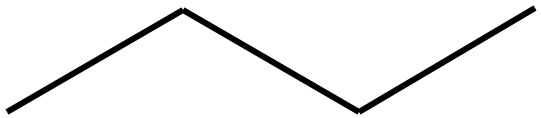
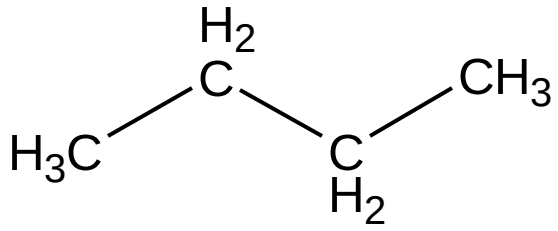
News du jour

- Quiz 10 results posted-mea culpa
- No new HW
- Exam is Thurs
  - standard format and length-have your tables
  - all equations and constants provided
  - Electrochemistry
  - Second Law
- I will be on campus:
  - Wed: 9 –3
  - Thurs: noon til the exam
- Exam Questions?
- Battery memory-an urban myth? http://www.dansdata.com/gz011.htm

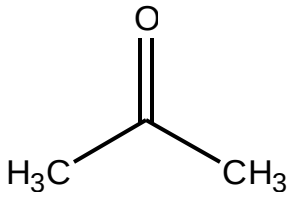
Drawing Simple Structures

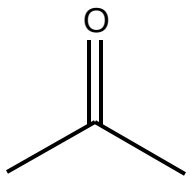
- In presenting strucutures of organic compounds a shorthand is often used
  - the structures are basically lines with hydrogens and carbons included only if they are part of a functional group. All other atoms are shown
  - carbon positions are line termini and junctions.
  - hydrogen counts (and positions) are determined by the requirement that carbon's valence be four
  - $CH_3CH_2CH_2CH_3$ would be drawn as:



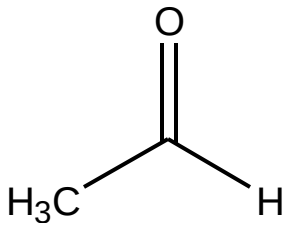


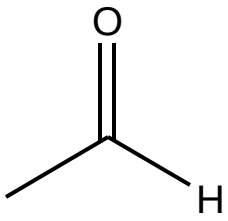
- CH_3COCH_3



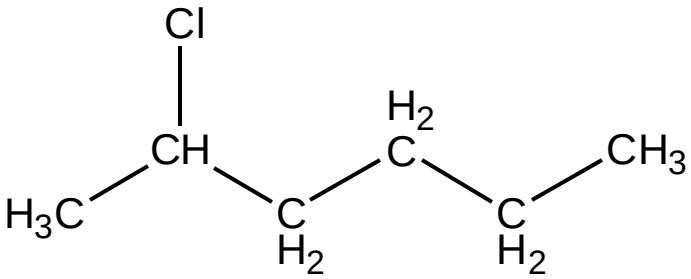


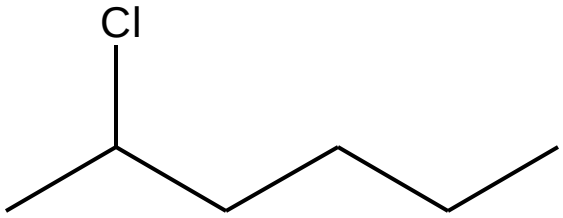
- CH_3CHO





- $CH_3CHCl(CH_2)_3CH_3$



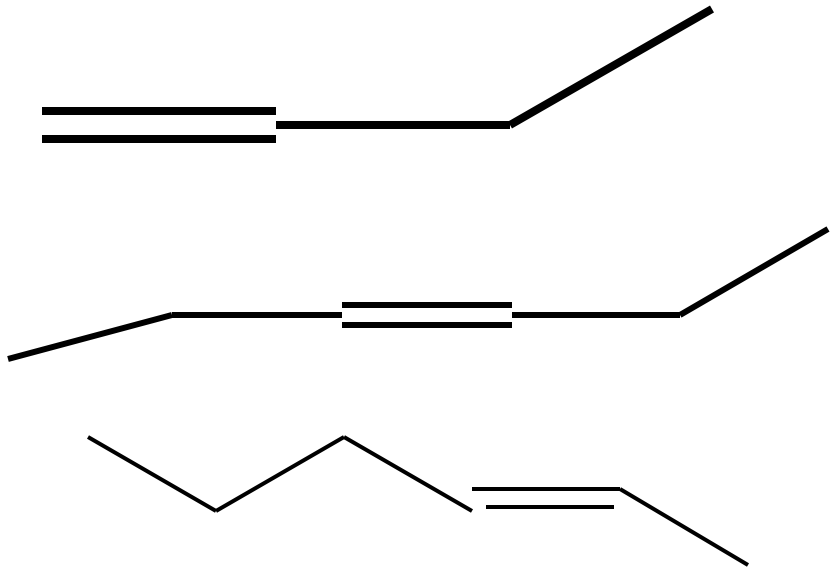


- Draw as many structures as you can for C_5H_8, without being concerned about differing geometries about the double bond(s)

Naming Simple alkenes and alkynes

- Be aware that our naming exercises are extremely limited and intended as a basic intro. For simple alkenes and alkynes (and many of our other compounds), we are limited to a total of 8 carbons which must be linear (often termed the n- structure) with a single site of unsaturation.
- There are two main points
  - avoiding duplicate structures
  - numbering the position of the unsaturated site (or functional group)
- For an alkene, the root alkane name is changed by replacing ane with ene. One also sees ylene used commonly
  - butane => butene
  - ethane => ethylene
- For an alkyne, the root alkane name is changed by replacing ane with yne. propane => propyne
- When there is more than one possible position for the unsaturated bond(when the number of carbons is greater than 3), it is numbered with the starting position of the unsat'd bond, using the lowest possible number. You do not automatically start numbering from the left. The number precedes the name followed by a hyphen 4-octene

- Name the following
- $CH_3CH{=}CHCH_2CH_2CH_3$



- Sketch
  - 2-butene
  - 3-hexyne

Preparation and Reactions of Alkenes

- Alkenes can be synthesized by
  - Dehydrohalogenation
    - $CH_3CH_2CHXCH_3$ => $CH_3CH=CHCH_3$ + HX
  - Dehydration of alcohols
    - $CH_3CH_2CHOHCH_3$ => $CH_3CH=CHCH_3$ + H_2O
- Addition reactions
  - Catalytic hydrogenation
    - -C=C- + H_2 (catalyst) => -CHCH-
    - $RCH=CH_2$ + H_2,Pd => RCH_2CH_3
  - Addition of halogens
    - -C=C- + X_2 (catalyst) => -CXCX-
    - $RCH=CH_2$ + Br_2, => $RCHBrCH_2Br$
  - Hydrohalogenation
    - -C=C- + HX => -CHCX-
    - RCH=CHR' + HX => RCH_2CHXR'
  - Hydration=as above with H_2O as the reagent
- There are many other reactions known for alkenes

Alcohols

- The grouping R-O-H is an alcohol
- Since alcohols can hydrogen bond they tend to have relatively high melting and boiling points
- Alcohols can be synthesized a number of ways
- hydration of alkenes
  - $H_2C=CH_2$ $=>CH_3CH_2OH$ (H_2O,H^+)
- fermentation of sugars by yeast
- Hydrolysis of halides
  - $RCl + OH^- => ROH + X^-$
- Reduction of C=O
  - C=O + reducing agent C-OH
  - $CH_3CHO + LiAlH_4 => CH_3CH_2OH$

Naming

- Operating under the very limited types of compounds noted earlier. Our alcohols will all be derived from n-alkanes
- IUPAC
  - longest continuous carbon chain-this is always the key to naming organic compounds (in our case it's the whole compound)
  - The position of the OH group is the lowest number possible.
- The naming scheme is similar to that for the alkenes, in this case the ane is replaced with anol
  - 1-propanol or 2-propanol (is there a 3 propanol)

Oxidation of Alcohols

- Alcohols can be oxidized to C=O containing compounds. Depending on the structure of the alcohol and the strength of the oxidizing agent. a number of products can be obtained.
- Alcohols which are on the end of the carbon chain(these are called primary) are converted into aldehydes or carboxylic acids.
  - $ROH + Cr_2O_7^{2-} \Rightarrow R'CHO$
  - $ROH + MnO_4^{-} \Rightarrow R'CO_2H$
- Secondary alcohols are converted into ketones
  - $RCHOHR' + Cr_2O_7^{2-} \Rightarrow RCOR'$

Aldehydes

- The grouping RCHO is an aldehyde
- Aldehydes are readily synthesized by the oxidation of primary alcohols if care is taken to prevent further conversion to the carboxylic acid
- Nomenclature-like alcohols only the suffix is –al
- CH_3CH_3CHO propanal

Reaction of aldehydes

Oxidation to carboxylic acids.

$RCHO + MnO_4^- \Rightarrow RCO_2H$

Reduction to alcohols

$RCHO + H_2(catalyst) \Rightarrow RCH_2OH$

Carboxylic acids

- RCO_2H
- good hydrogen bonding
- naming:
  - HCO_2H –formic causes ant string (Latin *formica*:ant)
  - $CH_3(CH_2)_2CO_2H$-butyric-cause rancid butter odor(Latin:*butyrum*:butter)
- systematic: add *oic acid*
  - $CH_3CH_2CO_2H$-propanoic acid
- Synthesis
  - oxidation of primary alcohols
  - $RCH_2OH + MnO_4^- \Rightarrow RCO_2H$
- Reactions-carboxylic acids are extremely useful synthetic reagents.
  - noted already-reduction to alcohols
  - conversion to esters by reaction with alcohols
    - $RCO_2H + R'OH \Rightarrow RCO_2R'$
    - $C_2H5CO_2H + CH_3OH \Rightarrow C_2H_5CO_2CH_3$

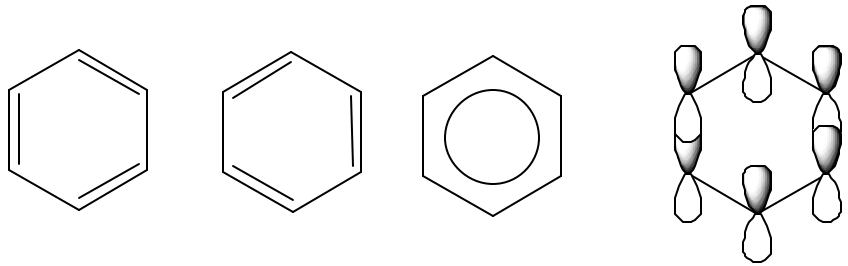
Ethers

- C-O-C is the ether linkage
- Nomenclature
  - name the two groups(alphabetically) followed by the word ether
  - $C_2H_5OCH_3$ ethyl methyl ether
  - if the two groups are the same
    - $C_2H_5OC_2H_5$ ethyl ether or diethyl ether
- Synthesis
  - large scale is done by condensation of alcohols
    - $2ROH + H_2SO_4 \Rightarrow ROR + H_2O$
  - small scale
    - $RX + R'O^- \Rightarrow ROR'$
- Ethers are relatively unreactive and commonly used as solvents.

- RNH_2,R_2NH,R_3N
- Nomenclature-groups present followed by the word amine
- CH_3NH_2 methylamine
- $(CH_3)_2NH$ dimethylamine
- $(CH_3)_3NH$ trimethylamine

Aromatic Compounds

- Aromatic compounds are a generally class with 4n+2 pi electrons in a cyclic conjugated system
- Benzene-C_6H_6 is the signature aromatic
- The pi bonds are delocalized about all six carbons making the structure anomalously stable-it is much more difficult to reduce than alkenes usually are.



- benzene is obtained at about 0.1% from coal and very large quantities are obtained from catalytic reforming of petroleum
- annual production 15 million tons pure and 10 million tons in fuels

Preferred Client	$6250
NonClient	$9250
SET and nonclient	$11750
SET + Preffered	$14750

Polymers

- Polymer means many parts and one commonly describes the component of a polymer as a *monomer*
- The polymer field is an especially rich and practical aspect of organic chemistry
- Addition polymers-the monomer units are added successively to an even growing chain
  - n $H_2C=CH_2$ (ethylene)=>$(CH_2CH_2)_n$ (polyethylene)
  - n $F_2C=CF_2$ (tetrafluoroethylene)=>$(CF_2CF_2)_n$ (poly tetrafluoroethylene, aka TEFLON)
- Condensation polymers-the monomer units combine with the production of a product molecule (water or similar) as waste
  - polyesters logical result of a dialcohol reacting with a diester
  - polyamide diamine + a diester => nylon
  - or 2 aminoacids => proteins