Chapter 4

Reactions In Aqueous Solution

I) General Properties of Aqueous Solutions

Homogeneous mixture on a
molecular level

- prop. same throughout

- separable by physical means

- variable composition

Has at least 2 components:

Solvent :   component present in
greatest amount
- same phase as soln.

Solute(s) :   other component(s)

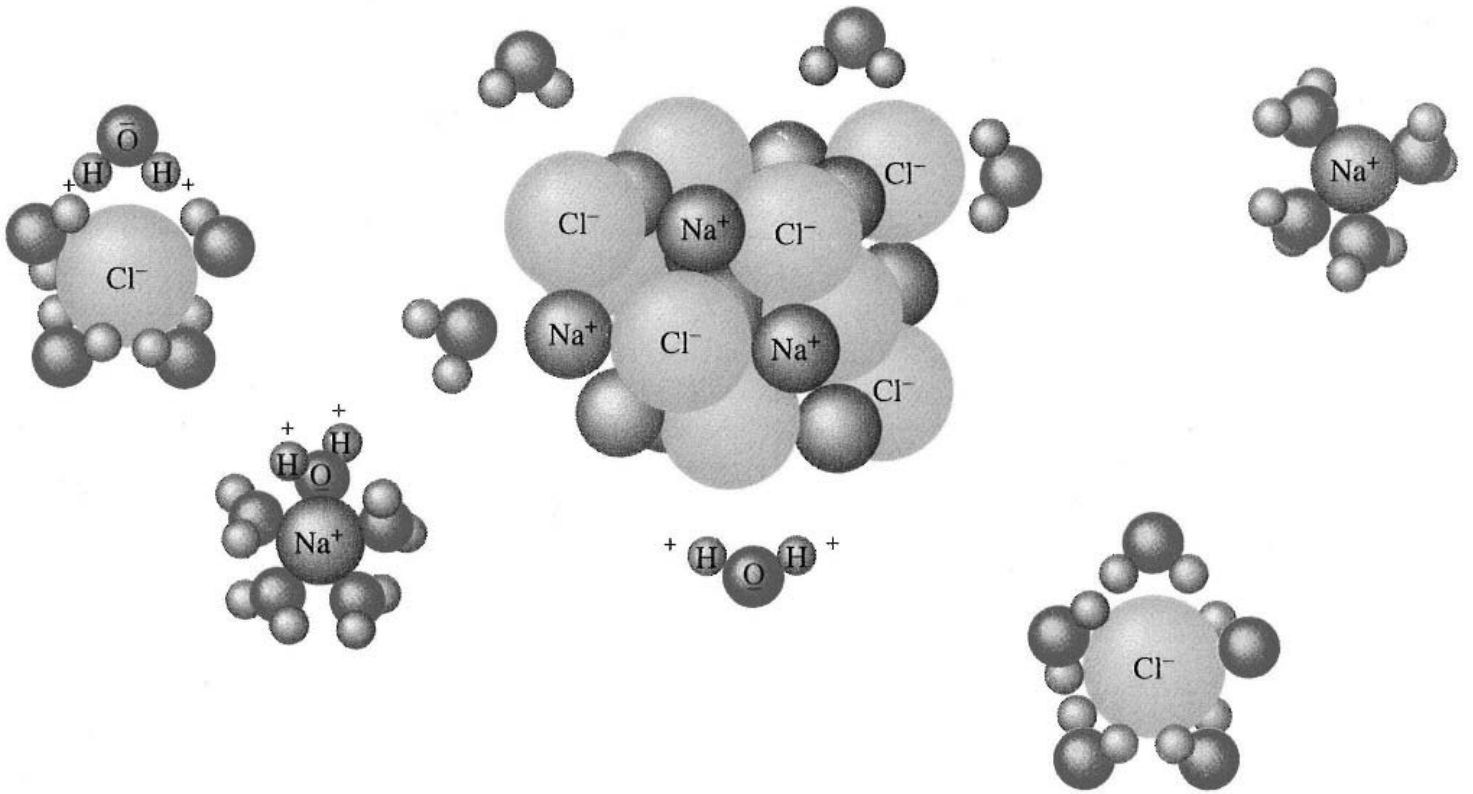# A) <u>Dissolution</u>

Process of dissolving

Solute is solvated by solvent

Solvent surrounds solute

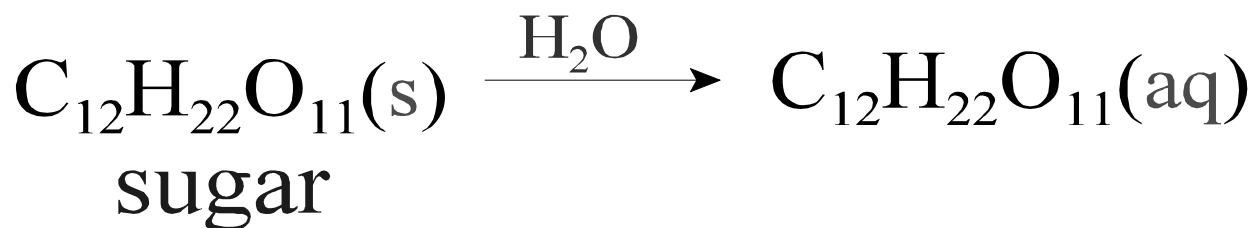Solvation

1) <u>Aqueous</u>

H_2O as solvent

B) Nonelectrolytes

Substances which dissolve
in molecular form

- Present as molecules in solid, liquid
  & gas states and in soln.

  - do NOT form ions in soln.

Soln. does NOT conduct electricity

Pure H_2O

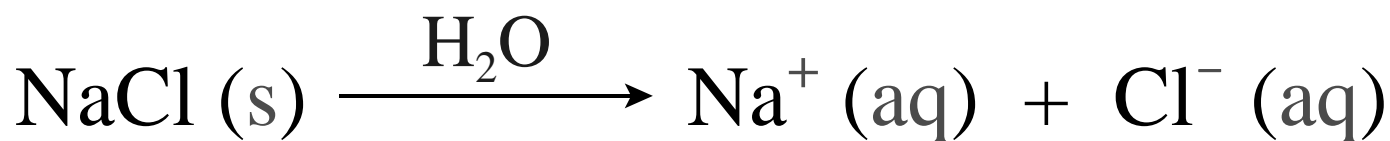$$C_{12}H_{22}O_{11}(s) \xrightarrow{H_2O} C_{12}H_{22}O_{11}(aq)$$

sugar

C) Electrolytes

Substance whose aqueous soln. conducts electricity

- due to ions in the soln.

