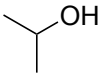
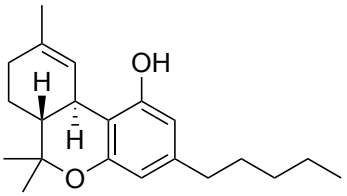
Chapter 12 – Alcohols

CH_3CH_2OH

Ethanol, bp 78 °C



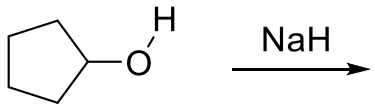
isopropanol
rubbing alcohol, bp 108 °C



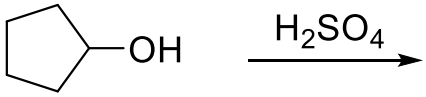
Tetrahydrocannabinol
(THC Δ-9), bp 155 °C

(12.2) Acid-Base Properties of Alcohols

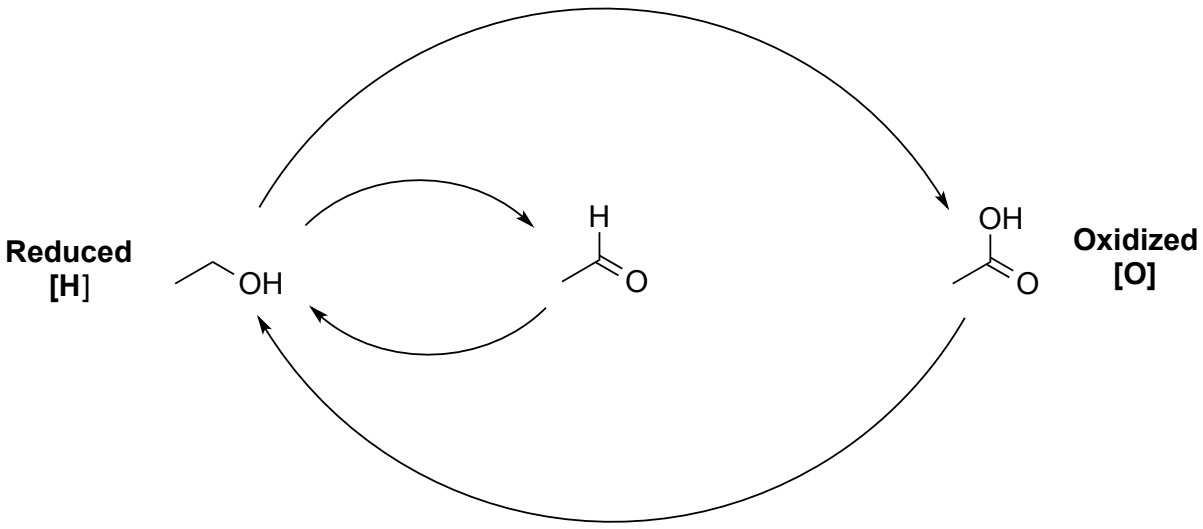
Alcohols are weak acids



Alcohols are weak bases

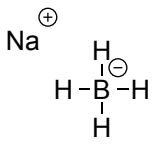
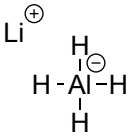
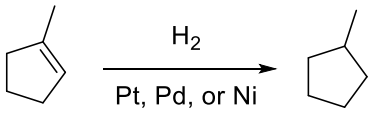


REDOX Reactions: Alcohols to & from Carbonyl Compounds

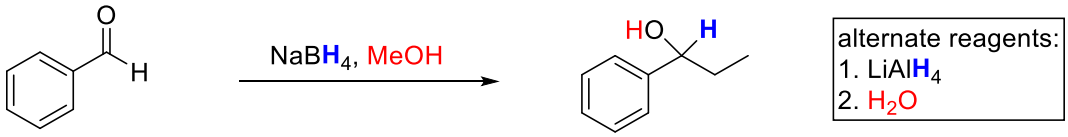


12.4 Preparation of Alcohols *via* Reduction

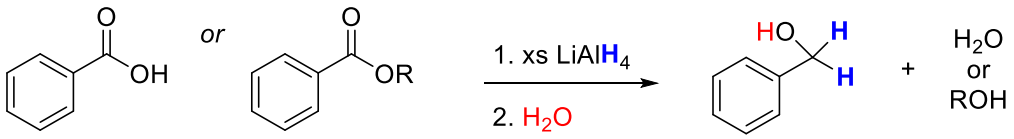
Reducing Agents:

$NaBH_4$	**$LiAlH_4$**	**H_2 with Pt, Pd, or Ni**
 sodium boro**hydride**	 lithium aluminium **hydride**	*hydrogen gas with platinum, palladium, or nickel* 

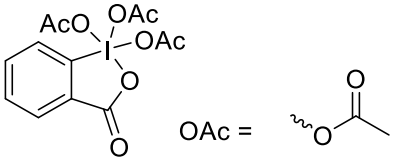
Reduction of Aldehydes & Ketones

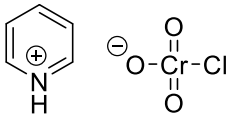


Reduction of Carboxylic Acids & Esters



12.10 Reactions of Alcohols: Oxidation

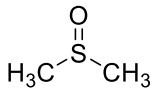
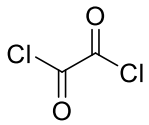
<table>
<tr><th colspan="2">Mild oxidizing agents</th><th>Strong oxidizing agents</th></tr>
<tr><td> 
OAc =

Dess-Martin Periodinane
(DMP)</td><td> 
pyridinium chlorochromate
(PCC)</td><td rowspan="2"><u>Chromic Acid (H_2CrO_4)</u>

Generated in situ by mixing together

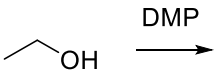
• $Na_2Cr_2O_7$, H_2SO_4, H_2O – sodium dichromate in aqueous sulfuric acid

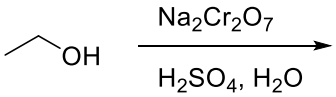
Or

• CrO_3, H_3O^+ - chromium (III) oxide in aqueous acid</td></tr>
<tr><td colspan="2">Swern oxidation: Dimethylsulfoxide & oxalyl chloride, then triethylamine
1. DMSO, $(COCl)_2$
2. Et_3N
 
dimethyl sulfoxide
(DMSO)
 
oxalyl chloride
$(COCl)_2$</td></tr>
</table>

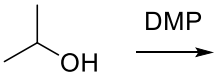
You are not responsible for oxidation mechanisms!

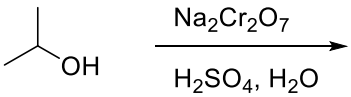
Primary alcohols



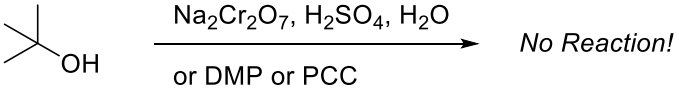


Secondary alcohols



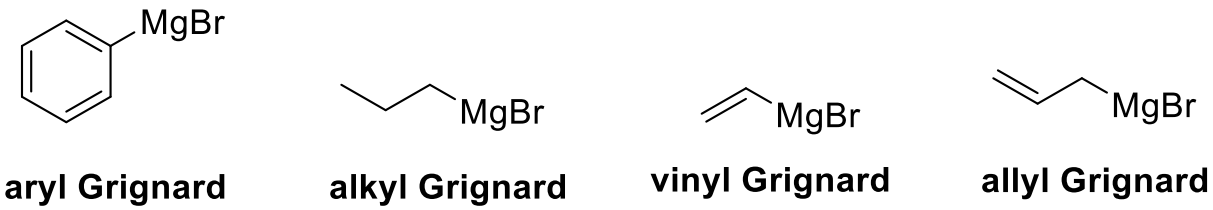


Tertiary alcohols



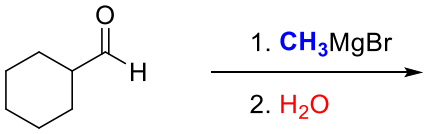
(12.6) Preparation of Alcohols *via* Grignard Reagents

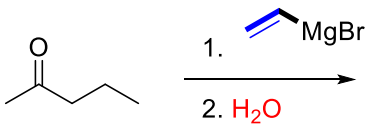
Add charges…



Nucleophilic Grignard Additions to Aldehydes & Ketones

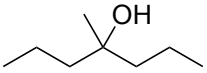
Predict the product…





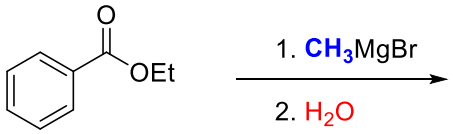
Make this alcohol using a

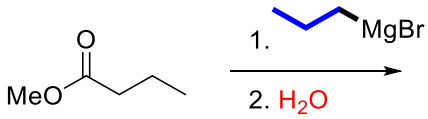
Grignard + (aldehyde or ketone)



