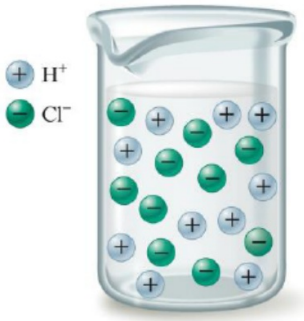
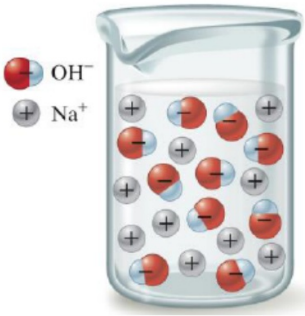
Acids & Bases

Definition	Acid	Base
Arrhenius	Produces H^+ ions when dissolved in water	Produces OH^- ions when dissolved in water
Bronsted-Lowry	Proton (H^+) donor	Proton (H^+) acceptor
Lewis	Electron pair acceptor	Electron pair donor

Strong Acids and Bases Completely Ionize in Water (100% dissociation into ions)

Strong Acids: HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_4$

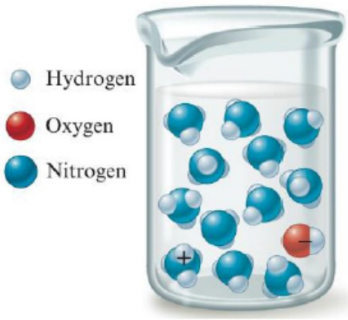




Strong Bases: LiOH, NaOH, KOH, RbOH, CsOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$ (the "b" hydroxides of Grp. I & II)

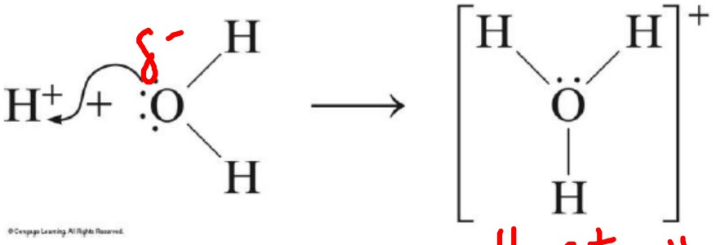
Weak Acids and Bases Ionize Partially in Water

Weak Acid Example: $HC_2H_3O_2$ (acetic acid) majority of molecules stay whole



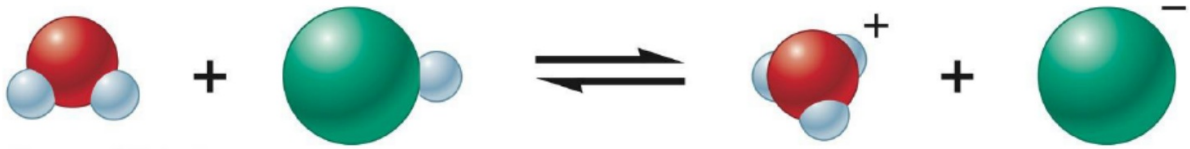
Weak Base Example: NH_3 (ammonia) majority of molecules stay whole

