

# Reactivity Patterns in Substitutions and Eliminations

Nucleophile	Weakly Basic, Anionic Nucleophiles ( $I^-$ , $Br^-$ , $SCN^-$ , $N_3^-$ , $CH_3CO_2^-$ , $RS^-$ , $CN^-$ , etc.)  conjugate acid $pK_a$ from -9 to 10 (left to right)	Strongly Basic, Anionic Nucleophiles ( $HO^-$ , $RO^-$ , $RC\equiv C^-$ )  conjugate acid $pK_a > 15$	Neutral Nucleophiles ( $H_2O$ , $ROH$ , $RSH$ , $R_3N$ )
Alkyl Group			
Primary $RCH_2-$	<b>S<sub>N</sub>2.</b> Rate may be reduced by adjacent substitution (e.g., neopentyl).	<b>S<sub>N</sub>2.</b> Some E2 may also occur (e.g., $ClCH_2CH_2Cl + KOH \rightarrow CH_2=CHCl$ ).	<b>S<sub>N</sub>2.</b> ( $N \approx S \gg O$ )
Secondary $R_2CH-$	<b>S<sub>N</sub>2 and/or E2.</b> Depends on the basicity of the nucleophile; bases weaker than acetate ( $pK_a = 4.8$ ) give less E2. S <sub>N</sub> 2 may be reduced by adjacent substitution (e.g., neopentyl); this will increase proportion of E2.	<b>E2.</b>	<b>S<sub>N</sub>2.</b> ( $N \approx S \gg O$ ) In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products may be formed slowly.
Tertiary $R_3C-$	<b>E2</b> will dominate with most nucleophiles, even if they are weak bases. No S <sub>N</sub> 2 due to steric hindrance. In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products are expected.	<b>E2.</b> No S <sub>N</sub> 2 substitution will occur. In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products may be formed.	<b>E2</b> , with nitrogen nucleophiles (they are good bases). No S <sub>N</sub> 2 substitution. In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products may be formed.
Allylic $H_2C=CHCH_2-$  Benzylic $C_6H_5CH_2-$	<b>S<sub>N</sub>2</b> for 1° and 2° halides. <b>E2</b> for 3° halides, if the nucleophile is moderately basic; slow S <sub>N</sub> 2 if not. In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products may be formed for 1° and 2° halides, expected for 3° halides.	<b>S<sub>N</sub>2</b> for 1° halides (because there are no β hydrogens). Competing <b>S<sub>N</sub>2 and E2</b> for 2° halides. <b>E2</b> for 3° halides. In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products may be formed for 1° and 2° halides, expected for 3° halides.	<b>S<sub>N</sub>2</b> ( $N \approx S \gg O$ ) for 1° and 2° halides. <b>E2</b> with nitrogen bases at 3° halides. In high-dielectric, ionizing solvents*, S <sub>N</sub> 1 and E1 products may be formed for 1° and 2° halides, expected for 3° halides. S <sub>N</sub> 1 hydrolysis favored for 2° & 3° halides in water.

\*High-dielectric, ionizing solvents: water, dimethyl sulfoxide, dimethyl formamide, acetonitrile

Adapted from <http://www.cem.msu.edu/~reusch/VirtualText/alhalrx3.htm>.