1) Dissociation

Ionic solutes dissolve as ions

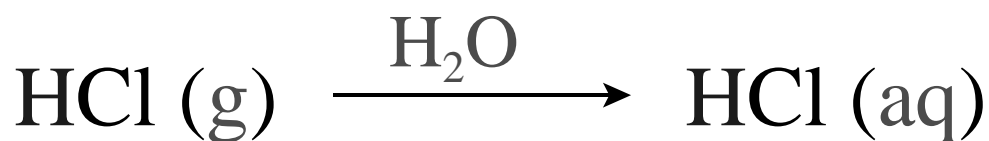$$NaCl\ (s) \xrightarrow{\text{H}_2\text{O}} Na^+\ (aq)\ +\ Cl^-\ (aq)$$

Dissociation

All soluble ionic substances dissociate completely

- strong electrolytes

2) Ionization

Some polar covalent molecules dissolve w. formation of ions.

1) Strong Acids

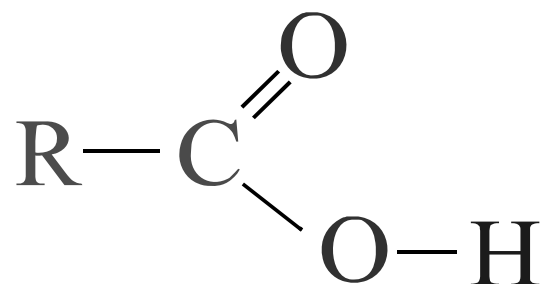$$HCl\ (g)\ \xrightarrow{\ H_2O\ }\ HCl\ (aq)$$

$$HCl\ (aq)\ \xrightarrow{\ H_2O\ }\ H^+\ (aq)\ +\ Cl^-\ (aq)$$

Ionization

HCl - strong electrolyte
(completely ionizes)

2) Weak Electrolytes

Weak conductors

- Partial ionization

a) Weak Acids & Bases
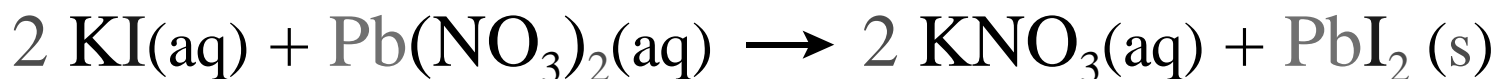
$$R-C\underset{O-H}{\overset{\displaystyle O}{<}}$$

$$CH_3CO_2H(aq) \rightleftharpoons H^+(aq) + CH_3CO_2^-(aq)$$

Chemical Equilibrium

- some molecular form remains

$$:NH_3(aq) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

II) Precipitation Reactions

Precipitate ≡ insoluble solid formed

$$2\ KI(aq) + Pb(NO_3)_2(aq) \longrightarrow 2\ KNO_3(aq) + PbI_2\ (s)$$

A) Solubility Rules

Which ionic cmpds. are soluble or insoluble in H_2O

1) Solubility

amt. of solid that dissolves in a given amt. of H_2O at a given temp.

NOTE: ALL ionic cmpds. of group IA & NH_4^+ are soluble

# EMPIRICAL RULES FOR THE SOLUBILITY OF IONIC SOLIDS IN H_2O

COMPOUNDS CONTAINING	SOLUBILITY	IMPORTANT EXCEPTIONS
alkali metal (grp 1A) ammonium (NH_4^+)	Soluble	None
nitrates (NO_3^-), acetates ($C_2H_3O_2^-$), chlorates (ClO_3^-), perchlorates (ClO_4^-), permanganates (MnO_4^-)	Soluble	None
chlorides (Cl^-), bromides (Br^-), iodides (I^-)	Soluble	Cmpds of Ag^+, Hg_2^{2+}, Pb^{2+}, Hg^{2+} iodide and Hg^{2+} bromide
sulfates (SO_4^{2-})	Soluble	Cmpds of Sr^{2+}, Ba^{2+}, Hg_2^{2+}, Pb^{2+}
hydroxides (OH^-), oxides (O^{2-}), sulfides (S^{2-})	Insoluble	Cmpds of alkali metals (grp 1A) , NH_4^+, Ca^{2+}, Sr^{2+}, Ba^{2+}
sulfites (SO_3^{2-}), carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^{2-})	Insoluble	Cmpds of alkali metals (grp 1A) , NH_4^+

B) Exchange (Metathesis) Reactions

Also called, Double-Replacement Rx's

Cations & Anions exchange partners

$$AX + BY \longrightarrow AY + BX$$

or

$$AX + BY \longrightarrow BX + AY$$
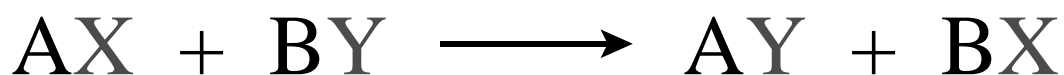
Must be a driving force for a rx. to occur (remove ions)

- formation of precipitate

- formation of gas

- formation of weak or
　　　　　　　　nonelectrolyte
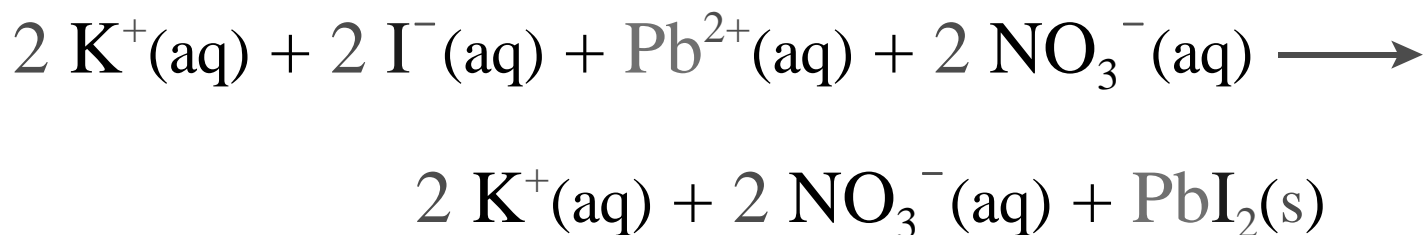
1) <u>Precipitation Reactions</u>

$$2 \text{ KI(aq)} + \text{Pb(NO}_3)_2\text{(aq)} \longrightarrow 2 \text{ KNO}_3\text{(aq)} + \text{PbI}_2 \text{ (s)}$$

a) <u>Molecular Eqn</u>:

written as if all substances were molecules

- tells what soln's are combined

- must use for quantitative calc.

