Acids and Bases

Acid/base defintions

There are many definitions to define acids and bases but we will focus on:

1) Arrehnius‘s Definition
2) Browsted and Lowry

Properties of Acid and base

Properties of Acids:

a) they ionize in water

b) acids react with metal to make H_2 gas

c) acids turn blue litmus red

d) acids neutralize bases

e) acids have a sour taste

Base is a substance whose water solution yields an OH^- ion (hydroxide ion) as it's only negative ion

ex: $NaOH \rightarrow Na^+ + OH^-$

Properties of Acid and base

Properties of Base:

Base is a substance whose water solution yields an OH^- ion (hydroxide ion) as it's only negative ion

ex: $NaOH \rightarrow Na^+ + OH^-$

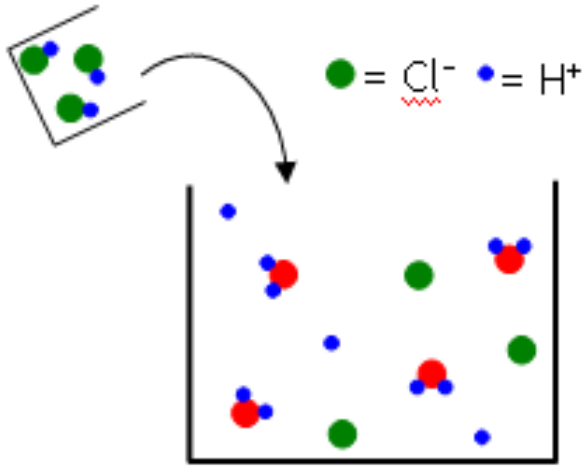
a) bases are electrolytes
b) bases turns red litmus blue
c) bases neutralize acids
d) bases taste bitter and feel slippery
e) bases dissociate because they are ionic

Arrhenius Theory

Arrhenius believed that acids were due to

- hydrogen ions H+ and
- bases were due to the presence of OH-, hydroxide ions.

The electrolytes break up in water to form aqueous solutions.



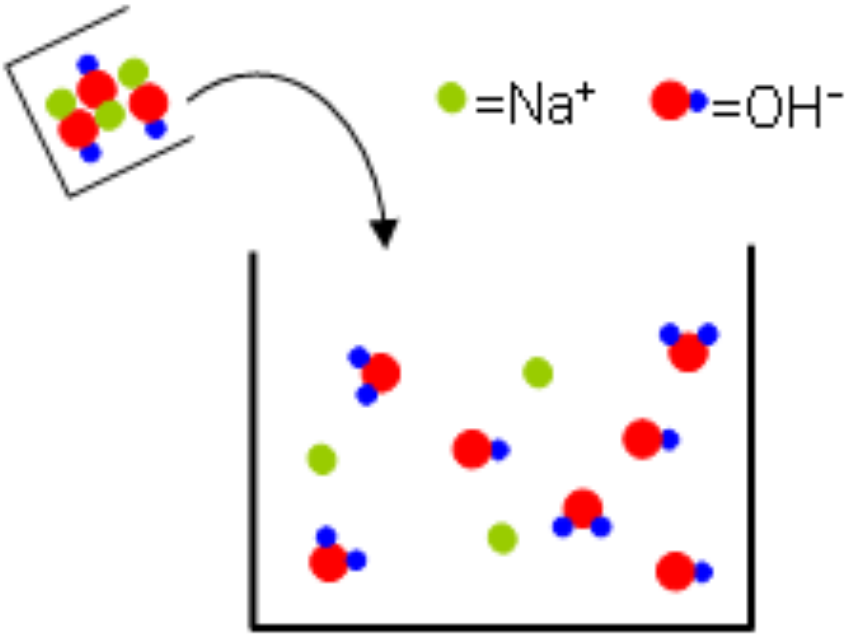
For Example:
Hydrochloric acid is a strong base,
in solution it is broken down into:
$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

Arrhenius Theory

Example 2.