Grignard Additions to Esters

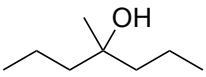
Predict the product…



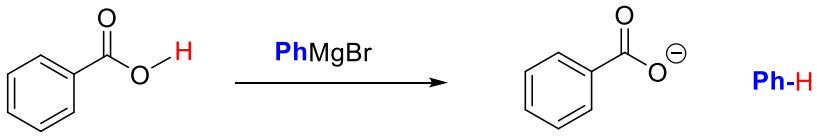


Make this alcohol using a

Grignard + ester

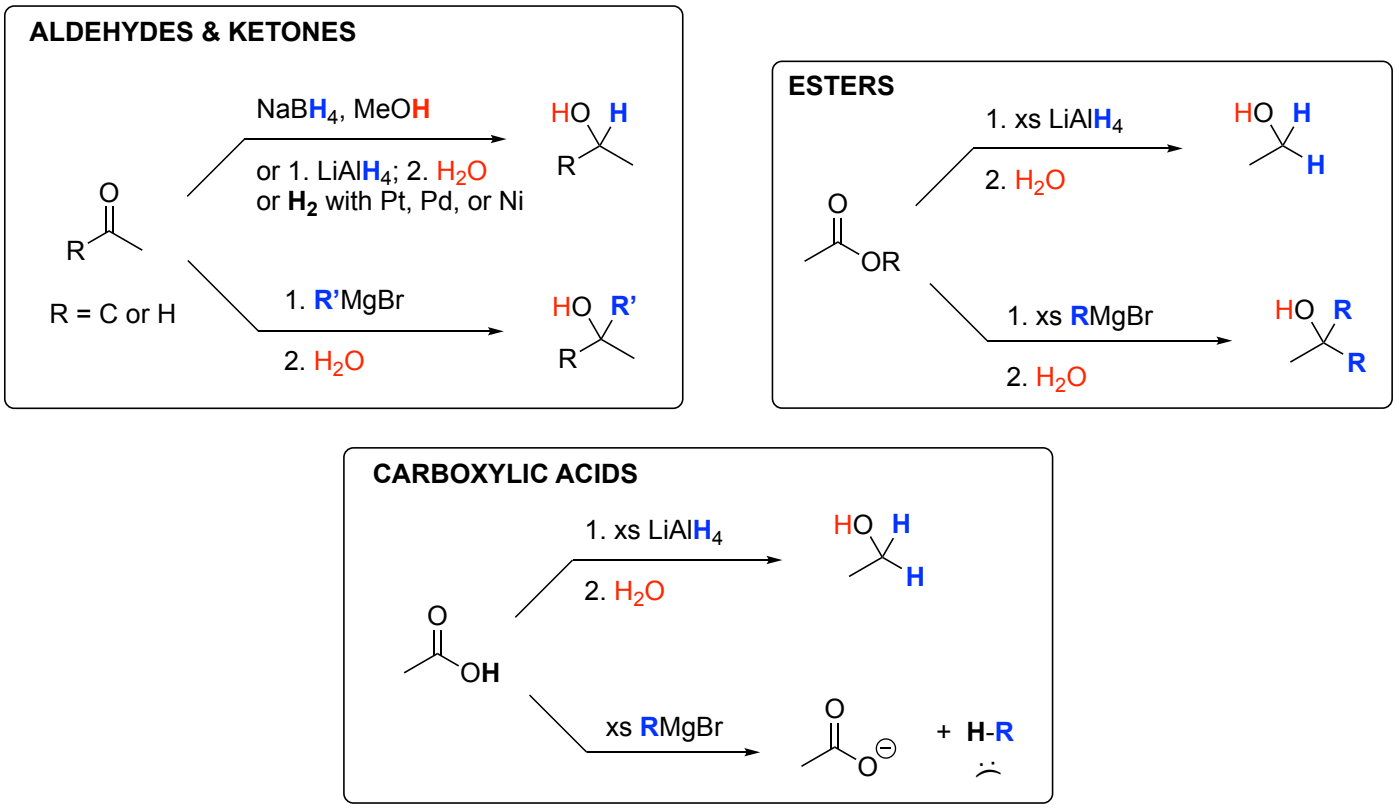


Grignards be Bases

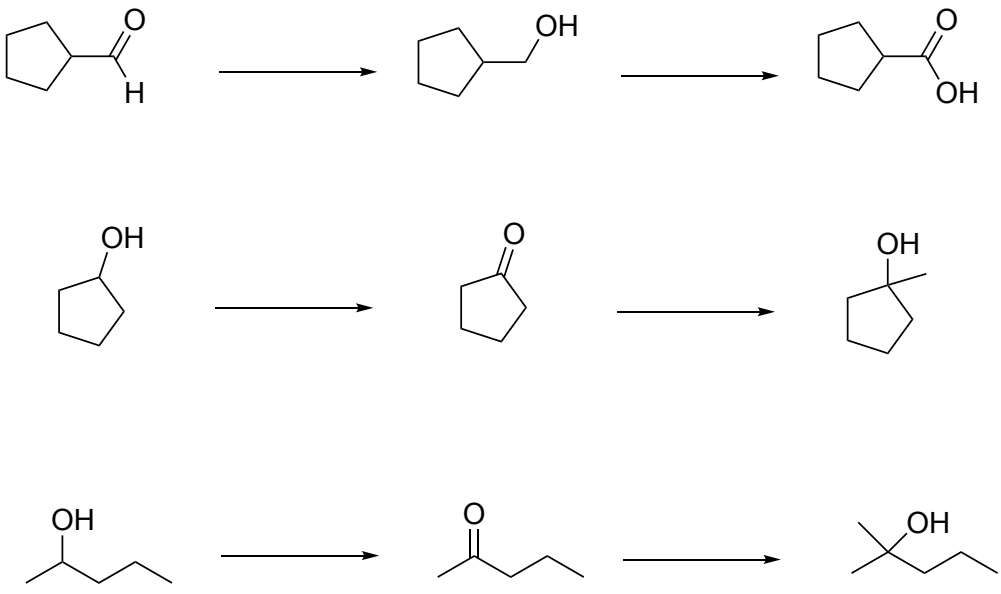


NO C-C formation

Summary of Carbonyl Compounds → Alcohols



REDOX RECAP: Fill in the missing reagent over the arrow with the **appropriate oxidizing or reducing agent**, or with a Grignard reagent (alkyl magnesium bromide).

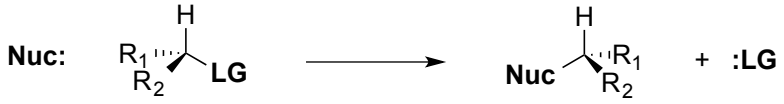


(12.9) Reactions of Alcohols: Substitution & Elimination

Substitution of Alcohols … "OH" is a bad leaving group!

S_N2 = Bimolecular Nucleophilic Substitution

