Lecture 4: Nucleophilic Substitution Reactions - SN2 Part 4
Discussion Section Problems Solutions

1. (a) No reaction. In both cases the leaving group is bonded to a 3° carbon. Regardless of the strength of the nucleophile or eagerness of the leaving group to leave, SN2 reactions cannot occur when the leaving group is bonded to a 3° carbon.

(b) An SN2 reaction is faster when the leaving group is bonded to a less sterically hindered (less highly substituted) carbon. In this reaction pair the reaction is faster for the 1° iodide than for the 2° iodide.

(c) Even though the extra methyl groups in the second reaction are not directly bonded to the carbon bearing the leaving group, these methyl groups still provide some steric hindrance to approach of the nucleophile. Verify this by examining molecular models.

(d) Any steric hindrance can slow an SN2 reaction. In this case the steric hindrance comes not from the electrophile, but from the extra methyl groups around the sulfur atom of the nucleophile. Confirm this effect by using models to explore the interaction of the electrophile and nucleophile.

2. From the Lecture Supplement solvents table we see that water (HOH) has \( \varepsilon = 80 \), methanol (CH\(_3\)OH) has \( \varepsilon = 33 \), and ethanol (CH\(_3\)CH\(_2\)OH) has \( \varepsilon = 25 \). Recalling that increasing nonpolar/polar bonds ratio decreases polarity, we predict that 1-propanol (CH\(_3\)CH\(_2\)CH\(_2\)OH) is less polar (lower \( \varepsilon \)) than ethanol. Therefore we assign \( \varepsilon = 20 \) to 1-propanol.

3. Using the same dependence of \( \varepsilon \) on the polar/nonpolar bonds ratio as noted in the previous question, we assign: 1,3-propanediol \( \varepsilon = 35 \), 1-propanol \( \varepsilon = 20 \), 1-pentanol \( \varepsilon = 13.9 \), and 1-hexanol \( \varepsilon = 13.3 \).

4. Yes, it is possible, if the solvent molecule has enough nonpolarity in its structure to outweigh the polarity of the polar hydrogen bond donor groups. Recall that a solvent is categorized as nonpolar when \( \varepsilon < 20 \). We've seen two nonpolar protic solvents here in this problem set: 1-pentanol (\( \varepsilon = 13.9 \)) and 1-hexanol (\( \varepsilon = 13.3 \)).
5. A protic solvent *shares a proton* (hydrogen) to the hydrogen bond acceptor via hydrogen bonding. No covalent bonds are made or formed. An acid, however, *transfers a proton* to the base, causing the acid to become its corresponding conjugate base, and the base to become its corresponding conjugate acid. The acid–H covalent bond is broken, and the base–H covalent bond is formed.

Review the definitions of protic solvent and acid at the Illustrated Glossary or Organic Chemistry, available at the course web site.