b) <u>Ionic Eqn</u>:

shows each substance as it exist in soln.

$$2 \text{ K}^+\text{(aq)} + 2 \text{ I}^-\text{(aq)} + \text{Pb}^{2+}\text{(aq)} + 2 \text{ NO}_3^-\text{(aq)} \longrightarrow$$

$$2 \text{ K}^+\text{(aq)} + 2 \text{ NO}_3^-\text{(aq)} + \text{PbI}_2\text{(s)}$$

1) soluble ionic substances written as ions(aq)

$$Na^+(aq) \; + \; Cl^-(aq)$$

2) insoluble ionic substances written as formula(s) $\Rightarrow$ XY(s)

$$AgBr(s)$$

3) molecular subst. that are strong electrolytes $\Rightarrow$ ions(aq)

$$H^+(aq) \; + \; Cl^-(aq)$$

4) molecular weak electrolytes or nonelectrolytes $\Rightarrow$ molecular formula (phase)

$$CH_3CO_2H(aq), \quad H_2O(\ell)$$
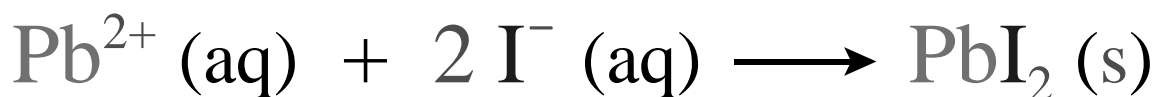
b) <u>Net Ionic</u> Eqn:

<u>Note</u> : K^+ & NO_3^- do not undergo change & appear on both sides of arrow

Spectator Ions

Eliminate spectator Ions $\Longrightarrow$
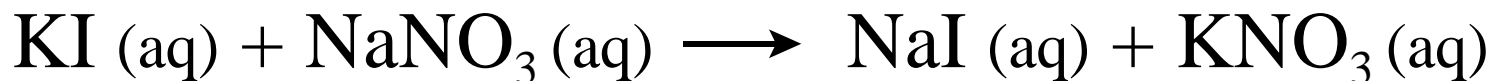
Net Ionic Eqn.

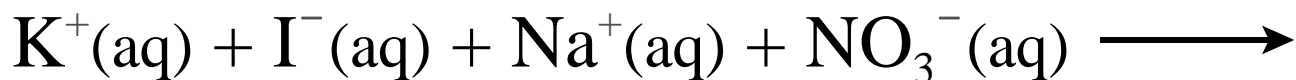Pb^{2+} (aq) + 2 I^- (aq) $\longrightarrow$ PbI_2 (s)

<u>2 Advantages</u>

1) focuses attention on change that is occurring

2) more general: Any subst. that produces Pb^{2+} + I^- in soln. will produce a ppt. of PbI_2 (s)

2) <u>Ex</u>: Mix KI (aq) & $NaNO_3$ (aq) soln's.

$KI_{(aq)} + NaNO_{3(aq)} \longrightarrow NaI_{(aq)} + KNO_{3(aq)}$

Ionic Eqn:

$K^+_{(aq)} + I^-_{(aq)} + Na^+_{(aq)} + NO_3^-_{(aq)} \longrightarrow$

$Na^+_{(aq)} + I^-_{(aq)} + K^+_{(aq)} + NO_3^-_{(aq)}$

Eliminate ALL spectator ions

- nothing left

No driving force

∴ If we know solubilities of cmpds then we can predict when a ppt. will occur.

III) Acids, Bases & Neutralization Rxns.

A) Acids

Ionize in water to form H^+(aq)

- Proton donors

HCl, H_2SO_4, $HC_2H_3O_2$ (CH_3CO_2H)

1) 7 Strong Acids

Ionize Completely

HCl, HBr, HI, HNO_3, $HClO_3$, $HClO_4$, H_2SO_4 (1st H^+ only)

$$HCl \, (aq) \longrightarrow H^+ \, (aq) \, + \, Cl^- \, (aq)$$

2) <u>Weak Acids</u>

Partial ionization

    - weak electrolyte

$$HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$$

Chemical Equilibrium

Acid that's NOT a strong acid

$HF,\ HNO_2,\ HClO_2, HSO_4^-$

B) <u>Bases</u>

Produce OH^- (aq) in water

   - Proton acceptors

NaOH, Ca(OH)$_2$, NH$_3$

1) <u>Strong Bases</u>

   soluble ionic cmpds. which dissolve to give OH^-

NaOH (s) $\longrightarrow$ Na$^+$ (aq) + OH^- (aq)

   Dissociate completely

   Hydroxides & Oxides of Groups
     IA & IIA (except Be, Mg)

2) Weak Bases

Partially ionized

a) Ammonia, NH_3

$$:NH_3(aq) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

b) Amines

$$R-\ddot{N}H_2, \quad R_2-\ddot{N}H, \quad R_3-\ddot{N}$$

$$CH_3\ddot{N}H_2(aq) + H_2O(\ell) \rightleftharpoons CH_3NH_3^+(aq) + OH^-(aq)$$

