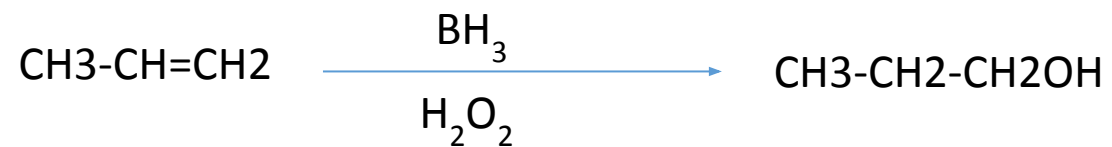
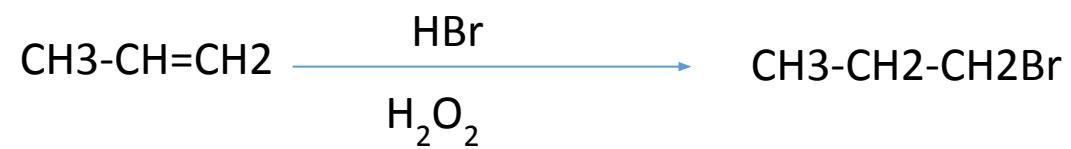
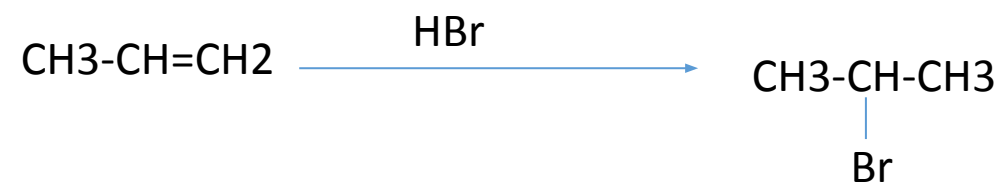
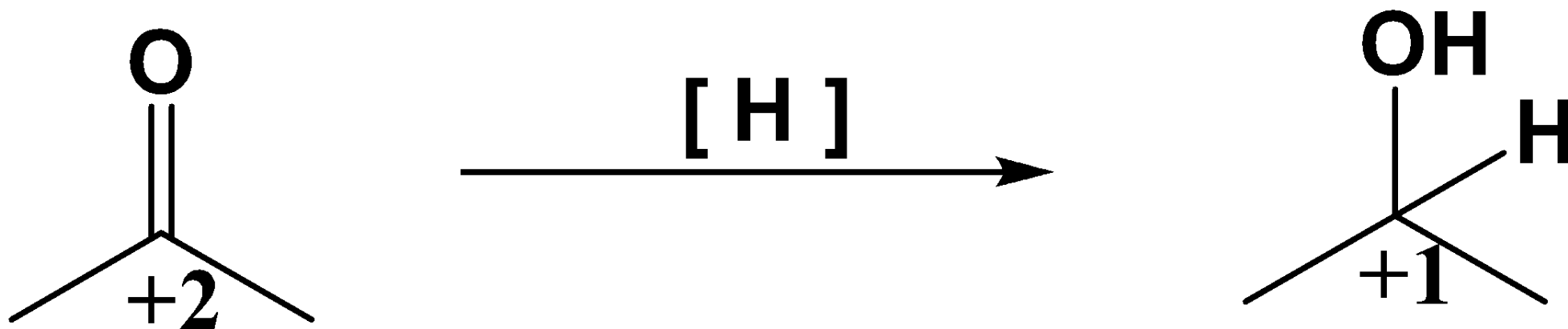


Reduction reaction

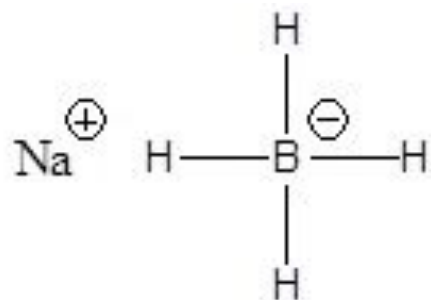


Reduction reaction

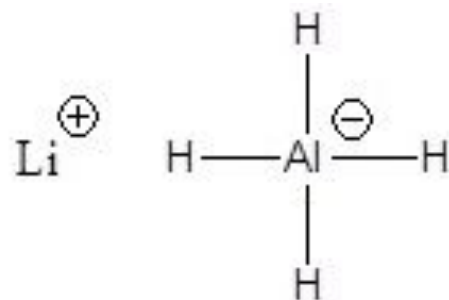


Reduction: decrease in oxidation state/ addition of hydrogen related to the carbon atom

