

UNIT: 17

Organometallic compounds

NEB syllabus (2 TH)

Introduction, general formula and examples of organolithium, organocopper & organocadmium compounds

Nature of Metal-Carbon bond

Grignard Reagent

Preparation (using haloalkane & haloarene)

Reaction of Grignard Reagent

i. water

ii. aldehydes & ketones

iii. carbon dioxide

iv. ester

v. acid chloride

vi. HCN

vii. RCN

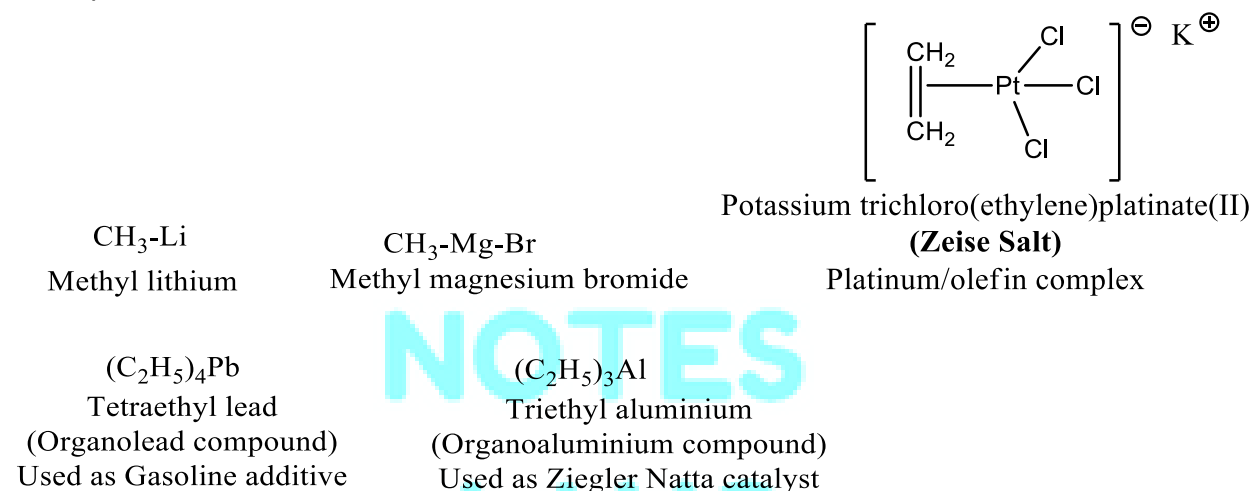
Introduction

The compounds in which carbon atom is directly bonded with metal atoms such as lithium, magnesium, copper, cadmium, zinc, lead, etc. are called organometallic compounds.

The branch of chemistry that deals with the study of organometallic compounds is known as organometallic chemistry.

Zeise's salt was first organometallic compounds to be reported. It was discovered by William Christopher Zeise, a professor at the University of Copenhagen, who prepared this compound in 1830 while investigating the reaction of PtCl_4 with boiling ethanol.

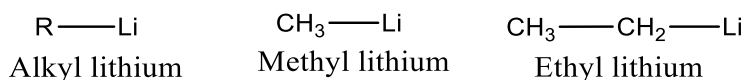
Examples:



General formula, general representation and example of some organometallic compounds

Organometallic compounds can be classified on the basis metal present into followings types;

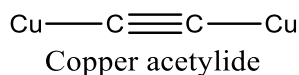
1. Organolithium compounds



2. Organocopper compounds



The above reagent is also called **Clayman Reagent**.



