Solubility

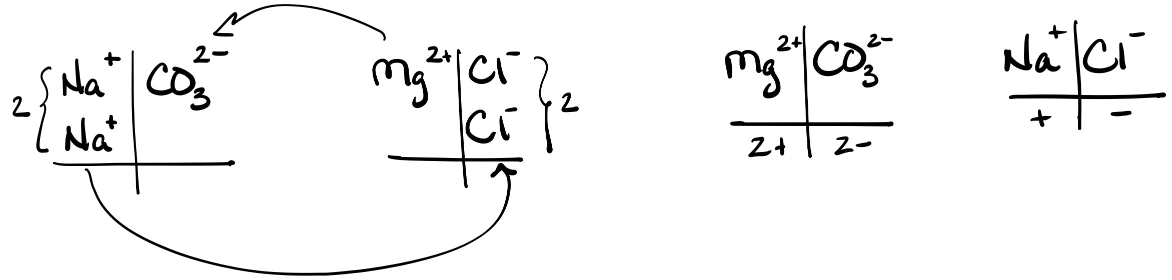
Solubility Rules

Ion	Rule	Exceptions
Group 1A (Na^+, K^+, Li^+) & NH_4^+	Always Soluble	None
NO_3^- & $C_2H_3O_2^-$	Always Soluble	None
Cl^-, Br^-, I^-	Usually Soluble	Pb^{2+}, Ag^+, Hg^{2+}
F^-, SO_4^{2-}	Usually Soluble	Pb^{2+}, Ca^{2+}, Ba^{2+}
OH^-, CO_3^{2-}, PO_4^{3-}	Usually Insoluble	Group 1A Cation & NH_4^+

Ex	(aq) (s) Soluble/Insoluble	Reason
$LiCl$	Soluble (aq)	Li^+ group 1A always soluble
$Fe(OH)_3$	Insoluble (s)	OH^- usually insoluble $\Rightarrow Fe^{3+}$ not an exception
$(NH_4)_3PO_4$	Soluble (aq)	NH_4^+ always sol.
$MgCO_3$	Insoluble	CO_3^{2-} usually insoluble & Mg^{2+} not an exception.

Give the products of the following double displacement react, decide on solubility, write the balanced Chemical, Ionic, and net ionic equations.

$$\underset{\overset{\uparrow}{\text{mon}}}{Na}_2\underset{\overset{\uparrow}{\text{poly}}}{CO_3}{}_{(aq)} + \underset{\overset{\uparrow}{\text{mon}}}{Mg}\underset{\overset{\uparrow}{\text{mon}}}{Cl}_{2(aq)} \longrightarrow MgCO_{3(s)} + NaCl_{(aq)}$$



① monatomic vs polyatomic to help w/ subscripts ✓

② Balance formulas for products ✓

③ decide on solubility ✓

④ Balance Chem Eq

⑤ write Ionic

⑥ write net ionic

$$MgCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow MgCO_{3(s)} + \underline{2}NaCl_{(aq)}$$

Mg^{2+}	1	1 ✓
Cl^-	2	✗ 2 ✓
Na^+	2	✗ 2 ✓
CO_3^{2-}	1	1 ✓

Chemical

$$MgCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow MgCO_{3(s)} + 2NaCl_{(aq)}$$

Ionic Eqs (aq) → dissociated but (s), (l), (g) → $\underline{\underline{\text{do}}}$ $\underline{\underline{\text{not}}}$ $\underline{\underline{\text{dissociate}}}$

$$Mg^{2+}_{(aq)} + \underline{2Cl^-_{(aq)}} + \underline{2Na^+_{(aq)}} + CO^{2-}_{3(aq)} \rightarrow MgCO_{3(s)} + \underline{2Na^+_{(aq)}} + \underline{2Cl^-_{(aq)}}$$

net Ionic

$$Mg^{2+}_{(aq)} + CO^{2-}_{3(aq)} \rightarrow MgCO_{3(s)}$$

① $2Na + H_2O \rightarrow Na_2O + H_2$ Single Replacement

A + B → C

② $2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$ Combination

A → B + C

③ $2H_2O \rightarrow H_{2(g)} + O_{2(g)}$ Decomposition

④ $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ Combustion

$$\overset{A\,B}{H_2SO_4} + \overset{C\,D}{2NaOH} \rightarrow \overset{C\,B}{Na_2SO_4} + \overset{\boxed{A\,D}}{2H_2O}$$

