Acid - Base Theories

Revised Arrhenius Theory of Acids and Bases

- acids are hydrogen-containing compounds that ionize in aqueous solutions to give H^+
- bases ionize to give OH^- ions

Monoprotic Acid - one hydrogen will ionize Ex. HNO_3

$HNO_3 \rightarrow H^+ + NO_3^-$

Diprotic Acid - two hydrogens will ionize Ex. H_2SO_4

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

Triprotic Acid - three hydrogens will ionize Ex. H_3PO_4

$H_3PO_4 \rightarrow 3H^+ + SO_4^{2-}$

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).

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. $H_2O + NH_{3(aq)} \longleftrightarrow OH^-_{(aq)} + NH_4^+{}_{(aq)}$

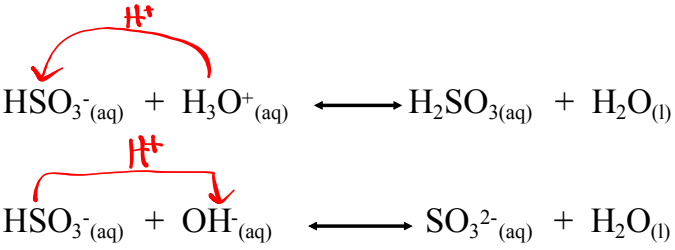
(H_2O acts as an acid, NH_3 acts as a base)

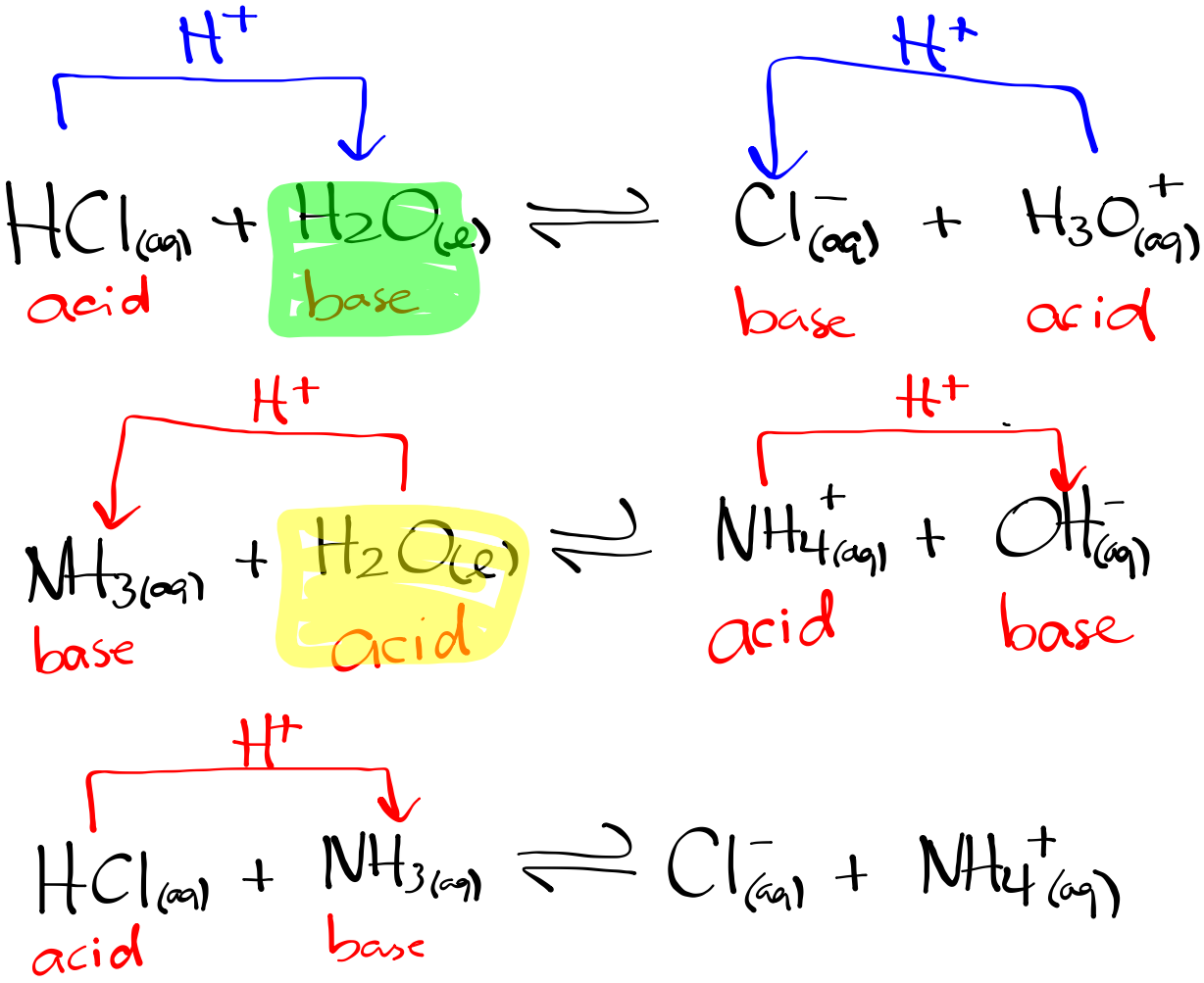
However water does not have to be present in order to have a proton exchange.

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.

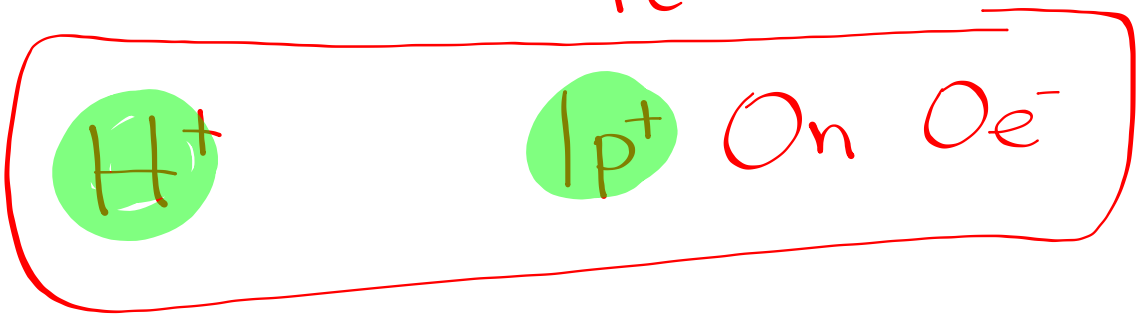



H+
HCl(aq) + H2O(l) ⇌ Cl−(aq) + H3O+(aq)
acid
base
base
acid
H+
NH3(aq) + H2O(l) ⇌ NH4+(aq) + OH−(aq)
base
acid
acid
base
H+
HCl(aq) + NH3(aq) ⇌ Cl−(aq) + NH4+(aq)
acid
base

PROTON

$^{1}H^{1.01} \longrightarrow 1p^{+} + 0n$

$1e^{-}$



Predict the products for the following reaction, and identify each substance as an acid or a base.