methylamine   methylammonium
                              ion
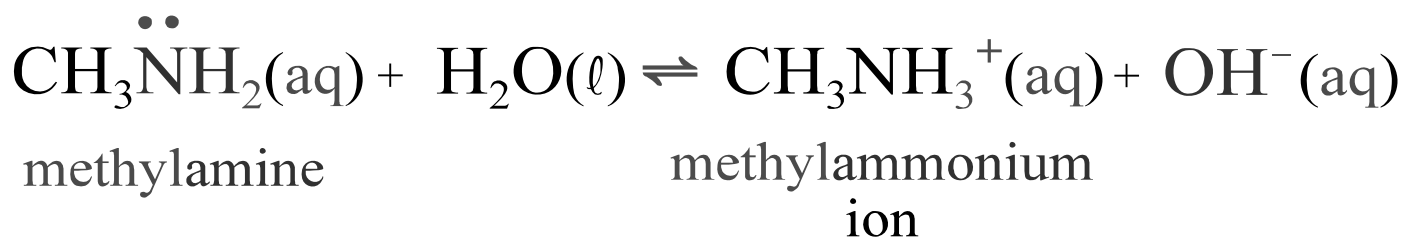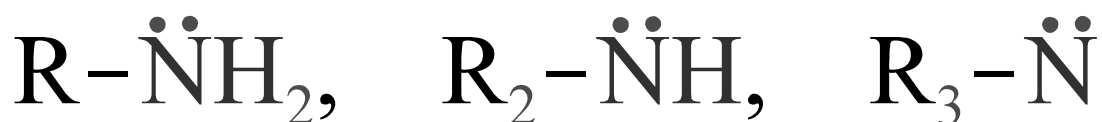
C) <u>Neutralization Rx's</u>

Formation of Weak or Nonelectrolyte

1) <u>Strong Acid & Strong Base</u>

$HCl\ (aq) + NaOH(aq) \longrightarrow NaCl(aq) + HOH(\ell)$
acid   base   salt   water
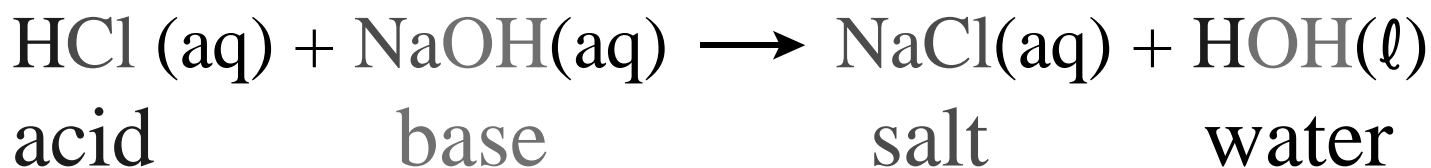
Driving Force $\Rightarrow$ formation of H_2O

<u>Net Ionic Eq.</u>

$H^+\ (aq)\ +\ OH^-\ (aq) \longrightarrow H_2O\ (\ell)$
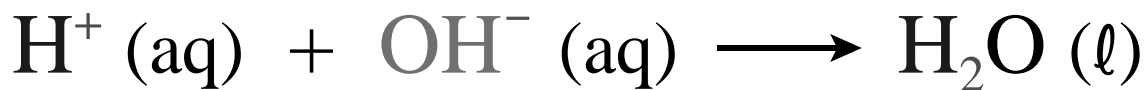
True for rx. between
any strong acid & strong base

2) Weak Acid & Strong Base

HF (aq) $+ KOH$ (aq) $\longrightarrow KF$ (aq) $+ H_2O$ (ℓ)

Net :

HF (aq) $+ OH^-$ (aq) $\longrightarrow F^-$ (aq) $+ H_2O$ (ℓ)
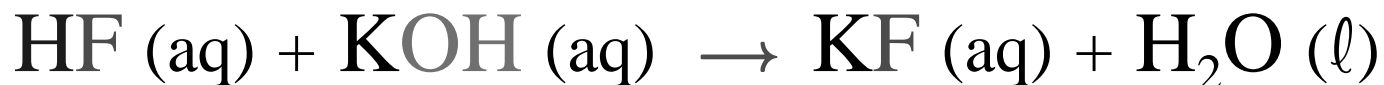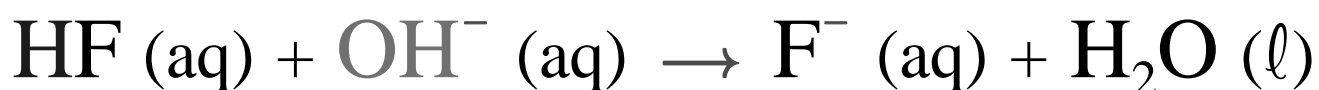
Generally,

Rx. of weak monoprotic acid
w. strong soluble base

HA (aq) $+ OH^-$ (aq) $\longrightarrow A^-$ (aq) $+ H_2O$ (ℓ)

3) Weak Base & Strong Acid

$$HCl \text{ (aq)} + NH_3 \text{ (aq)} \longrightarrow NH_4^+ \text{ (aq)} + Cl^- \text{ (aq)}$$

Net :

$$H^+ \text{ (aq)} + NH_3 \text{ (aq)} \longrightarrow NH_4^+ \text{ (aq)}$$
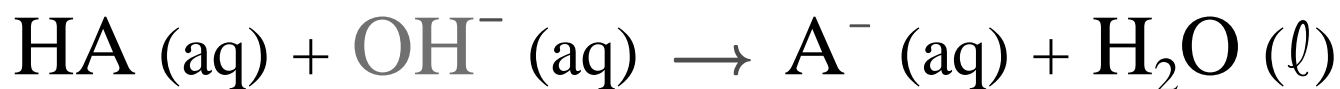
4) Insoluble Hydroxides & Acids

$$Cu(OH)_2 \text{ (s)} + 2 \, HCl \text{ (aq)} \longrightarrow CuCl_2 \text{ (aq)} + 2 \, H_2O \text{ (}\ell\text{)}$$