3. Organocadmium compounds



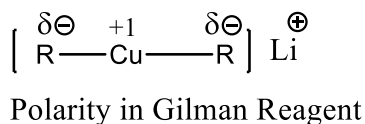
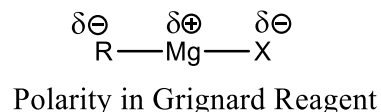
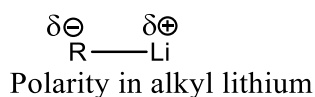
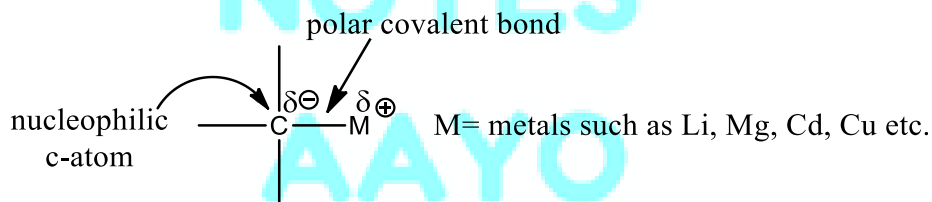
4. Organomagnesium compounds



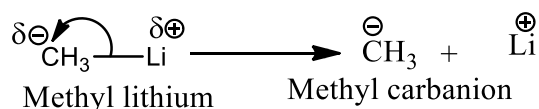
The above reagent is also called Grignard Reagent.

Nature of Metal-Carbon bond in organometallic compounds

In organometallic compounds, the carbon atom is covalently bonded with metal. Here, the carbon atom is more electronegative than metal. So, partial negative charge develops on carbon atom while partial positive charge develops on metal atom. Thus, the Carbon-Metal bond becomes polar. Hence, metal carbon bond is polar covalent in nature.

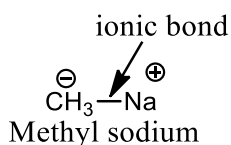


If C-M bond gets broken, there will be a formation of ion with negative charge on carbon atom known as carbanion. Such carbanion acts as a nucleophile.



NOTE:

Some organometallic compound like alkyl sodium contains ionic bond.



Grignard Reagent

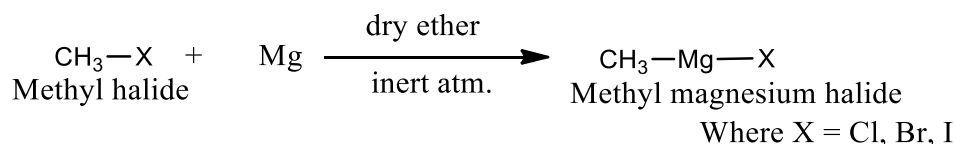
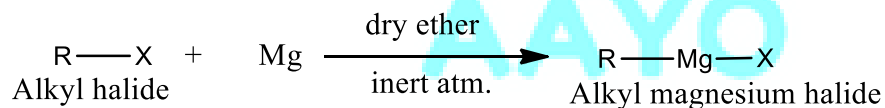
Alkyl magnesium halide (RMgX) and aryl magnesium halide (ArMgX) are commonly known as Grignard reagent.

Grignard reagent is an Organomagnesium halide, which is named after its discoverer Francois Auguste Victor Grignard in 1900 in his honor. He was awarded a Nobel Prize in 1912 for this discovery.

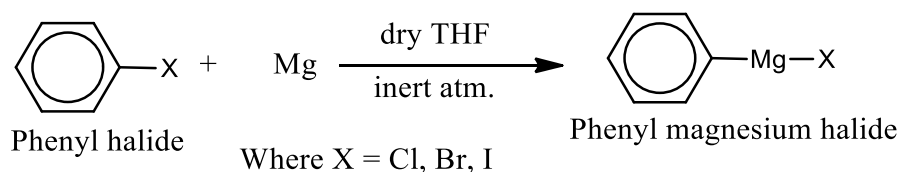
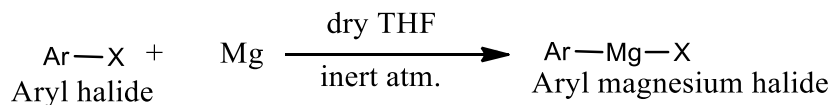


Preparation of Grignard reagents

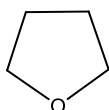
1. From Haloalkanes (Alkyl halides)



2. From Haloarenes (Aryl halide)



Note:

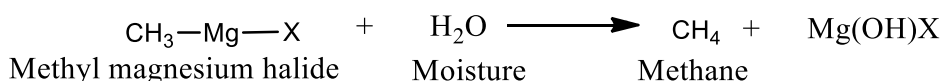


Tetrahydro furan (THF)

