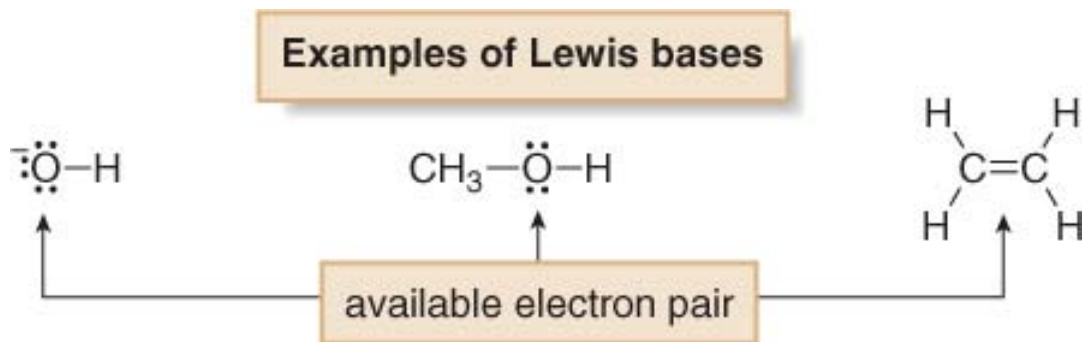


# Acids and Bases

## Lewis Acids and Bases

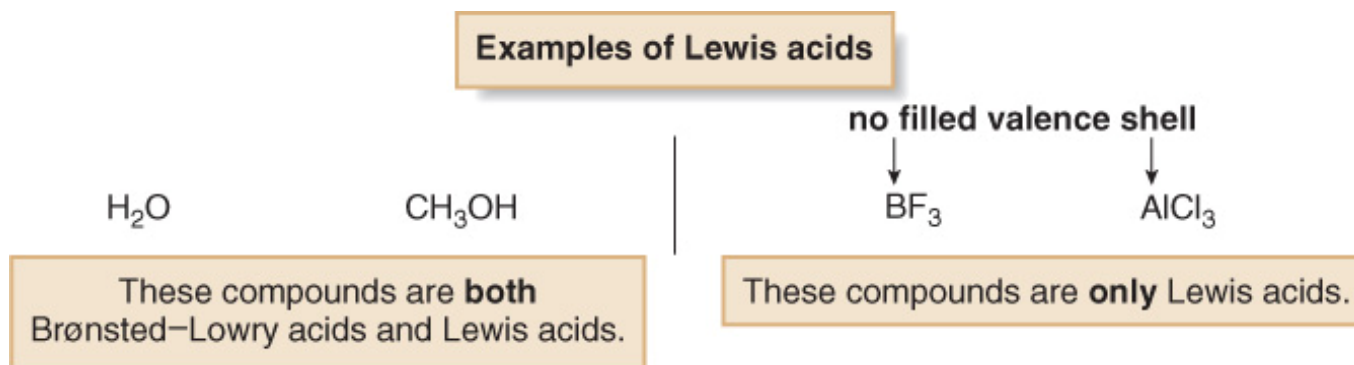
- The Lewis definition of acids and bases is more general than the Brønsted-Lowry definition.
- A Lewis acid is an electron pair acceptor.
- A Lewis base is an electron pair donor.
- Lewis bases are structurally the same as Brønsted-Lowry bases. Both have an available electron pair—a lone pair or an electron pair in a  $\pi$  bond.
- A Brønsted-Lowry base always donates this electron pair to a proton, but a Lewis base donates this electron pair to anything that is electron deficient.



# Acids and Bases

## Lewis Acids and Bases

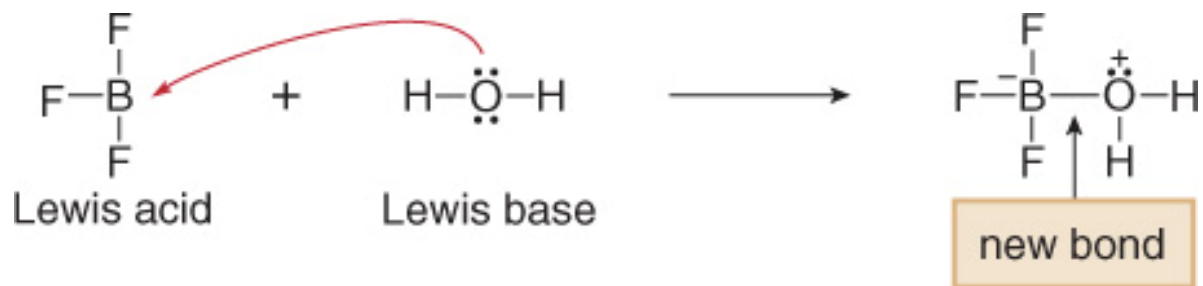
- A Lewis acid must be able to accept an electron pair, but there are many ways for this to occur.
- All Brønsted-Lowry acids are also Lewis acids, but the reverse is not necessarily true.
  - Any species that is electron deficient and capable of accepting an electron pair is also a Lewis acid.
- Common examples of Lewis acids (which are not Brønsted-Lowry acids) include  $\text{BF}_3$  and  $\text{AlCl}_3$ . These compounds contain elements in group 3A of the periodic table that can accept an electron pair because they do not have filled valence shells of electrons.



