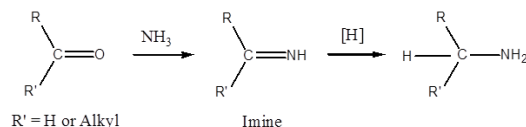


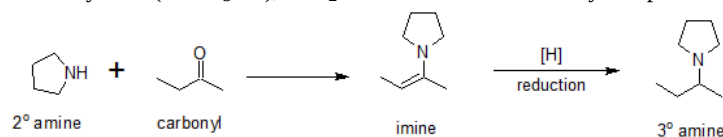
## 20.4: SYNTHESIS OF AMINES

### REDUCTIVE AMINATION OF ALDEHYDES AND KETONES (CARBONYLS)

Aldehydes and ketones can be converted into 1°, 2° and 3° amines using reductive amination. The reaction takes place in two parts. The first step is the nucleophilic addition of the carbonyl group to form an imine. The second step is the reduction of the imine to an amine using a reducing agent. A reducing agent commonly used for this reaction is sodium cyanoborohydride ( $\text{NaBH}_3\text{CN}$ ).

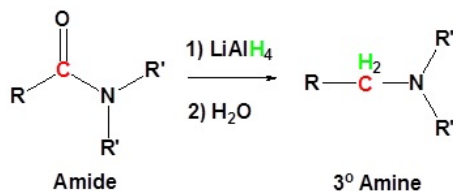
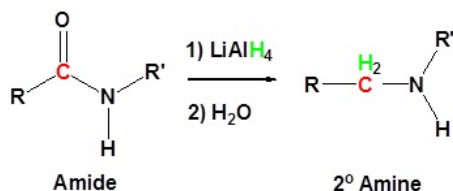
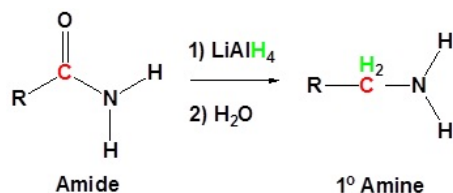


The nitrogen gains a bond to carbon during this reaction sequence. When carbonyls react with ammonia, a primary amine is produced. The reaction pattern continues for each amine classification. For example, pyrrolidine reacts with 2-butanone to produce the imine, which can be reduced by  $\text{LiAlH}_4$ , sodium cyanoborohydride ( $\text{NaBH}_3\text{CN}$ ), or  $\text{H}_2$  with an active metal catalyst to produce a tertiary amine.



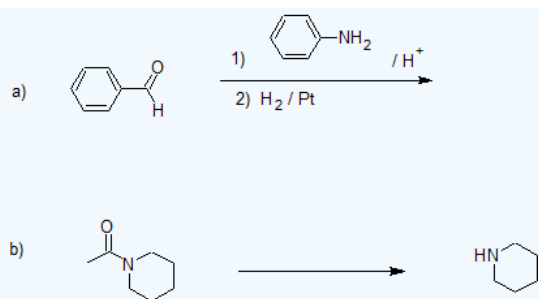
### AMIDE REDUCTION TO 1°, 2° OR 3° AMINES USING $\text{LiAlH}_4$

There is a direct correlation between the structure of the amide and the structure of the amine produced. Primary amides are reduced to primary amines. Secondary amides are reduced to secondary amines. Tertiary amides are reduced to tertiary amines. Lithium aluminum hydride is a stronger reducing agent than sodium borohydride, which is not strong enough for this reaction.



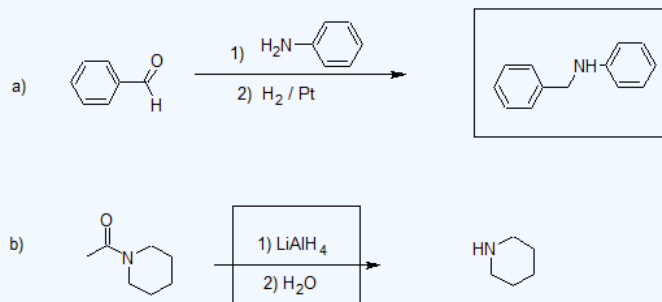
#### Exercise

8. Add the missing reactants/products to the following reactions.



Answer

8.



## CONTRIBUTORS AND ATTRIBUTIONS

- Dr. Dietmar Kennepohl FCIC (Professor of Chemistry, [Athabasca University](#))
- Prof. Steven Farmer ([Sonoma State University](#))
- William Reusch, Professor Emeritus ([Michigan State U.](#)), [Virtual Textbook of Organic Chemistry](#)
- [Organic Chemistry With a Biological Emphasis](#) by Tim Soderberg (University of Minnesota, Morris)
- Jim Clark ([Chemguide.co.uk](#))
- Gamini Gunawardena from the [OChemPal](#) site ([Utah Valley University](#))

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