Net:

$$Cu(OH)_2 \text{ (s)} + 2 \, H^+ \text{ (aq)} \longrightarrow Cu^{2+} \text{ (aq)} + 2 \, H_2O \text{ (}\ell\text{)}$$
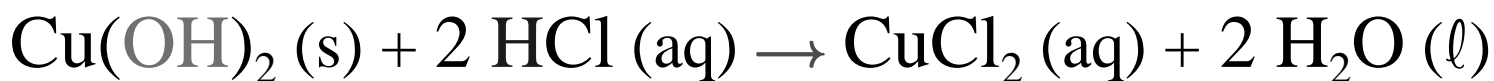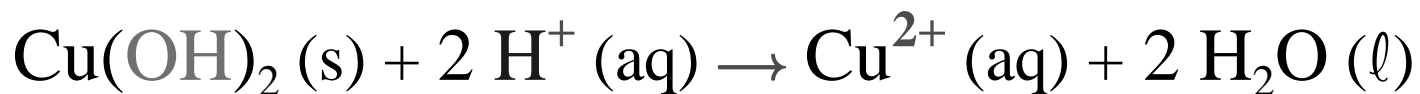
5) Formation of Weak Electrolyte

$$NaC_2H_3O_2(aq) + HCl(aq) \longrightarrow HC_2H_3O_2(aq) + NaCl(aq)$$

Net:

$$C_2H_3O_2^-\ (aq)\ +\ H^+\ (aq)\ \rightleftharpoons\ HC_2H_3O_2\ (aq)$$
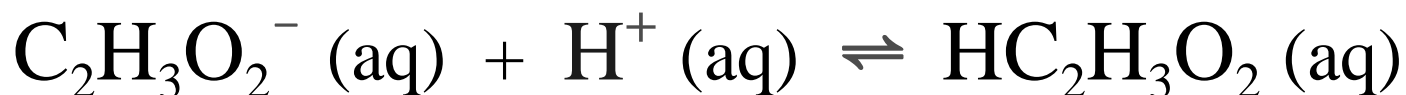
formation of $HC_2H_3O_2$ removes ions from soln.

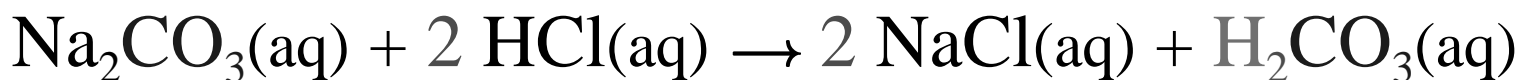**D)** Neutralization Rx's w. Gas Formation
Gaseous product which escapes
from the soln.

1) Carbonates & Bicarbonates

$$Na_2CO_3(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + H_2CO_3(aq)$$

Carbonic acid decomposes:

$$H_2CO_3(aq) \longrightarrow H_2O(\ell) + CO_2(g)$$

$$Na_2CO_3\ (aq)\ +\ 2\ HCl\ (aq) \longrightarrow$$

$$2\ NaCl\ (aq)\ +\ H_2O\ (\ell)\ +\ CO_2\ (g)$$

Net:

$$CO_3{}^{2-}(aq) + 2\ H^+(aq) \longrightarrow H_2O(\ell) + CO_2(g)$$
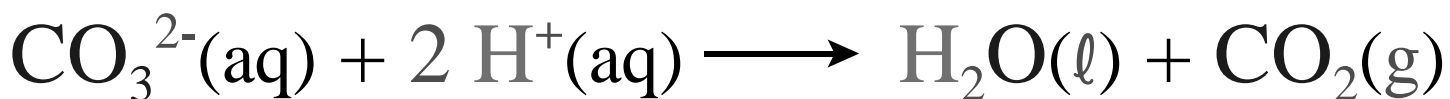
Insoluble Carbonates also work:

Net:

$$CaCO_3(s) + 2\ H^+(aq) \longrightarrow$$

$$Ca^{2+}(aq) + H_2O(\ell) + CO_2(g)$$

Bicarbonates

$$NaHCO_3\ (aq)\ +\ HCl\ (aq) \longrightarrow$$

$$NaCl\ (aq)\ +\ H_2O\ (\ell)\ +\ CO_2\ (g)$$

2) Sulfites & Bisulfites

$Na_2SO_3(aq) + 2 HCl(aq) \rightarrow 2 NaCl(aq) + H_2SO_3(aq)$
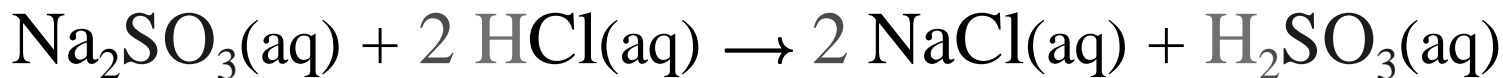
Sulfurous acid decomposes:

$H_2SO_3(aq) \longrightarrow H_2O(\ell) + SO_2(g)$

$Na_2SO_3 (aq) + 2 HCl (aq) \longrightarrow$

$2 NaCl (aq) + H_2O (\ell) + SO_2 (g)$

Net:

$SO_3{}^{2-}(aq) + 2 H^+(aq) \longrightarrow H_2O(\ell) + SO_2(g)$

Bisulfites

$NaHSO_3 (aq) + HCl (aq) \longrightarrow$

$NaCl (aq) + H_2O (\ell) + SO_2 (g)$

3) Sulfides

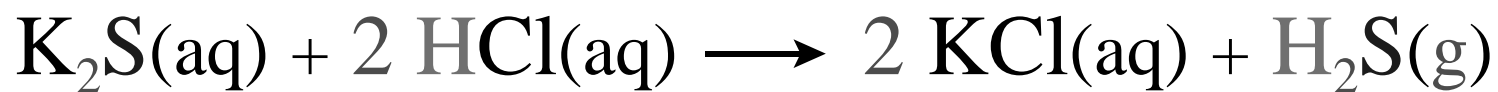$$K_2S(aq) + 2\ HCl(aq) \longrightarrow 2\ KCl(aq) + H_2S(g)$$

Net :

$$S^{2-}(aq) + 2\ H^+(aq) \longrightarrow H_2S(g)$$
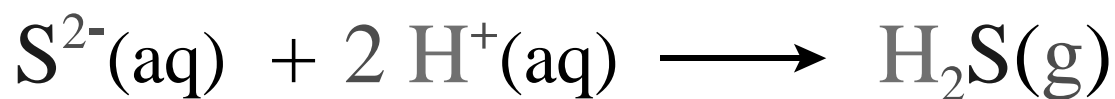
IV) Oxidation - Reduction Rx's (Redox)
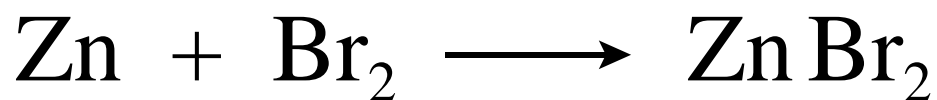
Involves loss of e^- by one element & gain of e^- by another element

