CHE 173
Winter, 2005
Specific Objectives for the Final Exam

1. Be able to interpret spectral data (IR, MS, UV-VIS, ^{1}H and ^{13}C NMR) in the identification of organic compounds.
2. Be able to draw the NMR spectra for a given organic compound.
3. Understand what is meant by the term "conjugation," what constitutes a "conjugated system" of π electrons, and the effects of conjugation on the relative energy of a compound.
4. Understand the basic structure of an allyl group, and be able to identify the allylic position(s) in a given molecule.
5. Understand that allylic carbocations and radicals are stabilized by resonance delocalization and know what effect this has on reactions that proceed through formation of these intermediates.
6. Understand that one consequence of resonance delocalization of allyl carbocations and radicals is that mixtures of products (regioisomers) can and will form; be able to predict the major and minor product(s) of a reaction for which this is possible.
7. Be able to identify different types of dienes (conjugated, isolated, and cumulated) and understand the relative stabilities of each; understand why conjugated dienes are most stable and that the s-cis conformation is slightly higher in energy than the s-trans (by about 12 kJ/mol); Understand that conjugated dienes can be prepared selectively by elimination of allyl halides (allyl halides in turn may be prepared from the corresponding hydrocarbon by allylic halogenation).
8. Understand the difference between kinetic control and thermodynamic control of a reaction and be able to predict the products that will result from a given reaction that is either under thermodynamic or kinetic control.
9. Be able to show a mechanism for and predict the product(s) of the following reactions of conjugated dienes: Hydrohalogenation, Halogenation, Diels Alder.
10. Understand what makes a compound aromatic and be able to determine whether a compound is aromatic, anti-aromatic, or not aromatic.
11. Be able to predict the products of and show mechanisms (electron flow shown by curved arrows) for the following reactions: Birch reduction of aromatic systems, Free radical, halogenation of alkyl benzenes, Oxidation of alkyl benzenes (no mechanism here, just predict the products), Nucleophilic substitution reactions (S_N2 or S_N1) vs. elimination reactions (E2 or E1) of benzylic halides.
12. Understand the general mechanism for electrophilic aromatic substitution reactions, and be able to predict the product(s) and show the mechanisms for the following

types of electrophilic aromatic substitution reactions: nitration, sulfonation, halogenation, Friedel-Crafts alkylation, Friedel-Crafts acylation.

13. Understand how substituents affect the rate and regioselectivity of EAS reactions.
14. Understand the nature of the C-M bond in organometallic compounds.
15. Know how to prepare organolithium compounds and Grignard reagents.
16. Understand that organolithium compounds and Grignard reagents are good sources of nucleophilic carbon species, but that they're also Bronsted basic and will react with Bronsted acids (protons, H^+).
17. Be able to synthesize a given alcohol from the reaction of an organometallic compound with a carbonyl compound (aldehyde or ketone) and be able to show the mechanism for the reaction.
18. Understand how to synthesize alkanes using organocopper reagents and alkyl halides, aryl halides and vinylhalides; be able to show the synthesis of cyclopropane compounds from the reaction of organozinc reagents with alkenes (Simmons-Smith reaction).
19. Understand what constitutes a formal oxidation and reduction reactions in organic chemistry, and be able to determine whether a given substrate has undergone oxidation or reduction; know how to determine the oxidation number (or oxidation state) of a carbon atom in a molecule.
20. Know the following methods for preparing alcohols:
    (a) acid-catalyzed hydration of alkenes (Markovnikov)
    (b) hydroboration/oxidation of alkenes (anti-Markovnikov)
    (c) hydrolysis of alkyl halides
    (d) reaction of organometallic reagents with carbonyl compounds
    (e) catalytic hydrogenation of aldehydes and ketones
    (f) treatment of aldehydes or ketones with $NaBH_4$
    (g) treatment of aldehydes or ketones with LAH
    (h) reduction of carboxylic acids and esters with LAH
    (i) treatment of epoxides with organometallic reagents (Grignards or organolithium reagents)
21. Know what a diol is and how to prepare one from the corresponding alkene; know that diols undergo oxidative cleavage to give two carbonyl compounds.
22. Know/understand the following reactions that alcohols undergo (Table 15. & 15.4):
    (a) reaction with HX
    (b) reaction with $SOCl_2$ (thionyl chloride)
    (c) reaction with PX_3
    (d) acid-catalyzed dehydration
    (e) conversion to Tosylates
    (f) conversion of alcohols to ethers

(g) esterification
(h) oxidation of alcohols

23. Understand the major function of crown ethers in organic chemistry.
24. Know how to prepare ethers by all of the following methods (including mechanisms):
    (a) acid-catalyzed condensation of alcohols
    (b) acid-catalyzed addition of alcohols to alkenes
    (c) the Williamson ether synthesis
25. Know that ethers undergo acid catalyzed cleavage to give alcohols.
26. Know how to prepare epoxides by the following methods (including mechanism and stereochemical considerations):
    (a) from alkenes and peroxyacids
    (b) base-catalyzed ring closure of vicinal halohydrins
27. Know the following reactions that ethers undergo (including mechanisms and regio- and stereochemical considerations):
    (a) reaction with anionic nucleophiles under basic or neutral conditions (S_N2-like)
    (b) reaction with nucleophiles under acidic conditions (S_N1-like)
28. Know that aryl halides undergo addition-elimination reactions and be able to show the mechanisms of these reactions and predict the product(s), including with benzyne-type intermediates.
29. Know how to prepare phenols and the reactions that phenols undergo.
30. Be able to apply ALL of the above chemistry to synthesis problems… these will be emphasized on the final exam.