Final Exam Review

Topics Covered:
- Acids and Bases
  - Equilibrium
- Resonance
- Functional Groups
- Stereochemistry
  - R and S configuration
  - Enantiomers & Diastereomers & Meso
- IR & NMR Spectroscopy
  - Diastereotopic Protons


   a. [Diagram of reaction involving an amine and an acid, showing the equilibrium towards the side with the weaker acid so the slowest different]

   b. [Diagram of reaction involving a secondary amine and an alcohol, showing the equilibrium towards the slowest reaction]

   c. [Diagram of reaction involving a primary amine and an alcohol, showing the equilibrium towards the slowest reaction]

   d. [Diagram of reaction involving a tertiary amine and an alcohol, showing the equilibrium towards the slowest reaction]
2. Rank the drawn-in protons in the following molecule in order of increasing pKa. (Smith 6th edition, Chapter 2 pq 23)

3. Draw resonance structures for the following molecule. Determine which resonance structure is the major contributor. (Master Organic Chemistry, Quiz 9 Problem B2)
4. Leukotriene C4 is a major contributor to the inflammation associated with asthma. (Smith 6th edition, Chapter 3 pq 11)
   a. Identify all of the functional groups and stereocenters.

   b. For each stereocenter, determine if they are R or S configuration.
c. Find the (1) most acidic and (2) the most basic site in leukotriene C4.

5. Convert each structure to a Newman projection. (Smith, 6th edition, Question 4.14)

a. 

b. For this structure, additionally convert it to a wedge and dash projection and determine the energy of the Newman projection.
6. Classify each molecule as chiral or achiral. If they are meso, label as such. (West Virginia University, 531_Stereochem Practice Key, Question 4)

a. CH₃-CH₃ eclipsing: 2.5 kcal/mol  
H-CH₃ eclipsing: 1.3 kcal/mol  
H-Br eclipsing: 1.3 kcal/mol  
———Total: 5.1 kcal/mol
7. Indicate the relationship between each of the compound pairs below. Are they enantiomers, diastereomers, constitutional isomers, or identical compounds? (West Virginia University, 531_Stereochem Practice Key, Question 6)
8. The conversion of $(\text{CH}_3)_3\text{Cl}$ to $(\text{CH}_3)_2\text{C}=\text{CH}_2$ can occur by either a one-step or a two-step mechanism, as shown in Equations [1] and [2]. (Smith, 6th edition, Question 6.54)

a. Draw in the curved arrows to show how each step of each reaction came to be.
b. What rate equation would be observed for the mechanism in Equation [1]?
Rate = k[(CH₃)₃Cl][OH]; one step mechanism, so rate equation must have all the reactants

c. What rate equation would be observed for the mechanism in Equation [2]?
Rate = k[(CH₃)₃Cl]; two-step mechanism with first step as rate-determining step

d. What is the order of each rate equation (i.e., first, second, and so forth)?
[1] is second order, dependent on two reactants; [2] is first order

e. Assume Equation [1] represents an endothermic reaction and draw an energy diagram for the reaction. Label the axes, reactants, products, Ea, and ΔH°. Draw the transition state.
f. Assume Equation [2] represents an endothermic reaction and that the product of the rate-determining step is higher in energy than the reactants or products. Draw an energy diagram for this two-step reaction. Label the axes, reactants and products for each step, and the $E_a$ and $\Delta H^o$ for each step. Label $\Delta H^o_{\text{overall}}$. Draw both transition states.
9. Which compound contains diastereotopic protons out of the molecules below? Show where the diastereotopic protons are. (West Virginia University, 531_Stereochem Practice Key, Question 7)
10. Answer the following questions using the IR, 1H NMR, and 13C NMR spectroscopy data of a molecule with formula C₆H₁₀O₂. (University of Delaware CHEM 322, Midterm 2 Problem 5)

a. Identify the peaks for the IR spectra.
b. Identify the peaks for the 1H and 13C NMR spectra.
c. What is the structure of the above compound with molecular formula \( \text{C}_6\text{H}_{10}\text{O}_2 \)?

Based on IR, there is a C=O → eliminate C and D
(OH would be a strong, broad curve)

Based on 13C NMR, there are two alkenes → eliminate B