CHEM 200

ALL EMAILS SENT TO
CHEM200@SDSU.EDU

OFFICE HOURS HELD VIRTUALLY THROUGH THE MSLC.

TUES 9.00 AM TO 11.00 AM

UPCOMING IMPORTANT DATES

- Safety Quiz due **Friday, February 3rd at 11:59 pm** (in OWL Lab & Canvas), *must pass with >60% to do in-person labs*

- How to write a lab notebook and prelab due **Sunday, February 5th at 11:59 pm**

- Volumetric Prelab due **Sunday, February 5th at 11:59 pm**

- Volumetric Lab Report due **Sunday, February ~~5th~~ 12th at 11:59 pm**

- Chapter 1-4 Chapter Problem Sets in OWL Lecture due **Thursday, February 9th at 11:59 pm** (**Start Now**)

- Chapter 1-4 Chapter Assessments in OWL Lecture is **Thursday, February 9th at 11:59 pm** (**Start Now**); 2 chances, no time limit

- Exam 1 starts at **3 pm Friday, February 10th and will close on Saturday, February 11th at 3pm** in OWL Lecture; Chapters 1-4. You have 24hrs. *Only 2 hrs once you start; be sure to give yourself a full 2 hr time slot.*

FINDING THE DENSITY OF STEEL: AVERAGES AND STANDARD DEVIATIONS

The total mass and volume of 10 steel ball bearings were measured.

	Trial 1	Trial 2
Total mass of ball bearings (g)	780.15	778.90
Average mass of one ball bearing (g)		
Total volume of ball bearings (mL)	100.9	100.4
Average volume of one ball bearing (mL)		
Density (g/mL)		
Average Density and SD (g/mL)		

FINDING THE DENSITY OF STEEL: AVERAGES AND STANDARD DEVIATIONS

	Trial 1	Trial 2
Total mass of ball bearings (g)	780.15	778.90
Average mass of one ball bearing (g)	78.015	77.890
Total volume of ball bearings (mL)	100.9	100.4
Average volume of one ball bearing (mL)	10.09	10.04
Density (g/mL)	7.740	7.757
Average Density and SD		

Calculations for Trial 1 only

Average mass of one ball bearing

$$\frac{780.15\ g}{10\ ball\ bearings} = 78.015\ g\ per\ ball\ bearing$$

Average volume of one ball bearing

$$\frac{100.9\ mL}{10\ ball\ bearings} = 100.9\ mL\ per\ ball\ bearing$$

Density

$$\frac{78.015\ g}{10.09\ mL} = 7.740\frac{g}{mL}$$

FINDING THE DENSITY OF STEEL: AVERAGES AND STANDARD DEVIATIONS

	Trial 1	Trial 2
Total mass of ball bearings (g)	780.15	778.90
Average mass of one ball bearing (g)	78.015	77.890
Total volume of ball bearings (mL)	100.9	100.4
Average volume of one ball bearing (mL)	10.09	10.04
Density (g/mL)	7.740	7.757
Average Density and SD	7.749 + 0.012	

Finding the Average Density of the 2 trials

$$\frac{\left(7.740\,\frac{g}{mL} + 7.757\,\frac{g}{mL}\right)}{2} = 7.749\,\frac{g}{mL}$$

Finding the SD

$$\sqrt{\frac{\left(7.740\,\frac{g}{mL} - 7.749\,\frac{g}{mL}\right)^2 + \left(7.757\,\frac{g}{mL} - 7.749\,\frac{g}{mL}\right)^2}{2-1}} = 0.012\,\frac{g}{mL}$$

CONVERSION BETWEEN CONCENTRATION EXAMPLE:

A solution contains 45.6 g of potassium bromide and 126.8 g of water and has a volume of 157 mL. Find the weight percent, the molarity and the mole fraction of potassium bromide.

Weight Percent

$$\frac{45.6\ g}{45.6\ g + 126.8\ g} \times 100\% = 26.5\%$$

CONVERSION BETWEEN CONCENTRATION EXAMPLE:

A solution contains 45.6 g of potassium bromide and 126.8 g of water and has a volume of 157 mL. Find the weight percent, the molarity and the mole fraction of potassium bromide.