Sodium hydroxide is a strong base

$NaOH(s) \rightarrow Na^{+}(aq) + OH^{-}(aq)$



Common Acids and bases

ACIDS

hydrochloric acid, HCl

sulfuric acid, H_2SO_4

nitric acid, HNO_3

acetic acid, $HC_2H_3O_2$ (vinegar)

carbonic acid, H_2CO_3

formic acid, $HCOOH$

acetylsalicylic acid, $C_6H_4(OCOCH_3)CO_2H$

BASES

sodium hydroxide, $NaOH$

potassium hydroxide, KOH

magnesium hydroxide, $Mg(OH)_2$

calcium hydroxide, $Ca(OH)_2$

ammonia, NH_3 - oops! Where's the OH^-?

Problem with Arrhenius Theory

There are many substances which are acidic or basic but do not have a hydrogen ion or a hydroxide ion.

For example,
baking soda (sodium bicarbonate, $NaHCO_3$) in water turns litmus **blue**, but has no apparent hydroxide ion.

The Arrhenius definition does not account for the acidity and basicity of these examples.

Bronsted-Lowry Theory

According to Bronsted-Lowry, an acid is a proton or H+ donor, while a base is a proton acceptor.

$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$

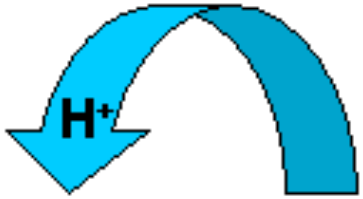
Acid	Base
Proton Donor	Proton Acceptor

In this example, **hydrogen chloride (hydrochloric acid)** reacts with **water** by donating a proton.

Water acts as the **base**, accepting the proton. The result is the H_3O^+ ion called the **hydronium ion**.

Bronsted-Lowry Theory

For the base ammonia, Bronsted-Lowry better explains the movement of the proton



$NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

Base Acid

Proton Acceptor

Proton Donor

Ammonia **accepts** a proton from water, making ammonia a **base** and water the acid.

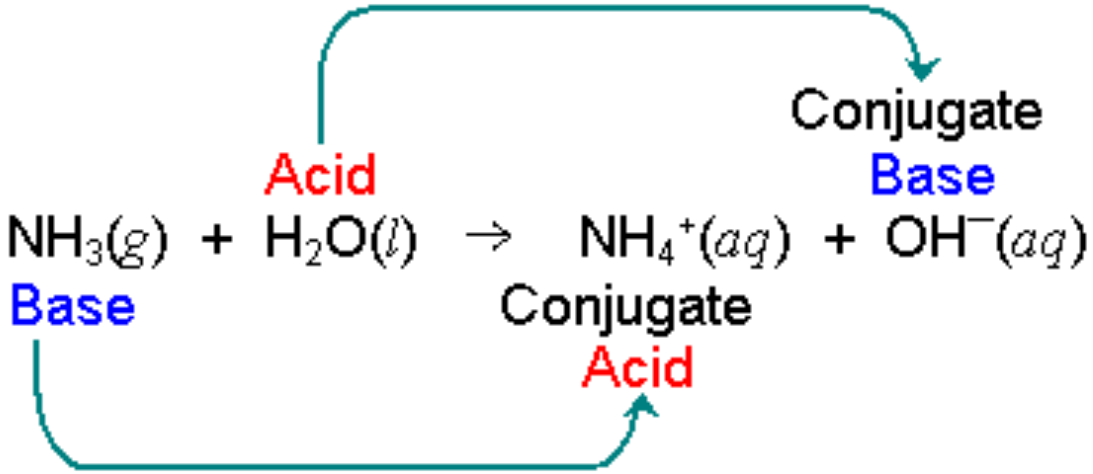
The result is the ammonium ion and the hydroxide ion.