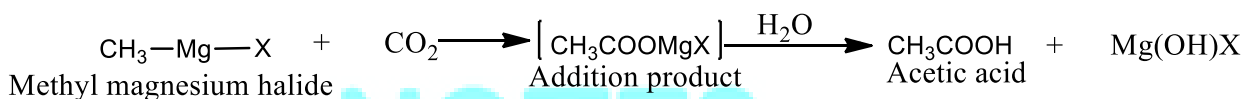
Precautions

Grignard reagent is prepared by taking following precautions;

a. The reagents and apparatus used should be dried to prevent the decomposition of Grignard reagent into alkanes by reaction with moisture(water).



b. The reaction should be carried out in inert condition to prevent the decomposition of Grignard reagent into carboxylic acid by reaction with gases like CO₂

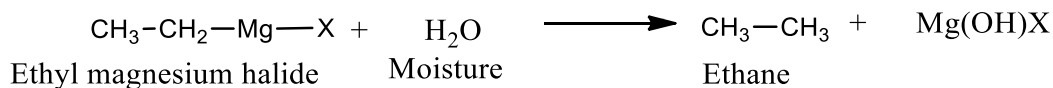
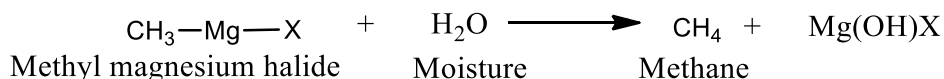


Question. What are the precautions that should to be taken while preparing Grignard reagent?

Chemical reactions of Grignard reagent

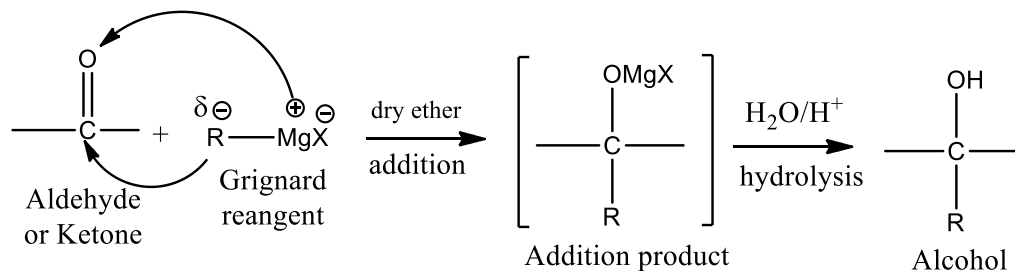
1. Reaction with Water

Grignard reagent reacts with water to form respective alkane.

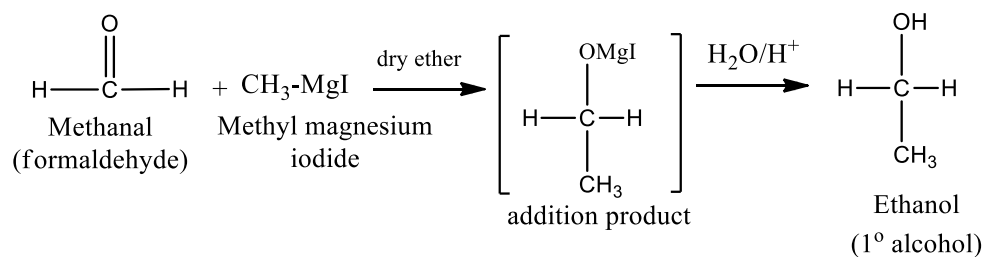


2. Reaction with Aldehydes and ketones

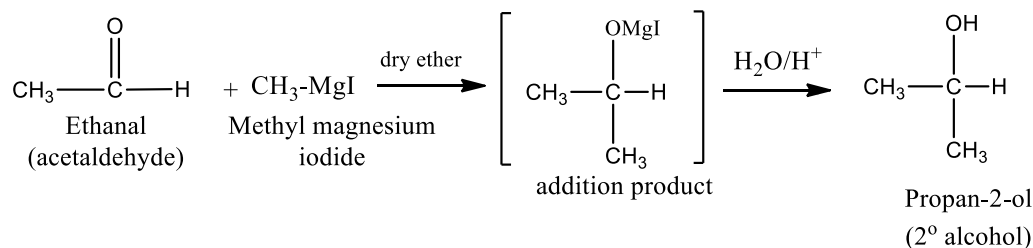
Grignard reagent reacts with aldehydes and ketones in presence of dry ether to form addition products, which on hydrolysis gives different types of alcohols.



