

### 8.3: E1/E2 Summary

The comparison between E1 and E2, in terms of rate law, mechanism, reaction condition etc., are summarized in the following table.

	E1	E2
Rate law	Rate = $k \times [\text{substrate}]$	Rate = $k \times [\text{substrate}] \times [\text{base}]$
Mechanism	multiple steps with carbocation intermediate	one step, concerted
Product	More substituted, more stable alkenes	

small base: more substituted alkenes (Zaitsev's rule)

bulky base: less substituted alkenes (Hoffmann rule)

Substrate tertiary  $3^\circ >$  secondary  $2^\circ >$  primary  $1^\circ$  (no E1)

tertiary  $3^\circ >$  secondary  $2^\circ >$  primary  $1^\circ$

Base weak base, ( $\text{H}_2\text{O}$ , ROH) strong base ( $\text{OH}^-$ ,  $\text{RO}^-$ , etc.)

The competition between E1 and E2, or whether a substrate goes through E1 or E2 mainly depends on the nature of the substrate, that is:

- Primary  $1^\circ$  substrates go with E2 only, because primary carbocations are too unstable to be formed.
- Secondary  $2^\circ$  and tertiary  $3^\circ$  substrates can go with either E1 or E2 reaction, and appropriate reaction conditions are necessary to facilitate a specific mechanism. E2 reaction is favored by a high concentration of strong base ( $\text{OH}^-$ ,  $\text{RO}^-$ , or  $\text{NH}_2^-$ ) and a polar aprotic solvent. E1 reaction is favored by a weak base, and polar protic compound,  $\text{H}_2\text{O}$ , ROH, can be both base and solvent (solvolysis).

For study purpose, the comparison between E1 and E2 mechanism help us to understand the two process in depth. In practice, however, the competition between E1 and E2 will not be an issue because they require rather different reaction conditions. More important actually, it is the competition between elimination and substitution. We will have detailed discussions next for the comparison and competition between all the four types of reactions  $\text{S}_{\text{N}}1$ ,  $\text{S}_{\text{N}}2$ , E1 and E2.

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