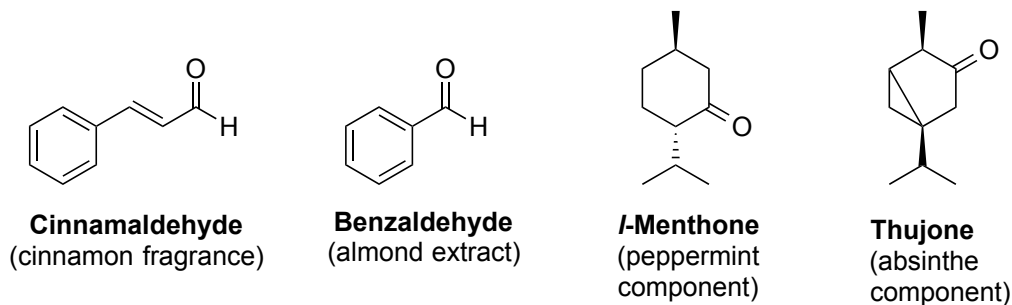


19.1 Intro to Aldehydes & Ketones	19.2 Nomenclature	19.3 Making Aldehydes & Ketones
19.4 Intro to Nucleophilic Addition Reactions	19.5 Oxygen Nucleophiles: Acetals & Hemiacetals	19.6 Nitrogen Nucleophiles: Imines and Enamines
19.7 Hydrolysis of Acetals, Imines, & Enamines	19.9 Hydrogen Nucleophiles: Reduction Reactions	19.10 Carbon Nucleophiles: Grignards, Cyanide, and Wittigs
19.12 Synthesis Strategies		

### [19.1] Introduction to some Cool Aldehydes & Ketones



### [19.2] Nomenclature

Aldehyde parent	Ketone parent	Aldehyde or ketone substituent on parent chain	Single C aldehyde substituent
-anal	-one	-oxo	-carbaldehyde

Draw structures from names...

Butanal

3-oxobutanal

4-hydroxy-2-pentanone

cyclohexanecarbaldehyde

### Reaction Review – what have we learned about aldehydes & ketones so far?

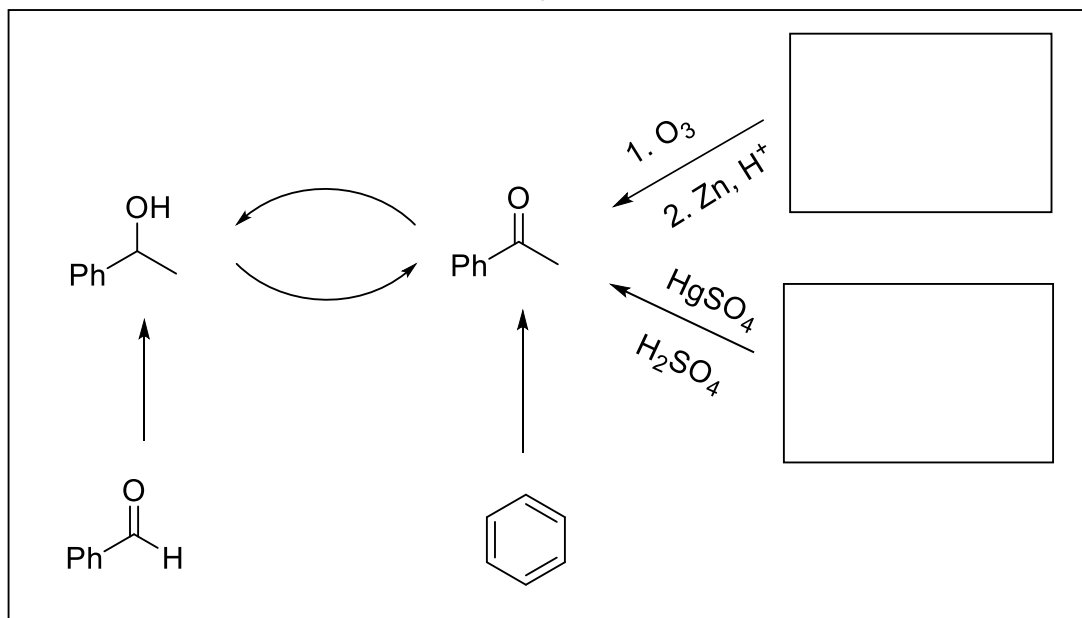
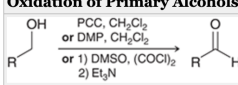
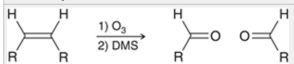
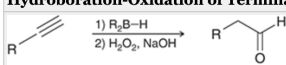
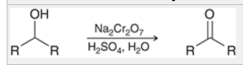
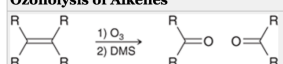
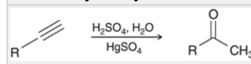
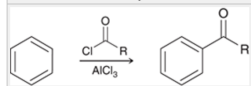


