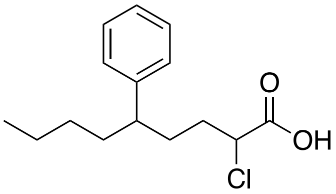
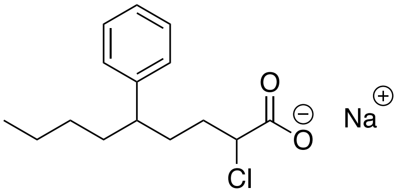
Chapter 17 Worksheet **Name:**
Self-paced study; use with textbook

what is the IUPAC name for this carboxylic acid?



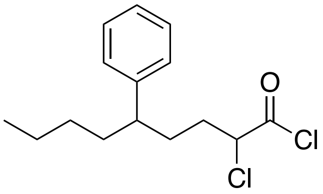
Name: ____

If we treat the acid above with base we remove a proton to make a carboxylate salt.
What is the IUPAC name for this salt? Hint: format: cation carboxylate



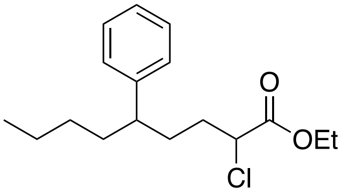
Name: ____

If the original acid is treated with thionyl chloride $SOCl_2$ the following molecule is formed. Name it. Hint: format: carboxoyl chloride

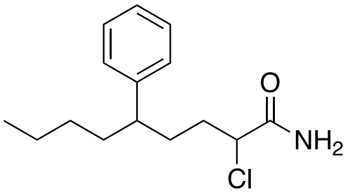


Name: ____

The acyl chloride can be converted in to the following two molecules. Name them. Hint Format for ester: alkyl carboxylate for amide: carboxamide or N-alkyl carboxamide



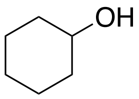
Name: ____



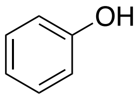
Name: ____

Let’s think about why carboxylic acids are so acidic.

What is the approximate K_a of each of these molecules?



K_a~ ______



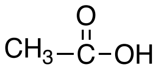
K_a~ ______

Draw the conjugate base of these two molecules.

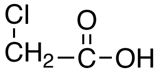
If you did this correctly then one of the drawings above represents a structure that doesn’t exist, ever. Not even for a moment.

Show what I’m talking about and then clearly explain why carboxylic acids are so much more acidic than alcohols.

Election withdrawing groups make carboxylic acids even more acidic. Why is that? Consider, for example. this molecule which is about 10 times more acidic than acetic acid.



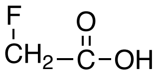
$CH_3-\overset{\overset{O}{\|}}{C}-OH$



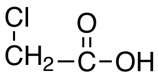
$\overset{\overset{Cl}{|}}{CH_2}-\overset{\overset{O}{\|}}{C}-OH$

Why is the second molecule more acidic. Be specific.

Which of these would be more acidic (circle it) and why?



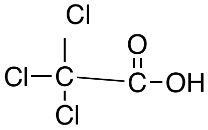
$\overset{\overset{F}{|}}{CH_2}-\overset{\overset{O}{\|}}{C}-OH$



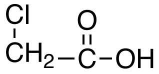
$\overset{\overset{Cl}{|}}{CH_2}-\overset{\overset{O}{\|}}{C}-OH$

Why?

Which of these would be more acidic (circle it) and why?



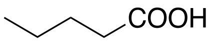
$Cl-\underset{\underset{Cl}{|}}{\overset{\overset{Cl}{|}}{C}}-\overset{\overset{O}{\|}}{C}-OH$

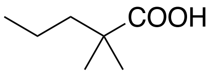


$\overset{\overset{Cl}{|}}{CH_2}-\overset{\overset{O}{\|}}{C}-OH$

Why?

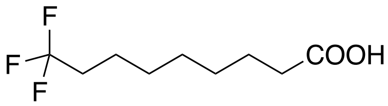
Remembering that R groups are electron releasing not withdrawing, which of these would be more acidic (circle it) and why?

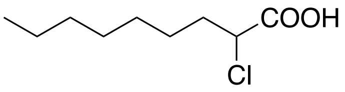




Why?

The effect of an electronegative atom as an electron withdrawing group declines exponentially with distance. With that in mind, which of these would be more acidic (circle it) and why?



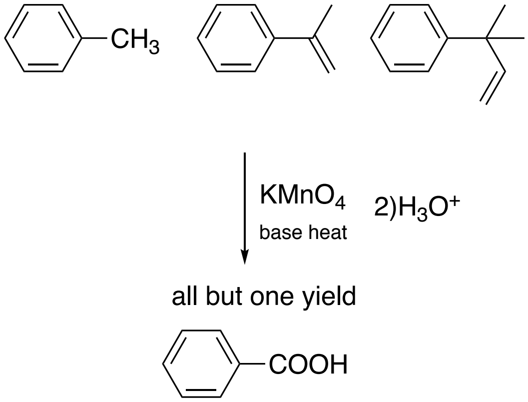


Why?

Go through your reaction facts and find as many ways as possible that we have learned to make carboxylic acids previously.

Carboxylic acid => ?

In chapter 15 there was a reaction called “side-chain oxidation” to make benzoic acid. Review it and answer this question: Which of these molecules can NOT be transformed into benzoic acid with that reaction and why not?



There are two additional ways to make a carboxylic acid.

RCOOH => nitrile

RCOOH => Grignard reagent & CO_2

Demonstrate these reactions by showing two ways to make each of these acids, once from a nitrile and again from a Grignard reagent.