⑤ Acid/Base

Double displacement

That Concludes Chapter 7

Chapter 8 is Acid / Base

$^{1}_{1}H^+$ hydrogen ion = or Proton

$p^+ = 1$ ⇐ only a proton

$e^- = 0$

$n^\circ = 0$

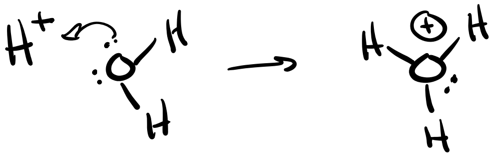
3 Definitions of Acid and Base

Arrhenius Definition

Acid = produces hydrogen ion / hydronium ion when placed into water.

$$HA_{(l)} \xrightarrow{H_2O} H^+_{(aq)}$$

Hydrogen ion



= H_3O^+

hydronium

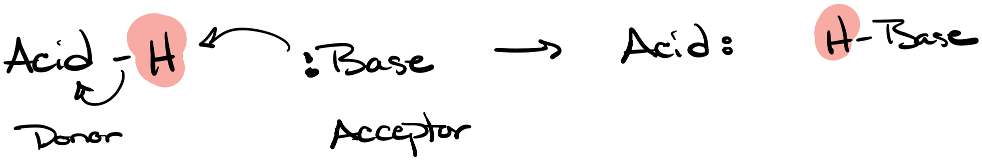
$$H^+_{(aq)} = H_3O^+$$

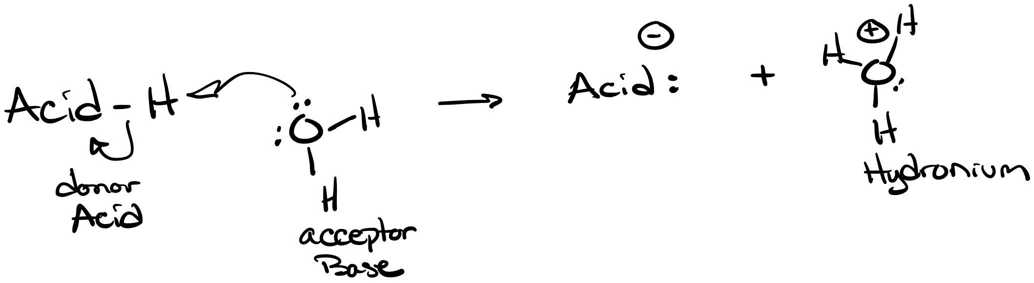
Base = A substance that produces hydroxide ion when placed into H_2O.

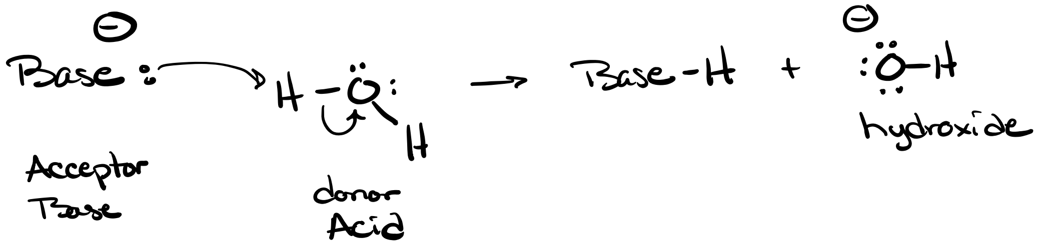
$MOH \xrightarrow{H_2O} OH^-$ hydroxide ion

A Better definition   Brönsted - Lowry

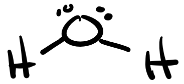
Acid - A proton donor
Base - A proton acceptor } water not part of def.