TABLE 19.1

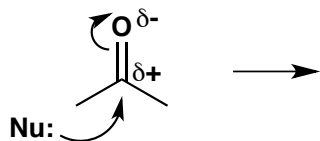
## A SUMMARY OF ALDEHYDE PREPARATION METHODS COVERED IN PREVIOUS CHAPTERS

REACTION	SECTION
<b>Oxidation of Primary Alcohols</b> 	12.10
<p>When treated with a strong oxidizing agent, primary alcohols are oxidized to carboxylic acids. Formation of an aldehyde requires a mild oxidizing agent, such as the oxidizing agents shown above, that will not further oxidize the resulting aldehyde.</p>	
<b>Ozonolysis of Alkenes</b> 	8.13
<p>Ozonolysis will cleave a C=C double bond. If either carbon atom bears a hydrogen atom, an aldehyde will be formed.</p>	
<b>Hydroboration-Oxidation of Terminal Alkynes</b> 	9.7
<p>Hydroboration-oxidation results in an <i>anti</i>-Markovnikov addition of water across a <math>\pi</math> bond, followed by tautomerization of the resulting enol to form an aldehyde.</p>	

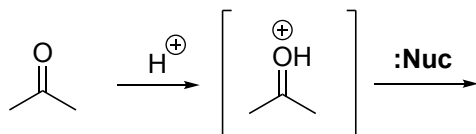
<b>Oxidation of Secondary Alcohols</b> 	12.10
<p>A variety of strong or mild oxidizing agents can be used to oxidize secondary alcohols. The resulting ketone does not undergo further oxidation.</p>	
<b>Ozonolysis of Alkenes</b> 	8.13
<p>Tetrasubstituted alkenes are cleaved to form ketones.</p>	
<b>Acid-Catalyzed Hydration of Terminal Alkynes</b> 	9.7
<p>This procedure results in a Markovnikov addition of water across the <math>\pi</math> bond, followed by tautomerization to form a methyl ketone.</p>	
<b>Friedel-Crafts Acylation</b> 	18.6
<p>Aromatic rings that are not too strongly deactivated will react with an acyl halide in the presence of a Lewis acid to produce an aryl ketone.</p>	