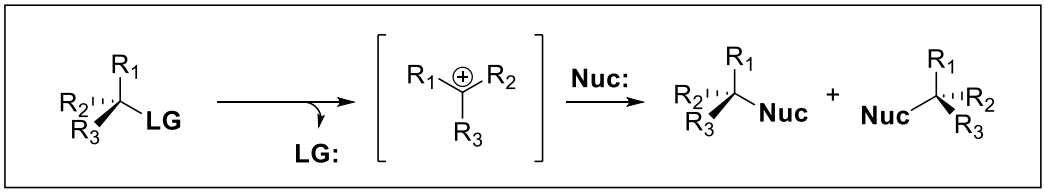
- One-step reaction: nucleophile attacks as the leaving group leaves



- S_N2 Conversion of Alcohol into Alkyl Bromide

S_N1 = Unimolecular Nucleophilic Substitution

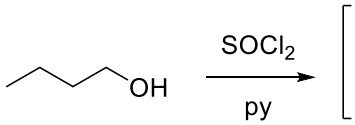
- Two-step reaction:
  1. Loss of a leaving group
  2. Nucleophilic Attack

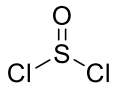


(12.9) Alcohol Substitution: Activation

- S_N2 Conversion of Alcohol into Alkyl Bromide

- S_N2 Conversion of Alcohol into Alkyl Chloride

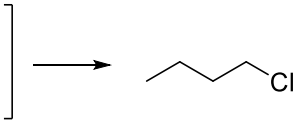




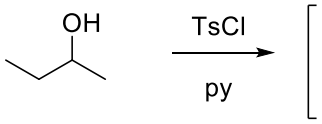
thionyl chloride
($SOCl_2$)

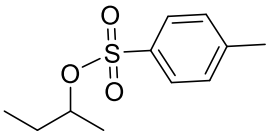
pyridine

(py)