Conjugate base pairs

The general form of a Brønsted-Lowry acid-base reaction is:

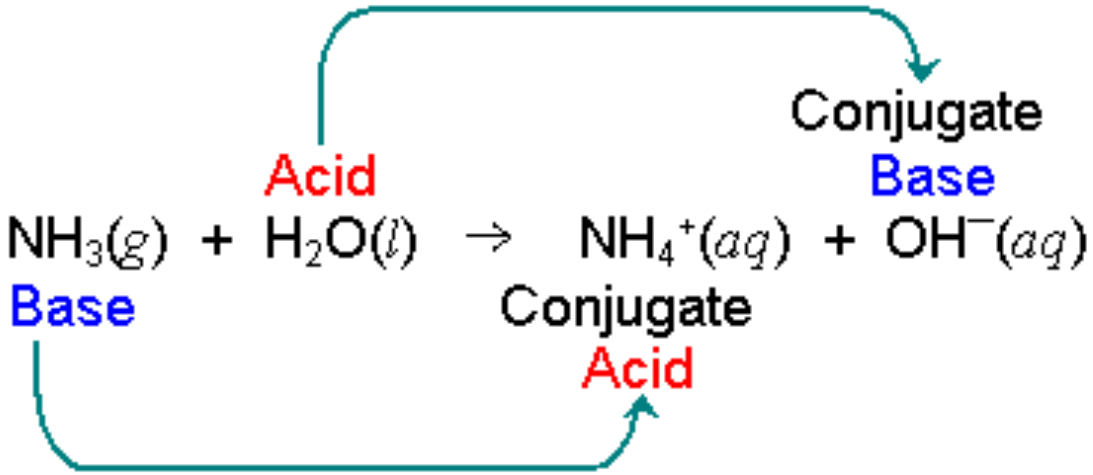
Acid + Base → Conjugate Acid + Conjugate Base

The **conjugate acid** is what remains after a base has accepted a proton and the **conjugate base** is what remains after the acid has donated its proton.



Conjugate Base pairs

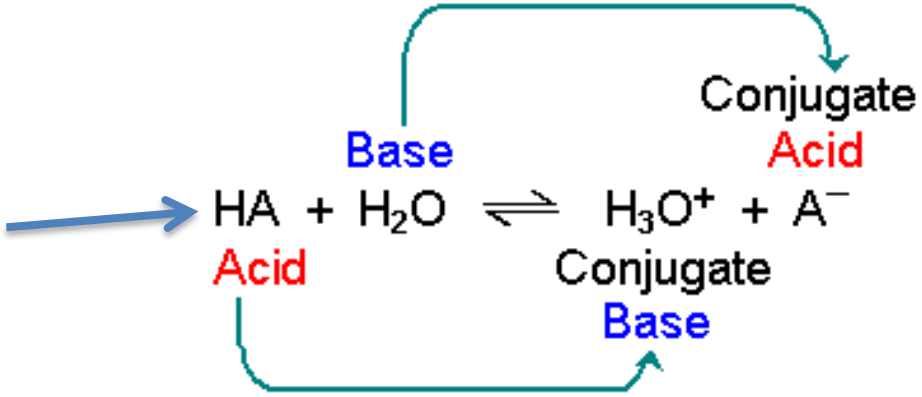
$NH_3(g)$ and $NH_4^+(aq)$ are called a conjugate acid-base pair, as are $H_2O(l)$ and $OH^-(aq)$.



