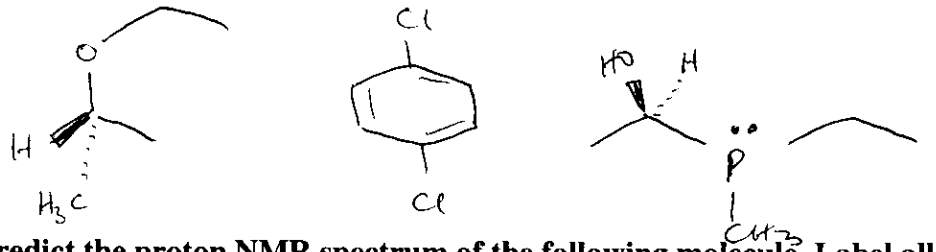
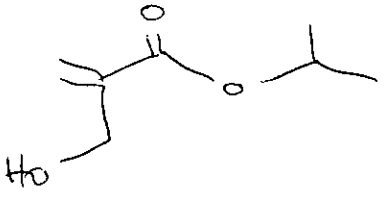
Practice Exam 2 - CHEM 322 - Spring 2005 - Dr. Neal Zondlo

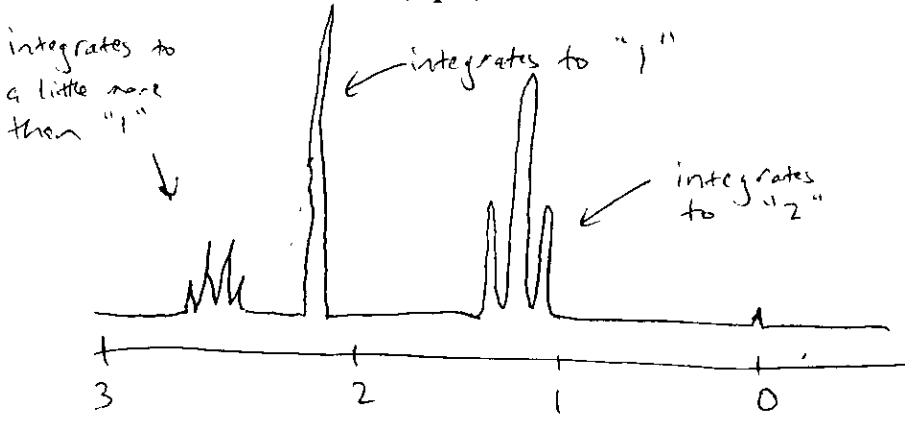
1. **Label all hydrogens in the following molecules (Ha, Hb, etc.), using the same label for chemically equivalent hydrogens. (10 pts)**

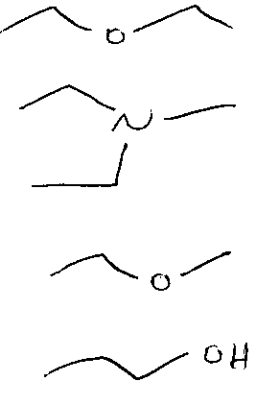


2. **Predict the proton NMR spectrum of the following molecule. Label all H's and indicate the approximate chemical shift, multiplicity (singlet, doublet, etc.), and integration (# of H's) for each signal. Would any signal change on addition of D_2O? (10 pts) (Note: you will be given table 15.4 on exam 1.)**



3. **Four compounds are shown below. The given ^1H NMR spectrum corresponds to that of one of these compounds. Which one? Assign the peaks to the H's of your chosen molecule. (6 pts)**

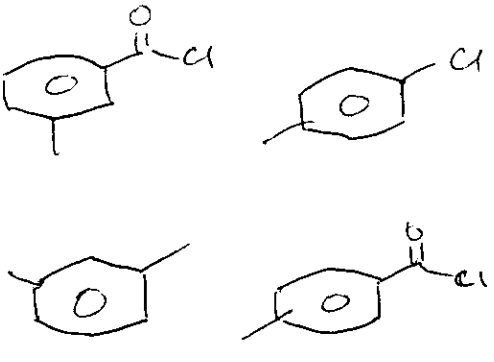




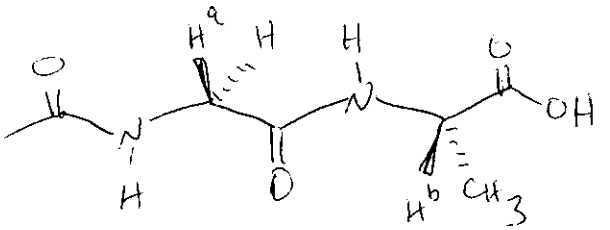
4. **The 1H and 13C signals for an unknown compound are given below. Do these spectra correspond to those expected for one of the given molecules? Which one and why (or why not)? (6 pts)**