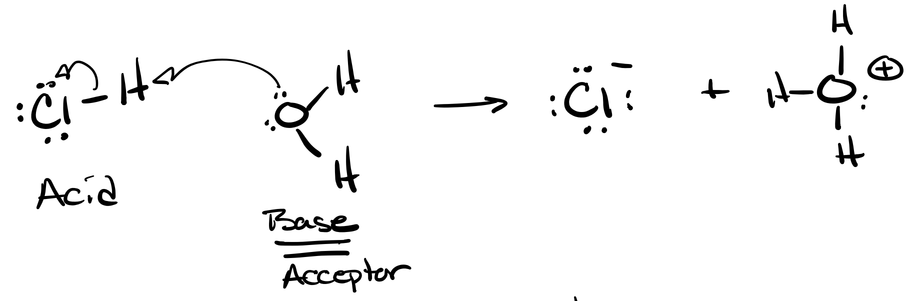


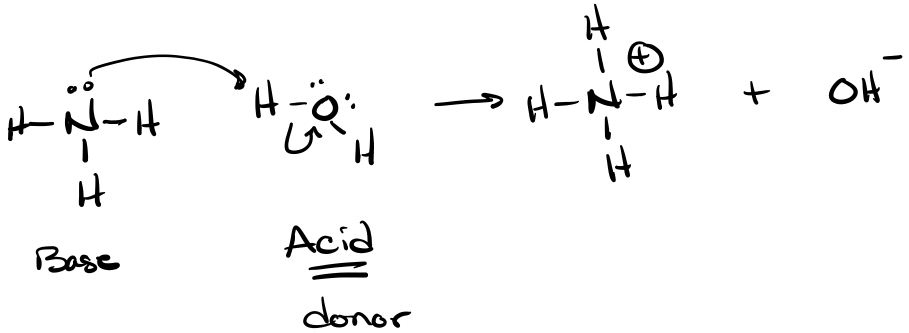




Is water an acid or base or neither?



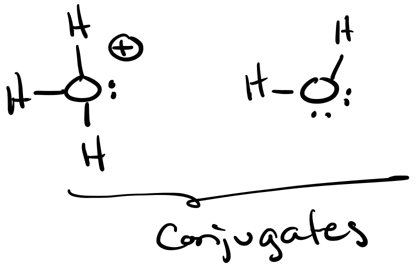


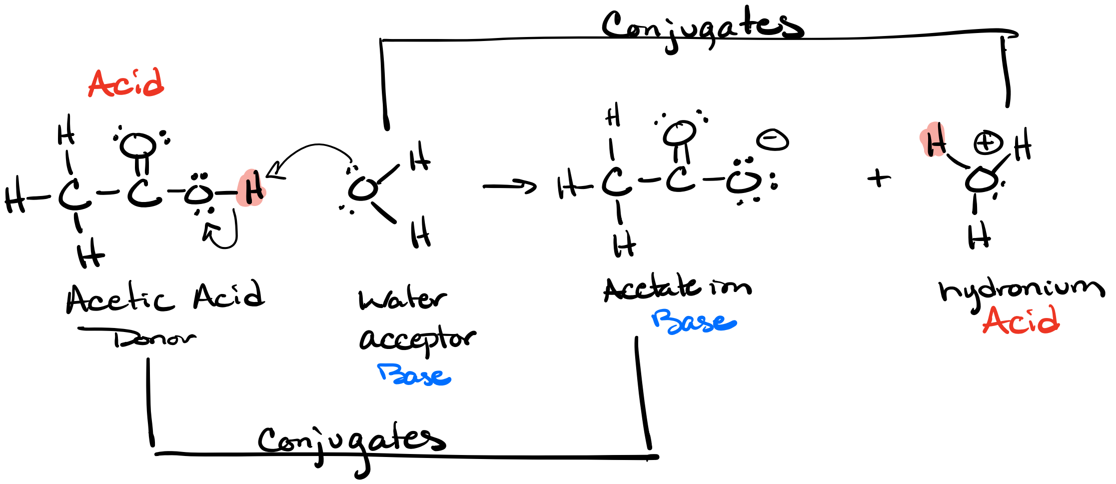


H_2O can be an acid or a base depending on what it is reacting with.

Amphoteric - can be an acid or a base.

Conjugate - A relationship between two Compounds that differ by one proton.





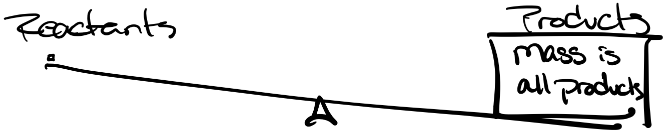
Strength of Acid - Degree of dissociation

Strong Acid - Dissociates Completely when placed into water

associate — dissociated

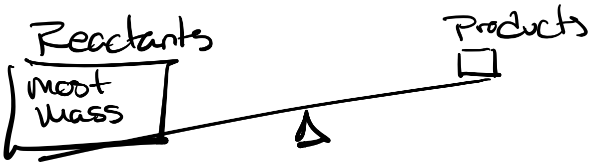
$$H-Cl_{(g)} + H_2O_{(l)} \rightarrow Cl^{-}_{(aq)} + H_3O^{+}_{(aq)}$$

Initially	100 molecules	100 molecules	0	0
After	1 molecule	1 molecule	99 ions	99 ions



Weak Acid - An acid that dissociates only a little when placed into water.

