CHEM 10052 - Introduction to Organic Chemistry
Final Examination Review

Functional Groups

While nomenclature (naming) has been limited, you are responsible for recognizing all of the followng functional groups:

alkenes, alkynes, aldehydes, ketones, ethers, alcohols, phenols, thiols,
carboxylic acids, esters, thioesters, anhydrides, phosphate esters, amines, amides

Properties

Least Polar **Most Polar**

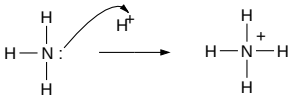
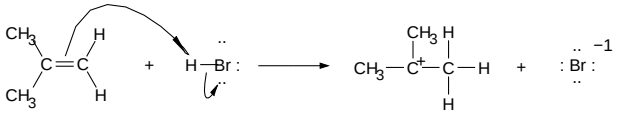
$$\left\{\begin{array}{c}\textit{alkane}\\ \textit{alkene}\\ \textit{alkyne}\end{array}\right\} < \text{ether} < \left\{\begin{array}{c}\textit{aldehyde}\\ \textit{ketone}\end{array}\right\} < \text{ester} < \text{amine} < \text{amide} < \left\{\begin{array}{c}\textit{alcohol}\\ \textit{phenol}\end{array}\right\} < \text{carboxylic acid}$$

Lowest b.p. **Highest b.p.**
Lowest water solubility **Highest water solubility**

Acids Strength, Base Strength, and Leaving Groups

Strongest Acids	$\approx pK_a$		***(Conjugate bases)*** **Weakest Base**		***(Carboxylic Acid Derivatives)*** **Best Leaving Groups**
HCl, HBr, HNO_3, H_2SO_4, ...	< 0		—		
H_3O^+	0		H_2O		
Carboxylic Acids	4		Carboxylate ion		Anhydrides
Aromatic Ammonium Ions	5		Aromatic amines		
Thiols, Phenols	9		Thiolate, Phenolate ions		Thioesters
Aliphatic Ammonium Ions	10		Aliphatic amines		
Alcohols, Water	16		Alkoxides, Hydroxide		Esters, Carboxylic Acids
C_α-H	20		—		
N–H	35		—		Amides
Weakest Acids			**Strongest Base**		**Worst Leaving Groups**

Curved Arrows

Case	**Arrow Starts on ...**	**Arrow Ends on ...**	**Result**
(a)	Lone pair	Different atom	New bond formed (lone pair 'lost') 
(b.1)	Bonding Pair	Different atom	Bond breaks & New bond formed *(C=C becomes C-C & new C-H formed)*  *(H-Br bond breaks, with Br getting new lone pair)*
(b.2)	Bonding Pair	Atom part of original bond	Bond breaks & Lone pair added

Reactions

Functional Group	Reaction	Class	Comments
-	organic + $O_2 \longrightarrow CO_2 + H_2O$	Combustion	-
Alkene	$\xrightarrow[\text{Pt or Pd}]{H_2}$ alkane	Reduction	-
Alkene	+ A–B $\longrightarrow$ alkyl compound	Addition	Markovnikov's Rule
	(A-B = H_2O, HX, or X_2)		
Benzene	$\xrightarrow[FeX_2]{X_3}$ C_6H_5-X	Substitution	X = Cl or Br
Benzene	$\xrightarrow[H_2SO_4]{HNO_3}$ C_6H_5-NO_2	Substitution	-
Benzene	$\xrightarrow{H_2SO_4}$ C_6H_5-SO_3H	Substitution	-
Alcohol	$\xrightarrow[\Delta]{H_2SO_4}$ alkene	Dehydration	Zaitsev's Rule
Alcohol	$\xrightarrow{[O]}$ carbonyl	Oxidation	[O] = oxidizing agent
Amine	amine + acid $\longrightarrow$ ammonium salt	Acid/Base	-
Aldehyde	$\xrightarrow{[O]}$ carboxylic acid	Oxidation	[O] = oxidizing agent
Aldehyde/Ketone	$\xrightarrow{[H]}$ alcohol	Reduction	[H] = reducing agent
Aldehyde/Ketone	+ $H_2O \longrightarrow$ hemiacetal	Addition	-
2 Aldehyde/Ketone	+ base $\longrightarrow$ condensation product	Aldol	-
	$RCOOH + OH^- \longrightarrow RCOO^- + H_2O$	Acid/Base	-
Carboxylic	$RCOOH \xrightarrow[2)\ H_2O]{1)\ LiAlH_4} RCH_2OH$	Reduction	
Acid	$RCOOH \xrightarrow{\text{heat}} R\text{-}H + CO_2$	Decarboxylation	Requires C_β=O
Derivatives	Acyl-L + H-L' $\rightleftharpoons$ Acyl-L' + H-L	Substitution	-
	Acyl-L + $L'^{-1} \rightleftharpoons$ Acyl-L' + L^{-1}	Substitution	-

Summary of Important Reactions