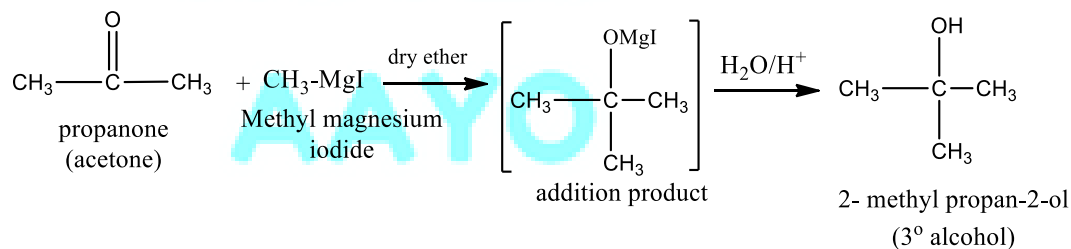
a. Formaldehyde gives primary alcohols.



b. Other aldehydes (except formaldehyde) give secondary alcohols

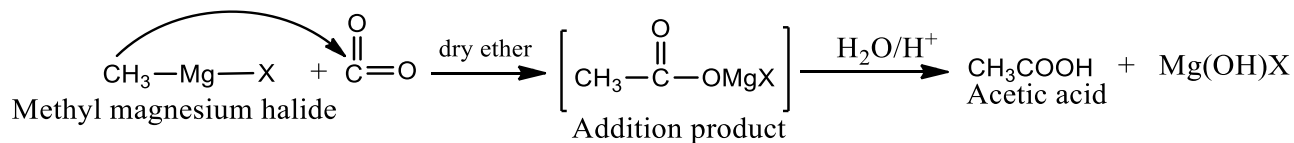


c. Ketones gives tertiary alcohols



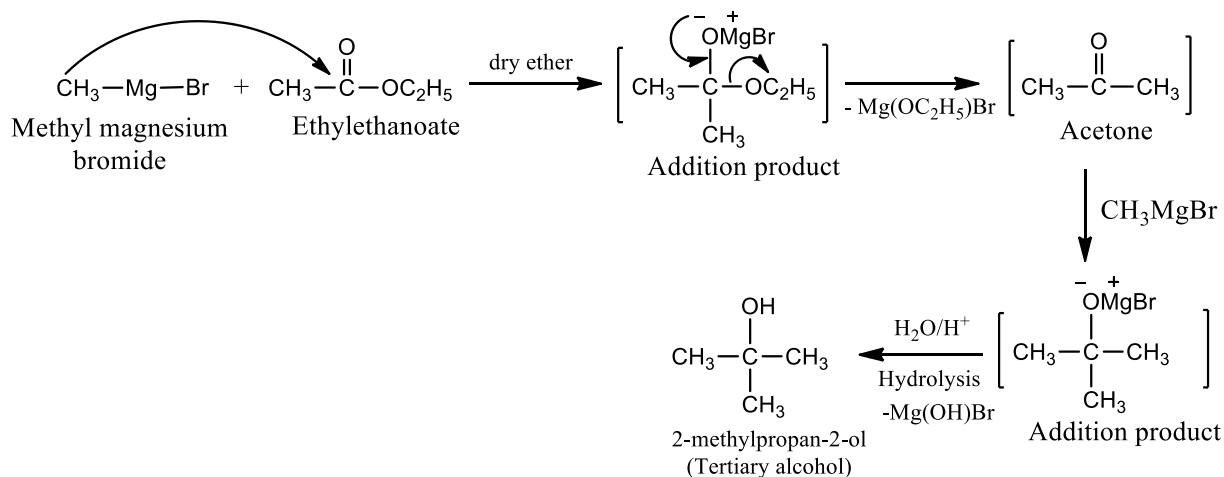
3. Reaction with Carbon dioxide

Grignard reagent reacts with carbon dioxide in presence of dry ether to form addition product, which on hydrolysis gives carboxylic acids.