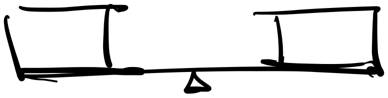
Initial	100 molecules	100 molecules	0	0
After	85 molecules	85 molecules	15 ions	15 ions



Chemical Reaction

Coefficients must balance

$$aA + bB \rightleftharpoons cC + dD$$



mass Balance

Equilibrium - what side is favored after coefficients are balanced.

Strong Acid

Reactants $\rightleftharpoons$ Products Product favored

weak acid

Reactant $\rightleftharpoons$ Products Reactant favored

Strong Acid

HCl	hydrochloric acid
HNO_3	Nitric acid
H_2SO_4	Sulfuric acid
HBr	hydrobromic acid
HI	hydroiodic acid

weak Acid

many weak acids

ex

$HC_2H_3O_2$	acetic acid
$H_2C_2O_2$	oxalic acid

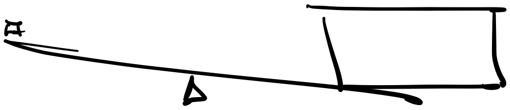
* Any acid not on strong list

Strength Base

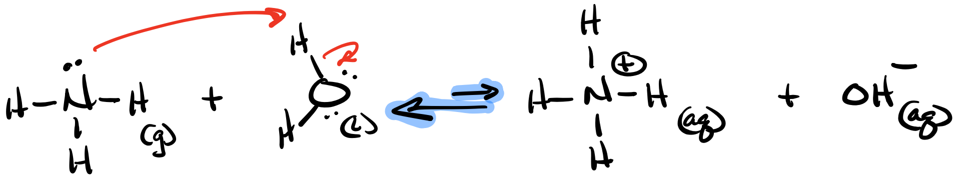
Strong base → dissociates completely in H_2O

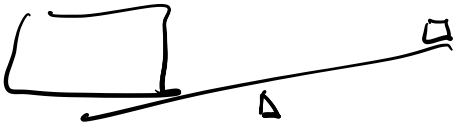
Generally Group 1A metal hydroxides

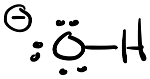
$$NaOH_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$$



weak base - dissociates only a little in H_2O







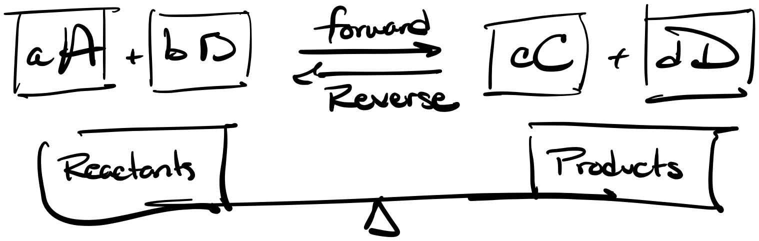
$$aA + bB \rightleftharpoons cC + dD$$

coefficients from balance eq.

$$\text{Reaction Qutient} = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b} = \frac{\text{Products}}{\text{Reactants}}$$

= measures the progress of a reaction

If chemical Reaction was Stuck smack in middle



two rates equal

all equal

$$Q = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b} = \frac{1 \times 1}{1 \times 1} = 1$$

exactly same amount of reactants as products.

[ ] = Concentration
molarity = moles/L

Strong Acid or Strong base

$$a\underset{\square}{A} + b\underset{\square}{B} \underset{\leftarrow}{\longrightarrow} \boxed{cC} + \boxed{dD}$$

$$Q = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b} = \frac{\text{Big }\#}{\text{Very Small }\#} >> \underline{1}$$

Weak acid or Weak Base

$$\boxed{aA} + \boxed{bB} \overset{\rightarrow}{\longleftarrow} c\underset{\square}{C} + d\underset{\square}{D}$$

$$Q = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b} = \frac{\text{Very Small }\#}{\text{Big }\#} << \underline{1}$$