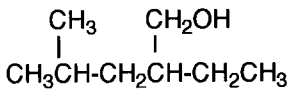
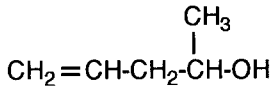
CHAPTER 10: Structure and Synthesis of Alcohols (omit: 10-12)

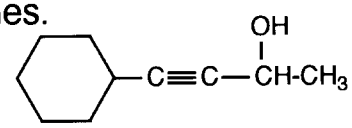
Nomenclature:

1. Longest chain containg the OH is the parent chain. Chain is numbered to give OH the lowest possible #. Suffix is "ol."

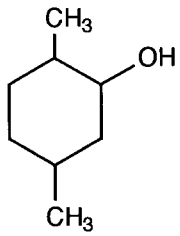


2. Alcohols have priority over alkenes and alkynes.

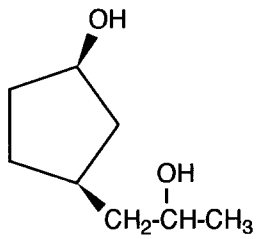




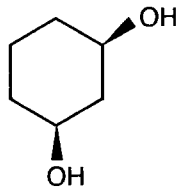
3. In cyclic alcohols, OH is always on carbon # 1.

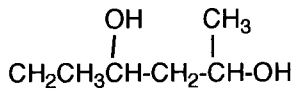


4. When the OH group cannot be incorporated into the parent chain, it is named as a "hydroxy" substituent.

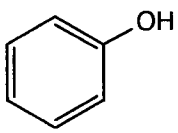


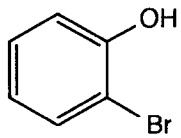
5. Alcohols with two OH groups are named as diols. Add "diol" to the alkane/alkene/alkyne name.

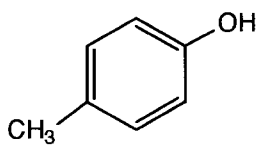




6. In phenols, the OH group is always on carbon # 1.



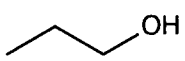




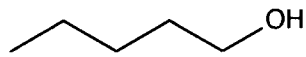
PHYSICAL PROPERTIES OF **R-O-H**

Boiling Point: $CH_3CH_2CH_3$ CH_3-O-CH_3 CH_3CH_2OH $HOCH_2CH_2OH$

Solubility:

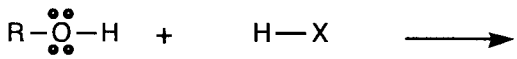


vs

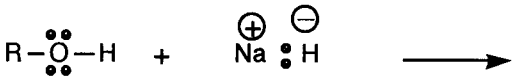


CHEMICAL PROPERTIES: ACIDITY/BASICITY
- can serve as weak acid or weak base

As a Base:

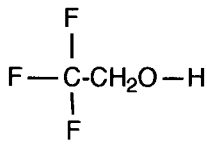


As an Acid:

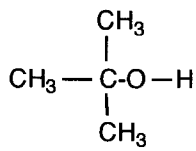


Structure vs Acidity:

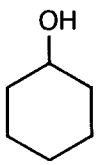
CH_3CH_2O-H vs



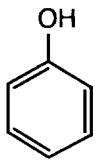
CH_3CH_2O-H vs

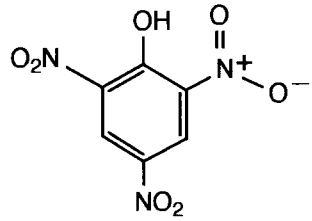


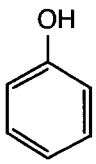
Acidity of Phenols:

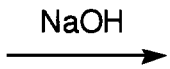


vs



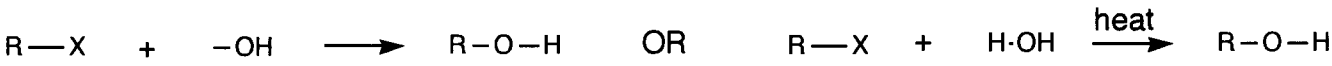






SYNTHESIS OF ALCOHOLS

I. From Alkyl Halides: Ch. 6



II. From Alkenes: Ch. 8

A. Hydration (acid catalyzed)

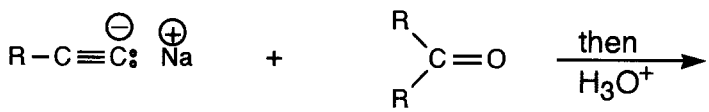
B. Oxymercuration/Demercuration

C. Hydroboration

D. Epoxidation followed by acidic hydrolysis

E. Hydroxylation

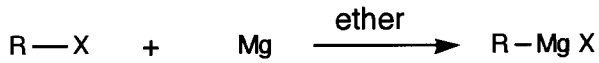
III. From Acetylide Anion and Carbonyl Compound: Ch. 9



