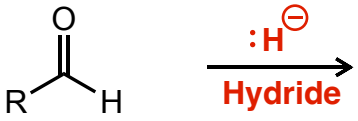
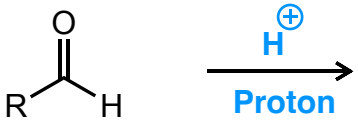
# Carbonyl Additions - Aldehydes and Ketones Worksheet Key

1. Considering that the carbonyl group (C=O) can react with nucleophiles or electrophiles, d**raw two example mechanisms**, one showing **how hydride interacts with an aldehyde and** one showing h**ow a proton interacts with an aldehyde**.



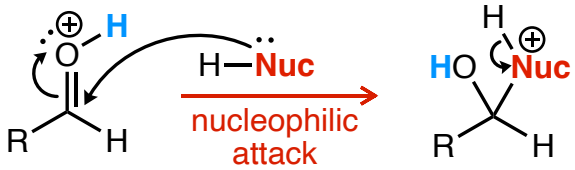




2. In acid catalyzed carbonyl additions, like acetal reactions, the first mechanistic step results in the formation of the species shown below (for an aldehyde).

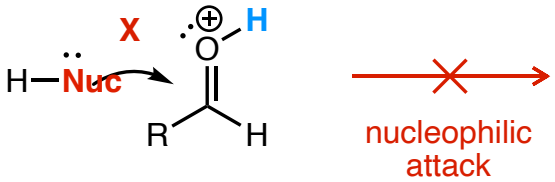
Given this Lewis structure, **why does nucleophilic attack occur at the carbonyl carbon as opposed to the oxygen with theformal positive charge**?