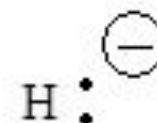
Source of reduction



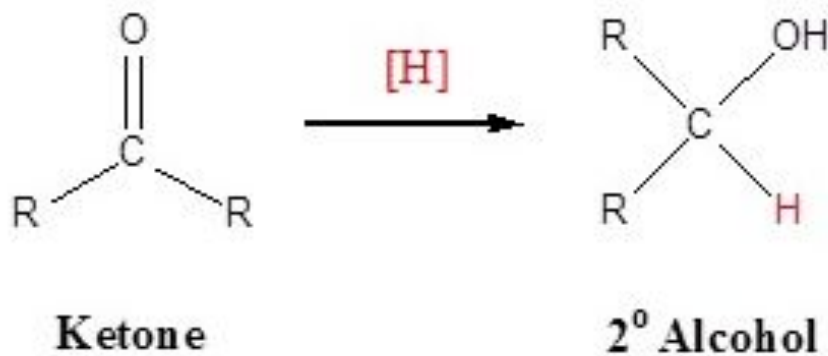
Sodium Borohydride



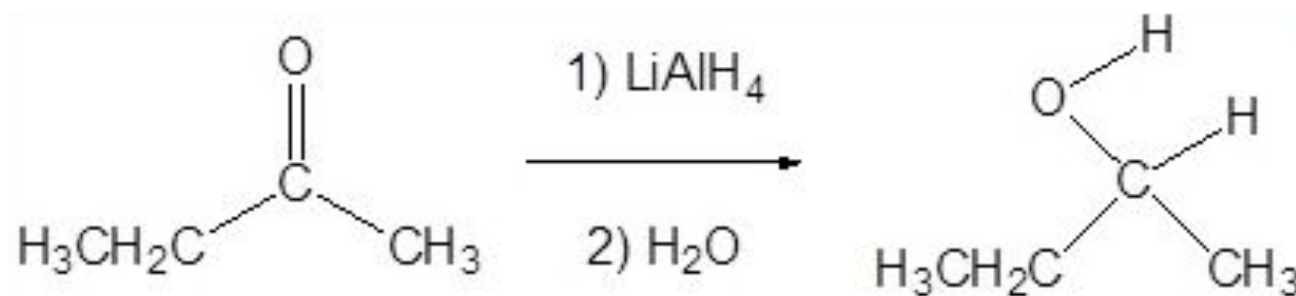
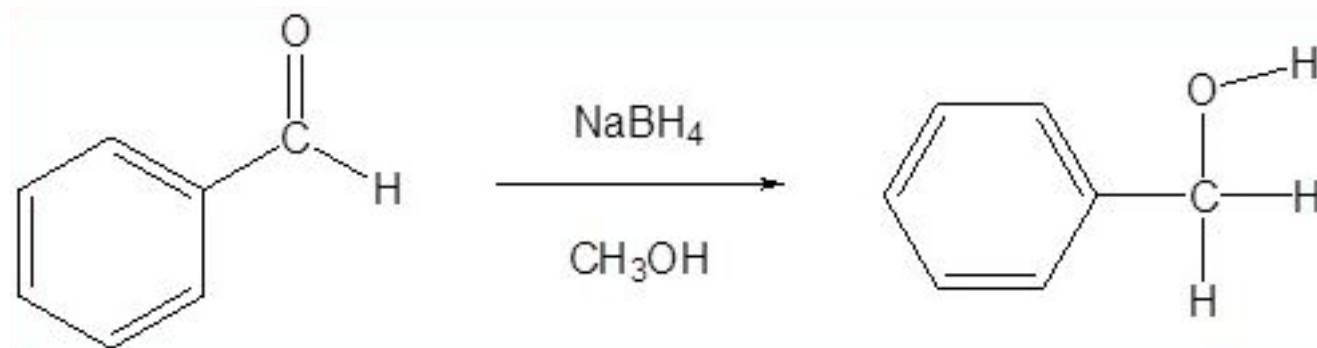
Lithium Aluminum Hydride