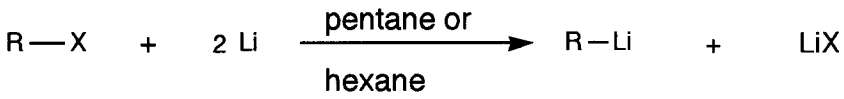
IV. Organometallic Reagents + Carbonyl Compounds ⟶ R-OH

A. Preparation of Reagents

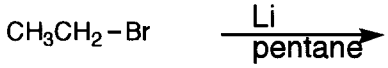
1. Grignard Reagent

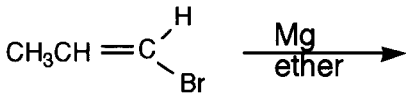


2. Organolithium Reagent

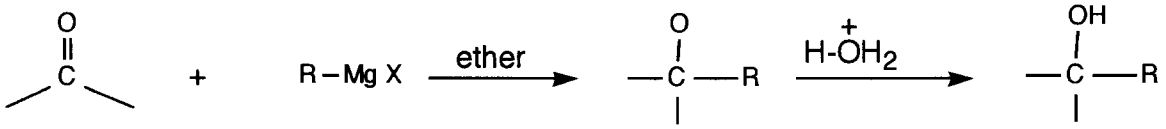


Examples:

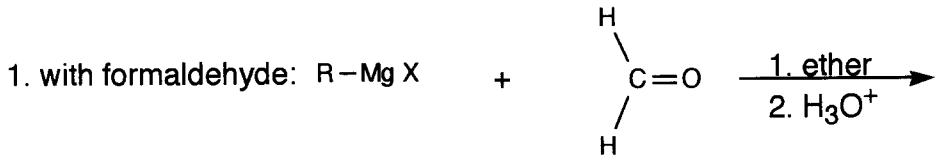


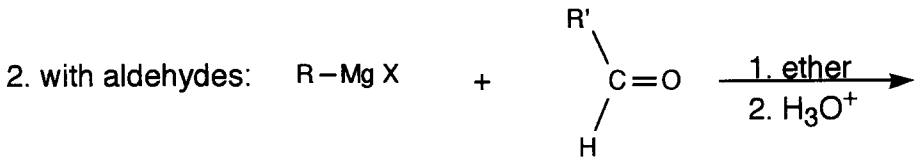


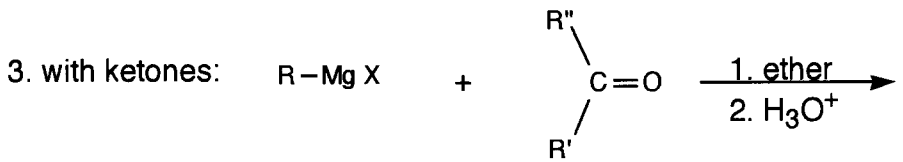
B. Mechanism of Grignard Reaction (mechanism of organolithium reaction is similar)



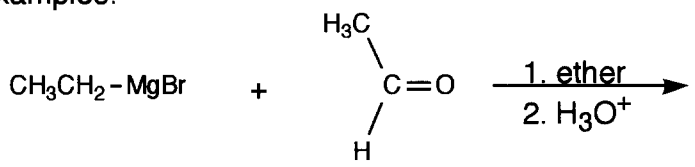
C. Grignard Reactions (RLi reactions are similar)

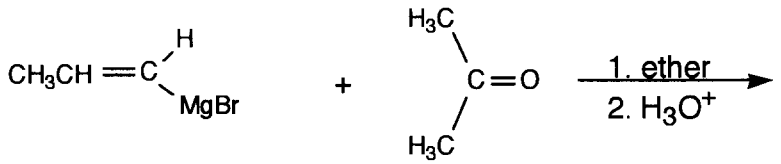
1. with formaldehyde: 

2. with aldehydes: 

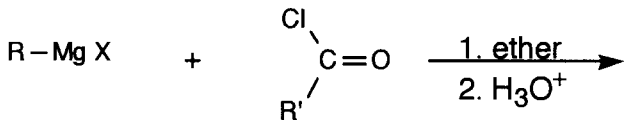
3. with ketones: 