Targets: benzoic acid and propanoic acid

What is the mechanism rule we learned earlier this year when a nucleophile breaks the π-bond in a carbonyl? For example, think of an ester with $LiAlH_4$ or R-Mg X

This reaction is called nucleophilic acyl substitution is a very common. Three things are needed: a carbonyl group, a nucleophile to attach to it and a leaving group to leave it.

For each of these kinds of carboxylic acid derivatives, what is the leaving group?

Acyl chloride	
Carboxylic ester	
Amide	

Thinking about the characteristics that make a good leaving group. List the three groups above from best to worst at leaving. This relates to the stability of the derivatives. Derivatives with poor leaving groups are more stable than those with good leaving groups the overall reactions can be summarized in this way:

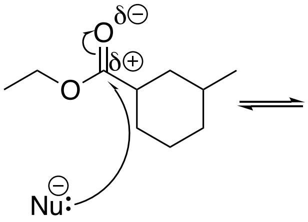
More stable derivative => less stable derivative or directly from carboxylic acid

.

There is only one derivative that must be made only directly from the carboxylic acid. Which one and why?

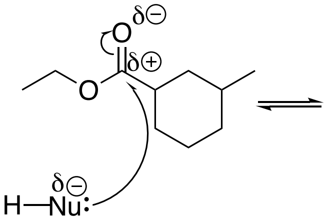
For that one thionyl chloride, $SOCl_2$, is the reagent for the transformation.

Complete this mechanism:



If the nucleophile is a neutral molecule with an H connected to the nucleophilic atom (like water or alcohols) then there is an additional proton transfer step to remove the H form the nucleophilic atom after it connects and become positively charged.

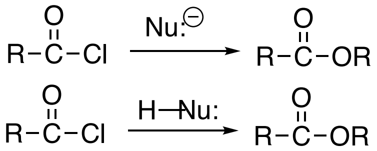
Complete this mechanism.



Now let’s figure out how to make the various derivatives.

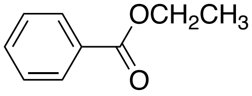
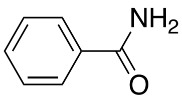
Ester, amide => acyl chloride & nucleophile.

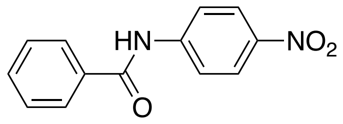
Fill in the nucleophile, both anionic and neutral with an H that could be used to convert an acyl chloride into each of the following. In other words, make the Nu specific for a reaction like



product	Nu-	H-Nu
ester		
amide		

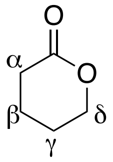
Now show how we can make the following products beginning with a carboxylic acid each time. It will always be a two-step answer. (hint: all thee begin with the same carboxylic acid)

Target: 	
	

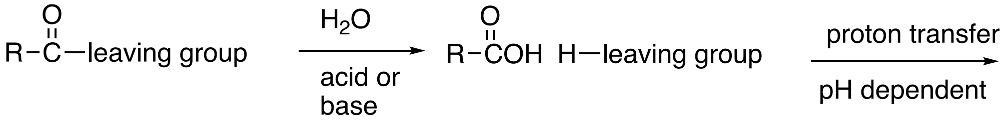
An important reaction these molecules can undergo is called hydrolysis. This happens when water reacts with the derivative either in the presence of acid or base catalysts.

Lactones are esters the are in a ring. Lactams are amidse that are in a ring. Examples:
See how this ester is contained in a ring:



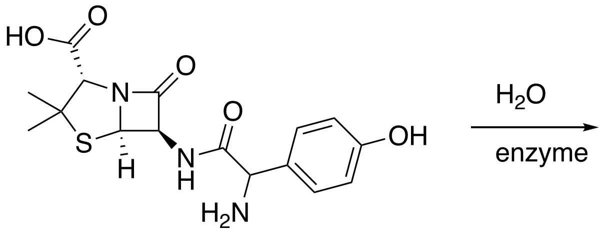
WE “count” the other atoms ins the ring by labelling in Greek letters. This is an example of a δ-lactone. Draw an example of a γ-lactone. Lactams re amides contained in a ring. Draw an example of a δ-lactam. Use the internet to look up the structure of a penicillin. Is penicillin a lactone or a lactam? What kind?

Water reacts to break the bond between the carbonyl and the leaving group in this way:



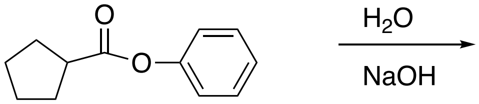
Acyl chlorides are rare in nature since they hydrolyze very easily. and since water abundant in nature. Draw the products that would form if benyoyl chloride is treated with water in the presence of e a catalytic drop of acid i.e. pH>7.

Penicillin-resistant bacteria have evolved an enzyme which is very good at catalyzing the hydrolysis of a lactam at the pH of a cell. Draw the product. find the bond that will break, then give the OH to one atom and the H to the other as shown on the previous example. Why aren't there two separate products this time?



amoxicillin

For historical reasons the base promoted hydrolysis of an ester is named saponification. Show the final products in this saponification:



Phosgene is the name of a very toxic and very reactive molecule with the formula $COCl_2$. Draw a Lewis structure for phosgene. It is so dangerous that it has been used in chemical warfare in the past.

Phosgene behaves as if it has two functional groups, not one. What two groups?

What is the final product when phosgene reacts in each of these example?

a one equivalent of ethanol
b. an excess of ethanol
c. one equivalent of ethanol followed by an excess of ammonia