Hydride Nucleophile



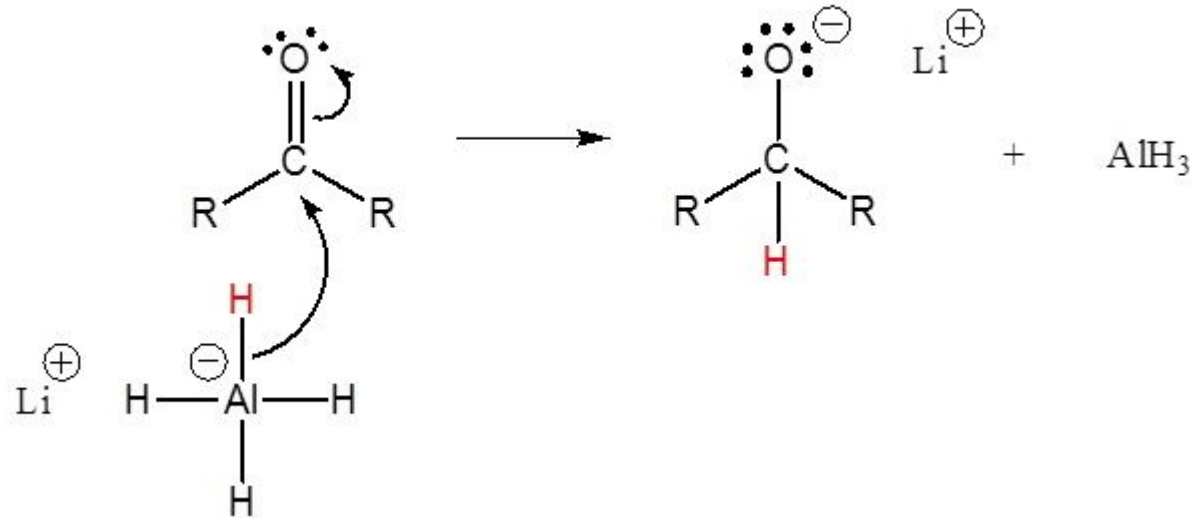
Reactivity difference



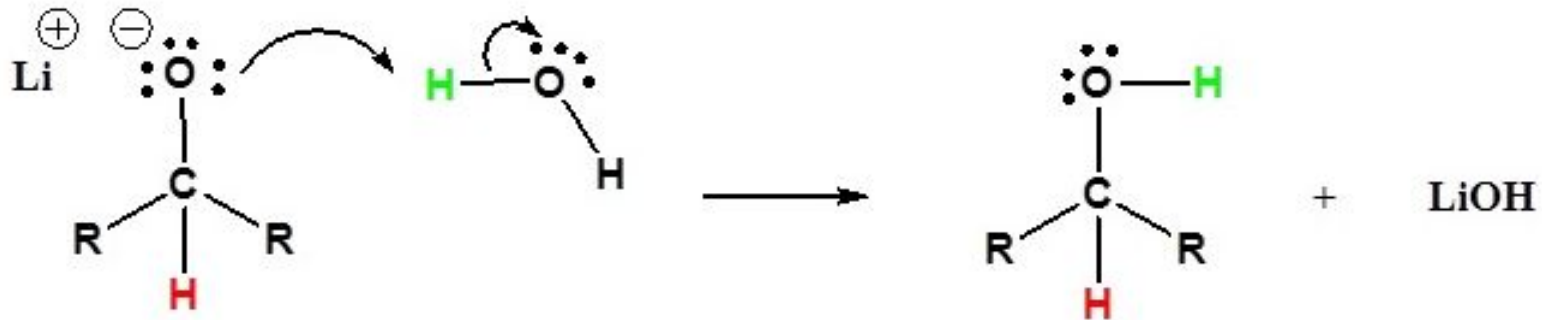
Lithium aluminium hydride (LiAlH_4) is more electropositive (more metallic) **than** boron in NaBH_4 . The hydride from LiAlH_4 is therefore more electron rich and thus is a **stronger** base (in reaction with water) and **stronger** nucleophile (with carbonyl group).

