CHE 102 - Study Guide Ch 22-23 – S10

Chapter 22:

Alcohols

1. Functional group R-OH

   3 classifications: Indicates the number of R groups attached to the C-OH group.

	Primary/1°:	Secondary/2°:	Tertiary/3°:
i.	H	R	R
	|	|	|
ii.	R - C – OH	R - C – OH	R - C – OH
	|	|	|
	H	H	R
iii.	One R group	Two R groups	Three R groups

2. Naming
   a. find longest chain containing –OH group
   b. # the chain so –OH carbon is lowest #
   c. parent name of alkane, change "e" → "ol"
   d. use "diol", "triol" if multiple –OH groups exist in the compound.

3. Physical properties:
   a. Intermediate between alkanes (non-polar, no hydrogen bonding) and water (polar, maximum hydrogen bonding).
   b. Boiling points:
      i. Alkanes < Alcohol < Water
      ii. Bp increases with increasing # of carbons
      iii. Mulitple –OH groups increases Bp dramatically
      iv. Bp of branched chain alcohols < straight chain alcohols
   c. Solubility:
      i. ∞ soluable < 3C
      ii. limited solubility > 4 C
      iii. solubility decreases as chain length increases

4. Chemical reactions:
   a. Oxidation: (Generally [O] or other oxidizing agent)
      i. Primary/1° → Aldehyde → Carboxylic Acid
      ii. Secondary/2° → Ketone
      iii. Tertiary/3° → No reaction
   b. Dehydration (loss of H_2O): Acidic conditions H_2SO_4 + Heat)
      i. Primary/1° + Primary/1° → Ether + H_2O
      ii. Secondary/2° → Alkene + H_2O
      iii. Tertiary/3° → Alkene + H_2O
      iv. Saytzeff Rule: Remove H from the carbon with the least H
   c. Esterification: Alcohol + Carboxylic Acid → Ester

Phenols

1. Naming
    a. 2 groups: Use ortho, meta, para (see figure from CH 19-20 Study guide)
    b. 3+ groups: Number molecule to give –OH group lowest number possible

Ethers

1. Functional group R-O-R'
2. Naming (IUPAC)
    a. Select longest alkane chain and name it
    b. name side chains normally, the O-R side chain is called by the alkane name, change "ane" → "oxy"
    c. ex: CH_3-CH_2-O-CH_2-CH_2-CH_2-CH_3 = ethoxy-1-butane
3. Naming (Common)
    a. Identify the two alkane groups on either side of the ether oxygen.
    b. Name them (alphabetical order)
    c. Add "ether" to ending
    d. Ex: CH_3-CH_2-O-CH_2-CH_2-CH_2-CH_3 = butyl ethyl ether
4. Physical Properties
    a. Bent shape like H_2O
    b. Polarity: Alkanes < Ethers < Alcohols < H_2O
    c. Solubility: slightly soluble due to O atom
    d. Boiling Point: Alkane < Ether << Alcohol (due to lack of hydrogen bonding)
    e. Misc:
        i. Excellent solvent for organic molecules and many polar molecules will dissolve slightly.
        ii. Limited chemical reactivity (thus used as a solvent for many organic reactions)
        iii. Volatile and explosive

Thiols

1. Functional Group = R-SH
2. Naming: As alcohols, change "ol" → "thiol"
3. Boiling point: < Alcohols due to no hydrogen bonding
4. Smell: responsible for most "rotten" odors
5. Oxidation Reaction: 2 RSH → R-S-S-H (disulfide bond)

Chapter 23

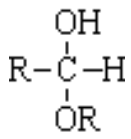
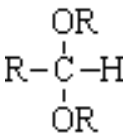
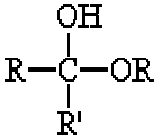
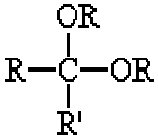
Aldehydes and Ketones

1. Functional Groups:

O ‖ C	O ‖ R - C – H	O ‖ R - C – R
Carbonyl Group	Aldehyde	Ketone

2. Naming
   a. Aldehydes:
      i. find longest chain with Aldehyde group in it
      ii. always number the aldehyde carbon #1
      iii. change parent name ending from "e" → "al"
      iv. name side chains like normal
      v. Ex: $CH_3 - CH - C(=O) - H$ = Propan**al**
   b. Ketones: (IUPAC)
      i. find longest chain containing the carbonyl group
      ii. number chain to give carbonyl carbon lowest possible number
      iii. change parent chain name ending from "e" to "one", number the position of the carbonyl carbon
      iv. name side chains like normal
      v. Ex: $CH_3 - CH - CH_2 - C(=O) - CH_3$ = 2 - pentanone
   c. Ketones (Common name)
      i. find the carbonyl carbon
      ii. name the two alkane chains attached to it
      iii. add the word "ketone" to the end of the name
      iv. Ex: $CH_3 - CH - CH_2 - C(=O) - CH_3$ = methyl propyl ketone
3. Physical Properties
   a. The carbonyl carbon is sp^2 hybridized similar to C=C bond in alkenes.
   b. Trigonal planar geometry with 120° bond angle
   c. Polar bond between C and O, this bond polarity is important in many chemical reactions
   d. No hydrogen bonding
   e. Boiling point: alkanes < Aldehydes/Ketones < Alcohols
   f. Solubility: Semi-soluble < 4 C, insoluble > 4 C
   g. Low molar mass = smell bad, High molar mass = responsible for many pleasant odors (Cinnamon, Spearmint, many perfumes)
   h. Sugars are a special class of aldehydes and ketones important in biological chemistry

4. Reactions
    a. Oxidation:
        i. Aldehyde → Carboxylic Acid
        ii. Tollens Reaction: Aldehyde + 2 Ag^+ → Carboxylic Acid Salt + 2 Ag (s) "Silver Mirror"
        iii. Fehling/Benidicts: Aldehyde + 2 Cu^+ (blue) → Carboxylic Acid Salt + Cu_2O (brick red)
        iv. Ketones → No reaction
    b. Reduction: (reaction conditions are generally heat + H_2 + Ni catalyst, or $LiAlH_4$ or $NaBH_4$)
        i. Aldehyde → Primary/1° Alcohol
        ii. Ketone → Secondary/2° Alcohol
    c. Addition:
        i. Form 4 classes of compounds:

			
Hemiacetal	Acetal	Hemiketal	Ketal

Aldehyde + alcohol → hemiacetal + alcohol → acetal
Ketone + alcohol → hemiketal + alcohol → ketal

        ii. Cyanohydrins: Aldehyde/Ketone + HCN → Cyanohydrin
        iii. Aldol Reaction:
            1. Aldehyde + Aldehyde → Aldol
            2. Aldehyde + Ketone → Aldol
            3. Ketone + Ketone → Aldol