4. Reaction with Esters

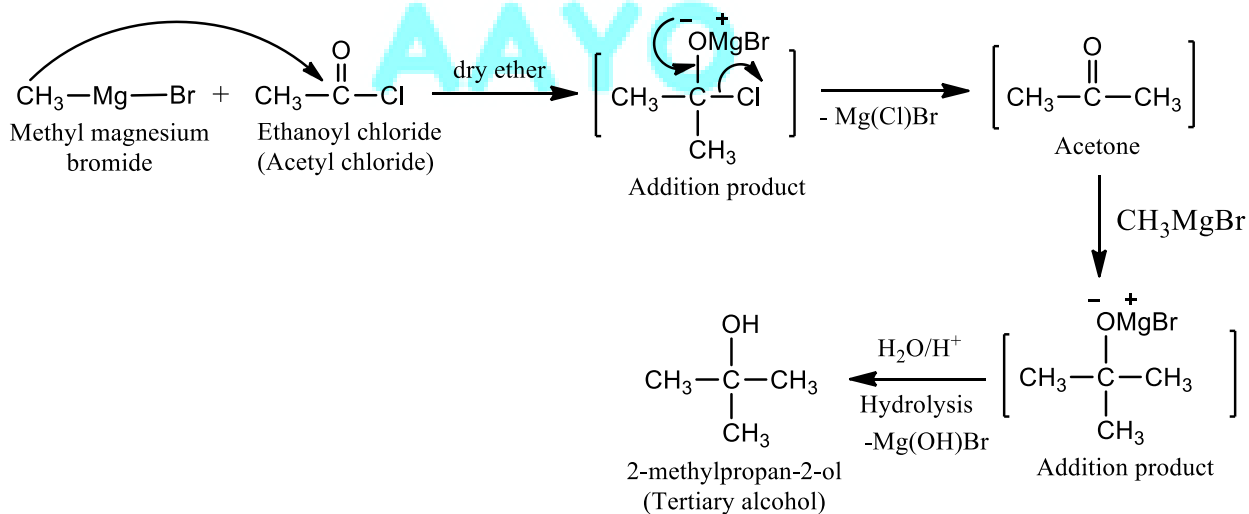
All esters except ester of formic acid (Methanoic acid) react with Grignard reagent to give tertiary alcohol via formation of Ketone.



Note: Ester of formic acid reacts with Grignard reagent to give secondary alcohol as final product via formation of aldehyde.

