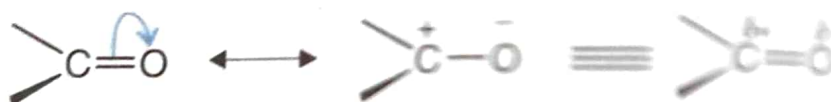
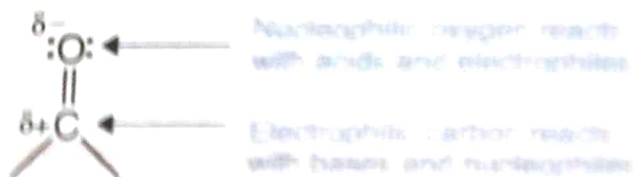


CHEMICAL PROPERTIES

Nucleophilic Addition Reactions. The carbonyl group of aldehydes and ketones is a polar group. It may be represented as :



The positively charged carbon is readily attacked by electron-rich nucleophiles. The negatively charged oxygen is attacked by electron-deficient electrophiles.



Aldehydes and ketones undergo nucleophilic addition reactions by the following mechanism.

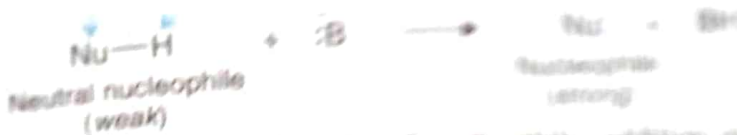
Step 1. The nucleophile (Nu⁻) attacks the carbonyl carbon, forming a tetrahedral intermediate. The pi bond breaks, and the electrons move to the oxygen, which acquires a negative charge.



Step 2. The electrophile (e.g. H⁺) attacks the negatively charged oxygen, forming the addition product.



The nucleophilic addition reactions of carbonyl compounds that is catalyzed by acids or bases is called **base-catalyzed addition**. Bases convert a weak neutral nucleophile to a strong one by deprotonating it. The strong nucleophile then adds to the carbonyl group as shown above.



acid-catalyzed addition. The acid-catalyzed nucleophilic addition occurs by the following

Step 1. The hydrogen ion from the acid attacks the negatively charged carbonyl oxygen to give a protonated carbonyl group. The protonated carbonyl group is resonance stabilized.

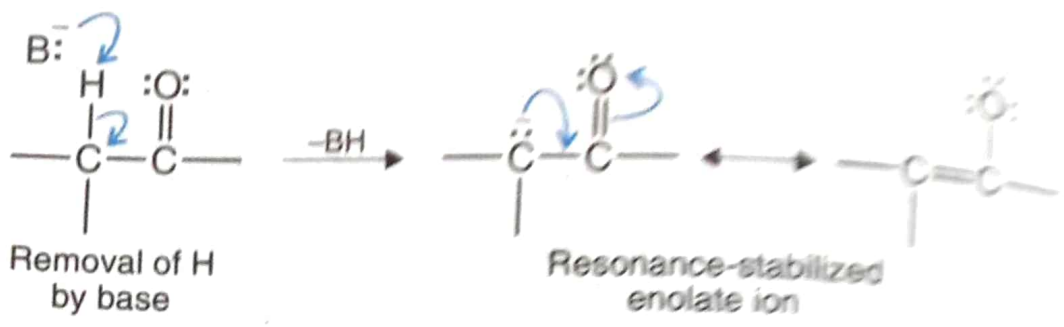


Step 2. The nucleophile attacks the protonated carbonyl group to form the addition product.

