1. Fill in the following banks with the correct word or phrase.
   a) Typically **Lewis Acids** accept electrons from **Lewis Base** which results in the formation of a new bond.
   b) The following compound (labeled 1) is an example of a(n) **ketone** features a **cyclohexane** and **alkyne**.
   c) Compounds such as ethylene, unlike ethane and acetylene, has **triple bonds** between carbons; compounds coined ethylene are termed **alkenes**.

2. Label the Lewis acid and Lewis base in each reaction and draw curved arrows to indicate the transfer of electron pairs.

   \[ \text{Cl}^- + \text{BCl}_3 \rightarrow \]

   \[ \text{Cl}^- \text{ is the lewis base} \]

   \[ \text{BCl}_3 \text{ is the lewis acid} \]

   \[ \text{Lewis base} \]

   \[ \text{Lewis acid} \]

   \[ \text{H}_3\text{C} - \text{C} - \text{H}_3 \]  + \[ \text{H}_2\text{SO}_4 \rightarrow \]

   \[ \text{H}_3\text{C} - \text{C}^+ - \text{H}_3 \]  + \[ \text{HSO}_4^- \]

   \[ \text{F} - \text{B} - \text{F} \]  + \[ \text{H}_2\text{O} \rightarrow \]

   \[ \text{F} - \text{B} - \text{O}^+ - \text{H} \]

   \[ \text{H} - \text{O} - \text{H} \]
3. Draw the products of each Lewis acid-base reaction and label the electrophile and nucleophile.

\[ \text{CH}_3\text{CH}_2\text{OH} + \text{BF}_3 \rightarrow \]
Nucleophile Electrophile

\[ \text{CH}_3\text{SH}_3 + \text{AlCl}_3 \rightarrow \]
Nucleophile Electrophile

\[ \text{+ H}_2\text{O} \rightarrow \]
Electrophile Nucleophile

4. How many \( \pi \) bonds and \( \sigma \) bonds does each molecule have? (Taken from the example in lecture slides); don’t forget to count the C-H, O-H, and N-H bonds!

\[ \pi: 3 \]
\[ \sigma: 6 \]
5. What is the hybridization and the bond angle of the Nitrogen in each resonance structure?

sp³ and 107

sp² and 120

6. Circle and identify all the functional groups in each molecule

- Amide
- Carboxylic Acid
- Amine
- Sulfide

Extra question: circle all the alkenes in this molecule (indicated by red arrow)

- Ketone
- Ester
7. (Taken from lecture slides) Which one of these molecular interactions is governed by ionic forces? **Right most option**

8. List all of the intermolecular forces exhibited by each compound

   - Hydrogen bonding, dipole, VDW
   - Dipole, VDW
   - Van Der Waals Forces

9. Rank each group of compounds in order of increasing boiling point

   a. $\text{CH}_3\text{(CH}_2\text{)}_3\text{CH}_3 < \text{CH}_3\text{(CH}_2\text{)}_4\text{I} < \text{CH}_3\text{(CH}_2\text{)}_6\text{I}$

   b. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < (\text{CH}_3)_3\text{N} < \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$
c. \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{Br} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \)

10. Rank each of group of compounds in order of increasing melting point.

\[
\begin{align*}
\text{a.} & \quad \text{<} \\
\text{b.} & \quad (\text{CH}_3)_2\text{CH}_2 \quad \text{<} \quad (\text{CH}_3)_2\text{C=O} \quad \text{<} \quad \text{CH}_3\text{NH}_2
\end{align*}
\]

\[
\begin{align*}
\text{c.} & \quad \text{<} \\
\text{The molecule on the right has the highest melting point due to the fact that it is the more symmetrical and compact molecule than the molecule on the left.}
\end{align*}
\]

11. Circle the compound with the highest melting point. Star the compound with the highest boiling point.

\[
\begin{align*}
\text{The middle compound has the highest melting point due to its tightly packed and symmetrical structure.} \\
\text{The last compound has the highest boiling point due to the larger surface area.}
\end{align*}
\]

12. Which of the following compounds has the higher boiling point. Explain.
Has a higher boiling point as hydrogen bonds in the compound is stronger than the simple dipole and VDW intermolecular forces of the thiol compound.

13. Rank the following sets of compounds in order of increasing water solubility.

a. \((\text{CH}_3)_3\text{CH} \quad \text{CH}_3\text{OCH}_2\text{CH}_3 \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}\)

\((\text{CH}_3)_3\text{CH} < \text{CH}_3\text{OCH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}\)

b. i. ii. iii. iii < i < ii

14. Label the electrophilic and nucleophilic sites on each molecule.
15. Circle the most acidic proton and draw out its conjugate base.

a) The hydrogen attached to the oxygen in the carboxylic acid group is the most acidic. Due to the fact carbon is very electronegative and pulls the electrons away from the hydrogen. 
b) The hydrogen attached to the carbon with a triple bond (alkyne) is the most acidic due to its larger s-character. 
c) The hydrogen in attached to the oxygen in the hydroxyl group adjacent to the Cl\textsubscript{3}C is the most acidic. This is due to the fact that the Cl is more electronegative than C which is able to stabilize the conjugate base.

16) Draw the skeletal structures for the following molecules. Make sure to include one pairs (Discussion worksheet + modifications)

a) \(\text{CH}_3(\text{CH}_2)_3\text{CH}_3\)
17) Draw the resonance structures for the following molecules and determine the major resonance structure. Explain why. (Discussion worksheet + modifications)

a) \( \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \)

The middle resonance structure is the major resonance structure because the positive charge is on the Nitrogen, which is the least electronegative atom out of the three heteroatoms.

b) \( \text{CH}_3\text{CH}_2\text{COOH} \)

The middle resonance structure is the major resonance structure because the positive charge is on the Nitrogen, which is the least electronegative atom out of the three heteroatoms.
The first resonance structure is the major one because it has no charge separation.

18) For the following pairs, label the stronger acid and explain why. (Discussion worksheet + modifications)

a) 

\[ \text{Stronger Acid - Inductive Effects} \]

b) 

\[ \text{Stronger Acid - Hybridization} \]

c)
19) Fill in the blanks. (self-made)
   a) A more ___stable___ conjugate base indicates a stronger acid.
   b) The four factors used to predict the pKa of an acid are: resonance, inductive effect, hybridization, and element effect.

20) Predict the following acid-base reaction and draw curvy arrows. Label the Bronsted-Lowry acid/base and Lewis acid/base. (discussion worksheet + modifications)

BL base                               BL acid
Lewis base                            Lewis acid

Good luck everyone! We believe in you!