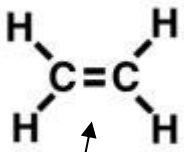
i) NAMING

Alkane name ending is changed from "ane" to "_____"

eg) ethane becomes _____



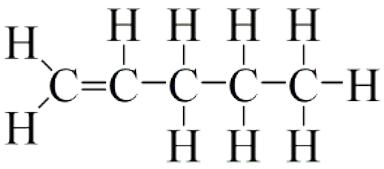
bond CAN rotate



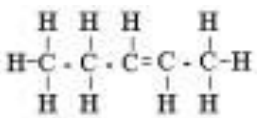
bond CANNOT rotate

a) Always locate the double-bond (db).

eg) _____:



eg) _____

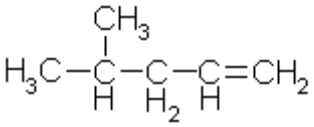


b) if alkene also has substitutions

- numbering starts _____ the db & identify db (db is more important)
- must count across db (**Double Bond**)
- write locations and _____ _____ first

eg) _____

branch first



Practice: Draw 3,4-diethyl-cyclopentene

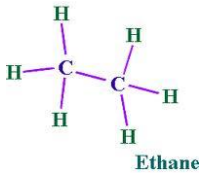
Type 4. ALKYNES

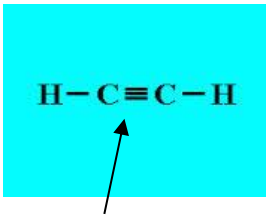
- contain C≡C triple bonds
- ∴ are un_____

i) NAMING

Alkane name ending is changed from "ane" to "____"

eg) _____ becomes _____





bond CANNOT _____

Unit 5: Assignment 3

- # P.377 #1-7
- P.380 #1, 4, 6- 9, 11

- **ALWAYS** include both name & drawing

ALKYL HALIDES

these are hydrocarbons with halogen(s) attached.

Branch	Name
–F	Fluoro
–Cl	Chloro
–Br	Bromo
–I	Iodo

eg) chloromethane : _____

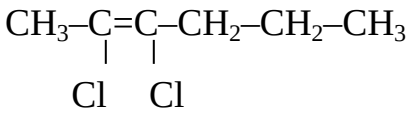
eg) _____: $CH_3CH_2CH_2Br$

General formula: R–F, R–Cl, R–Br, R–I

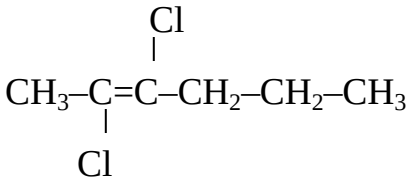
the "R" represents any _____ _____
∴ R–OH represents any carbon compound with an OH group attached
∴ R–Cl " " " " " a Cl attached

eg. CH_3Br , CH_3CH_2 Br, and $CH_3CH_2CH_2$ Br can all be represented by the general formula: R– Br

eg) _____



eg) _____



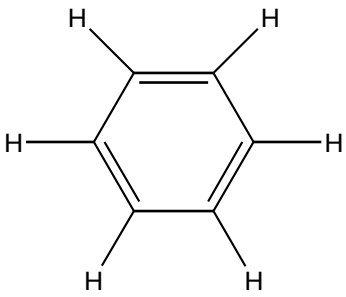
Unit 5: Assignment 4

- P. 418 #1-3, 4(c,d), 5(b,d)
- P. 422 # 7, 9, 11
- P.424 # 2-4

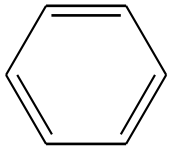
- **ALWAYS** include both name & drawing

4. AROMATIC COMPOUNDS

_____ (C_6H_6):

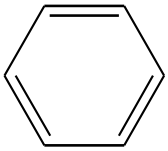


or simply

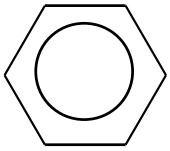


Two _____ structures exist

- Due to electrons _____ freely within the ring.

