Nucleophilic Addition to Carbonyl Groups

An alkoxide (usually stable under reaction conditions)
Addition of "C" to Carbonyl Groups

Sources of "C-":

\[ \text{Li}^+ \text{Me} \quad \text{Cl-Mg}^+ \text{Me} \]

- (alkyl) lithium [butyllithium]
- Grignard reagent [butylmagnesium chloride]

How do we make these reagents?

\[ \text{X-Me} \quad \text{X-Me} \]

- Li\(^+\) in ether
- Mg\(^+\) in ether

X = Cl, Br, I

Electronegativity:

- 0.9
- 1.3
Think of as: A Ketone

Usually written as:

Product – a tertiary alcohol

Think of as: An aldehyde

Usually written as:

Product – a secondary alcohol
A Wide Variety of "C−" Reagents are Readily Available

- **alkyl**: Me–Li
- **alkynyl**: Me–≡–Li
- **vinyl**: MgBr
- **aryl**: Li
- **allyl**: MgCl
Addition of "H−" to Carbonyl Groups – Carbonyl Reduction

NaBH₄

An ketone

+ BH₃

Product – a secondary alcohol

BH₄⁻ can transfer one hydride (H⁻)

LiAlH₄ can also be used (much stronger than NaBH₄):

NaBH₄

An aldehyde

+ BH₃

Product – a primary alcohol
Addition of Cyanide Ion

Product – a cyanohydrin

Nitrile Hydrolysis:

mild $H_3O^+$

strong $H_3O^+$
Carbonyl Groups to Olefins: The Wittig Reaction

An $S_{N}2$ displacement

A phosphonium salt

A strong base

A phosphorus ylide

An oxaphosphetane

Product