# Acids and Bases

## Lewis Acids and Bases

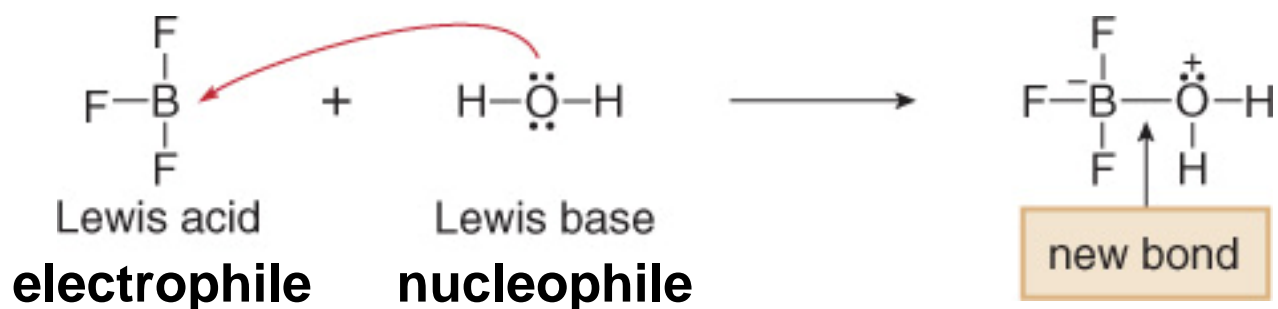
- Any reaction in which one species donates an electron pair to another species is a Lewis acid-base reaction.
- In a Lewis acid-base reaction, a Lewis base donates an electron pair to a Lewis acid.
- Lewis acid-base reactions illustrate a general pattern in organic chemistry. Electron-rich species react with electron-poor species.
- In the simplest Lewis acid-base reaction one bond is formed and no bonds are broken. This is illustrated in the reaction of  $\text{BF}_3$  with  $\text{H}_2\text{O}$ .  $\text{H}_2\text{O}$  donates an electron pair to  $\text{BF}_3$  to form a new bond.