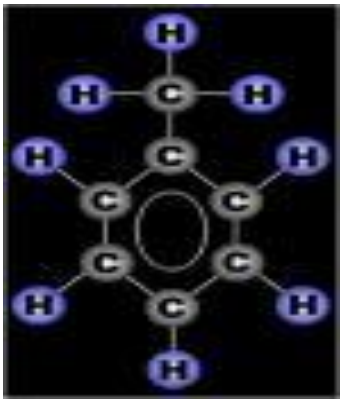


Benzene is a mixture of the two & is sometimes represented like this

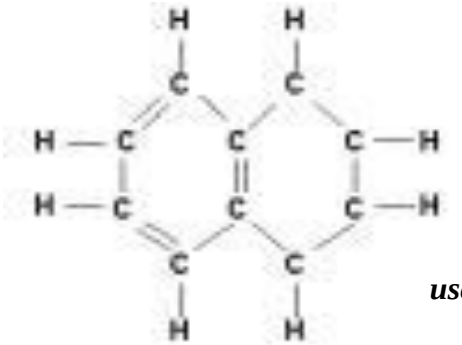


Aromatic compound: contains one or more _____ _____

eg1) methylbenzene



eg2) naphthalene ($C_{10}H_8$)



used in moth-balls

5. FUNCTIONAL GROUPS

Functional group: a specific group of atoms which exists in a molecule and gives the molecule an ability to _____.

Types of *functional groups (*Not needed in Chem 30)*:

- **A. alcohols** (R–OH)
- ***_____** (R–CHO)
- ***_____** (R–CO–R)
- ***_____** (R–O–R)
- ***_____** ($R–NH_2$)
- ***_____** ($R–CONH_2$)
- **B._____ _____** (R–COOH)
- **C._____** (R–COO–R)

Note: for the groups we cover, you have to be able to identify these different structures from a diagram or a name.

A. Alcohols (R–OH)

An alcohols is an organic compound that contains an _____ _____

i) Naming Alcohols

- Number the hydrocarbon chain so that OH group attached to lowest # C
- Place number immediately before the hydrocarbon name, separated by a dash
- Alkyl groups placed before the # for OH
- Change ending of hydrocarbon name to "ol"

eg) $CH_3CH_2CH_2–OH$ _____

propane ol

eg) $CH_3–CH_2–CH_2–CH_2–CH_2–OH$ _____

eg) $CH_3CH_2CH_2\ CH_3$ _____
|
OH

eg) $CH_3–\ CH_2–CH_2–CH_2–CH_2–CH_3$ _____
| |
OH CH_2CH_3

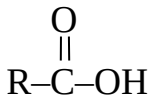
Unit 5 Assignment 5
- # P. 430 #5-9, 11, 13, 14
- P. 432 #19
- P. 435 # 2, 4, 6, 8

ii) Properties of Alcohols

- The OH group is _____, which tends to make alcohols _____ in water
- Hydrocarbon chains are _____, tending to make alcohols _____ in water.
- ∴ The _____ the hydrocarbon chain, the _____ _____ the alcohol.
- Alcohols are _____

B. Carboxylic acids

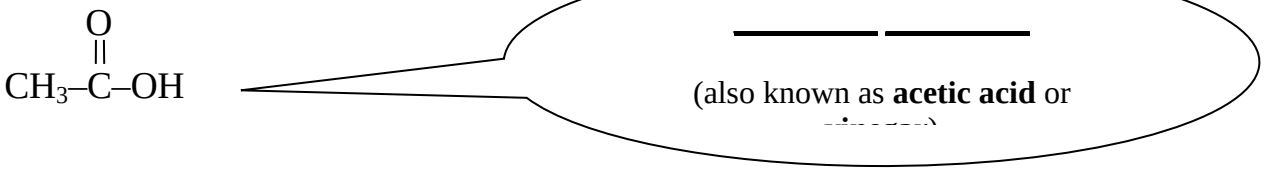
A carboxylic acid is an organic compound that contains a COOH group.



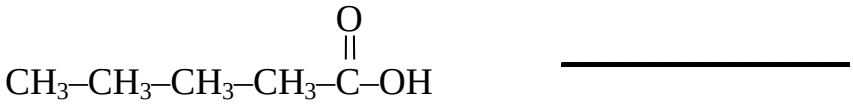
(written as R–COOH)

Naming: Change the end of the hydrocarbon name from "e" to "oic acid"

eg)

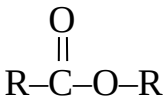


eg)



Organic acids have a "sharp" and "biting" odor.

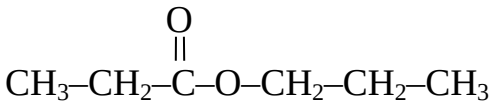
C. Esters



(written as R–COO–R)

An ester is a compound in which a COO group joins two hydrocarbons.

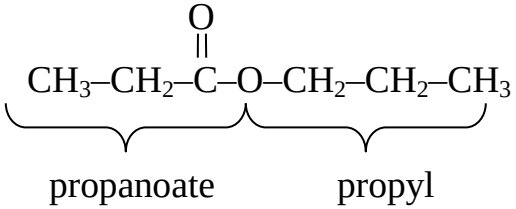
eg)



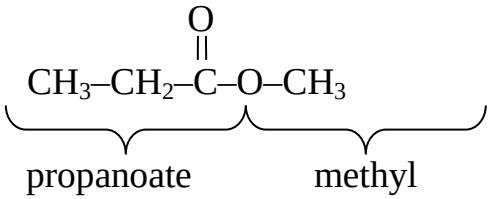
Naming Esters

- They hydrocarbon chain attached directly to the carbon side of the COO group has its ending "e" changed to "oate"
- The COO group is part of the hydrocarbon chain
- The other hydrocarbon chain is attached to the oxygen side of the COO and is named as an alkyl group
- The alkyl name is used as a separate, initial word.

eg)



propyl

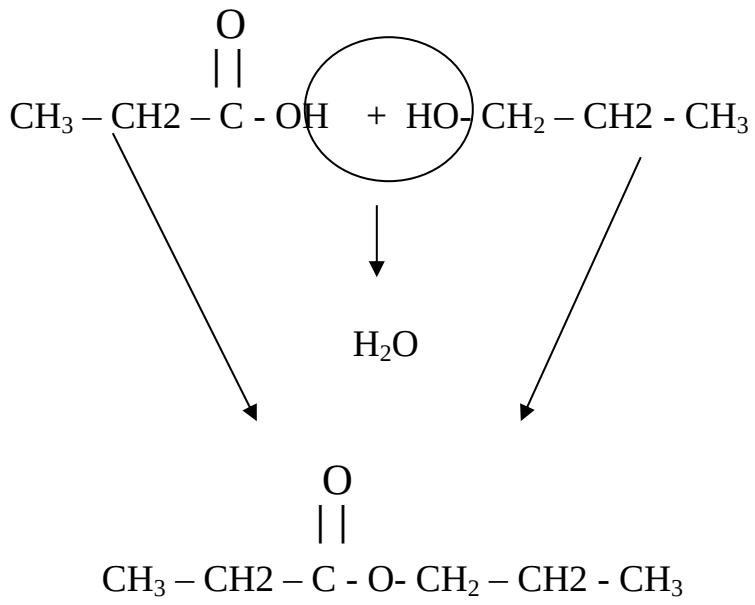


Unit 5 Assignment 6

- # P. 438 #1 & 2
- P. 441 # 3-5
- P. 444 # 6-8

Making Esters

Esters are prepared by _____ an _____ with a _____.



OR ALSO DRAWN LIKE THIS

CH_3-CH_2-COOH + CH_3-CH_2-CH_2-OH → CH_3-CH_2-C-O-CH_2-CH_2-CH_3 + H_2O

_____ + _____ → _____ + _____

Generally, esters have a pleasant smell

eg) the odour in bananas is _____

" " " pineapples is _____

Unit 5 Assignment 7

- # P. 448 # 1-5
- P. 451 # 10
- P. 452 # 12,13
- P. 455 # 15, 17