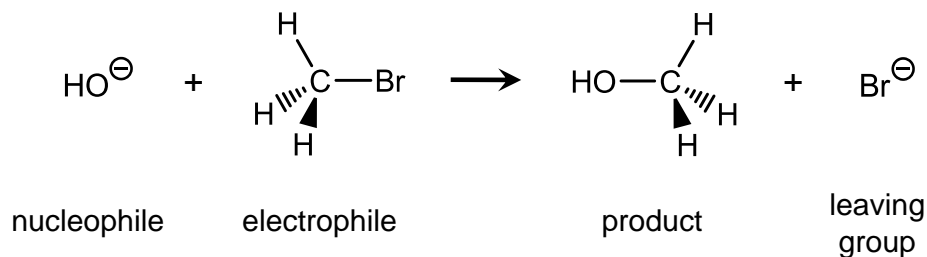


2nd Order Nucleophilic Substitution (S_N2)

S_N2 is a reaction mechanism that substitutes one functional group for another.

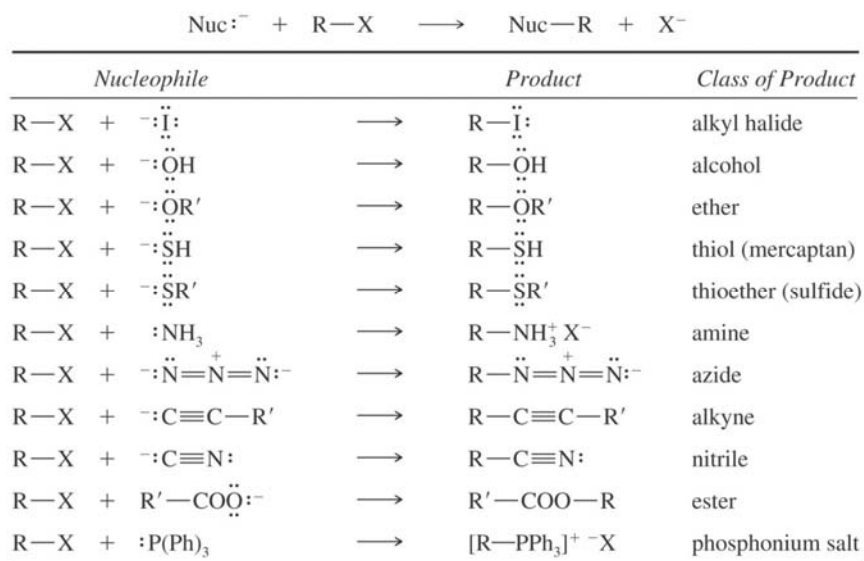


2nd Order because two molecules involved in rate expression:

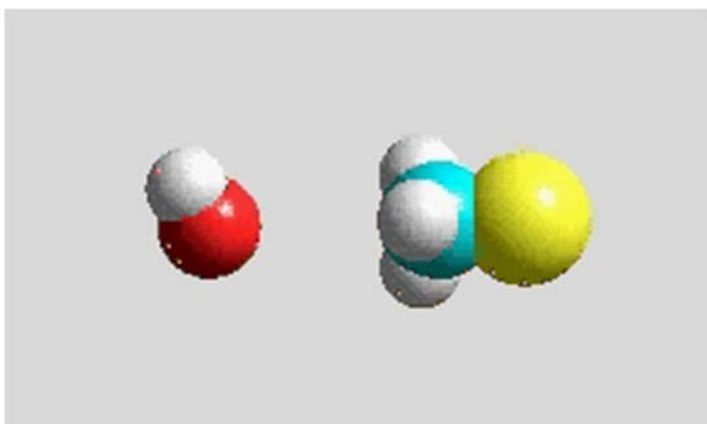
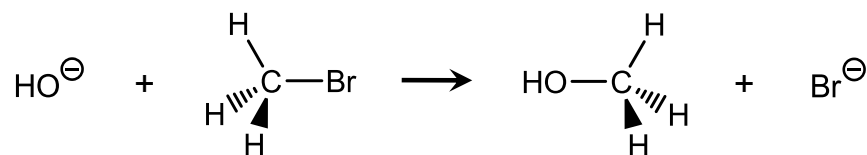
$$\text{rate} = k[\text{OH}^{\ominus}][\text{CH}_3\text{Br}]$$

Nucleophile-Electrophile Combinations

Common feature of nucleophiles: electrons available to donate to a new bond.