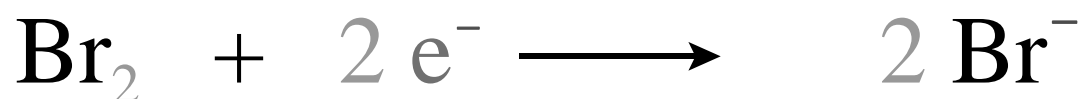Oxidation: lose e^-

> (inc. in oxidation #)

Reduction: gain e^-

> (dec. in oxidation #)

Oxidizing agent: substance that is reduced

Reducing agent: substance that is oxidized

$$Zn + Br_2 \longrightarrow ZnBr_2$$

$$Zn \longrightarrow Zn^{2+} + 2\,e^-$$

Zn lost e^- $\Rightarrow$ oxidized

$$Br_2 + 2\,e^- \longrightarrow 2\,Br^-$$

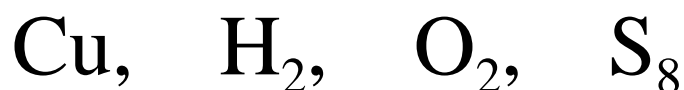Br gained e^- $\Rightarrow$ reduced

A) Oxidation Numbers

Charge that an atom would have if e^- in cmpds. are assigned in a certain way.

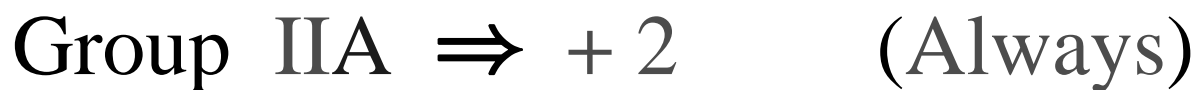## 1) Elemental Form

$$Cu, \quad H_2, \quad O_2, \quad S_8$$

$$ox.\# = 0 \quad (zero)$$

2) Monatomic Ion

$$ox.\# = charge$$

$$Na^+, \; Zn^{2+}, \; Al^{3+}, \; O^{2-}, \; Br^-$$

Group IA $\Rightarrow$ $+1$ (Always)

Group IIA $\Rightarrow$ $+2$ (Always)

Group IIIA $\Rightarrow$ $+3$ (usually)

3) Hydrogen

$H \Rightarrow +1$ (usually)

exceptions

hydrides, $H \Rightarrow -1$
NaH , CaH_2

4) Oxygen

$O \Rightarrow -2$ (usually)

exceptions

peroxides, O_2^{2-} $O \Rightarrow -1$

H_2O_2 Na_2O_2

superoxides, O_2^{1-} $O \Rightarrow -1/2$

KO_2
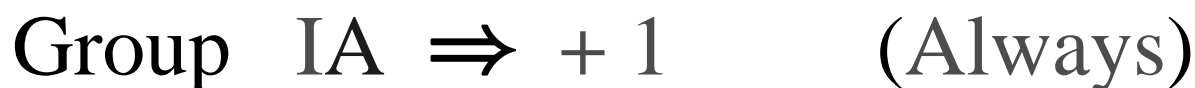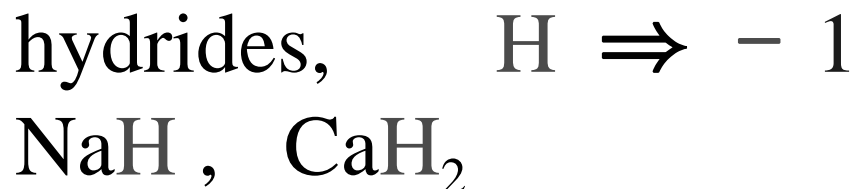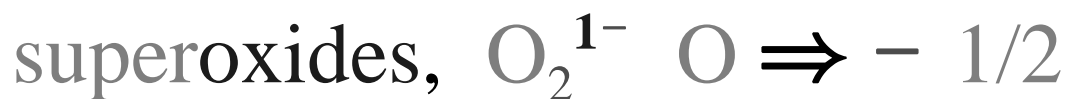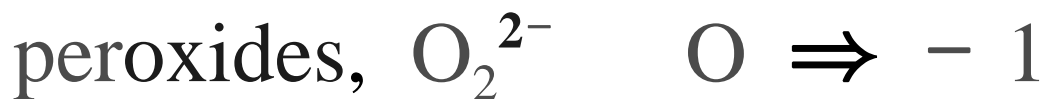
5) Fluorine

F $\Rightarrow$ − 1   Always

6) Halogens: Cl, Br, I

− 1 except when combined
w. a more E.N. element

CBr_4 : Br $\Rightarrow$ − 1

can be : +1, +3, +5, +7

ClO_4^- : +7

7) Sum of ox. no.'s of atoms
   in neutral cmpds. =

   0 (zero)

8) Sum of ox. no.'s of atoms
   in a polyatomic ion =

   charge

9) Ox. no. can't be:

   more positive than the group #

   or

   more negative than (group # − 8)

B) Examples

1) <u>Ex 1</u>: What is ox. # of N in NH_3 ?

$$\# \; x_N \; + \; 3(+1) \; = \; 0$$

$$\# \; x_N \; = \; -3$$

2) <u>Ex 2</u>: What is ox. # of N in NO_3^- ?

3) <u>Ex 3</u>: What is ox. # of N in NO_2^- ?

4) <u>Ex 4</u>:   What is ox. # of Xe
in $XeOF_4$?

5) <u>Ex 5</u>:   What is ox. # of Cr
in $K_2Cr_2O_7$?

C) Redox Reactions

Oxidation: inc. in ox. #
$$\text{(lose } e^- \text{)}$$

Reduction: dec. in ox. #
$$\text{(gain } e^- \text{)}$$

1) Combination

$$2\,Ca \;+\; O_2 \longrightarrow 2\,CaO$$

2) Decomposition

$$2\,NH_3 \longrightarrow N_2 \;+\; 3\,H_2$$

3) Combustion

$$CH_4 \;+\; 2\,O_2 \longrightarrow CO_2 \;+\; 2\,H_2O$$
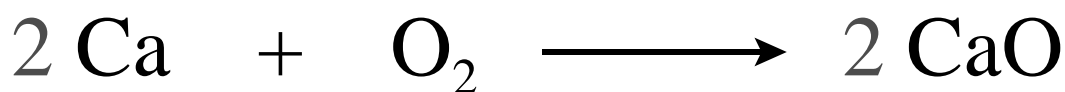
4) <u>Displacement Rxs.</u>

Single – Replacement Rxs

one element replaces another
    element in a cmpd.