Examples:

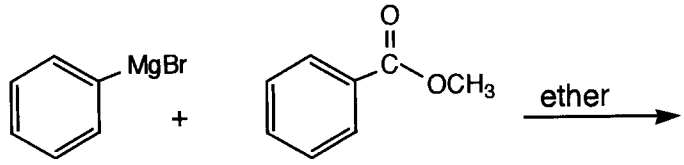


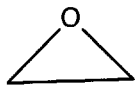


4. with esters or acid halides:

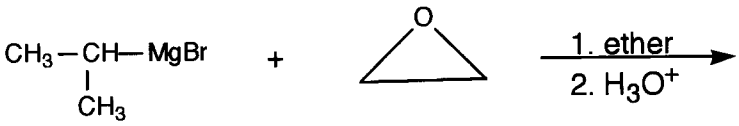


Example of RMgX + acid chloride or ester:



5. with ethylene oxide: R–Mg X +  1. ether, 2. H_3O^+

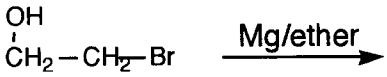
Example:

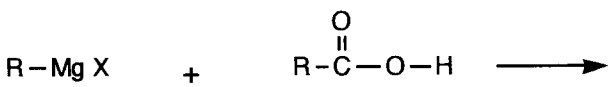


D. Limitations on Grignard / Organolithium reactions: Use caution when selecting the halide compound that forms the Grignard or organolithium reagent and the carbonyl compound. Observe the following rules.

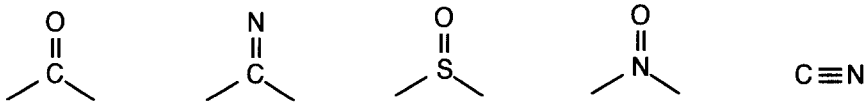
1. NO ACIDIC HYDROGENS!! (NO -OH, -NH, -SH, $-CO_2H$ or $-C\equiv C-H$)

Examples:



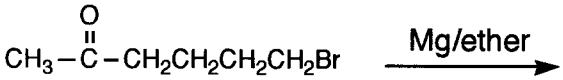


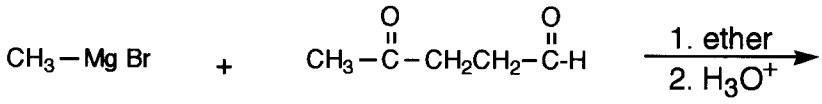
2. NO functional groups that react with Grignard/ organolithium reagents (besides the intended carbonyl component):

NO: 

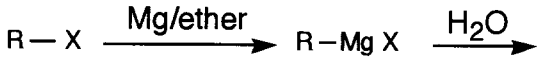
Notice the general structural feature: a multiple bond in which one atom is strongly partial +

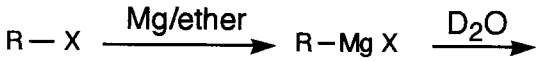
Examples:



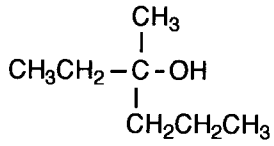


3. Dubious and Worthwhile Uses of a Side Reaction:





SYNTHESIS INTERLUDE:



A Slightly Related Reaction of an Organolithium Reagent:

The Corey-House Reaction: forms a new carbon-carbon bond

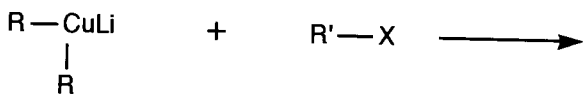
a multiple step synthesis:

1. $R\text{-}X + 2\,Li \longrightarrow R\text{-}Li + LiX$

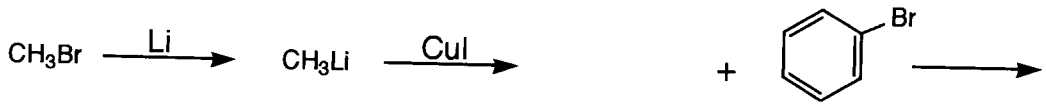
2. $2\,R\text{-}Li + CuI \longrightarrow R_2CuLi + LiI$

3. $R_2CuLi + R'\text{-}X \longrightarrow R\text{-}R' + RCu + LiX$

Mechanism: Not well understood, but NOT a typical substitution reaction



Example:



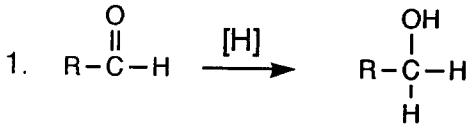
V. Synthesis of Alcohols: Reduction of a Carbonyl