2nd Order Nucleophilic Substitution (S_N2)



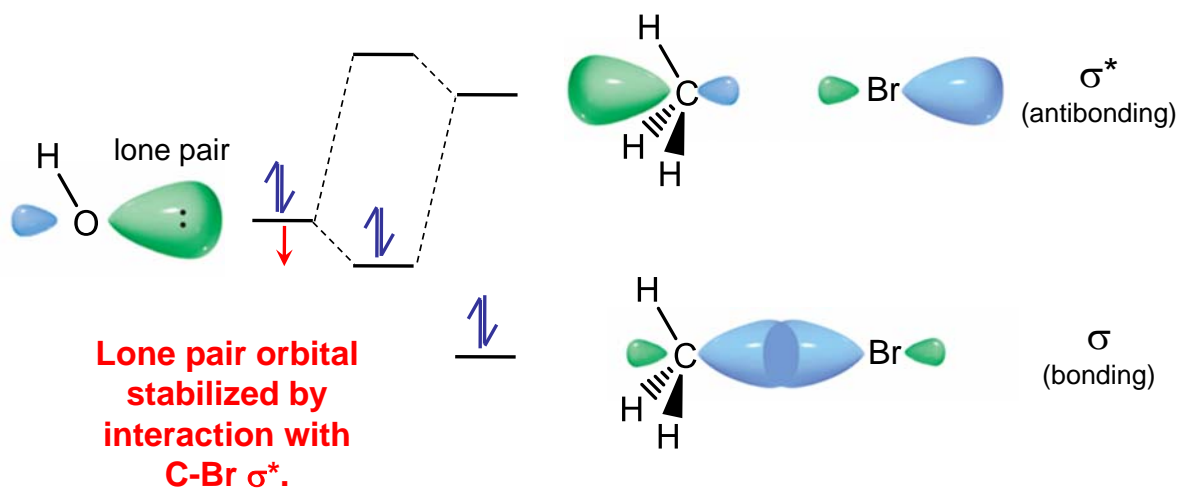
Nucleophile approaches, adds from behind leaving group.

As a result, stereochemistry at electrophile *inverts*.

Halfway, reaction passes through its **transition state**.

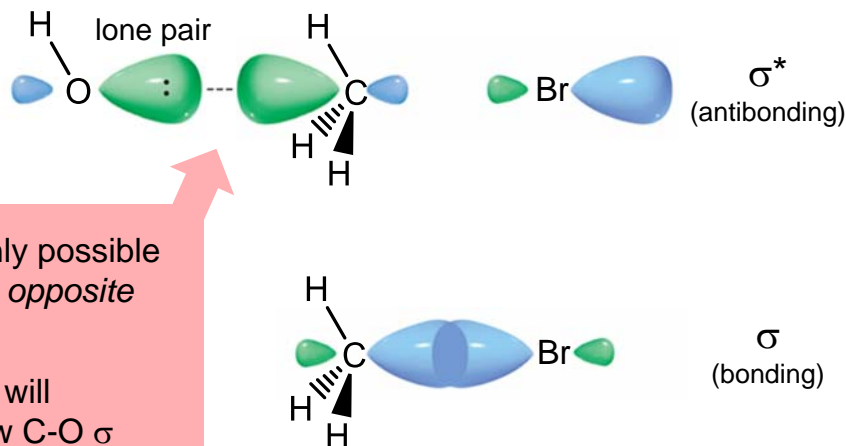
Backside Attack in S_N2

Explained by orbital interactions and mixing.



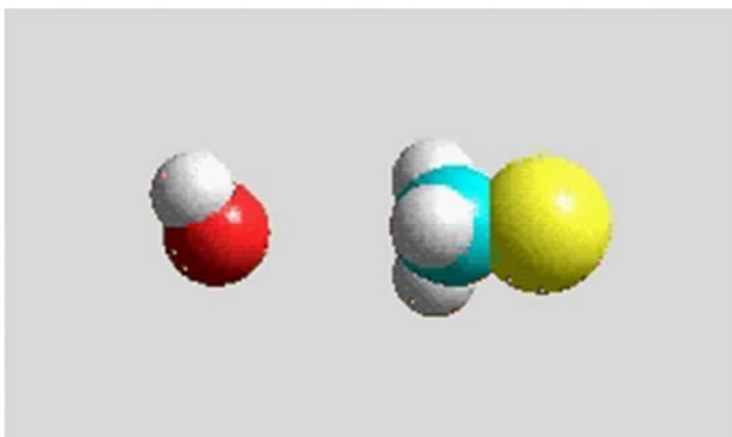
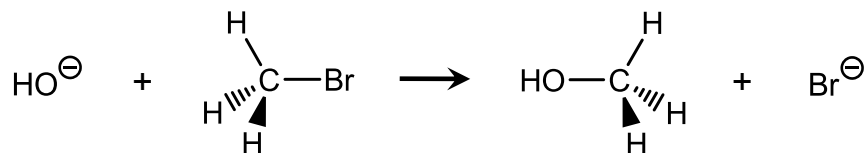
Backside Attack in S_N2

Explained by orbital interactions and mixing.



- Interaction is only possible if nucleophile is *opposite* leaving group.
- This interaction will become the new C-O σ bonding orbital; only possible in this orientation.