Mechanism of LiAlH_4 reduction

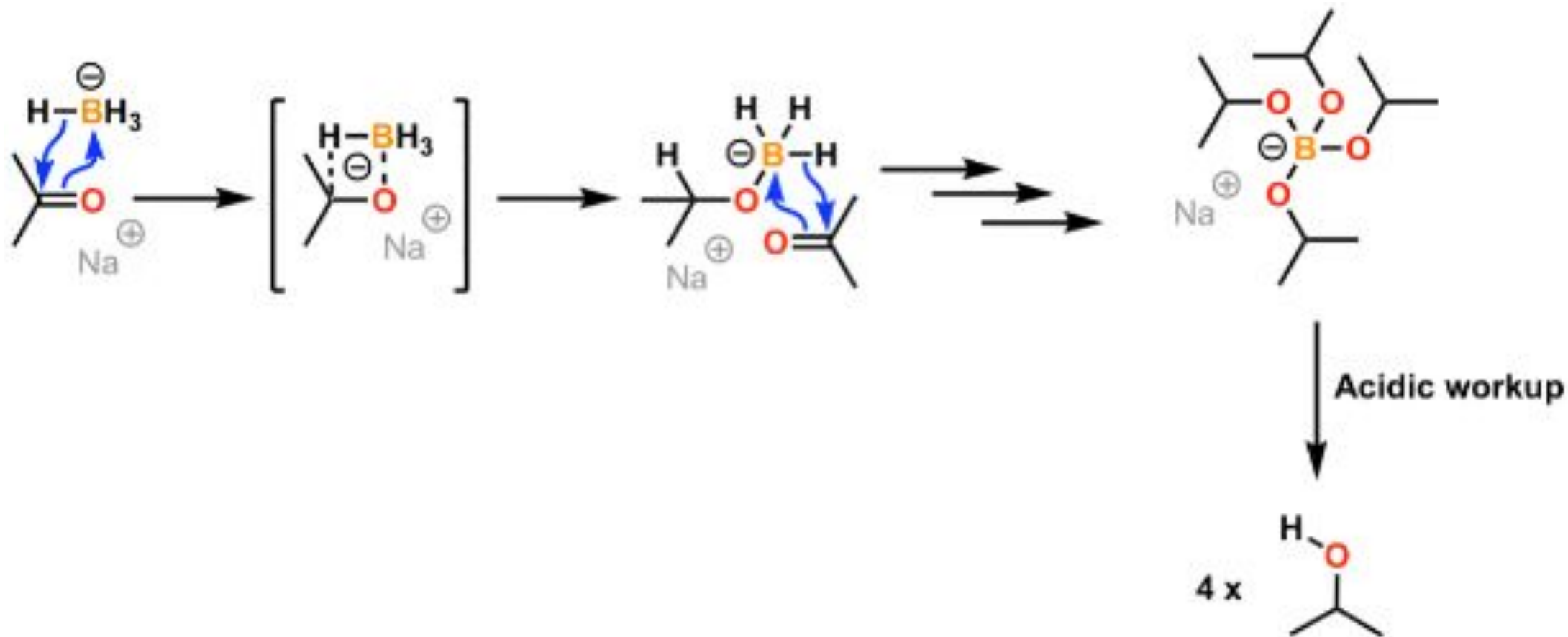
Step 1: Nucleophilic attack of hydride ion



Step 2: Protonation of the alkoxide



NaBH₄ reduction mechanism

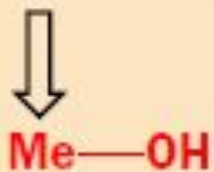


Primary, secondary, tertiary and quarternary carbon

● Primary, secondary, and tertiary

The prefixes *sec* and *tert* are really short for secondary and tertiary, terms that refer to the carbon atom that attaches these groups to the rest of the molecular structure.

methyl
(no attached C)



methanol

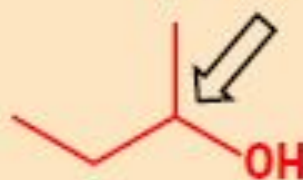
primary
(1 attached C)



butan-1-ol

n-butanol

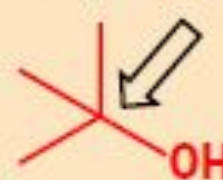
secondary
(2 attached C)



butan-2-ol

sec-butanol

tertiary
(3 attached C)