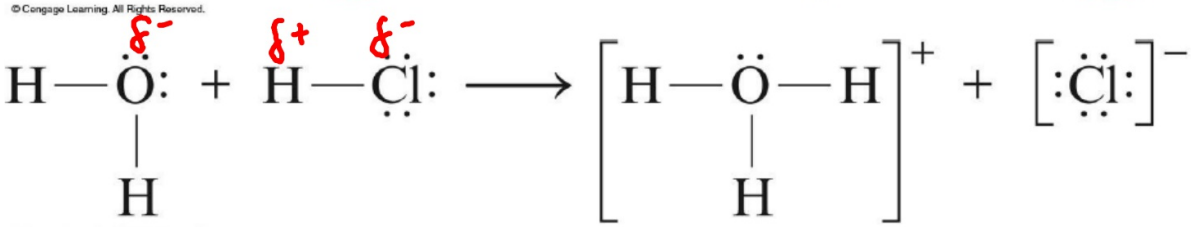
How H^+ (a proton) Reacts with Water



H_3O^+ = Hydronium

HCl Dissociation





H_3O^+

$HC_2H_3O_2$ Dissociation

acetic acid

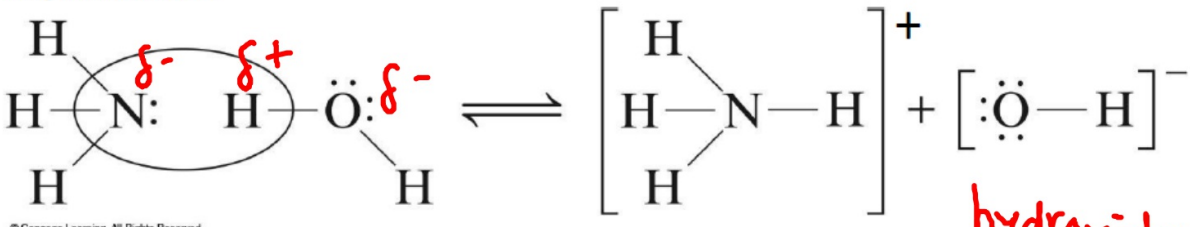
$HC_2H_3O_2$

acetate

$C_2H_3O_2^-$

H_3O^+

NH_3 Dissociation



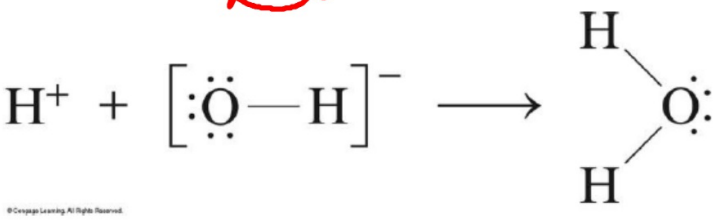
NH_4^+
ammonium

hydroxide

Acid-Base Reactions (aka Neutralization Rxns)

1. **Strong Acid + Strong Base**

   Example: $HCl + NaOH \rightarrow H_2O + NaCl$

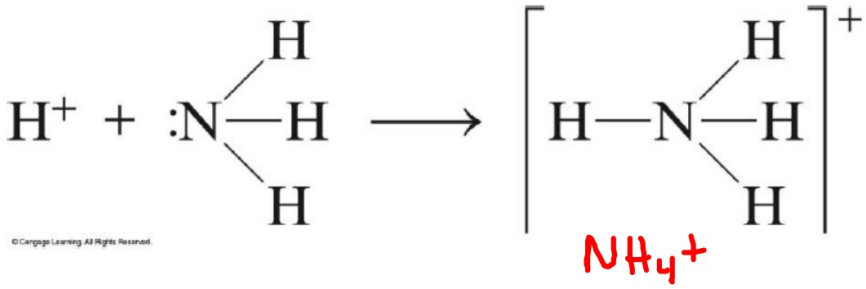


2. **Weak Acid + Strong Base**

   Example: $HC_2H_3O_2 + NaOH \rightarrow NaC_2H_3O_2 + H_2O$

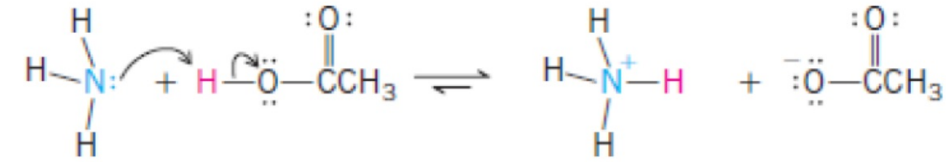
3. **Strong Acid + Weak Base**

   Example: $HCl + NH_3 \rightarrow NH_4^+ + Cl^-$



4. **Weak Acid + Weak Base**

   Example: $HC_2H_3O_2 + NH_3 \rightarrow NH_4^+ + C_2H_3O_2^-$



Ammonia	Acetic acid $pK_a = 4.7$ stronger acid	Ammonium ion $pK_a = 9.2$ weaker acid	Acetate ion

Net Ionic Equations for Acid-Base Reactions

- Strong acids and bases completely ionize, thus write as ions
  - Strong acid will always produce H^+ (anion spectates)
  - Strong base will always produce OH^- (cation spectates)
- Weak acids and bases mainly stay as whole molecule, thus write complete formulas (no ions)
- Nonelectrolytes (like water) do not ionize, thus write complete formulas

<u>Examples</u>:

1. $HClO_4(aq) + KOH(aq)$

SA SB

$$H^+_{(aq)} + \cancel{ClO_4^-_{(aq)}} + \cancel{K^+_{(aq)}} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + \cancel{K^+_{(aq)}} + \cancel{ClO_4^-_{(aq)}}$$

$$\boxed{H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}}$$ NET

2. $HI(aq) + CH_3NH_2(aq)$

SA WB

$$H^+_{(aq)} + \cancel{I^-_{(aq)}} + CH_3NH_2(aq) \rightarrow CH_3NH_3^+{}_{(aq)} + \cancel{I^-_{(aq)}}$$

$$\boxed{H^+_{(aq)} + CH_3NH_2(aq) \rightarrow CH_3NH_3^+{}_{(aq)}}$$ NET

3. $HNO_2(aq) + Ca(OH)_2(aq)$

WA SB

$$HNO_2(aq) + \cancel{Ca^{2+}_{(aq)}} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + \cancel{Ca^{2+}_{(aq)}} + NO_2^-{}_{(aq)}$$

$$\boxed{HNO_2(aq) + OH^-_{(aq)} \rightarrow H_2O_{(l)} + NO_2^-{}_{(aq)}}$$ NET

Acid-Base Calculations

1. List the species in the combined solution before any reaction occurs, and decide what reaction will occur.
2. Write the balanced net ionic equation for this reaction.
3. Calculate the moles of reactants. For reactions in solution, use the volumes of the original solutions and their molarities.
4. Determine the limiting reactant where appropriate.
5. Calculate the moles of the required reactant or product.
6. Convert to grams or volume (of solution), as required.