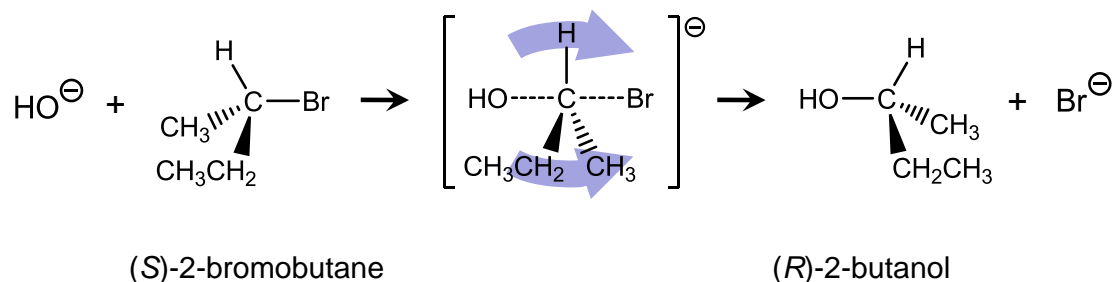
2nd Order Nucleophilic Substitution (S_N2)



Nucleophile approaches, adds from behind leaving group.

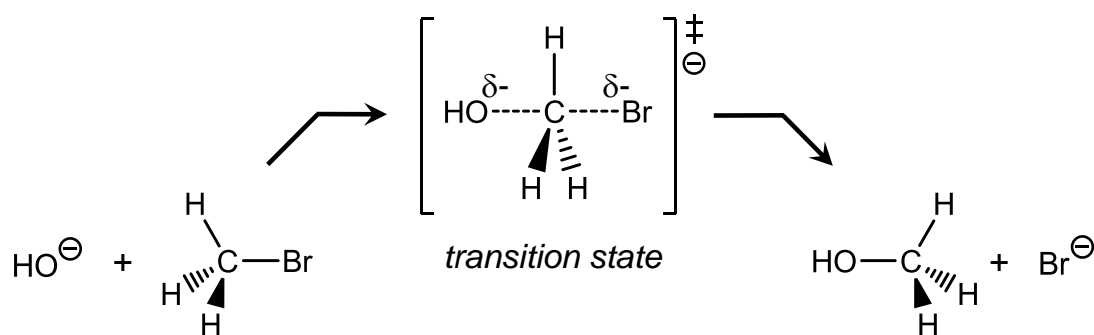
As a result, stereochemistry at electrophile **inverts**.

S_N2 Proceeds with Inversion of Configuration



Warning: Inversion of stereochemistry doesn't necessarily mean inversion of naming. (S) doesn't always become (R).

The S_N2 Transition State



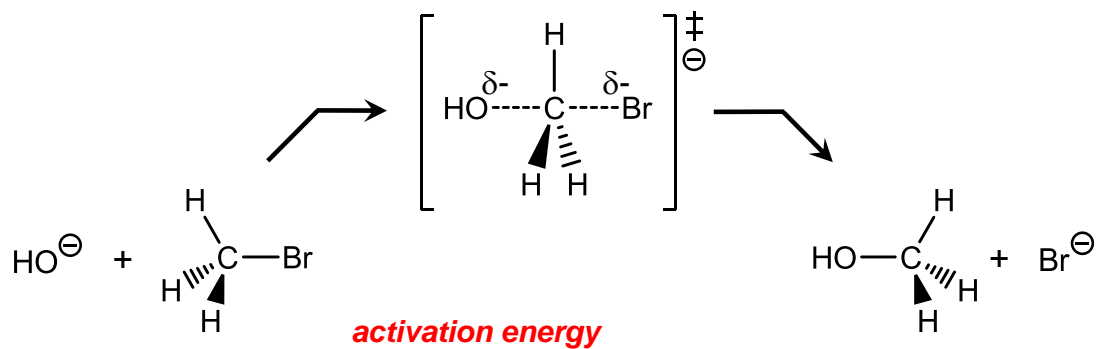
positive:

Electron density distributed between nucleophile and leaving group.

even more negative:

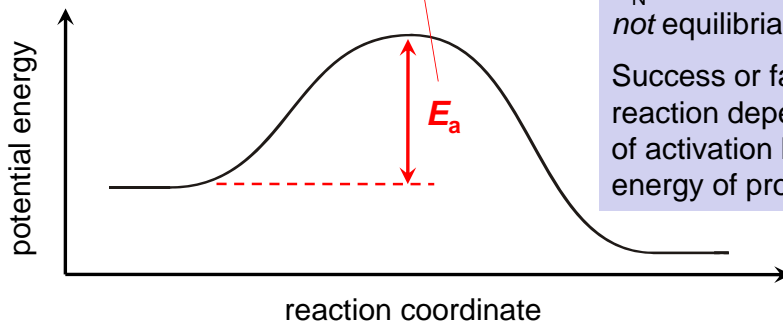
5 repelling electron pairs at reaction center.

The S_N2 Transition State



activation energy

$$k = Ae^{(-E_a/RT)}$$



S_N2 reactions are usually *not* equilibria.

Success or failure of reaction depends on height of activation barrier (not on energy of products).