    Active metals displace
      less active metals or hydrogen

the most active metals lose
    their e^- most easily

    – most easily oxidized
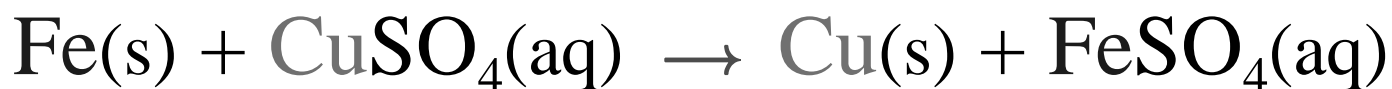
    (strongest reducing agent)

a) <u>Metals</u>

$$2\ K(s) + 2\ H_2O(\ell) \rightarrow 2\ KOH(aq) + H_2(g)$$

  metal   water   hydroxide   hydrogen

$$Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

  metal   acid   salt   hydrogen

$$Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$$

  metal   salt   metal   salt

$$3CuCl_2(aq) + 2Al(s) \longrightarrow 2AlCl_3(aq) + 3Cu(s)$$

  +2   0   +3   0
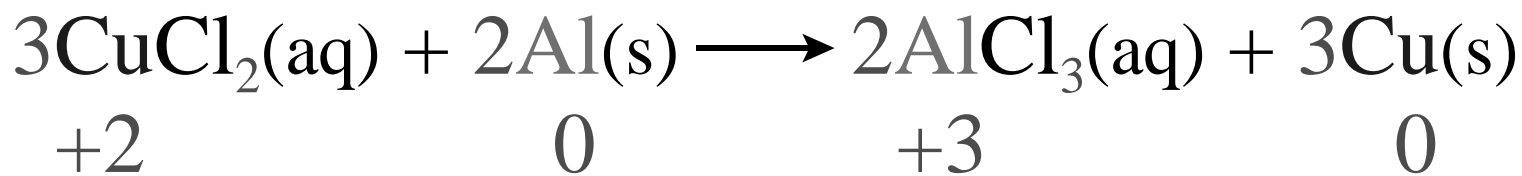
b) <u>Nonmetals</u>

<u>Halogens</u>

order
of $\quad$ F > Cl > Br > I
activity

$$2\ KI(aq) + Cl_2(g) \longrightarrow 2\ KCl(aq) + I_2(s)$$

$$2\ NaCl(aq) + F_2(g) \longrightarrow 2\ NaF(aq) + Cl_2(g)$$

$$NaBr(aq) + I_2(s) \longrightarrow$$
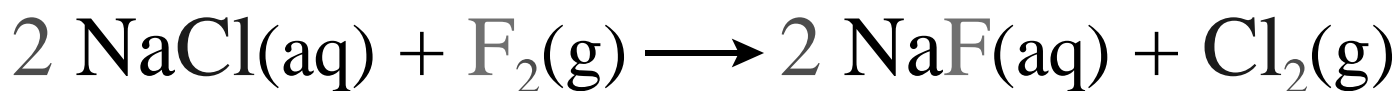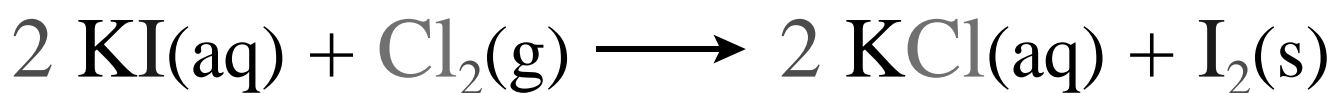
c) <u>Metal Salt & Hydrogen or Carbon</u>

$$CuO(s) + H_2(g) \longrightarrow Cu(s) + H_2O(\ell)$$

$$NiO(s) + C(s) \longrightarrow Ni(s) + CO(g)$$
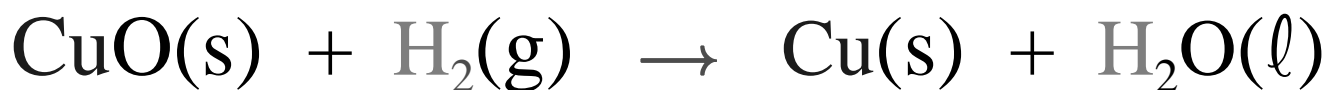
TABLE 4.5 • Activity Series of Metals in Aqueous Solution

Metal	Oxidation Reaction	
Lithium	$Li(s) \longrightarrow Li^+(aq) + e^-$	
Potassium	$K(s) \longrightarrow K^+(aq) + e^-$	
Barium	$Ba(s) \longrightarrow Ba^{2+}(aq) + 2e^-$	
Calcium	$Ca(s) \longrightarrow Ca^{2+}(aq) + 2e^-$	
Sodium	$Na(s) \longrightarrow Na^+(aq) + e^-$	
Magnesium	$Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^-$	
Aluminum	$Al(s) \longrightarrow Al^{3+}(aq) + 3e^-$	
Manganese	$Mn(s) \longrightarrow Mn^{2+}(aq) + 2e^-$	Ease of oxidation increases
Zinc	$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$	
Chromium	$Cr(s) \longrightarrow Cr^{3+}(aq) + 3e^-$	
Iron	$Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$	
Cobalt	$Co(s) \longrightarrow Co^{2+}(aq) + 2e^-$	
Nickel	$Ni(s) \longrightarrow Ni^{2+}(aq) + 2e^-$	
Tin	$Sn(s) \longrightarrow Sn^{2+}(aq) + 2e^-$	
Lead	$Pb(s) \longrightarrow Pb^{2+}(aq) + 2e^-$	
Hydrogen	$H_2(g) \longrightarrow 2\,H^+(aq) + 2e^-$	
Copper	$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$	
Silver	$Ag(s) \longrightarrow Ag^+(aq) + e^-$	
Mercury	$Hg(l) \longrightarrow Hg^{2+}(aq) + 2e^-$	
Platinum	$Pt(s) \longrightarrow Pt^{2+}(aq) + 2e^-$	
Gold	$Au(s) \longrightarrow Au^{3+}(aq) + 3e^-$	

f) <u>Ex</u> : If iron is placed in a soln. of silver nitrate will silver plate out?