# Acids and Bases

## Lewis Acids and Bases

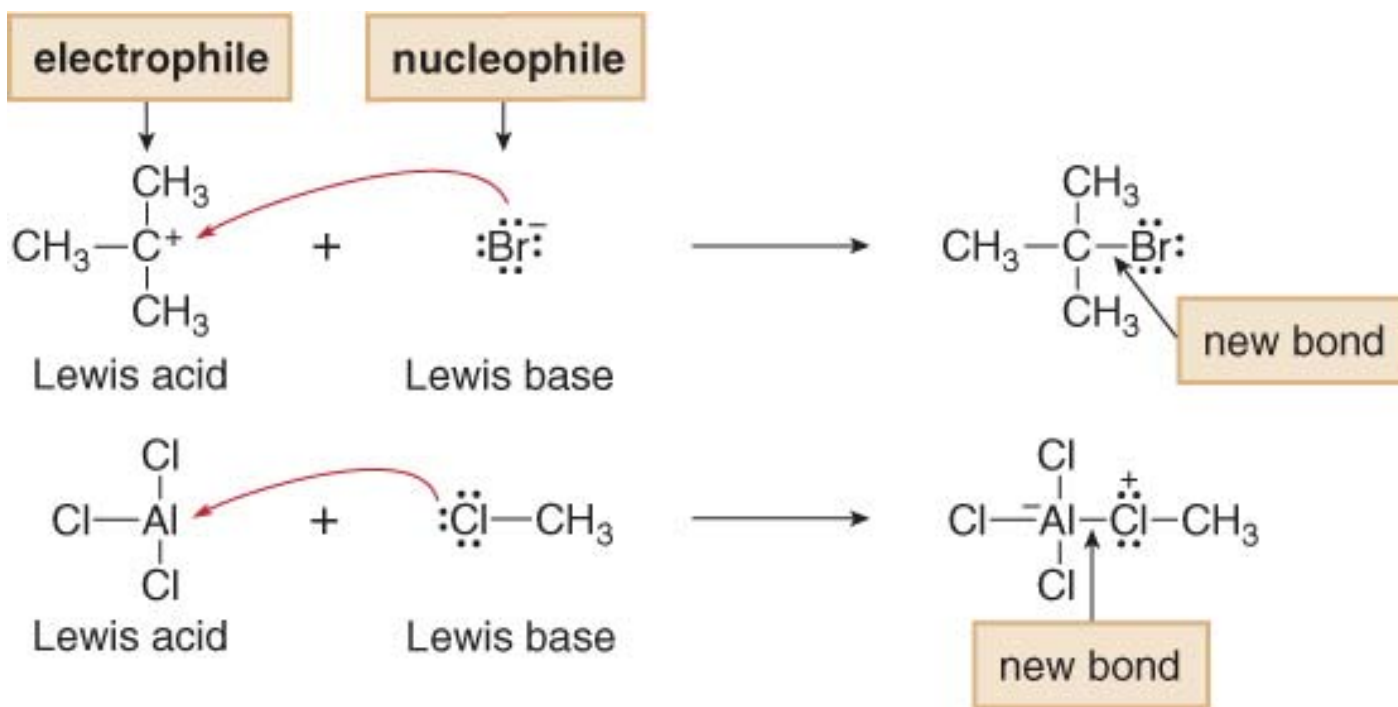
- A Lewis acid is also called an **electrophile**.
- When a Lewis base reacts with an electrophile other than a proton, the Lewis base is also called a **nucleophile**. In this example,  $\text{BF}_3$  is the electrophile and  $\text{H}_2\text{O}$  is the nucleophile.



# Acids and Bases

## Lewis Acids and Bases

- Two other examples are shown below. Note that in each reaction, the electron pair is not removed from the Lewis base. Instead, it is donated to an atom of the Lewis acid and one new covalent bond is formed.



# Acids and Bases

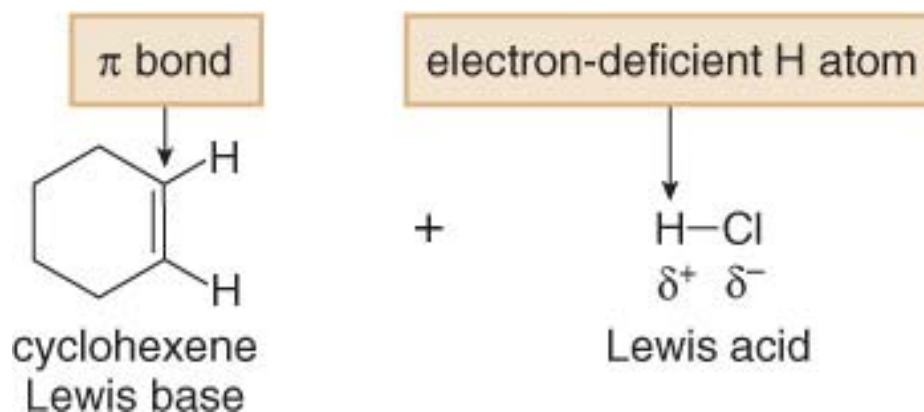
## Lewis Acids and Bases

- In some Lewis acid-base reactions, one bond is formed and one bond is broken. To draw the products of these reactions, keep in mind the following steps:
  - ➡ Always identify the Lewis acid and base first.
  - ➡ Draw a curved arrow from the electron pair of the base to the electron-deficient atom of the acid.
  - ➡ Count electron pairs and break a bond when needed to keep the correct number of valence electrons.

# Acids and Bases

## Lewis Acids and Bases

Consider the Lewis acid-base reaction between cyclohexene and H—Cl. The Brønsted-Lowry acid HCl is also a Lewis acid, and cyclohexene, having a  $\pi$  bond, is the Lewis base.



# Acids and Bases

## Lewis Acids and Bases

- To draw the product of this reaction, the electron pair in the  $\pi$  bond of the Lewis base forms a new bond to the proton of the Lewis acid, generating a carbocation.
- The H—Cl bond must break, giving its two electrons to Cl, forming  $\text{Cl}^-$ .
- Because two electron pairs are involved, two curved arrows are needed.