**Hint**: think about resonance and dipoles.

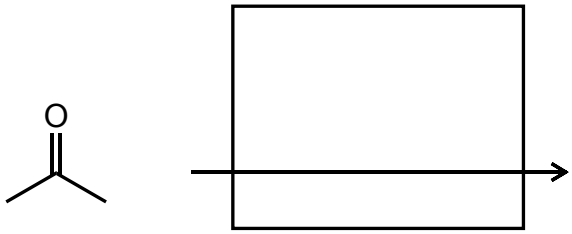
**Reactivity observed:**



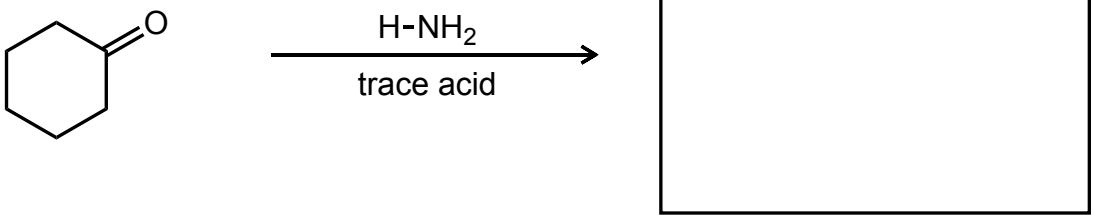

***NOT observed:***

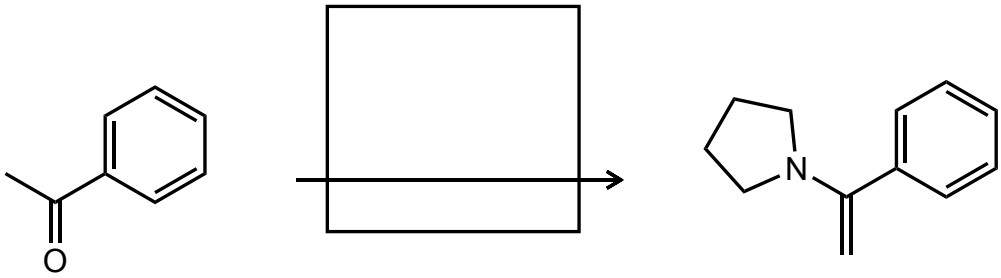


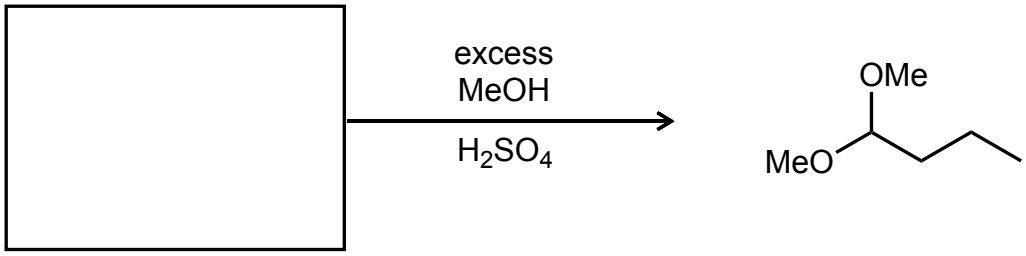
3. **Provide** the missing **starting material, reagent(s), or major product** in each reaction below.

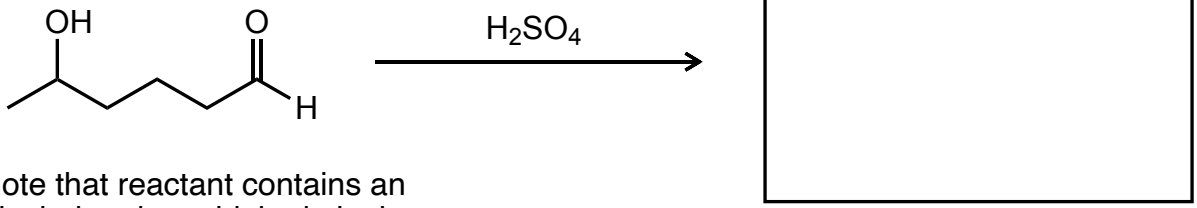



2-methylhex-2-ene



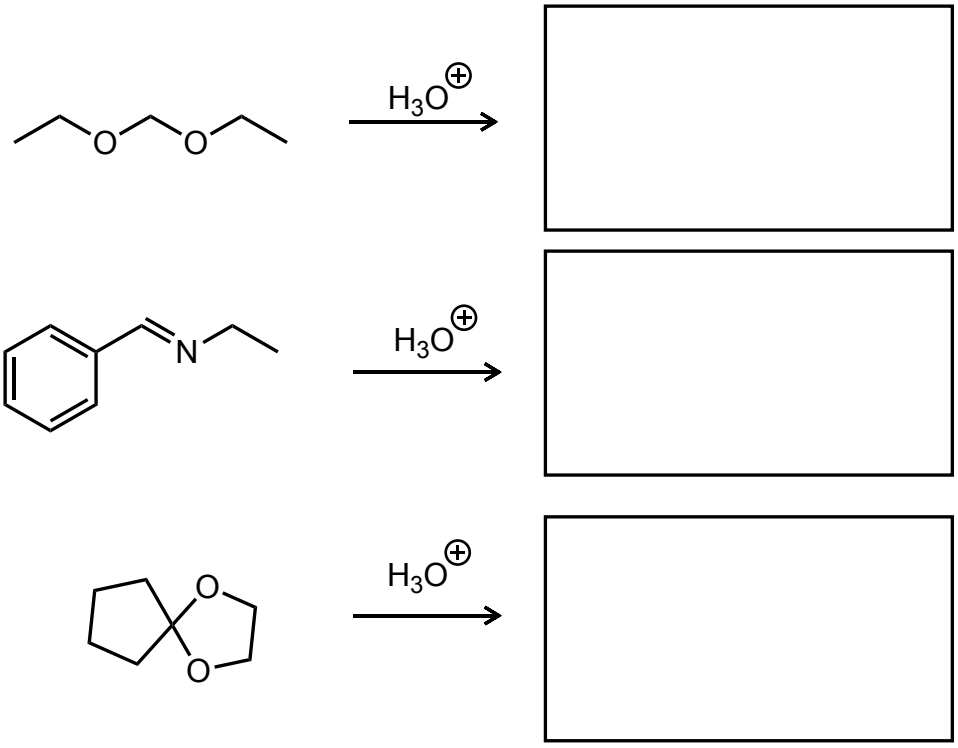




* note that reactant contains an alcohol and an aldehyde in the presence of a strong acid