## [19.4] Nucleophilic Attack at Carbonyl C

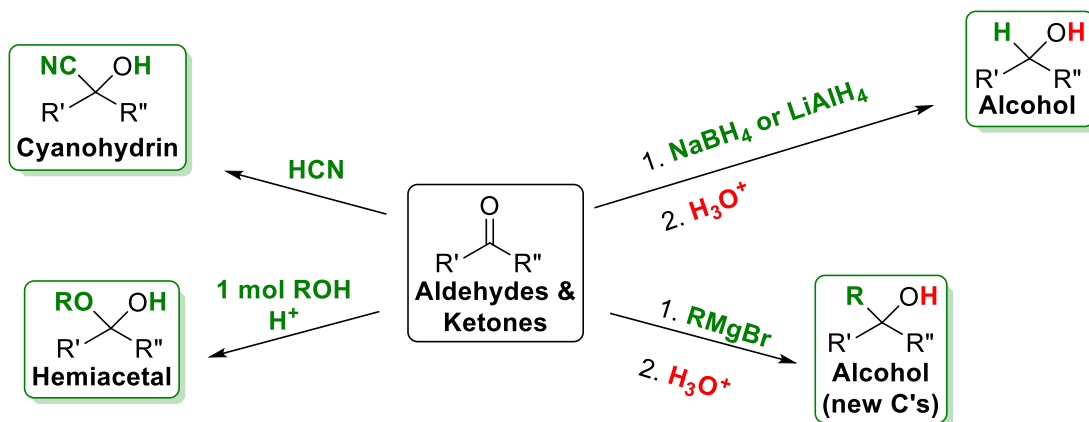
## Basic Conditions



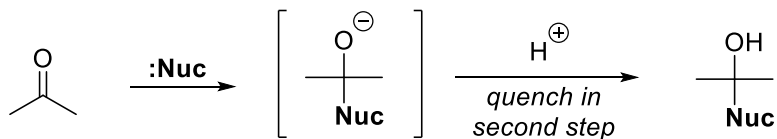
## Acidic Conditions



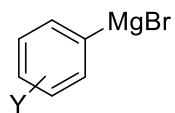
**Nucleophilic Addition:** A sampler platter of hydrogen, carbon, and oxygen nucleophiles



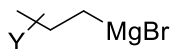
## Basic Nucleophilic Addition Mechanism – Grignard &amp; Hydride Additions

**[19.10] Organomagnesium bromides (Grignards)**\*\*Grignards are **carbon-nucleophiles**\*\***Carbon Electrophiles:**

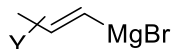
Alkyl Halides, Carbonyl C's, Epoxide C's



aryl Grignard

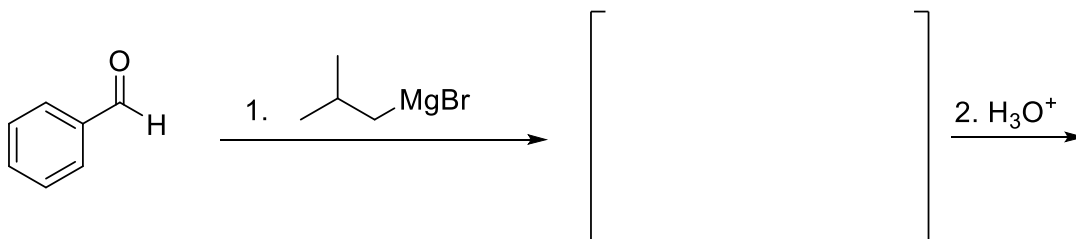
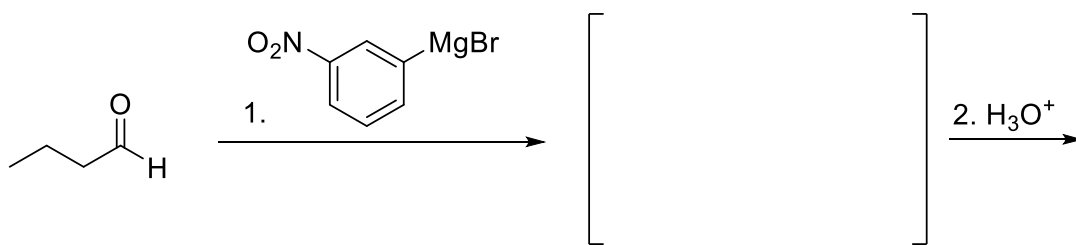
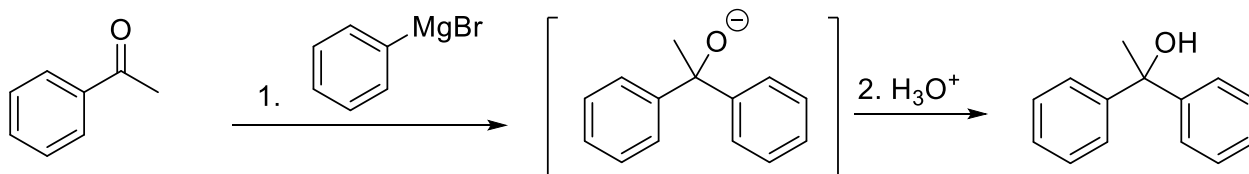