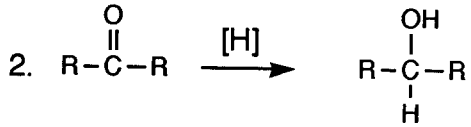
The "organic" definitions of oxidation and reduction:

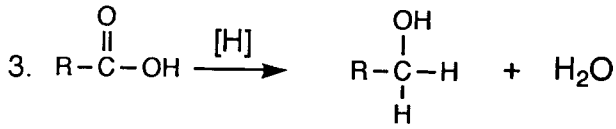
oxidation -

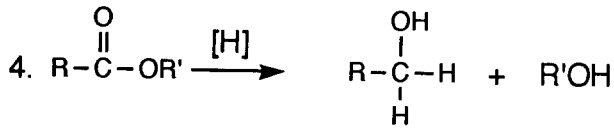
reduction -

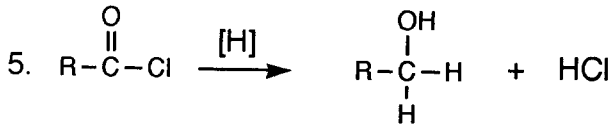
A. Hydride Reductions

1. 

2. 

3. 

4. 

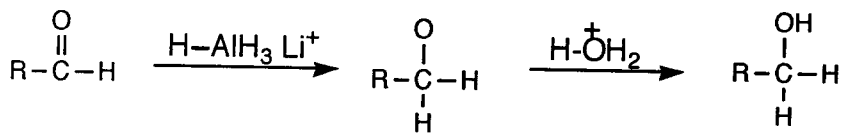
5. 

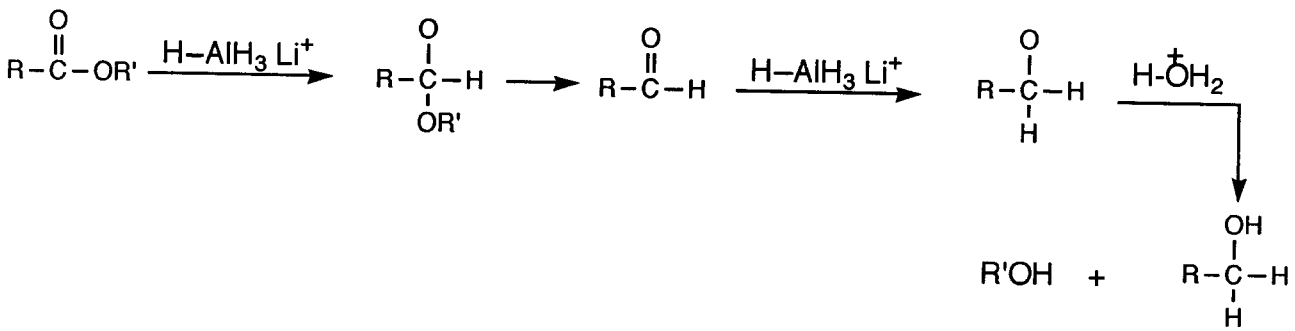
Reducing agents:

$NaBH_4$ - the milder choice; usually chosen for aldehydes and ketones
- may use H_2O or alcohol as solvents
- very slow reduction of esters; will not reduce acid chlorides or carboxylic acids

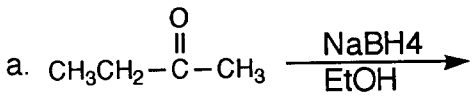
$LiAlH_4$ - more reactive than $NaBH_4$
- reduces aldehydes, ketones, esters, acid halides and carboxylic acids
- CAUTION: reacts violently with H_2O and alcohols! Must use ethers as solvents.

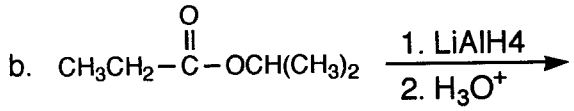
Mechanism:



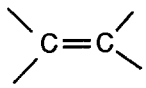


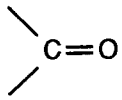
Examples:

a. 

b. 

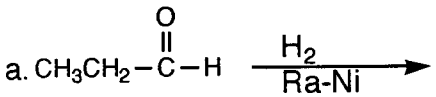
B. Catalytic Hydrogenation of Aldehydes and Ketones:





- catalytic reduction of carbonyl is slower than reduction of double bond
- Raney Ni is best catalyst

Examples:

a. 

b.