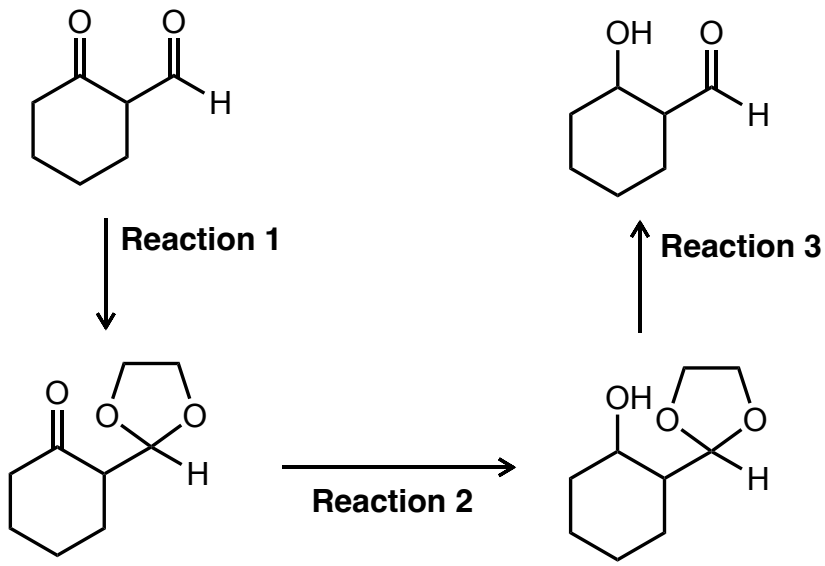
product is a cyclic hemiacetal

4. **Many carbonyl addition reactions are reversible**. Considering this, **identify the carbonyl compound formed** from the following reactions.

**Note**: It may be helpful to identify the reactant functional group and think about what carbonyl would have generated it.




5. Often times, acetal (or ketal) reactions are referred to as protection reactions because they protect the C=O bond from nucleophiles. The process shown below is an example of this. **For each reaction, select the appropriate reaction description and the reagents needed for the transformation.**




**Reaction descriptions:**

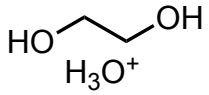
**Protection**
**Deprotection**
**Reaction with Nucleophile**

**Reagents**

**A.** 1. $NaBH_4$
2. $H_3O^+$

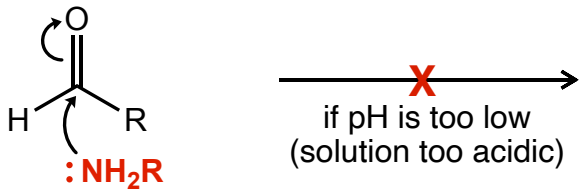
**B.** $H_3O^+$

**C.** 1 equiv.



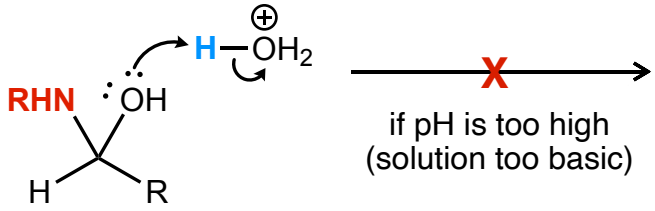
6. Although the formation of an imine, **requires** acidic conditions (pH range of 4-5), **the mechanism assumes nucleophilic attack of $H_2NR$ first**, rather than protonation of the carbonyl oxygen. **So why is the pH range of 4-5 so important?**

A. Explain why an even lower pH would slow down (or stop!) the first step of this mechanism (check your class notes or the book for the mechanism). The mechanism for the nucleophilic attack is shown below.




**desired reactivity**

B. Additionally, why does a higher pH slow down the elimination of the carbonyl oxygen? The mechanism for the desired elimination of the carbonyl oxygen is shown.




**desired reactivity**