^{13}C : 170, 147, 132, 130, 128, 22 ppm

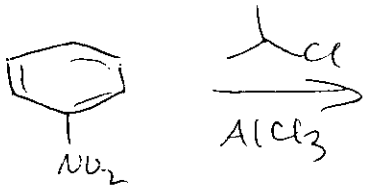
^1H : 8.0 (doublet), 7.3 (doublet), 2.5 (singlet) ppm



5. Analyze coupling in the following molecule. Draw a tree diagram to explain the expected splitting for Ha. (6 pts) (for practice, also try H^b)

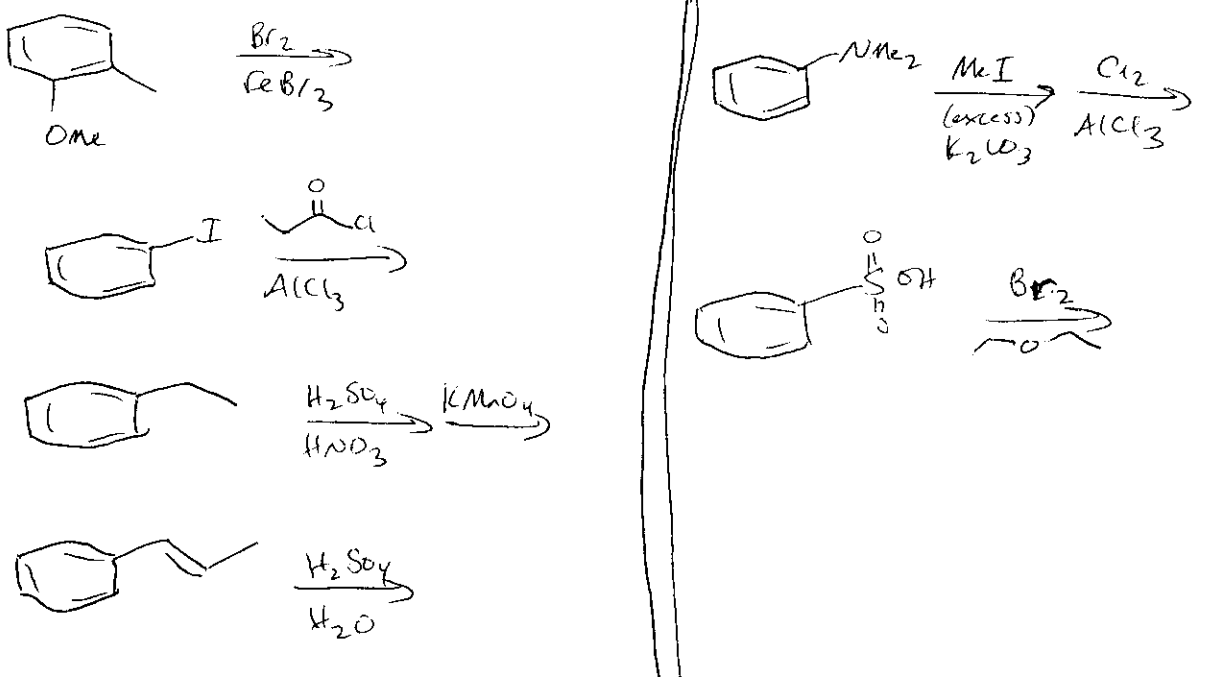


6. Analyze the kinetic and thermodynamic parameters of the following electrophilic aromatic substitution reaction.(20 pts)

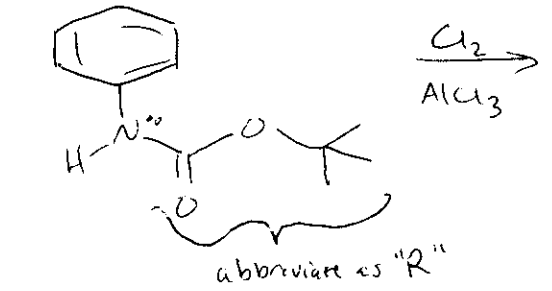


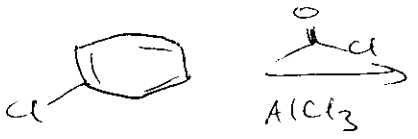
(a) Provide mechanisms for both meta and para addition in an electrophilic aromatic substitution reaction. Provide the complete mechanism to generate the final products. (8)
(b) Using your mechanisms above and showing important resonance structures, EXPLAIN (i) whether the nitro group directs to ortho, para and/or meta positions and (ii) whether it is activating or deactivating (relative to hyrogen). Clearly indicate your reasoning for your answers. (8)
(c) Generate and label an energy diagram showing the relative energies of the starting materials, meta and para intermediates and transition states, and products. (4)

7. Provide the major product(s) of the following reactions. (15 pts)



8. Provide mechanisms and products for the following transformations. (12 pts)





9. Provide a synthesis for each of the following molecules using benzene or anisole (PhOMe) as the starting material. If you don't know how to complete the synthesis, you are encouraged to submit a partial synthetic scheme for partial credit. (15 pts)