

Preparing Carboxylic Acids

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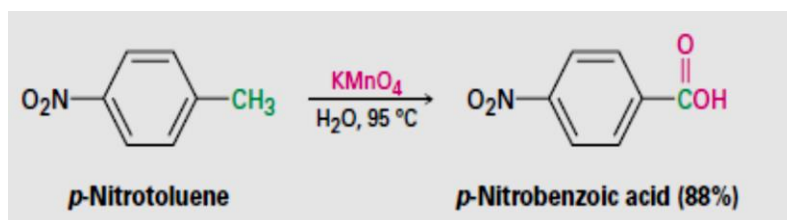
Reference Text Book:

- John McMurry "Organic Chemistry" 10th Edition, OpenStax, Rice University, USA (2023).

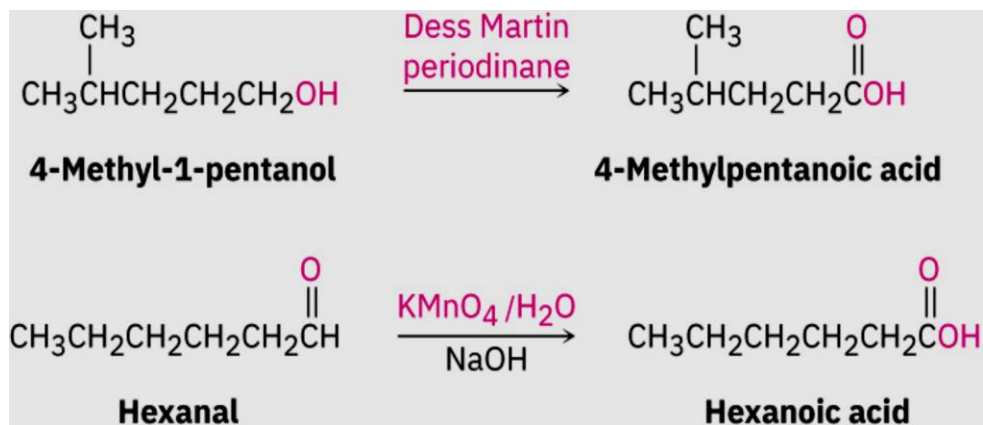
Preparing Carboxylic Acids

Let's review briefly some of the methods for preparing carboxylic acids.

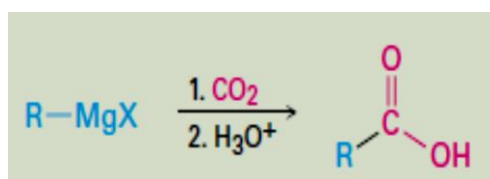
1. **Oxidation of substituted alkyl benzene:** with KMnO_4 or $\text{Na}_2\text{Cr}_2\text{O}_7$ gives a substituted benzoic acid. Both primary and secondary alkyl groups can be oxidized, but tertiary groups are not affected.



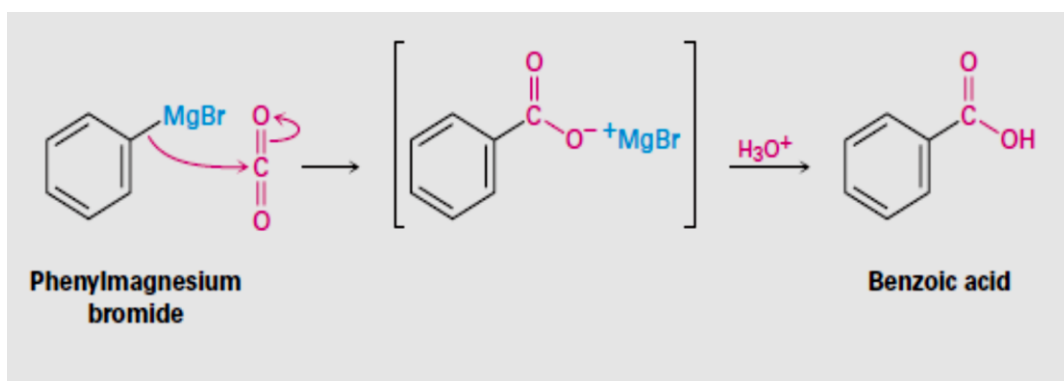
2. **Oxidation of a primary alcohol or an aldehyde:** yields a carboxylic acid. Primary alcohols are often oxidized with the Dess Martin periodinane, and aldehydes are similarly oxidized with alkaline KMnO_4 .



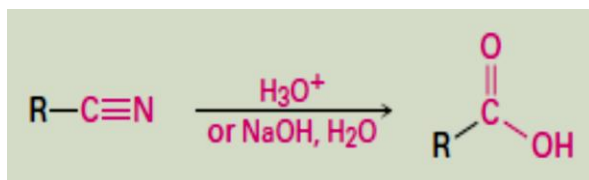
3. Carboxylation of Grignard reagents:



Another method for preparing carboxylic acids is by reaction of a Grignard reagent with CO_2 to yield a metal carboxylate, followed by protonation to give a carboxylic acid. This **carboxylation** reaction is usually carried out by bubbling a stream of dry CO_2 gas through a solution of the Grignard reagent. The organomagnesium halide adds to a $\text{C}=\text{O}$ bond of carbon dioxide in a typical nucleophilic carbonyl addition reaction, and protonation of the carboxylate by addition of aqueous HCl in a separate step then gives the free carboxylic acid. For example:



4. Hydrolysis of nitriles



Carboxylic acids can be prepared from nitriles on heating with aqueous acid or base by a mechanism. Since nitriles themselves are usually made by S_{N}^2 reaction of a primary or secondary alkyl halide with CN^- , the two-step sequence of cyanide displacement followed by nitrile hydrolysis is a good way to make a carboxylic acid from an alkyl halide ($\text{RBr} \rightarrow \text{RC}\equiv\text{N} \rightarrow \text{RCO}_2\text{H}$).

Note that the product acid has one more carbon than the starting alkyl halide. One example occurs in a commercial route for the synthesis of the nonsteroidal anti-inflammatory drug ibuprofen.

