CHE 171
Fall, 2005
Specific Objectives for Exam 3

1. Be able to differentiate between methyl-, 1°, 2°, 3°, alkyl halides, allyl (allylic), benzyl (benzylic), vinyl (vinylic) halides and know which ones undergo nucleophilic substitution and/or elimination reactions.

2. Be able to name alkyl halides (or halo alkanes) using the IUPAC system or common names (including stereochemistry where applicable).

3. Know the general requirements for a substitution reaction and be able to identify the "substrate", the "nucleophile" and the "leaving group" for a given substitution reactiton.

4. Know what constitutes a good leaving group and be able to assess relative leaving group ability.

5. Know what constitutes a good nucleophile and be able to assess relative nucleophile strength; know that nucleophile strength and base strength are directly proportional except when the nucleophile is sterically hindered and/or when the reaction is conducted in polar protic solvent (like water or alcohols).

6. Be able to predict whether an equilibrium favors products or reactants based on the relative basicities of the leaving group and nucleophile.

7. Know the difference between polar protic and aprotic solvents.

8. Know what a mechanism is.

9. Be able to show (arrow pushing) S_N2 and S_N1 mechanisms and know the differences between the two.

10. Know that an S_N2 reaction at a stereogenic center proceeds with inversion of configuration because bond-making and bond-breaking occur simultaneously with backside attack of the nucleophile.

11. Know that an S_N1 reaction at a stereogenic center proceeds with racemization (loss of optical activity) because the nucleophile may attack either face of the planar carbocation intermediate.

12. Know that the order of reactivity for an S_N2 reaction is methyl-X > 1° > 2° (3° substrates do not undergo S_N2 reactions); the reverse is true for SN1 reactions 3° > 2° (1° and methyl substrates do not undergo S_N1 reactions because they cannot form stable carbocation intermediates).

13. Know that the S_N2 mechanism is favored in the presence of strong nucleophiles and polar, aprotic solvents and that the S_N1 mechanism is favored in the presence of weak nucleophiles and polar protic solvents.

14. Be able to predict whether a substitution reaction will proceed via an S_N2 or S_N1 mechanism based on the substrate, nucleophile, and solvent.

15. Know the two mechanisms by which nucleophilic substitution reactions can proceed and be able to differentiate between the two (be able to decide whether a reaction will proceed by a unimolecular or bimolecular mechanism and what effect(s) that has on the structure of the product(s)).

16. Be able to show (using curved arrows) an S_N2 and S_N1 mechanism; also be able to show the energetics of these mechanisms on an energy diagram.

17. Be able to show the product(s) of a substitution reaction (by either mechanism) where the reacting carbon center is a stereogenic center.

18. Be able to devise a synthesis for a given product (i.e., be able to determine what nucleophile must react with what substrate and under what conditions to give the desired product; often there's more than one possibility); see Table 7.8 in Smith for a good list of common transformations (R-X → R-Nu).

19. Know the structure of a C=C bond (one sigma and one pi bond, both C's sp^2 hybridized, 120° bond angles, etc.).

20. Be able to classify alkenes by their substitution patterns (mono-, di- (gem, cis, trans), tri-, tetra-) and know the relative stabilities of these classes of alkenes (more substituted = more stable).

21. Be able to identify the α and β carbons (and β hydrogens) of a given alkyl halide.

22. Know the general features of an elimination reaction (or β-elimination or dehydrohalogenation) and know that elimination can proceed by two different mechanisms (E1 or E2).

23. Know the general features of the E2 mechanism and be able to show an E2 mechanism (using curved arrows) and represent an E2 reaction on an energy diagram.

24. Know what a strong, non-nucleophilic base is and be able to give a few examples (butoxide ion, DBN, DBU).

25. Know that elimination reactions (by either E2 or E1) are generally regioselective and that the regioselectivity is governed by Zaitsev's rule—the major product in a

β-elimination reaction has the more substituted double bond (is the more/most stable product).

26. Know the general features of the E1 mechanism and be able to show an E1 mechanism (using curved arrows) and represent an E1 reacction on an energy diagram.

27. Know that an E2 reaction proceeds through an anti-periplanar transition state with respect to the CH and CX bonds and be able to show how this affects the structure of the product (see Smith's problem 8.17!).

28. Know that an E2 reaction with substituted cyclohexanes proceeds through an anti-periplanar transition state that places H and X trans-diaxial; the Zaitsev product is not necessarily the major product in these cases.

29. Know that treatment of a vicinal or geminal dihalide with two equivalents of a strong base (such as sodium amide) results in two successive E2 reactions to give an alkyne product.

30. Be able to predict when substitution or elimination will predominate with a given alkyl halide and base/nucleophile; be able to predict which mechanism will predominate and what product(s) will form.

31. Be able to identify, classify and name alcohols, ethers, and epoxides.

32. Know how to synthesize: (a) alcohols from alkyl halides; (b) ethers from alkyl halides and alkoxides; (c) epoxides from the intramolecular S_N2 reaction of a halohydrin.

33. Be able to show the E2 and E1 mechanisms for alcohol dehydration and predict the product(s) that are formed.