2-methylpropan-2-ol

tert-butanol

quaternary
(4 attached C)

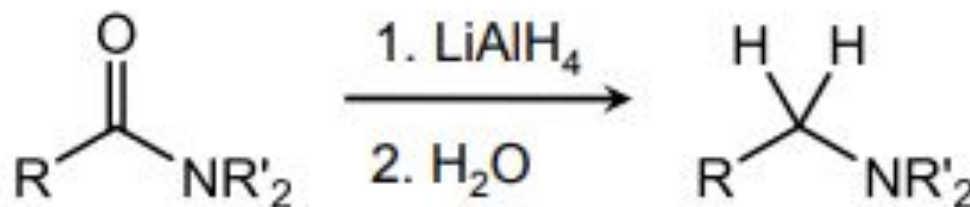
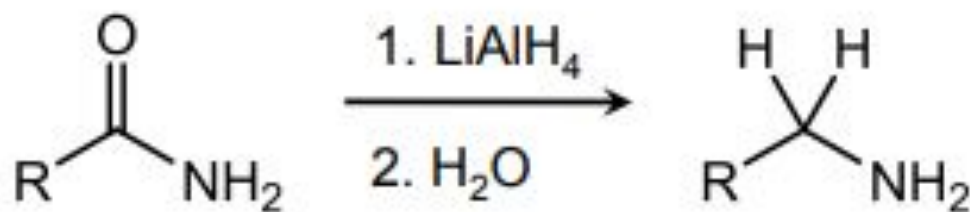


2,2,-dimethylpropan-1-ol

Reactivity of the hydrides

Reagent	Preferred Solvents	Functions Reduced	Reaction Work-up
Sodium Borohydride NaBH_4	ethanol; aqueous ethanol 15% NaOH; diglyme avoid strong acids	aldehydes to 1°-alcohols ketones to 2°-alcohols inert to most other functions	1) simple neutralization 2) extraction of product
Lithium Aluminum Hydride LiAlH_4	ether; THF avoid alcohols and amines avoid halogenated compounds avoid strong acids	aldehydes to 1°-alcohols ketones to 2°-alcohols carboxylic acids to 1°-alcohols esters to alcohols epoxides to alcohols nitriles & amides to amines halides & tosylates to alkanes most functions react	1) careful addition of water 2) remove aluminum salts 3) extraction of product

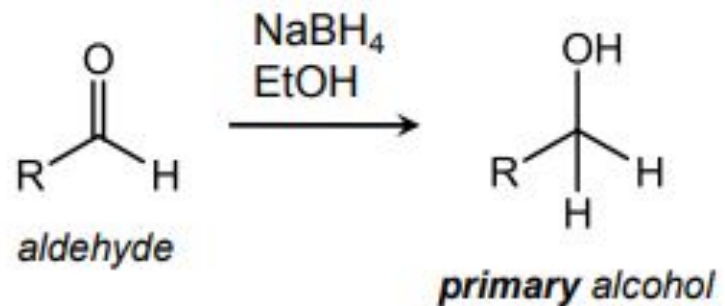
Amide to amine



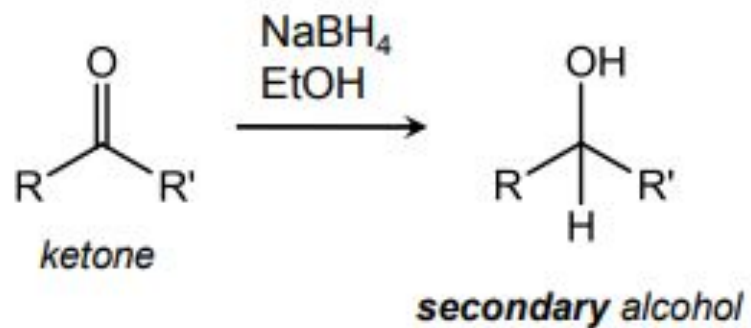
Mechanism depends slightly on whether amide has an N-H or not.

But the result is the same.

Carbonyl to Alcohol



NaBH_4 isn't as basic as LiAlH_4 , so reaction can be conducted in protic solvent, and separate workup step isn't essential.



Versatility of LiAlH_4 as a reducing agent