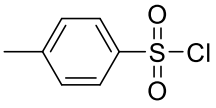


- **Tosylates – the versatile alcohol activator**

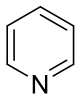




tosylate

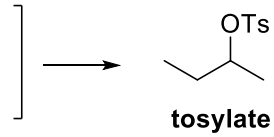


***para*-toluenesulfonic chloride**
(tosyl chloride, TsCl)



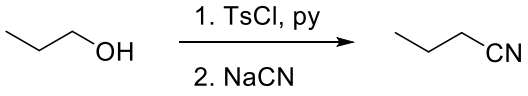
pyridine

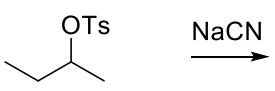
(py)



tosylate

- **Substitution with Tosylates – add your favorite nucleophile**



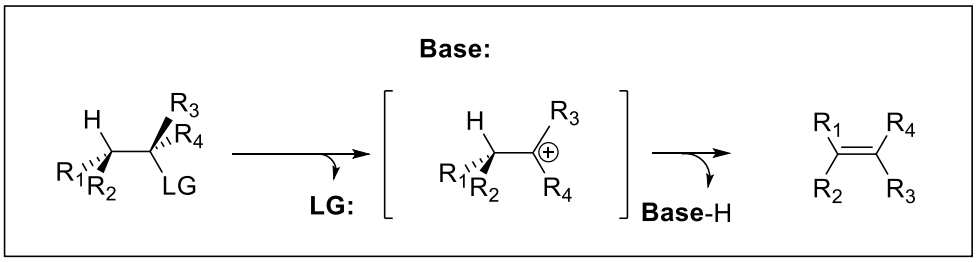


(12.9) Alcohol Elimination, aka Dehydration

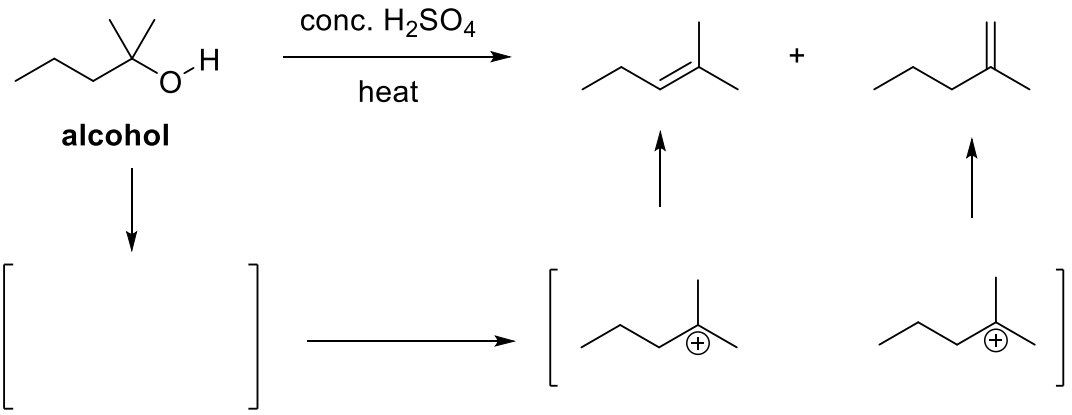
E1 – Unimolecular Elimination

Two step reaction,
1. Loss of a leaving group
2. Proton transfer

occurs with weak bases

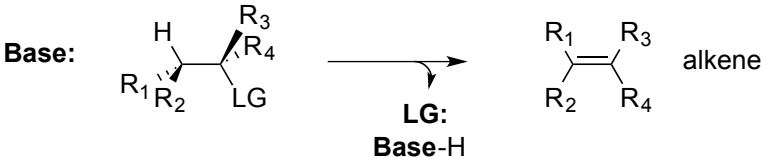


Tertiary Alcohols

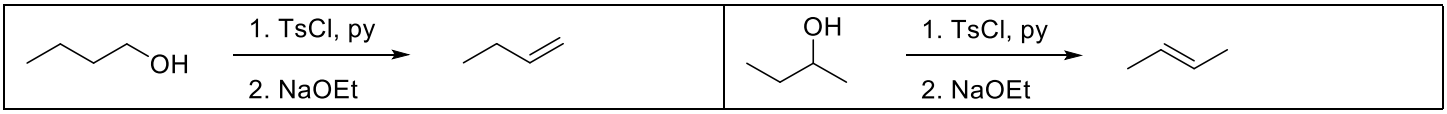


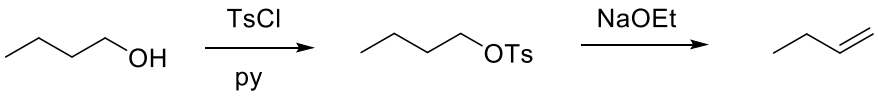
E2 – Bimolecular Elimination

- 1 step, requires **strong base** (alkoxide, hydroxide, or amide ions)