alkyl Grignard



vinyl Grignard

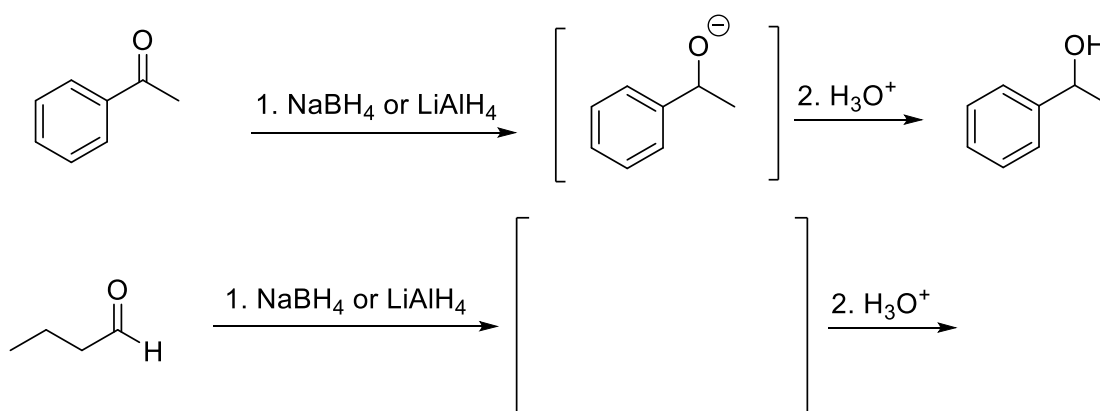
## Examples



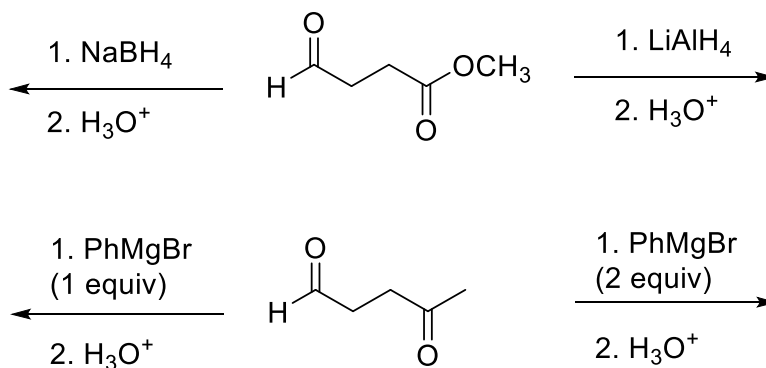
**[19.9] Aldehyde & Ketone Reductions – Hydride Additions****\*\*Hydrides are hydrogen-nucleophiles\*\***NaBH<sub>4</sub> = sodium borohydrideLiAlH<sub>4</sub> = lithium aluminum hydride

Limitations:

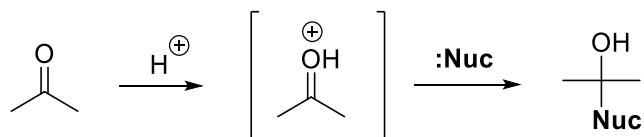
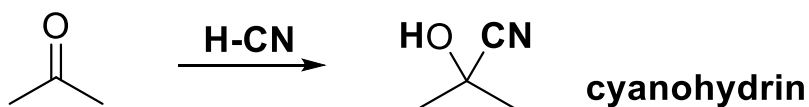
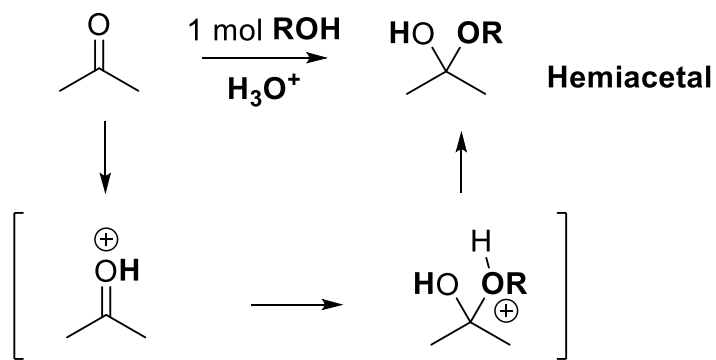
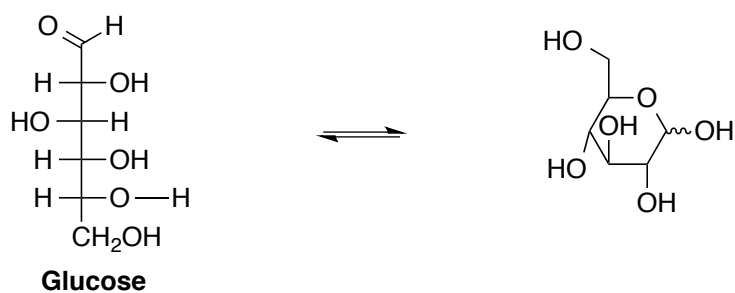
Examples

