Biophysical Chemistry
Acid & Bases
Lecture-3

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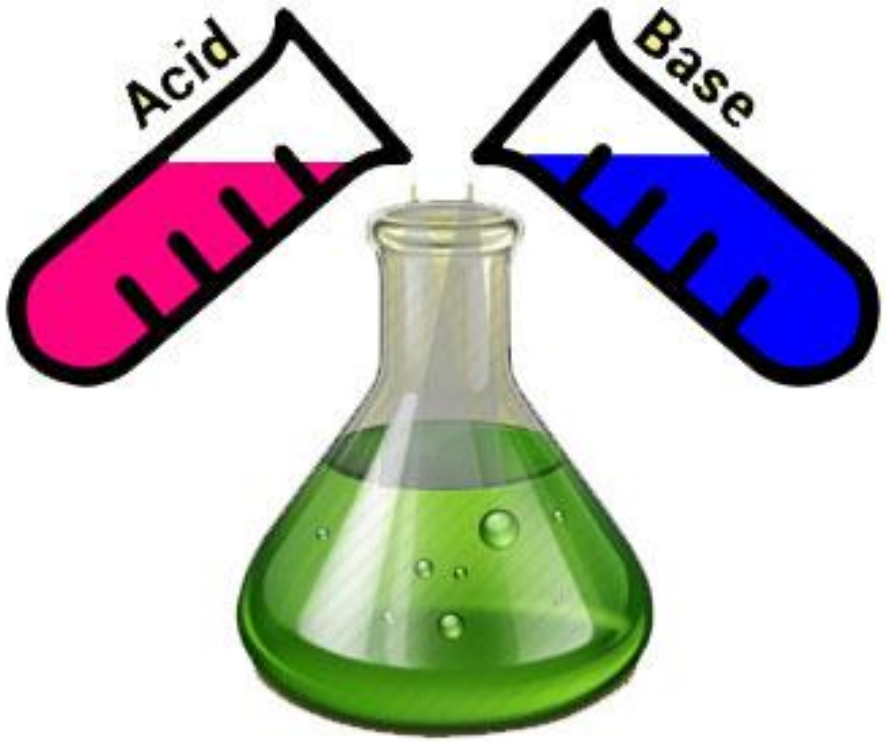
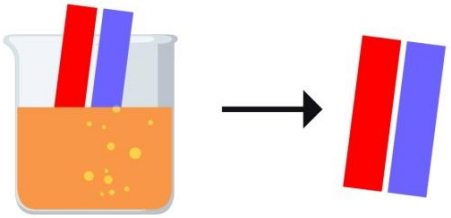


Salt + Water

teachoo

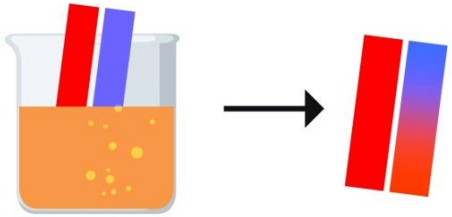
NATURAL INDICATORS

Neutral



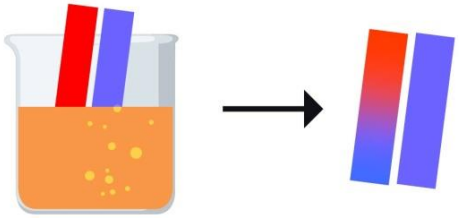
Red litmus remains Red
Blue litmus remains Blue

Acid



Red litmus remains Red
Blue litmus turns Red

Base



Red litmus turns Blue
Blue litmus remains Blue

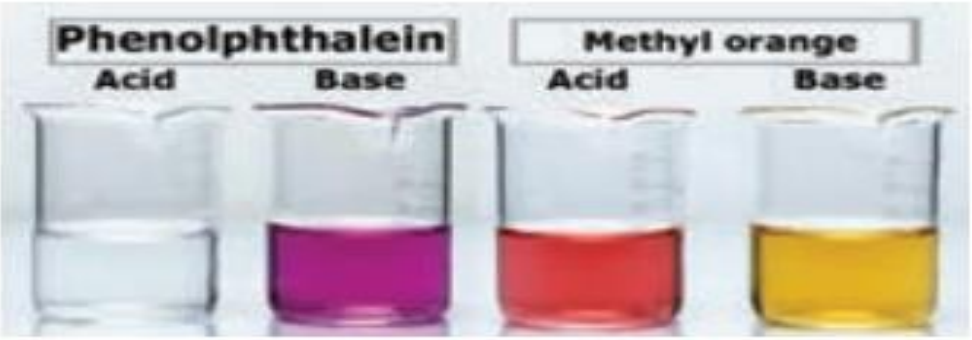


Figure 6.4 Test for acid and base using indicator

Table 6.4 Acid base indicator

Indicator	Colour in acid	Colour in base
Litmus	Blue to Red	Red to Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Pink	Yellow

Lewis Bases

Lewis Bases

- A Lewis base must contain at least one lone pair of electrons.
- All anions are Lewis bases, but not all Lewis bases are anions.
- The lone pair is frequently, but not always, located on oxygen or nitrogen atoms.
- The strength of a base is increased by electron density.

Lewis Acid

- **Lewis Acids**
- Lewis acids are often more difficult to identify. The following should help.

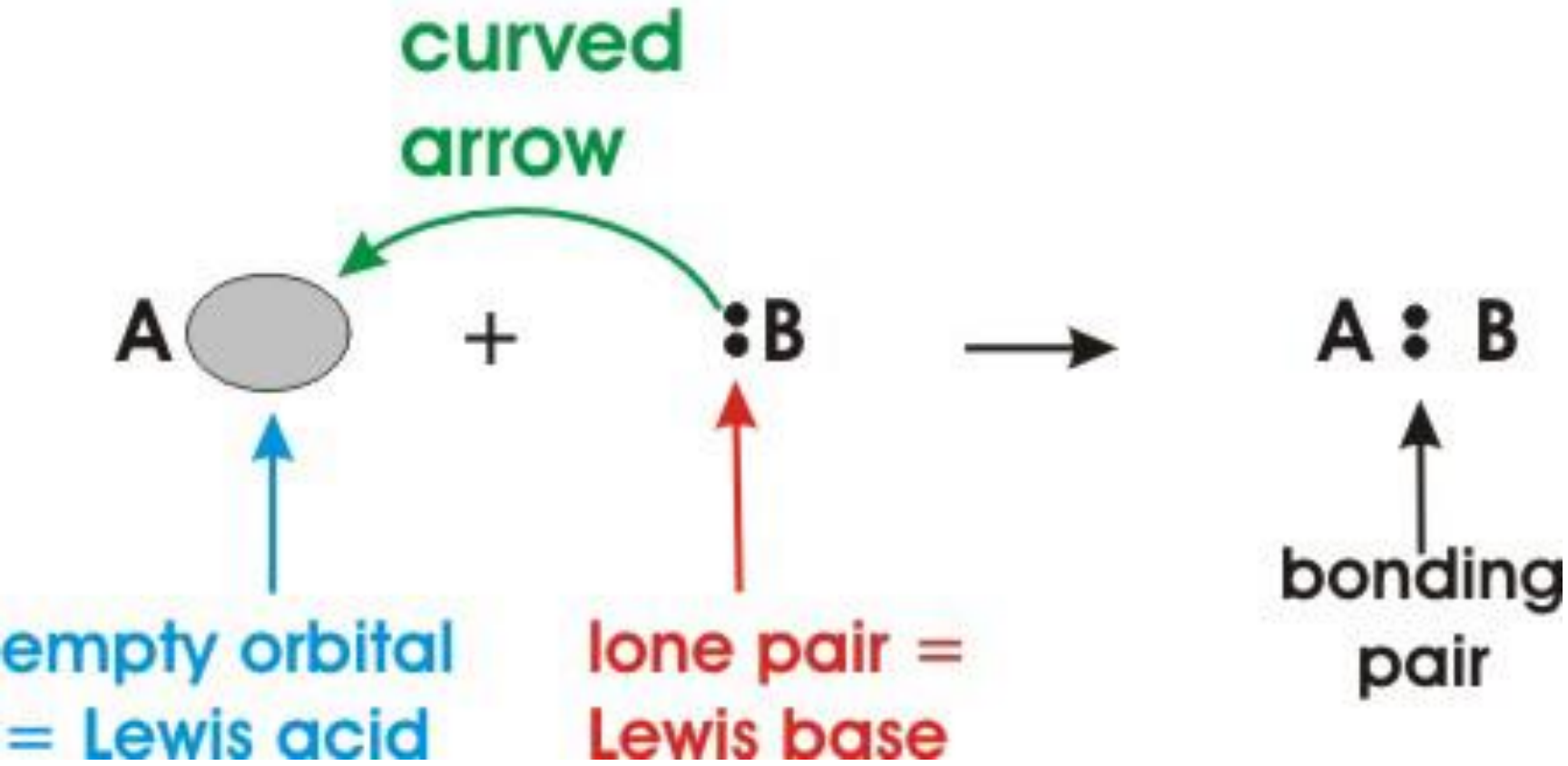
- A Lewis acid must be able to accommodate an additional electron region (the new bond), so, if it obeys the octet rule, a Lewis acidic atom must have less than four regions.

- Attack by a lone pair is facilitated by positive charge, so Lewis acidity is strengthened by positive charge.

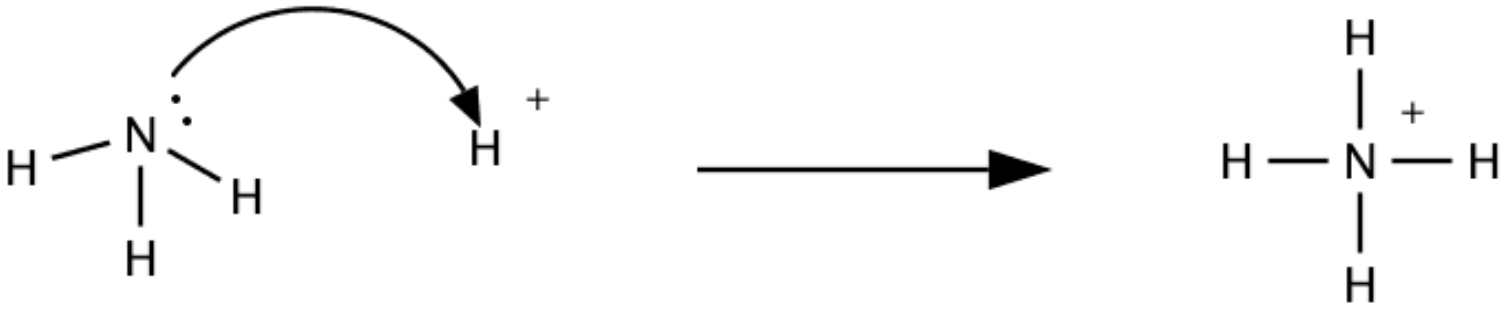
- All cations are Lewis acids, but not all Lewis acids are cations.

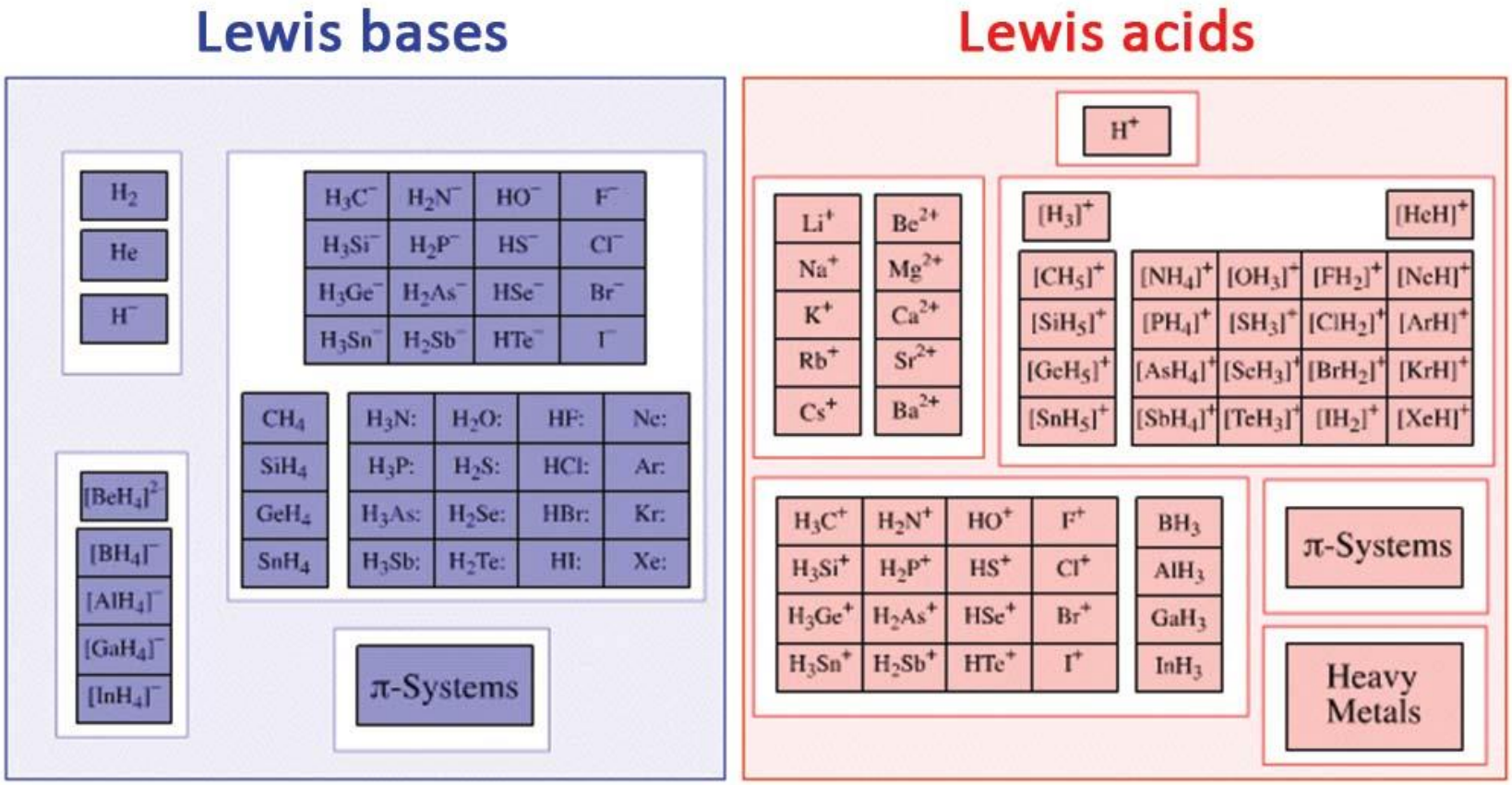
Lewis Acids and Bases

$$A + B \rightarrow A\text{-}B$$



$NH_3 + BF_3 \rightarrow H_3 \rightarrow BF_3$



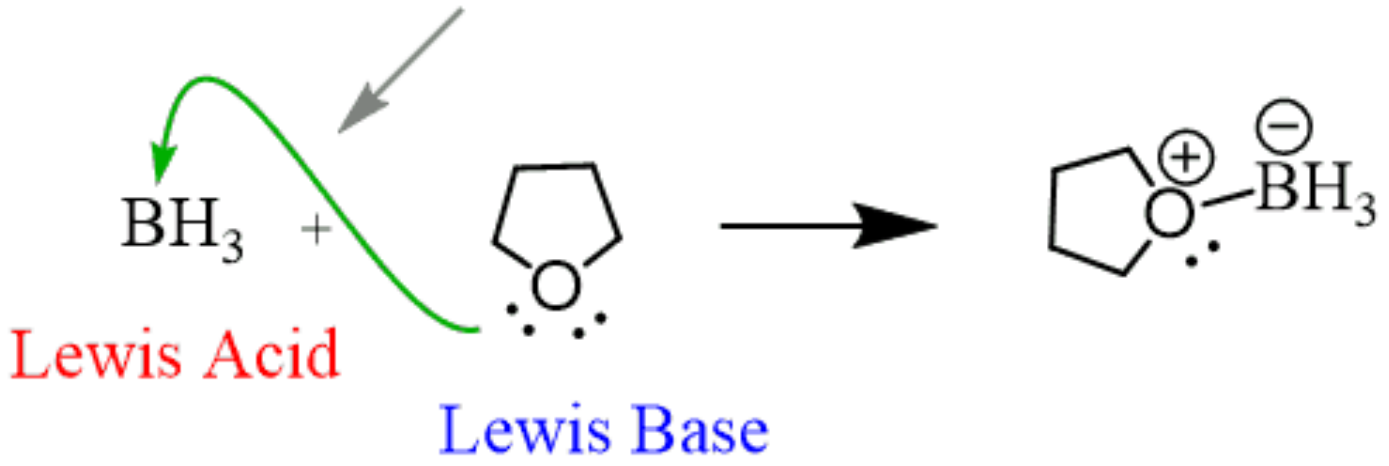

Lewis bases
Lewis acids
H2
He
H−
H3C− H2N− HO− F−
H3Si− H2P− HS− Cl−
H3Ge− H2As− HSe− Br−
H3Sn− H2Sb− HTe− I−
CH4 H3N: H2O: HF: Ne:
SiH4 H3P: H2S: HCl: Ar:
GeH4 H3As: H2Se: HBr: Kr:
SnH4 H3Sb: H2Te: HI: Xe:
[BeH4]2−
[BH4]−
[AlH4]−
[GaH4]−
[InH4]−
π-Systems
H+
Li+ Be2+
Na+ Mg2+
K+ Ca2+
Rb+ Sr2+
Cs+ Ba2+
[H3]+
[HeH]+
[CH5]+ [NH4]+ [OH3]+ [FH2]+ [NeH]+
[SiH5]+ [PH4]+ [SH3]+ [ClH2]+ [ArH]+
[GeH5]+ [AsH4]+ [SeH3]+ [BrH2]+ [KrH]+
[SnH5]+ [SbH4]+ [TeH3]+ [IH2]+ [XeH]+
H3C+ H2N+ HO+ F+
H3Si+ H2P+ HS+ Cl+
H3Ge+ H2As+ HSe+ Br+
H3Sn+ H2Sb+ HTe+ I+
BH3
AlH3
GaH3
InH3
π-Systems
Heavy Metals

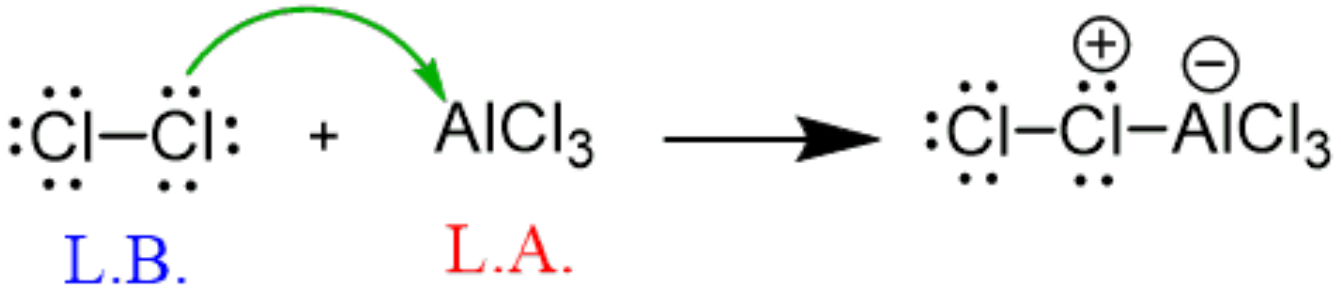
Advantages of lewis acid base concept

Advantages of Lewis Concept of Acid and Base:

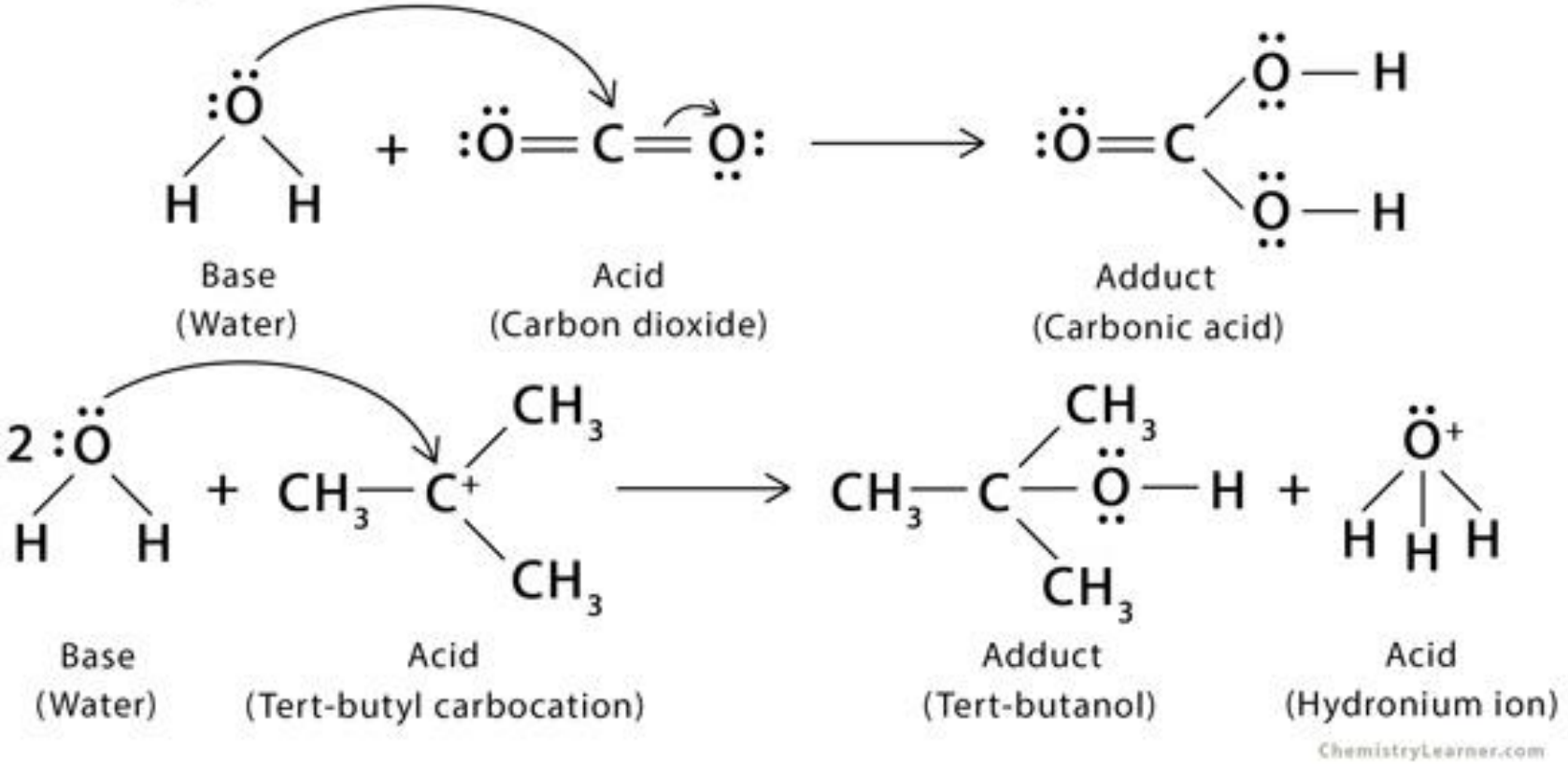
- It can explain the acidic nature of carbon dioxide (CO_2) and $AlCl_3$.
- It can explain the reaction in which proton is not involved.
- It can share the pair of an electron with no change in the oxidation numbers.
- It complements the method of the oxidation-reduction method. Oxidation and reduction reactions method consists of a transfer of electrons from one atom to another atom with a change in the oxidation number of one or more than one atoms.

Lewis Base donates electrons



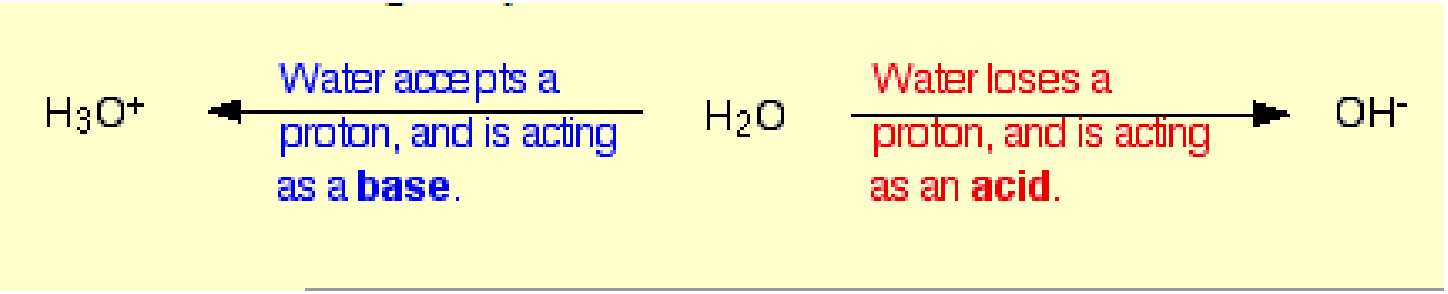


Examples of Lewis Acid-Base Reactions For Water

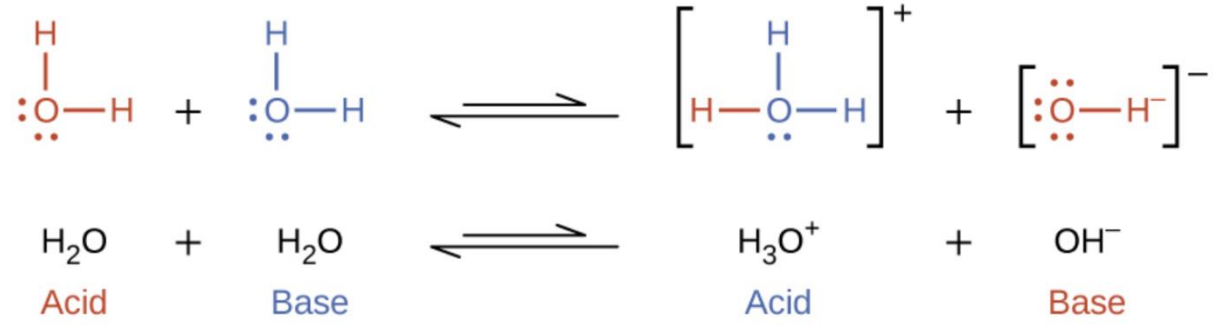


Water can act both as acid and base

- **Amphoteric substances**
- A substance which can act as either an acid or a base is described as being ***amphoteric***.



water can function as either an acid or a base, depending on the nature of the solute dissolved in it. In fact, in pure water or indeed any aqueous solution, water acts both as an acid and a base. A very small fraction of water molecules donate protons to other water molecules to form hydronium ions and hydroxide ions:



This type of reaction, in which a substance ionizes when one molecule of the substance reacts with another molecule of the same substance, is referred to as **autoionization**.

Autoionization of Water

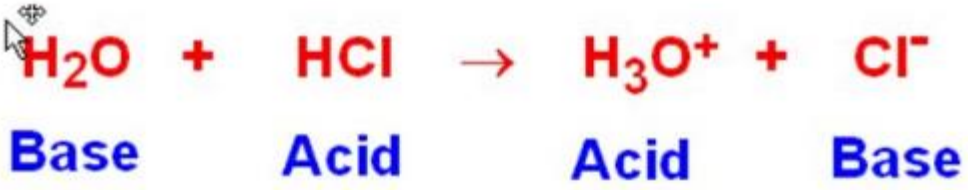
- An equilibrium constant expression can be written for the autoionization of water:

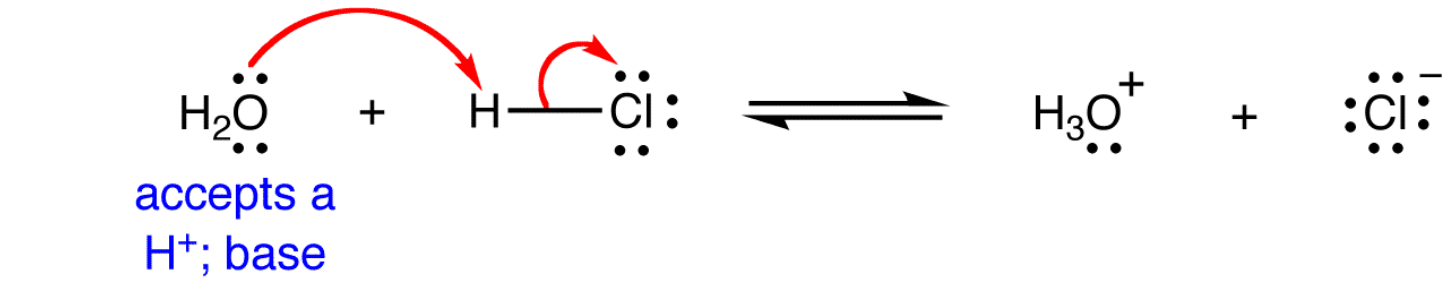
$$2\ H_2O\ (l) \rightleftharpoons H_3O^+\ (aq) + OH^-\ (aq)$$

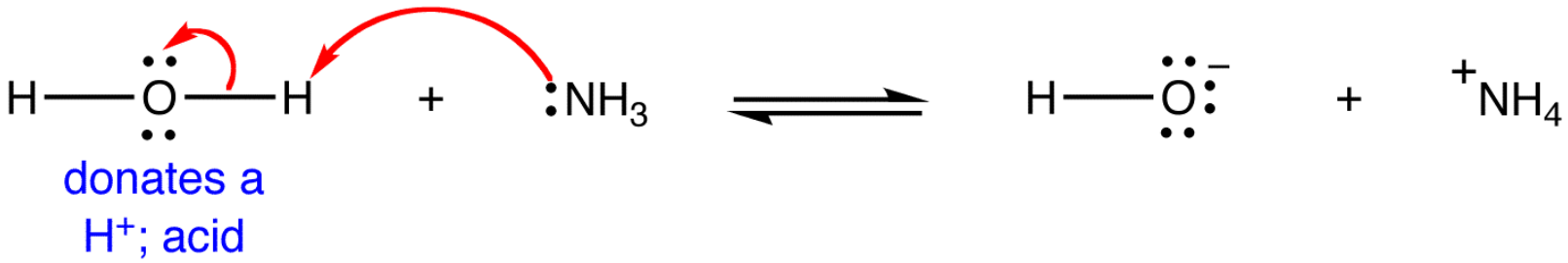
$$K_w = [H_3O^+]\ [OH^-] = [H^+]\ [OH^-]$$

where K_w = ionization constant for water
= ion-product constant
= 1.00×10^{-14} at 25°C

- Water can act like both an acid and a base.
- **When substances can act as both an acid and a base they are called amphoteric**




H2O
+
H
Cl
H3O+
+
Cl
accepts a
H+; base


H
O
H
+
NH3
H
O
+
NH4
donates a
H+; acid