

Problem Set 7

1. Read Chapter 6 Section 13: You should be familiar with the S_N1 reaction (1st-order nucleophilic substitution), the general mechanism, that S_N1 reactions involve formation of a carbocation intermediate, what the energy profile looks like, the rate equation for S_N1 reactions and why the rate depends only on the concentration of the substrate (alkyl halide) and not the nucleophile. Why is the degree of substitution on the substrate important and what role do alkyl substituents play in stabilizing the carbocation intermediate? What effect does leaving-group ability have on S_N1 reactions? Why? What impact does the choice of solvent play in promoting or inhibiting S_N1 reactions? Study Key Mechanism 6-4 and also the Problem-Solving Hints regarding nucleophilic attack by neutral protonated nucleophiles such as water and alcohols. You should know that S_N1 reactions often are carried out as solvolysis reactions, where the solvent—typically water or alcohols—is used as the nucleophile as well as the solvent. Nucleophilic attack on the carbocation intermediate by neutral solvents necessarily involves deprotonation of the solvent as a last step in the mechanism of S_N1 reactions. Deprotonation occurs via collision of another solvent molecule with the acidic proton such that the proton ends up bonded to a lone pair of electrons on the solvent.

Work the following problems found in Section 13 of Chapter 6: **Problems 22-24.**

2. Read Chapter 6 Section 14: You should be familiar with why S_N1 reactions lead to racemic mixtures rather than a single stereoisomer when the product contains a stereocenter. Study Mechanism 6-5: Racemization in the S_N1 reaction.
3. Read Chapter 6 Section 15: You are responsible for knowing that 1° and 2° carbocations are prone to undergoing rearrangement via a hydride (H:) or alkyl (R:) shift to form more stable 3° carbocations. Such rearrangements lead to mixtures of products in S_N1 reactions. You can expect that some degree of rearrangement always will occur under conditions that promote S_N1 reactions and formation of a 1° or 2° carbocation if a hydride (H:) or alkyl (R:) shift leads to formation of a more substituted carbocation. Study Mechanism 6-6: Hydride Shift in an S_N1 reaction and also Mechanism 6-7: Methyl Shift in an S_N1 reaction.

Work the following problems in Section 15 of Chapter 6: **Problems 25, 26.**

4. Read Chapter 6 Section 16: You are responsible for knowing the difference between S_N1 and S_N2 reactions and how factors such as the nucleophile, the degree of substitution on the substrate, the solvent, and the leaving group affect substitution reactions. Keep in mind that (1) 1° alkyl halides usually always react via an S_N2 mechanism (why?); (2) 3° alkyl halides usually always react via an S_N1 mechanism (why?); and (3) 2° alkyl halides can react via both mechanisms. In the case of 2° alkyl halides, the strength of the nucleophile, solvent used, and the stability of the leaving group will greatly affect which mechanism predominates. Review the Summary: Nucleophilic Substitutions, and also the handout summarizing S_N1 and S_N2 reactions posted on the course website.

Work the following problems in Section 16 of Chapter 6: **Problems 27-29.**

Work the following problems found at the back of Chapter 6: **Problems 34, 36, 38, 40-44, 46, 49, 52, and 54.**