**Aldehydes are more reactive than ketones and esters \*\***

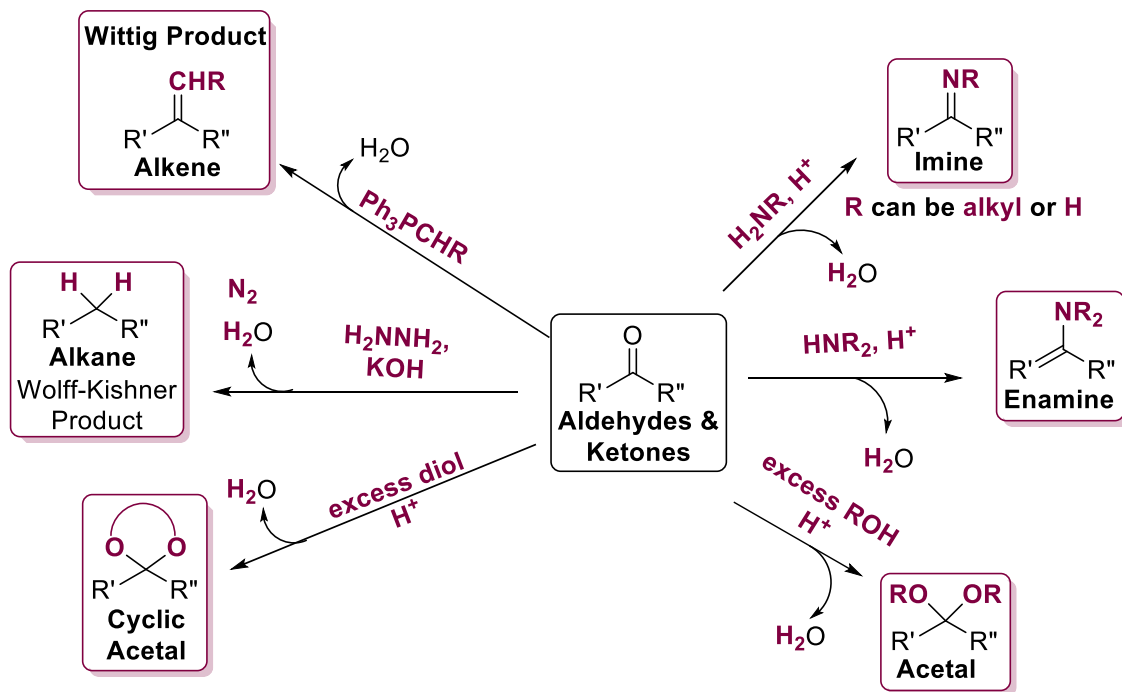
Chemoselective Reactions Examples



## Simple Acidic Nucleophilic Addition Mechanisms – Cyanohydrins &amp; Hemiacetals

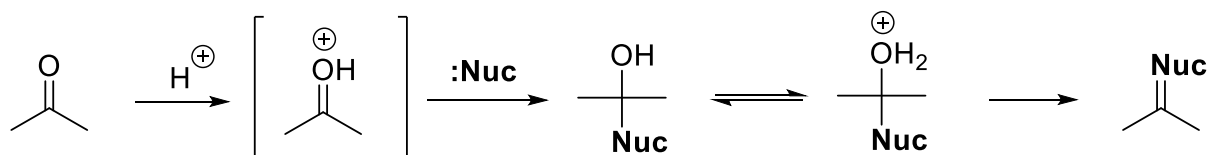
[19.10] Addition of HCN: Cyanohydrin Formation[19.5] Addition of Alcohols: Hemiacetal Formation*Hemiacetals in Nature: Sugars*

