

Alcohol Phenol Ether

Synthetic Uses of Grignard Reagents

Grignard reagents (organomagnesium halides, RMgX) are versatile reagents used in organic synthesis to form carbon-carbon bonds. They are highly reactive and can be used to synthesize a wide range of organic compounds, including alcohols, carboxylic acids, and ketones. Below are some common synthetic uses of Grignard reagents along with their reaction mechanisms.

1. Formation of Alcohols

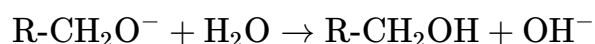
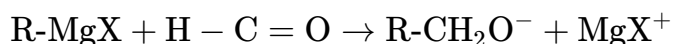
a. Reaction with Aldehydes and Ketones

- **With Formaldehyde (Methanal):** Produces primary alcohols.

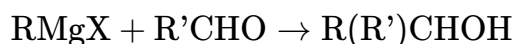


Mechanism:

1. Nucleophilic addition of Grignard reagent to the carbonyl carbon.
2. Protonation of the alkoxide intermediate during work-up.

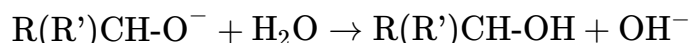
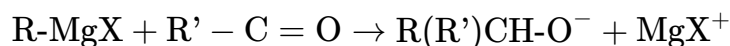


- **With Other Aldehydes:** Produces secondary alcohols.

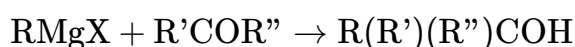


Mechanism:

1. Nucleophilic addition to the carbonyl carbon.
2. Protonation of the resulting alkoxide.

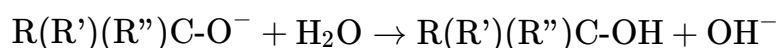
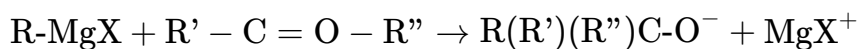


- **With Ketones:** Produces tertiary alcohols.



Mechanism:

1. Nucleophilic addition to the carbonyl carbon.
2. Protonation of the resulting alkoxide.



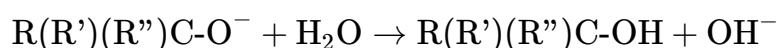
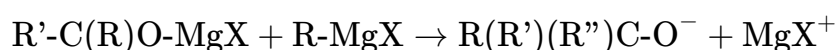
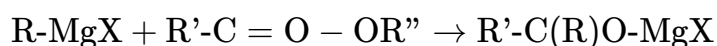
b. Reaction with Esters

- Produces tertiary alcohols after two equivalents of the Grignard reagent react with the ester.



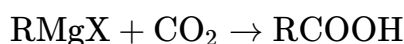
Mechanism:

1. Nucleophilic attack of the Grignard reagent on the ester carbonyl.
2. Formation of a ketone intermediate.
3. Second nucleophilic attack by another equivalent of the Grignard reagent.
4. Protonation to yield the tertiary alcohol.



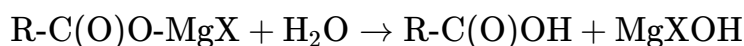
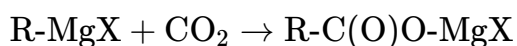
2. Formation of Carboxylic Acids

- **Reaction with Carbon Dioxide (CO₂)**



Mechanism:

1. Nucleophilic attack on the carbon dioxide molecule.
2. Protonation of the resulting carboxylate anion.



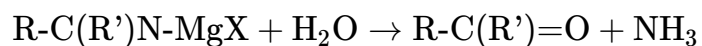
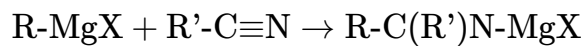
3. Formation of Ketones

- **Reaction with Nitriles**



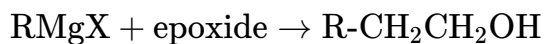
Mechanism:

1. Nucleophilic attack on the nitrile carbon.
2. Formation of an imine intermediate.
3. Hydrolysis of the imine to form a ketone.



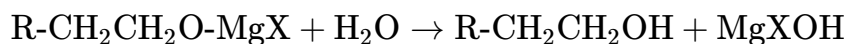
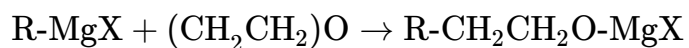
4. Formation of Ethers

- **Reaction with Epoxides**



Mechanism:

1. Nucleophilic attack on the less hindered carbon of the epoxide.
2. Protonation of the resulting alkoxide.



These mechanisms demonstrate the versatility of Grignard reagents in forming various organic compounds through nucleophilic addition reactions.