Acid - Base Theories

Revised Arrhenius Theory of Acids and Bases

- acids are hydrogen-containing compounds that ionize in aqueous solutions to give H^+ HCl, HBr, CH_3COOH, . . .
- bases ionize to give OH^- ions

Monoprotic Acid - one hydrogen will ionize Ex. HNO_3

$H^+ NO_3^-$

Diprotic Acid - two hydrogens will ionize Ex. H_2SO_4

H^+ H^+ SO_4^{2-} } polyprotic

Triprotic Acid - three hydrogens will ionize Ex. H_3PO_4

H^+ H^+ H^+ PO_4^{3-}

Advantage: it explained neutralization as H^+ and OH^- combining to give H_2O

Disadvantage: not all hydrogen containing substances have acid properties (i.e., CH_4) and not all bases have OH^- (NH_3).

H^+ = proton (1.01)

$1p^+$

$0e^-$

$0n$

H_2O CH_4 NH_3

NH_4OH

BRONSTED - LOWRY THEORY OF ACIDS & BASES

Bronsted-Lowry Acids and Bases

A new theory was needed because:
(i) not all acid/base reactions involve water.
(ii) not all bases contain hydroxide ions (Na_2CO_3, NH_3).

Bronsted - Lowry Acid - a proton (hydrogen-ion) donor
Bronsted - Lowry Base - a proton (hydrogen-ion) acceptor

- **acids lose a proton** to a water molecule (H^+ is a proton!)

Ex. $HCl_{(l)} + H_2O_{(l)} \longleftrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

hydronium ion
(water molecule gains a proton)

- **bases gain a proton** from a water molecule

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

(H_2O acts as an acid, NH_3 acts as a base)

However water does not have to be present in order to have a proton exchange.

Ex. $HCl_{(g)} + NH_{3(g)} \longleftrightarrow NH_4^+{}_{(aq)} + Cl^-_{(aq)}$

HCl donates a proton (acid)
NH_3 accepts a proton (base)

amphoteric (amphiprotic) - substance that can act as a Bronsted-Lowry acid in some reactions and a Bronsted-Lowry base in other reactions.

$HSO_3^-{}_{(aq)} + H_3O^+_{(aq)} \longleftrightarrow H_2SO_{3(aq)} + H_2O_{(l)}$

$HSO_3^-{}_{(aq)} + OH^-_{(aq)} \longleftrightarrow SO_3^{2-}{}_{(aq)} + H_2O_{(l)}$