**Aldehydes & Ketones** gone wild!  
When they lose their carbonyl oxygen...

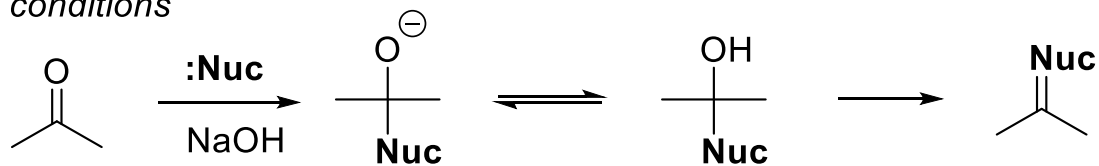


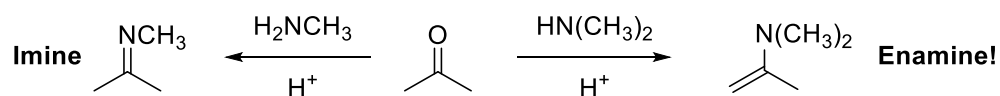
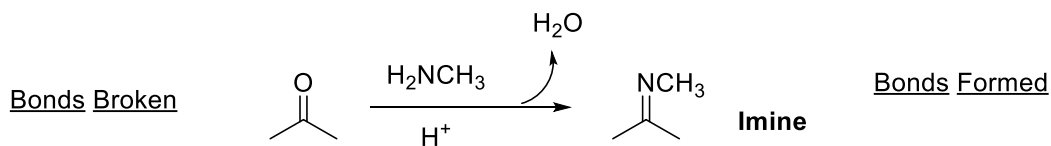
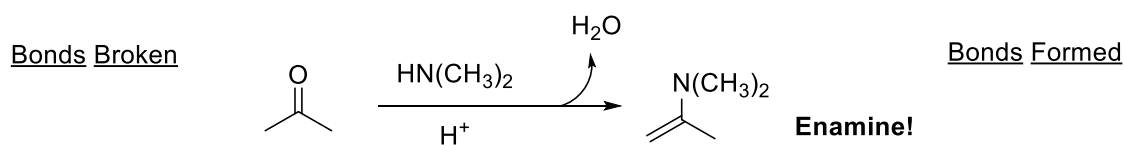
### Nucleophilic Addition w/ Dehydration

*Acidic conditions*

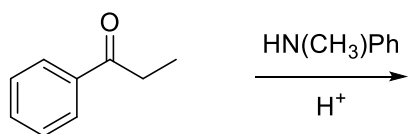
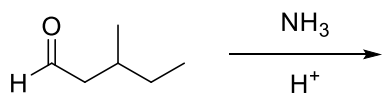


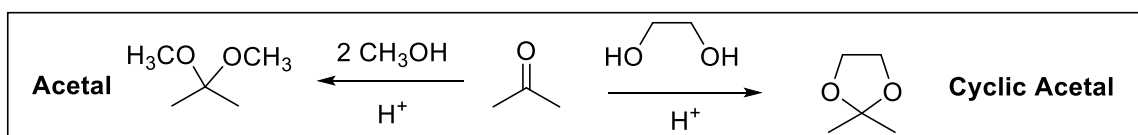
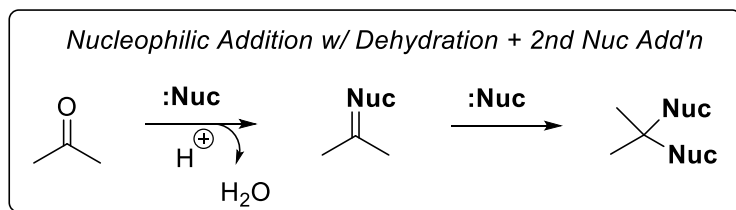
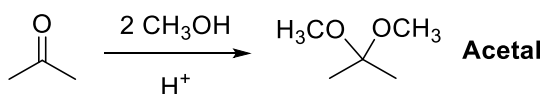
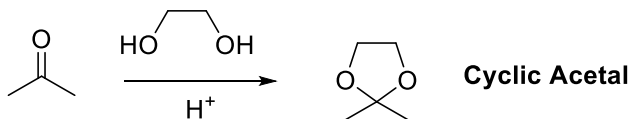
*Basic conditions*



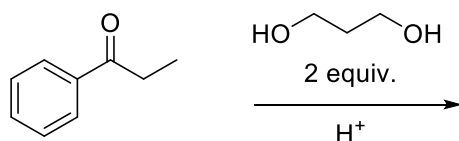
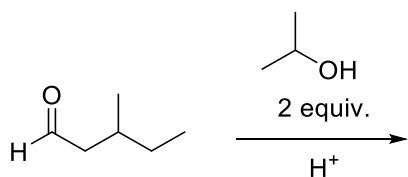
**[19.6] IMINES & ENAMINES FROM ALDEHYDES & KETONES****Imine Mechanism****Enamine Mechanism**