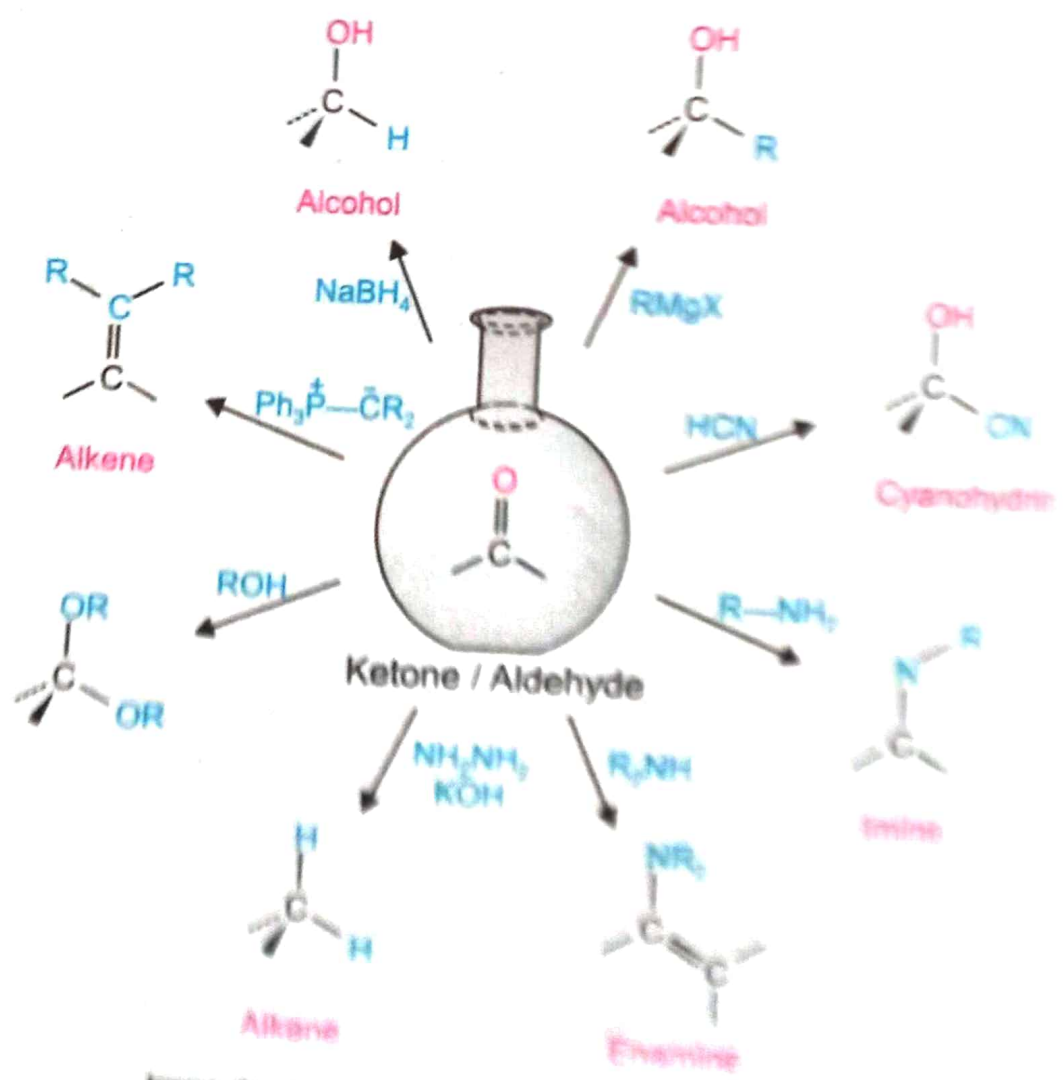


Note that the addition product is the same whether the reaction is acid-catalyzed or base-catalyzed. The nucleophile always adds to the carbonyl carbon and the proton adds to the oxygen. Generally ketones are less reactive than aldehydes in nucleophilic addition reactions.

Acidity of α Hydrogens. A carbon atom next to the carbonyl group is called an α carbon. If a carbon is bonded to an α carbon, it is called a β carbon. The α hydrogens are relatively acidic in nature. The acidity is due to the fact that the negative effect results from the removal of an α hydrogen by a base B⁻ is stabilized by resonance. The resonance-stabilized anion is called an enolate ion.



The α -carbon of the enolate ion is negatively charged. It can act as a nucleophile. The formation of the enolate ion followed by its addition to a carbonyl group is the process involved in all condensation reactions of aldehydes and ketones.



Important reactions of Carbonyl compounds

Some of the important reactions of aldehydes and ketones are described below: