كيمياء العناصر الممثلة١

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محاضرة ٤

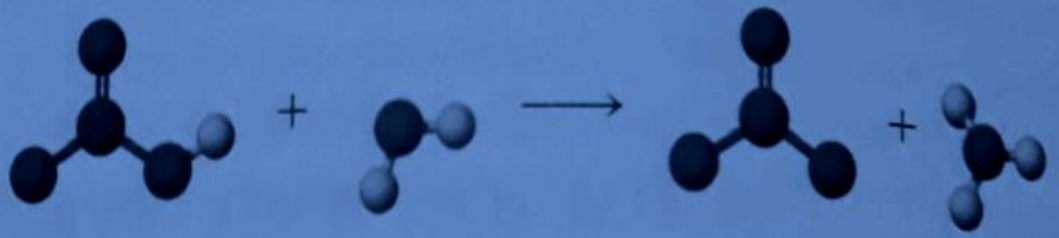
Thomas M.Lowry independently suggested acid and base concept. The proposed that an acid is any substance that can donate a proton to another substance .thus ,acid can be neutral compounds or anion or cation.

According to the Bronsted and lowry ,a base is a substance that can be accept a proton from another substance .They can be neutral compounds or anion.

neutral compounds such as

$$HNO_3(aq) + H_2O(\ell) \longrightarrow NO_3^-(aq) + H_3O^+(aq)$$

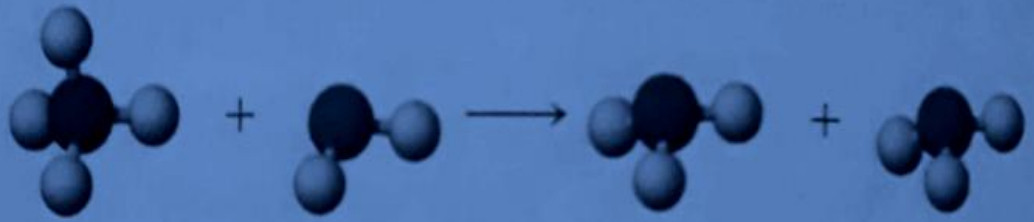
Acid



or they can be cations or anions:

$$NH_4^+(aq) + H_2O(\ell) \longrightarrow NH_3(aq) + H_3O^+(aq)$$

Acid

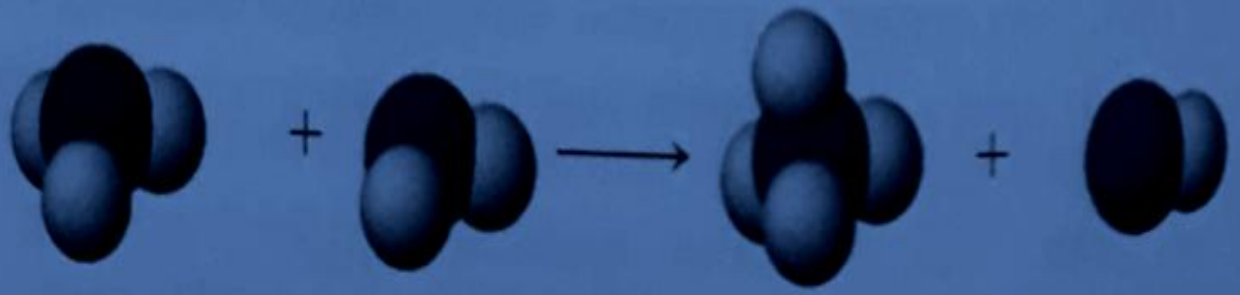


$$H_2PO_4^-(aq) + H_2O(\ell) \longrightarrow H_3O^+(aq) + HPO_4^{2-}(aq)$$

Acid

$$NH_3(aq) + H_2O(\ell) \longrightarrow NH_4^+(aq) + OH^-(aq)$$

Base



ammonia NH_3 | H_2O | ammonium ion NH_4^+ | hydroxide ion OH^-

or anions:

$$CO_3^{2-}(aq) + H_2O(\ell) \longrightarrow HCO_3^-(aq) + OH^-(aq)$$

Base

$$PO_4^{3-}(aq) + H_2O(\ell) \longrightarrow HPO_4^{2-}(aq) + OH^-(aq)$$

Base

- الجدول في الصفحة القادمة يوضح الحوامض متعددة البروتون وكما نعلم هناك مجموعة من الحوامض احادية البروتون تسمى monoprotic acid ومتعددة البروتون تسمى poly protic acid

monoprotic acid:-**such as HCl,HNO_3,HF**, **CH_3COOH** are all capable donating one proton

.

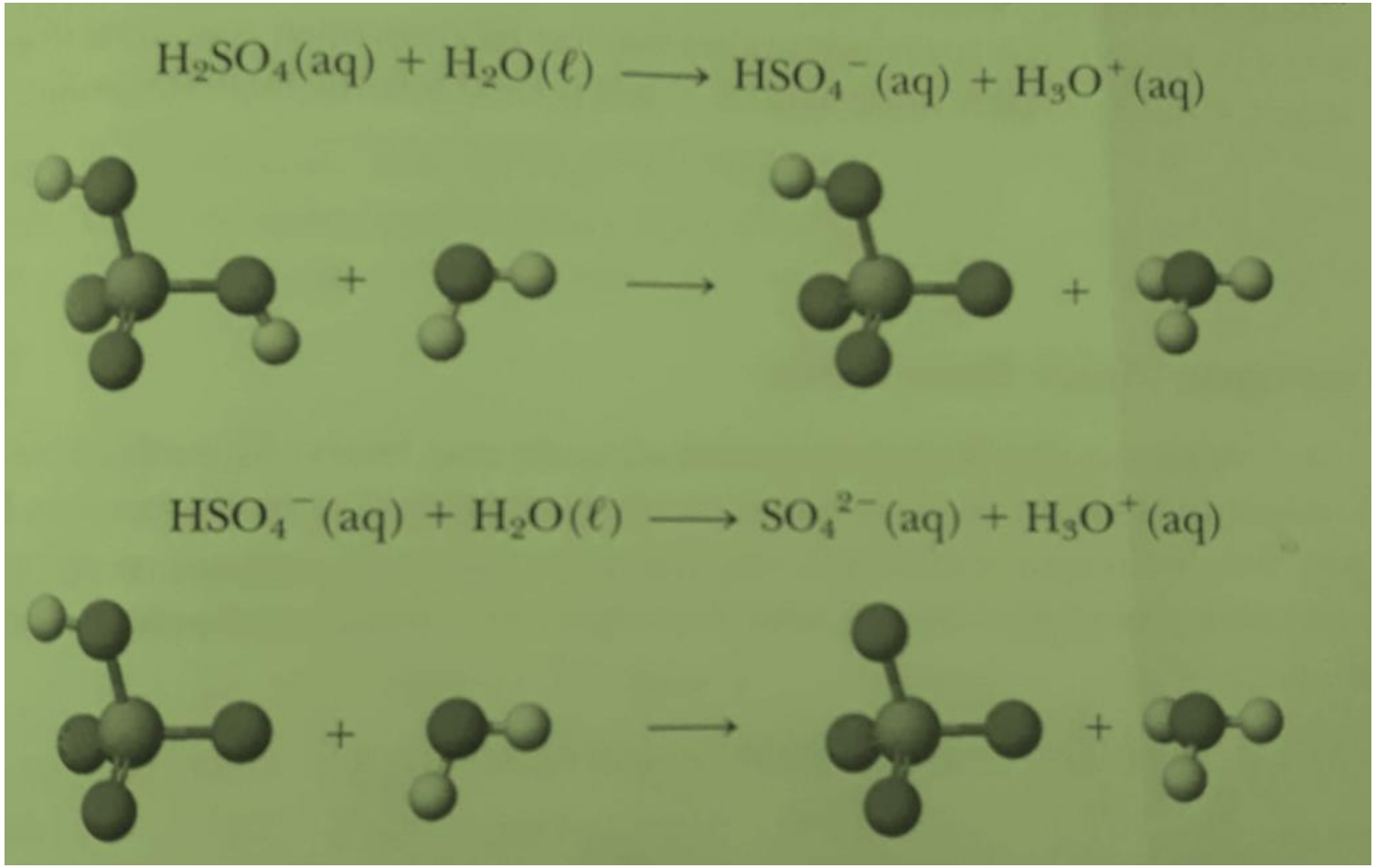
Polyprotic acid:- such as H_2SO_4,H_3PO_4

Are all capable donating two or more proton.

Polyprotic acid and base

Acid Form	Amphiprotic Form	Base Form
H_2S (hydrosulfuric acid or hydrogen sulfide)	HS^- (hydrogen sulfide ion)	S^{2-} (sulfide ion)
H_3PO_4 (phosphoric acid)	$H_2PO_4^-$ (dihydrogen phosphate ion)	HPO_4^{2-} (hydrogen phosphate ion)
$H_2PO_4^-$ (dihydrogen phosphate ion)	HPO_4^{2-} (hydrogen phosphate ion)	PO_4^{3-} (phosphate ion)
H_2CO_3 (carbonic acid)	HCO_3^- (hydrogen carbonate or bicarbonate ion)	CO_3^{2-} (carbonate ion)
$H_2C_2O_4$ (oxalic acid)	$HC_2O_4^-$ (hydrogen oxalate ion)	$C_2O_4^{2-}$ (oxalate ion)

An example sulfuric acid



- Just as some acids can donate more than proton ,**polyprotic base** can accept more than one proton .The anions of polyprotic acids are polyprotic bases example of which include SO_4^{-2} ,PO_4^{-3},CO_3^{-2} and $C_2O_4^{-2}$.This behavior is illustrated by the carbonate ion.

$$CO_3^{2-}(aq) + H_2O(\ell) \longrightarrow HCO_3^{-}(aq) + OH^{-}(aq)$$

Base

$$HCO_3^{-}(aq) + H_2O(\ell) \longrightarrow H_2CO_3(aq) + OH^{-}(aq)$$

Base

Amphiprotic substance

- Amphiprotic substance :-are molecules or ions that can be behave either as a Bronsted acid or base ,and one of the best examples is water. water as a base in the presence of HCl, in that H_2O accept a proton from the acid ,
- $HCl_{(aq)}+H_2O_{(l)}\rightarrow H_3O^+_{(aq)}+Cl^-_{(aq)}$
- Acid base

- And it is an acid when donating a proton to ammonia

- $NH_{3(aq)}+H_2O_{(l)}\rightarrow NH_4^{+}{}_{(aq)}+OH^{-}{}_{(aq)}$

base acid

Conjugate Acid –Base Pairs

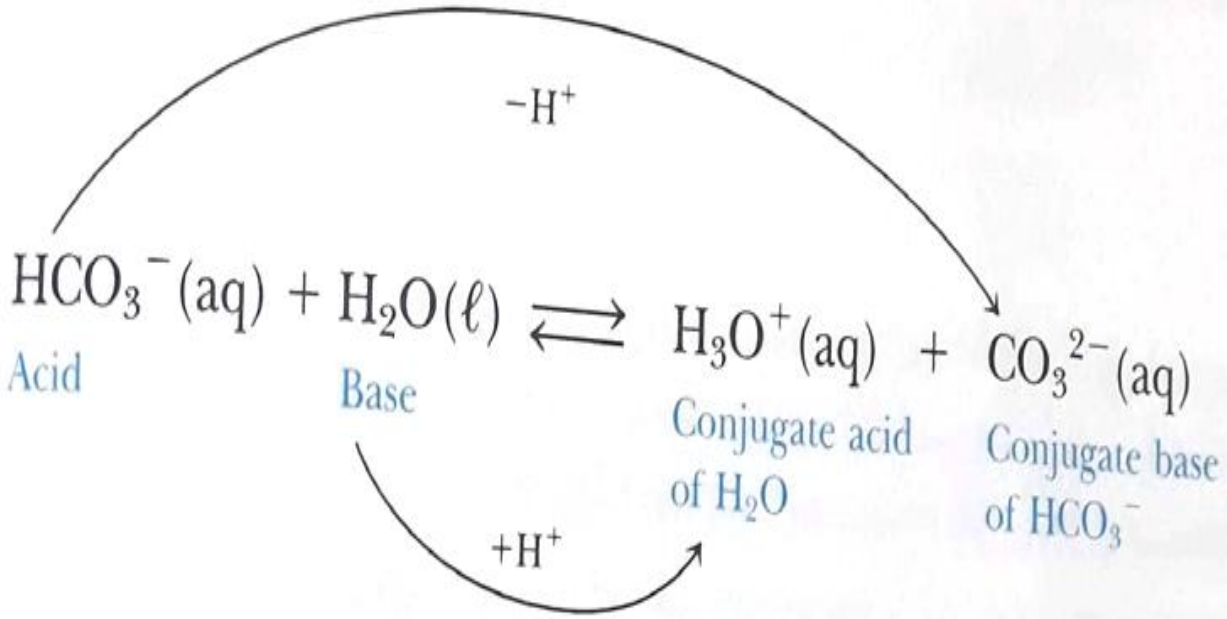
Let us expand on the Bronsted notion of acids and bases. In each of the chemical equations written so far a proton has been transferred to or from water. For example, the hydrogen carbonate ion(bicarbonate ion) can act as an acid and can transfer a proton to water, which accepts the proton and acts as a Bronsted base:

$HCO_3^{-}{}_{(aq)}+H_2O\rightarrow\leftarrow CO_3^{-2}{}_{(aq)}+H_3O^{+}{}_{(aq)}$

Acid base base acid

- The hydronium ion, however ,is a proton donor ,an acid ,and the carbonate ion is a base .Thus, the H_3O^+ ion can transfer a proton to the CO_3^{-2} ion re-form the HCO_3^- ion and H_2O.The reaction is reversible and is written as an equilibrium reaction. Another observation is important in the reaction of the hydrogen carbonate ion with water.The hydrogen carbonate and carbonate ions are related to one another by the loss or gain H^+, as are H_2O and H_3O^+.

- Apair of compounds or ions that differ by the presence of one H^+ unit is called **a conjugate acid –base pair.** We say that CO_3^{-2} is the conjugate base of the acid HCO_3- ,and HCO_3^- is the conjugate acid of the base CO_3^{-2} .
- $HCO_3^-{}_{(aq)} + H_2O \rightarrow\leftarrow CO_3^{-2}{}_{(aq)} + H_3O^+{}_{(aq)}$
- Acid Base Conjugate base
  - **conjugate acid**



Every acid–base reaction involving H^+ transfer has two conjugate acid–base pairs. To convince yourself of this, look at the preceding reactions and those in Table 17.2.

Table: conjugate acid-base pairs

Table 17.2 • Conjugate Acid–Base Pairs

Name	Acid 1		Base 2		Base 1	Acid 2*
Hydrochloric acid	HCl	+	H_2O	$\longrightarrow$	Cl^-	+ H_3O^+
Nitric acid	HNO_3	+	H_2O	$\longrightarrow$	NO_3^-	+ H_3O^+
Hydrogen carbonate	HCO_3^-	+	H_2O	$\rightleftharpoons$	CO_3^{2-}	+ H_3O^+
Acetic acid	CH_3CO_2H	+	H_2O	$\rightleftharpoons$	$CH_3CO_2^-$	+ H_3O^+
Hydrocyanic acid	HCN	+	H_2O	$\rightleftharpoons$	CN^-	+ H_3O^+
Hydrogen sulfide	H_2S	+	H_2O	$\rightleftharpoons$	HS^-	+ H_3O^+
Ammonia	H_2O	+	NH_3	$\rightleftharpoons$	OH^-	+ NH_4^+
Carbonate ion	H_2O	+	CO_3^{2-}	$\rightleftharpoons$	OH^-	+ HCO_3^-
Water	H_2O	+	H_2O	$\rightleftharpoons$	OH^-	+ H_3O^+

*Acid 1 and base 1 are a conjugate pair, as are base 2 and acid 2.