Predict the products:

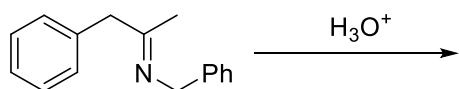
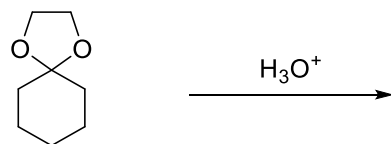
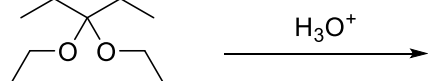


**[19.5] ACETALS FROM ALDEHYDES & KETONES****Acetal Mechanism – The Combo!**Bonds BrokenBonds FormedBonds BrokenBonds Formed

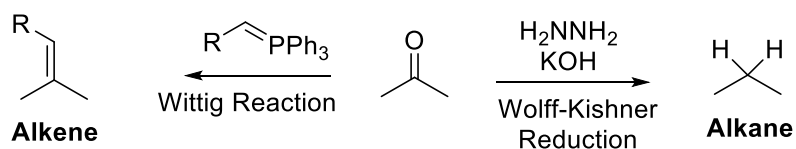
Predict the products:



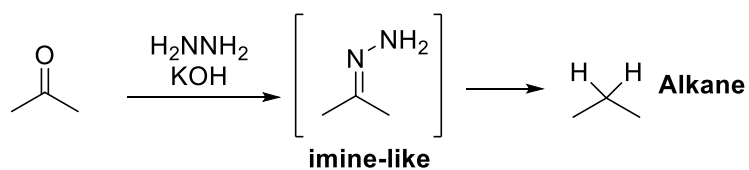


**[19.7] Imine, Enamine, and Acetal Hydrolysis***Amine**Carbonyl**Alcohol**Carbonyl*

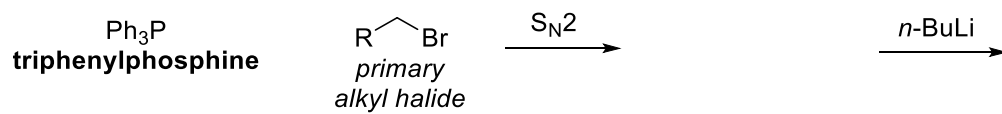
# ALKENES & ALKANES FROM ALDEHYDES & KETONES



