1. Provide the structure of the conjugate acid of each of these compounds. (2 points)

![Conjugate Acid Structures]

2. Identify the most acidic hydrogen in this compound. (2 points)

\[ \text{pK}_a = 15 \quad \text{pK}_a = 25 \quad \text{all others, } \text{pK}_a \approx 50 \]

3. Which species below is the stronger acid? Explain your reasoning. (4 points)

![Acid Structures]

\( \text{O is more electronegative than N. O-H bond is more polar than N-H.} \)
\( \text{It better accommodates negative charge in conjugate base anion.} \)

4. Which species below is the stronger base? Explain your reasoning. (4 points)

\( \text{HN} = \text{CH}_2 \) is a stronger acid than \( \text{H}_2 \text{N} = \text{CH}_3 \)
\( \text{because } \text{sp}^2 \text{ N is more electronegative than } \text{sp}^3 \text{ N.} \)
\( \text{So, } \text{HN} = \text{CH}_2 \text{ is a weaker base than } \text{H}_2 \text{N} = \text{CH}_3 \)

5. Alcohols typically have pKa values on the order of 15 while carboxylic acids have pKa values near 5. Explain this observation in terms of the concepts discussed in class. Support your arguments with any necessary structures. (8 points)

\( \text{Acid} \quad \text{R-CH}_2 \text{-OH} \)
\( \text{Conjugate base anion is not resonance-stabilized.} \)

\( \text{Conjugate base anion is resonance-stabilized.} \)
6. Which species below is the stronger acid? Explain your reasoning. (4 points)

![Inductive Effect of F's or CF₃ group](image)

F₃C~OH

Inductive Effect of F's or CF₃ group

H₃C~OH

make OH back more polar, in acid and
more negative charge

stabilizes conjugate base.

7. Consider the reaction acid-base reaction below. (8 points)

R~OH

this is

a weaker base than

stronger acid than

a. Use curved-arrow notation to show the movement of electrons in the reaction.
b. Which side of the reaction is favored at equilibrium, reactants or products? Explain your answer.

8. Provide IUPAC names (12 points)

- 2-ethyl-4-fluoro-1-methylcyclohexane
- 5-chloro-2-ethyl-3-methylhexan-1-ol
- 4-chloro-3-methylcyclopentane

9. Provide structures for these compounds. (6 points)

(Z)-2-chloro-3-methylhex-2-ene

3-methoxy-2-methylpentane
10. Define the following terms. (12 points)
   a. Stereoisomer
      Isomers with same connectivity but different configuration.
   b. Conformer
      Stereoisomers that are interconvertible by single bond rotation.
   c. Torsional Strain
      Strain caused by eclipsing interactions.

11. Classify each of the labeled carbons as: primary, secondary, tertiary, or quaternary. (Terms may be used multiple times or not at all.) (4 points)

12. Provide the Newman projection for this structure when viewed down the C-C bond. (4 points)
13. Consider the stereoisomers A and B below: (12 points)

![Isomer A](image1) ![Isomer B](image2)

a. Draw the chair conformations for isomer A and explain which, if either, is lower in energy and why.

b. Draw the chair conformations for isomer B and explain which, if either, is lower in energy and why.

c. Which stereoisomer is more stable, A or B? Explain your reasoning.

14. The axial penalty for an OH group on a cyclohexane is 0.9 kcal/mol. The diaxial conformation of isomer A is 1.8 kcal/mol higher in energy than the diequatorial. But, isomer B, the diaxial is slightly lower in energy than the diequatorial. Explain this observation. (8 points)
15. For 1,1,2-trichloroethane:

a. Draw Newman projections of the three staggered conformations looking down the C-C bond and label them A, B, and C. Indicate their relative stability.

A is highest in energy because it has 2 gauche C-Cl interactions. B and C are the same in energy and lower than A, because they both have one gauche C-Cl interaction.

b. Draw Newman projections of the three eclipsed conformations looking down the C-C bond and label them I, II and III. Indicate their relative stability.

I and II are the highest in energy because they both have 1 eclipsing C-Cl interaction. III is lower in energy than I, II because it has no C-Cl eclipsing interactions.

c. Sketch a plot of energy vs dihedral angle when viewed down the C-C bond.

d. Label the locations of A, B, C, and I, II, and III on your plot.

(10 points)