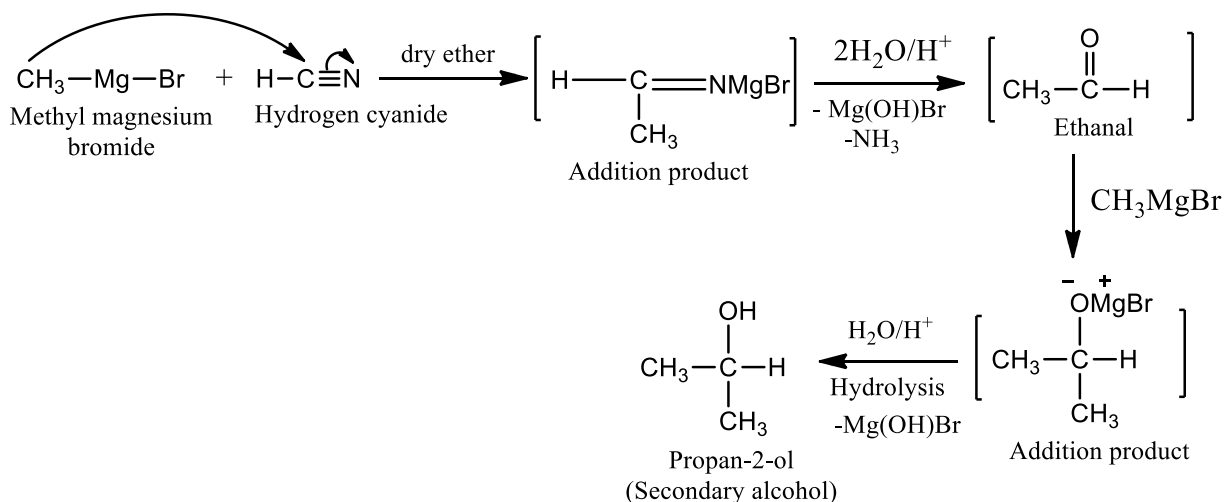
5. Reaction with Acid chlorides

Acid chloride reacts with Grignard reagent in the presence of dry ether to give tertiary alcohol.



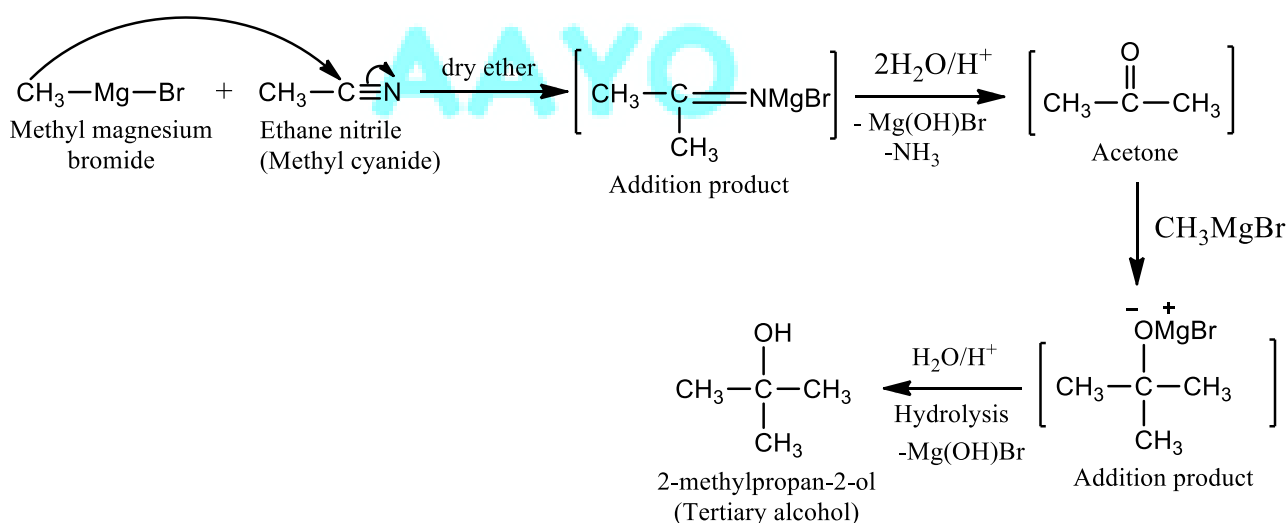
6. Reaction with Hydrogen cyanide (HCN)

When hydrogen cyanide reacts with Grignard reagent in the presence of dry ether, it gives secondary alcohol as final product via formation of aldehyde.



7. Reaction with Alkyl cyanides (R-CN)

When alkyl cyanide is treated with Grignard reagent, it gives tertiary alcohol as final product via formation of ketone.



Applications of Organometallic compounds

Organometallic Compounds have a broad range of applications in the field of chemistry. Some of them are given below-

In some commercial chemical reactions, organometallic compounds are used as homogeneous catalysts.

These compounds are used as stoichiometric reagents in both industrial and research-oriented chemical reactions.

These compounds are also used in the manufacture of some semiconductors, which require the use of compounds such as trimethylgallium, trimethylaluminum, trimethylindium, and trimethyl antimony.

They are also used in the production of light emitting diodes (or LEDs).

These compounds are used as catalysts and reagents during the synthesis of some organic compounds.

Aromatic Grignard reagent