V) Concentration of Solutions

amount of solute dissolved in a given quantity of solvent or solution

A) Molarity (M)

$$M = \frac{\text{moles solute}}{\text{L soln}}$$

Conversion factor between moles solute & L soln.

1) <u>Ex 1</u>: How many moles of $CaCl_2$ are present in 200.0 mL of 2.0 M $CaCl_2$?

2) <u>Ex 2</u>: A rx. req. 1.94 g Ca^{2+} ions. What vol. of 2.00 M $CaCl_2$ is req. to provide this amt. of Ca^{2+} ?

B) <u>Dilution</u>

Add more solvent & get
a more dilute soln.

$$\text{moles solute} = \frac{\text{moles}}{\text{L}} \times \text{L} = \text{M} \times \text{V}$$

$$\text{moles solute before dilution} = \text{moles solute after dilution}$$
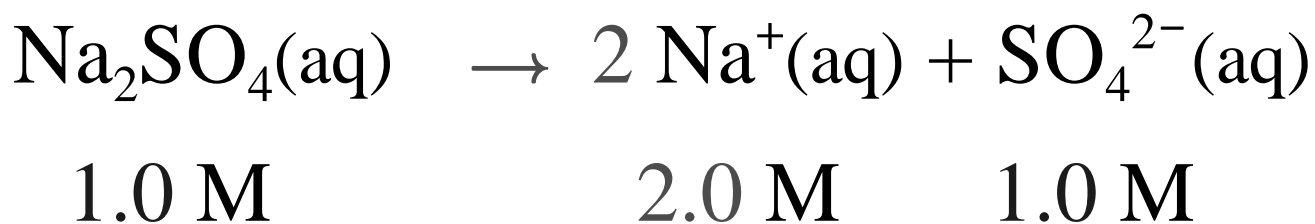
$$\boxed{M_1 V_1 = M_2 V_2}$$

1) <u>Ex 1</u>: A 100.0 mL sample of 0.200 M sucrose was diluted to 500.0 mL. Calc. the new molarity.

2) <u>Ex 2</u>: How much water must be added to 100.0 mL of 0.300 M NaCl to prepare a 0.0500 M NaCl soln?

VI) Solution Stoichiometry

When working w. solutions "How much" may refer to either volume required or concentration.

A) Ions and Ionic Compounds

$$Na_2SO_4(aq) \longrightarrow 2\,Na^+(aq) + SO_4{}^{2-}(aq)$$

   1.0 M   2.0 M   1.0 M

Use stoichiometry of balanced eqn. to determine molarity of ions in soln.

1) <u>Ex</u> : What is the molarity of OH⁻ in a 0.20 M Ba(OH)$_2$ soln.?

a) <u>Use</u> dimensional analysis

$$? \frac{\text{mol OH}^-}{\text{L soln}} = \frac{0.20 \text{ mol Ba(OH)}_2}{\text{L soln}} \times \frac{2 \text{ mol OH}^-}{1 \text{ mol Ba(OH)}_2}$$

$$= 0.40 \text{ M OH}^-$$

b) <u>Use "ICE"</u> table in Molarity

	1 Ba(OH)$_2$	→	1 Ba^{2+}	+ 2 OH$^-$
Initial	0.20		0	0
Change	- 0.20		+ 0.20	+ 0.40
Equilibrium	0		0.20	0.40

B) Reaction Stoichiometry

Stoichiometry problems involving solns

1) <u>Ex</u> : What volume (mL) of 0.215 M HCl is req. to completely react w. 10.00 mL of 0.400 M $Ba(OH)_2$?

$$Ba(OH)_2 + 2\ HCl \longrightarrow BaCl_2 + 2\ H_2O$$

$$? \text{ L} = 0.01000 \text{ L} \times \frac{0.400 \text{ mol } Ba(OH)_2}{1 \text{ L soln}} \times \frac{2 \text{ mol HCl}}{1 \text{ mol } Ba(OH)_2} \times \frac{1 \text{ L soln}}{0.215 \text{ mol HCl}}$$

$$= 0.0372 \text{ L} = 37.2 \text{ mL}$$

Could also calc. moles of $Ba(OH)_2$ first by using M*V and then do a mole-to-mole stoich. problem to find moles of HCl and then use M*V to solve for the volume of HCl.

C) Titrations (Volumetric Analysis)

neutralization, precipitation, redox

1) Titration

Method for determining conc. of a substance, A, by adding a measured volume of a soln. of known conc., S, (standard soln.).

Rxn. between A and S must go to completion.

a) Equivalence Point

Point in titration at which stoichiometrically equivalent amts of reactants have reacted.

b) Endpoint

Point at which an indicator changes color

Want endpoint and eq. pt. to be close to each other

1) Indicator

Substance which changes color as close as possible to the eq. pt.

2) Acid-Base Titration

At eq. pt.:

mol Acid $=$ mol Base

$$M_a * V_a = M_b * V_b$$

In this eqn. the molarities are the molarities of H^+ and OH^-.

The volumes can be left in mL.

a) <u>Ex</u> : It takes 60.00 mL of 0.1000 M NaOH to titrate 20.00 mL of HCl to the eq. pt. What is the conc. of the original HCl solution?

$$HCl \ (aq) + NaOH(aq) \ \longrightarrow \ NaCl(aq) + HOH(\ell)$$

? mol HCl = 0.06000 L NaOH x $\dfrac{0.1000 \ mol \ NaOH}{1 \ L \ soln}$ x $\dfrac{1 \ mol \ HCl}{1 \ mol \ NaOH}$

= 0.006000 mol HCl

M (HCl) = $\dfrac{0.006000 \ mol \ HCl}{0.02000 \ L \ soln}$ = 0.3000 M HCl

Could use $M_a*V_a = M_b*V_b$

$M_a = \dfrac{M_b*V_b}{V_a} = \dfrac{(0.1000 \ M) \ (60.00 \ mL)}{20.00 \ mL}$ = 0.3000 M