The following are animations of gas-phase trajectories for reactants with different amounts and types of energies. The reactant energy includes a relative translational energy, $E_{\text{rel}}$, between Cl$^- + \text{CH}_3\text{Br}$, and a temperature, $T_{\text{vr}}$, for the CH$_3$Br vibrational and rotational energies.

**Select Trajectories of the Cl$^- + \text{CH}_3\text{Br} \rightarrow \text{ClCH}_3 + \text{Br}^-$ S$_N$2 Reaction**

Cl$^- + \text{CH}_3\text{Br} \rightarrow \text{ClCH}_3 + \text{Br}^-$

Nucleophilic substitution by a *direct mechanism*; $E_{\text{rel}} = 50$ kcal/mol and $T_{\text{vr}} = 300\text{K}$

Cl$^- + \text{CH}_3\text{Br} \rightarrow \text{Cl}^-\text{---CH}_3\text{Br} \rightarrow \text{ClCH}_3\text{Br} + \text{Br}^-$

Nucleophilic substitution by an *indirect mechanism*, involving the Cl$^-\text{---CH}_3$ complex; $E_{\text{rel}} = 1.0$ kcal/mol and $T_{\text{vr}} = 300\text{K}$

Cl$^- + \text{CH}_3\text{Br} \rightarrow \text{Cl}^-\text{---CH}_3\text{Br} \rightarrow \text{ClCH}_3\text{---Br}^-$

Nucleophilic substitution by an *indirect Reaction mechanism*, involving both Cl$^-\text{---CH}_3\text{Br}$ and ClCH$_3$---Br$^-$ complex; $E_{\text{rel}} = 1.0$ kcal/mol and $T_{\text{vr}} = 300\text{K}$

Cl$^- + \text{CH}_3\text{Br} \rightarrow \text{Cl}^- + \text{CH}_3\text{Br}$

A non-reactive collision; $E_{\text{rel}} = 1.0$ kcal/mol and $T_{\text{vr}} = 300\text{K}$
Cl\(^-\)+CH\(_3\)Br → Cl\(^-\)-CH\(_3\)Br → Cl\(^-\)+CH\(_3\)Br

A non-reactive collision forming the Cl\(^-\)-CH\(_3\)Br complex, which dissociates back to reactants; E\(_{rel}\) = 1.0 kcal/mol and T\(_{vr}\) = 300K.

Cl\(^-\)+CH\(_3\)Br → Cl\(^-\)-CH\(_3\)Br → ClCH\(_3\)-Br\(^-\) → Cl\(^-\)

CH\(_3\)Br → Cl\(^-\)+CH\(_3\)Br

Nucleophilic substitution by an indirect mechanism involving both the Cl\(^-\)-CH\(_3\)Br and ClCH\(_3\)-Br\(^-\) complex and recrossing the transition state separating these complexes; E\(_{rel}\) = 1.0 kcal/mol and T\(_{vr}\) = 300K.
References


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