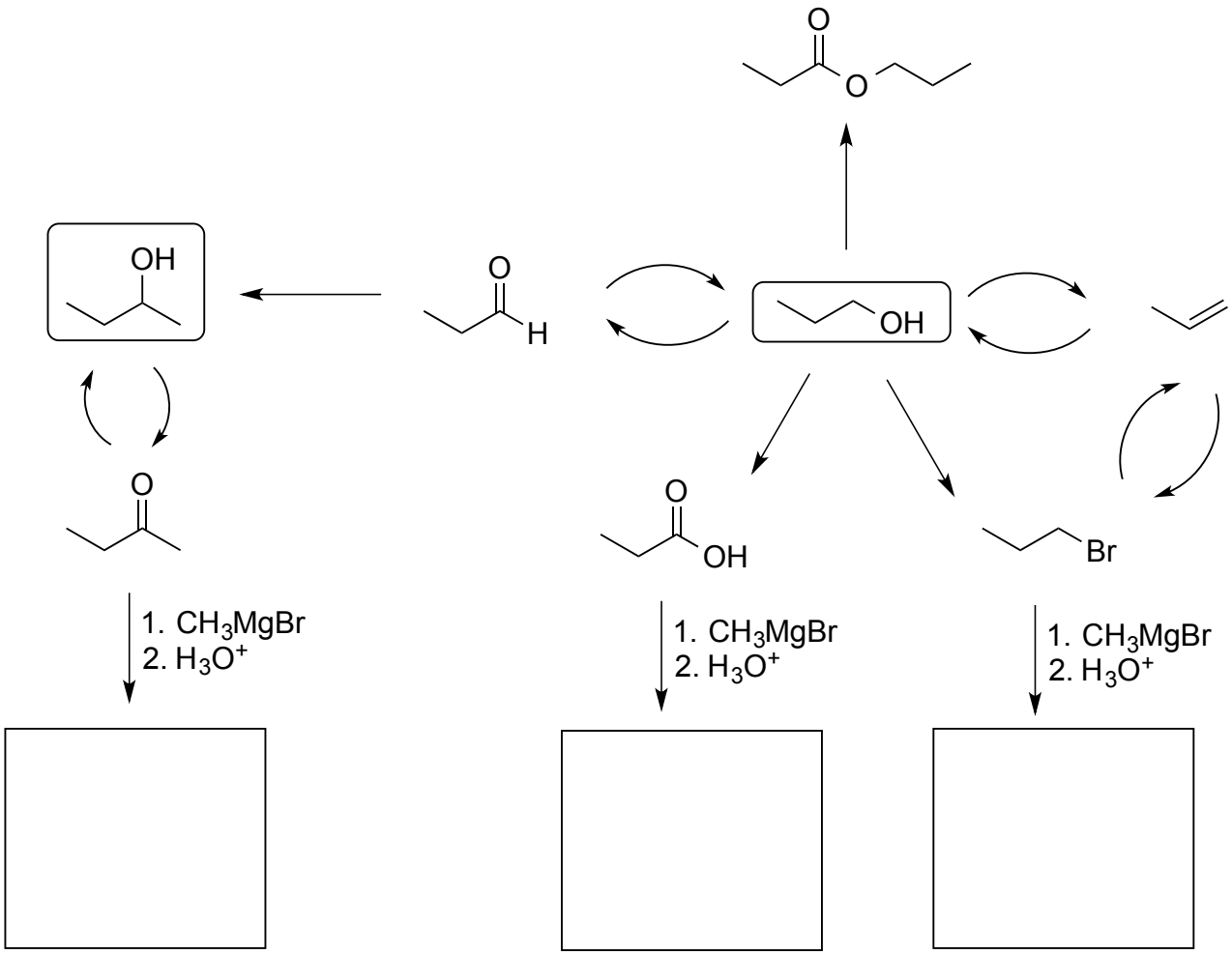
Primary and Secondary Alcohols





Chapter 12 - Alcohol Reaction Puzzle

Rxn Overview & Synthesis Prep: Add reagents over each arrow and fill in the empty boxes



Multi-Step Synthesis: Each transformation below requires more than one reaction to be completed. Indicate the steps involved to make each compound from the starting material provided and any reagents or carbon sources.