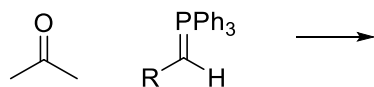
## [19.6] Wolff-Kishner Reduction



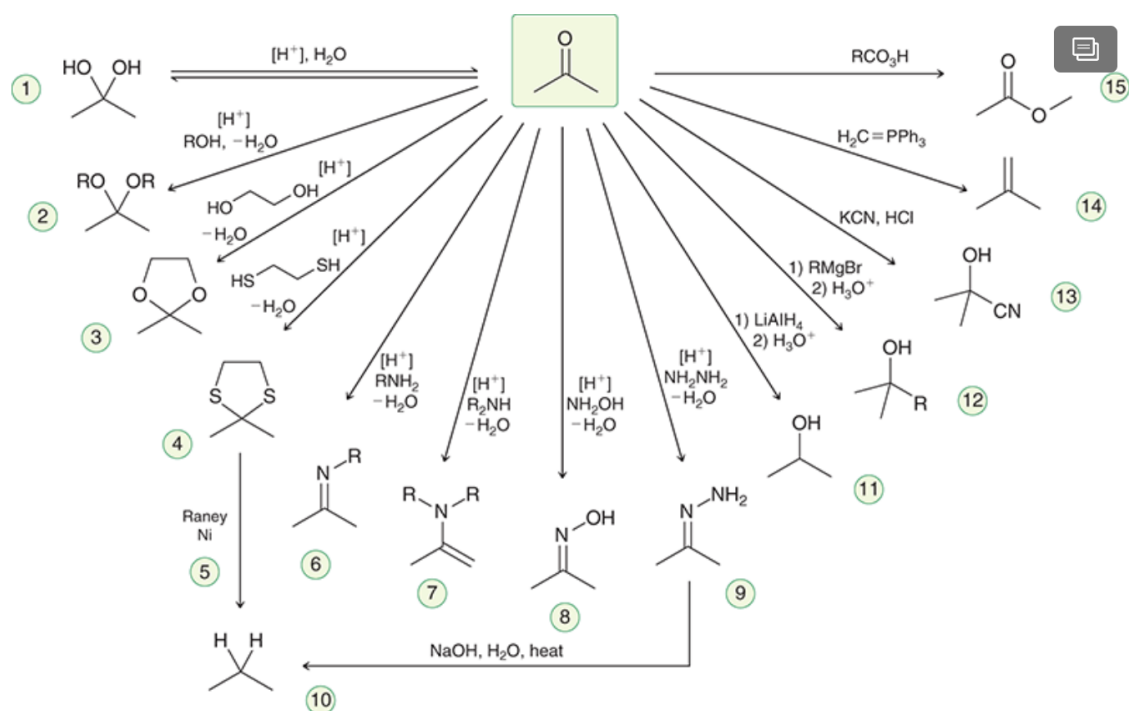
## [19.10] Wittig Reagent



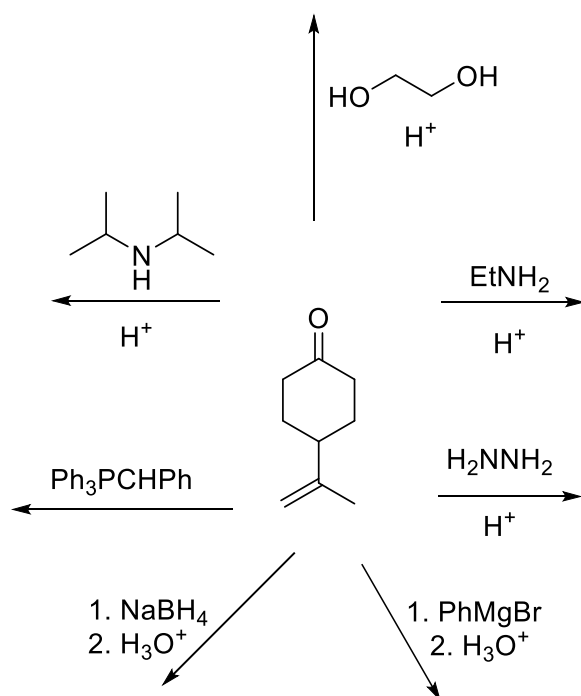
Reaction with ketone

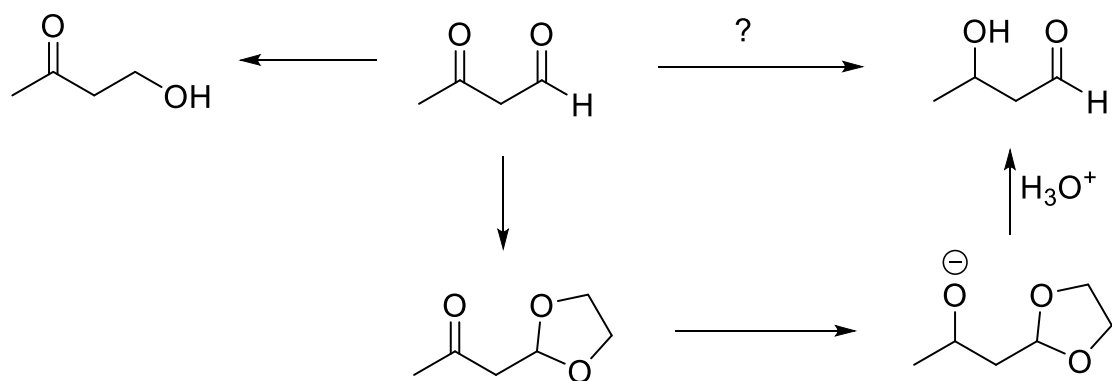


## SYNTHETICALLY USEFUL REACTIONS



## Ketone Reaction Starburst



**[19.5] Acetal Protecting Group** – Temporarily mask aldehydes & ketones

Both syntheses below require a protecting group. Outline the steps.

