1. Acids and Bases: Draw the products of the acid-base reaction and show the movement of electrons using curved arrows. Predict the direction of the equilibrium and the ratio of reactants to products. Label the acid, base, conjugate acid, and conjugate base. The pKa of the reactant on the left of H₂O is approximately 4 pKa.

Draw 2 additional resonance structures of the conjugate base and the hybrid structure. Label the major resonance structure(s).

➢ Draw valid Lewis structures and count formal charges.
➢ Draw valid resonance structures
  ○ be able Identify major and minor resonance structures, and draw resonance hybrids.
2. Functional Groups: Circle and label **ALL** functional groups on the molecule below.

➢ Recognize and identify common functional groups. Memorization heavy.


➢ Draw **Newman projections** in both **staggered** and **eclipsed** configurations
  ○ Determine which projections are either high or low energy and explain why in terms of **anti-** and **gauche-interactions**
4. Chair conformations: Answer the following questions using the molecule below.

a. Convert the structure into the chair conformation and flip the chair. Indicate the direction of the equilibrium between the two chair conformations using equilibrium arrows, not resonance arrows.

b. Identify if the molecules below are enantiomers, diastereomers, identical molecules, or constitutional isomers to the (1S,2R,4S)-4-chloro-2-fluoro-1-isopropylcyclohexane.

➤ Draw chair conformations and properly label the substituents in equatorial or axial positions
  ○ Perform a chair flip and explain why one chair conformation may be higher in energy than the other
5. Thermodynamics: Answer the following questions using the energy diagram of the two-step reaction.

![Energy diagram of two-step reaction]

a. How many steps are in the reaction?

b. Label the transition states with a "*"

c. Draw the transition state of the rate-determining step.

- Draw energy diagrams that showcase potential intermediates in an organic reaction
- Identify factors that influence the rate of an organic reaction, such as activation energy, concentration, and temperature

7. Enantiomeric Excess: The sample mixture of a + and - enantiomeric compound has a specific rotation of -84°. The S enantiomer’s specific rotation is +180°. What is the ee% of the sample mixture? How much of each enantiomer is in the mixture? What is the observed rotation if the ee% is 10% for a mixture with excess S enantiomer?

8. Acids and bases: Rank the molecules in order of increasing acidity.

- Element and electronegativity (what element is the potential acid H attached to)
- Inductive effect (electron-withdrawing elements nearby, but NOT directly attached to the acidic H)
- Resonance stabilization (is the conjugate base stabilized by resonance)
- Hybridization (if all other things are equal, what is the hybridization of the atom directly attached to the acidic H)
9. IR spectrum and NMR: Below are the IR Spectrum and the NMR of C₉H₁₀O₃. Draw the structure that corresponds to the IR spectrum and the NMR below.

Problems were sourced from https://chem.libretexts.org/ and 6th edition Smith Organic Chemistry