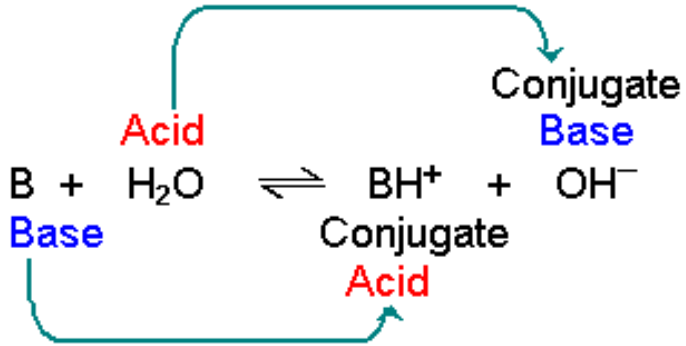
Conjugate base pairs

In general acid term,

H = proton

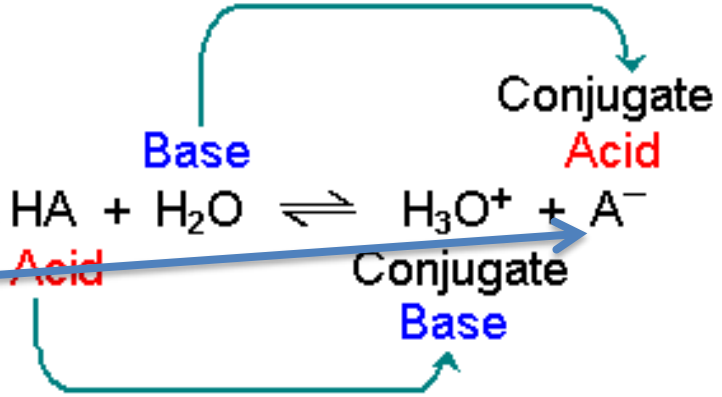


In general base term,



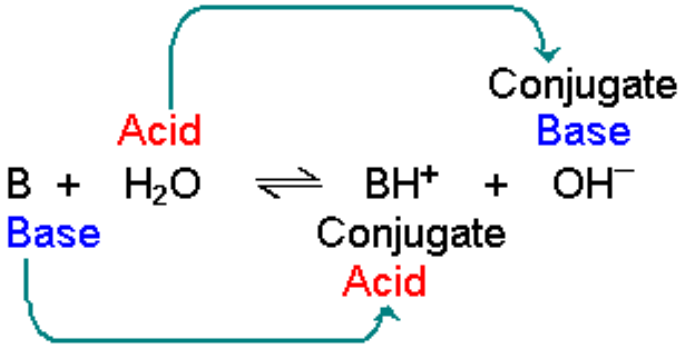
Determining your pairs

1. Look at your reaction
2. Look for 1 species on the **reactant** side and look for the **same** one on the product side
3. Did it gain or lose a H+?
4. If it lost a H+ then it is an acid
5. If it gained a H+ then it is a base



H = proton

In general base tern



Examples

		H + donor (the acid)	H + acceptor (the base)
a.	$HNO_{3\,(l)} + H_2O_{(l)} \rightarrow H_3O^+_{\,(aq)} + NO_3^-{}_{(aq)}$		
b.	$C_2H_5NH_{2\,(l)} + H_2O_{(l)} \rightarrow C_2H_5NH_3^+{}_{(aq)} + OH^-_{(aq)}$		
c.	$CH_3CO_2H_{(l)} + H_2O_{(l)} \rightarrow CH_3CO_2^-{}_{(aq)} + H_3O^+_{(aq)}$		

Identify the acid/base and the conjugate acid/base of the following

$HSO_4^-{}_{(aq)}$	+	$CO_3^{2-}{}_{(aq)}$	→	$SO_4^{2-}{}_{(aq)}$	+	$HCO_3^-{}_{(aq)}$
$HCO_3^-{}_{(aq)}$	+	$OH^-_{(aq)}$	→	$CO_3^{2-}{}_{(aq)}$	+	$H_2O_{(l)}$

Water as acid and base

Water can act as BOTH an acid and a base in terms of Bronsted-Lowry's definition.

These types of substances are called **amphoteric** (the root "amph" is similar to the root of amphibian which means "having two lives", on land and in water).

$$HA + H_2O(l) \leftrightarrows H_3O^+(aq) + A^-(aq)$$

Acid Base Conj Acid Conj Base

or

$$B + H_2O(l) \leftrightarrows BH^+(aq) + OH^-(aq)$$

Base Acid Conj Acid Conj Base