Molarity

$$45.6\ g\ KBr\left(\frac{1\ mole\ KBr}{119.0\ g}\right) = 0.383\ moles\ KBr$$

$$\frac{0.383\ moles\ KBr}{0.157\ L\ of\ solution} = 2.44\ M$$

CONVERSION BETWEEN CONCENTRATION EXAMPLE:

A solution contains 45.6 g of potassium bromide and 126.8 g of water and has a volume of 157 mL. Find the weight percent, the molarity and the mole fraction of potassium bromide.

Mole Fraction

$$126.8\ g\ H_2O\ \left(\frac{1\ mole\ H_2O}{18.01\ g}\right) = 7.040\ moles\ H_2O$$

$$\frac{0.383\ moles\ KBr}{7.040\ moles + 0.383\ moles} = 0.0516$$

TYPES OF CHEMICAL REACTIONS

Precipitation Reaction

Formation of a solid precipitate

Acid-Base Reaction

Reaction between an acid and a base

Redox Reaction

Reaction that involves the transfer of electrons

PRECIPITATION AND SOLUBILITY RULES

- Precipitates form when a pair of ions in solution form an insoluble compound
- Compounds are soluble when the energy associated with the ionic bond is less than the energy associated with hydration

SOLUBILITY RULES

Soluble

1. All common compounds of Group 1A(1) ions (Li^+, Na^+, K^+...) and ammonium ions ($NH4^+$)

2. All common nitrates (NO_3^-), acetates ($CH_3CO_2^-$) and most perchlorates (ClO_4^-)

3. All common chlorides (Cl^-), bromides (Br^-) and iodides (I^-); *except* those of Ag^+, Pb^{2+}, Cu^+ and Hg_2^{2+}. All common fluorides (F^-) are soluble; *except* for Pb^{2+} & Group2A(2)

4. All common sulfates (SO_4^{2-}); *except* Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+ & Pb^{2+}

Insoluble

1) All common metal hydroxides are **insoluble**; *except* those of Group 1A(1) and the larger members of Group 2A(2) - beginning with Ca^{2+}.

2) All common carbonates (CO_3^{2-}), phosphates (PO_4^{3-}) and chromates (CrO_4^{2-}) are **insoluble**; *except* those from Group 1A(1) and ammonium (NH_4^+).

3) All common sulfides (S^{2-}) are **insoluble**; *except* those of Groups 1A(1), 2(A)2 and NH_4^+.

SOLUBILITY RULES

SOLUBILITY EXAMPLE

- Write the molecular, ionic and net ionic equation for the reaction of lead (II) nitrate with potassium iodide.

$$Pb(NO_3)_{2(?)} + 2\,KI_{(?)} \rightarrow 2\,KNO_{3(?)} + PbI_{2(?)}$$

$$Pb(NO_3)_{2(aq)} + 2\,KI_{(aq)} \rightarrow 2\,KNO_{3(aq)} + PbI_{2(s)}$$

$$Pb^{+2}_{(aq)} + 2\,NO_3^-{}_{(aq)} + 2\,K^+_{(aq)} + 2\,I^-_{(aq)} \rightarrow 2\,K^+_{(aq)} + 2\,NO_3^-{}_{(aq)} + PbI_{2(s)}$$

$$Pb^{+2}_{(aq)} + 2\,I^-_{(aq)} \rightarrow PbI_{2(s)}$$

SOLUBILITY EXAMPLE 2

Write the molecular, total ionic and net ionic equations for the reaction of potassium nitrate with silver acetate.

$$KNO_{3(?)} + AgCH_3COO_{(?)} \rightarrow AgNO_{3(?)} + KCH_3COO_{(?)}$$

$$KNO_{3(aq)} + AgCH_3COO_{(aq)} \rightarrow AgNO_{3(aq)} + KCH_3COO_{(aq)}$$

$$K^+_{(aq)} + NO^-_{3(aq)} + Ag^+_{(aq)} + CH_3COO^-_{(aq)} \rightarrow Ag^+_{(aq)} + NO^-_{3(aq)} + K^+_{(aq)} + CH_3COO^-_{(aq)}$$

All species are aqueous = NO REACTION

LECTURE PARTICIPATION: PREDICT IF A PRECIPITATE WILL FORM

Indicate if a precipitate would form after combining the following solutions

Lead (II) Nitrate + Calcium Chloride

Potassium Chromate + Ammonium Hydroxide

ACID AND BASE REACTIONS: ACIDS

Produce H_3O^+ ions when dissolved in water.

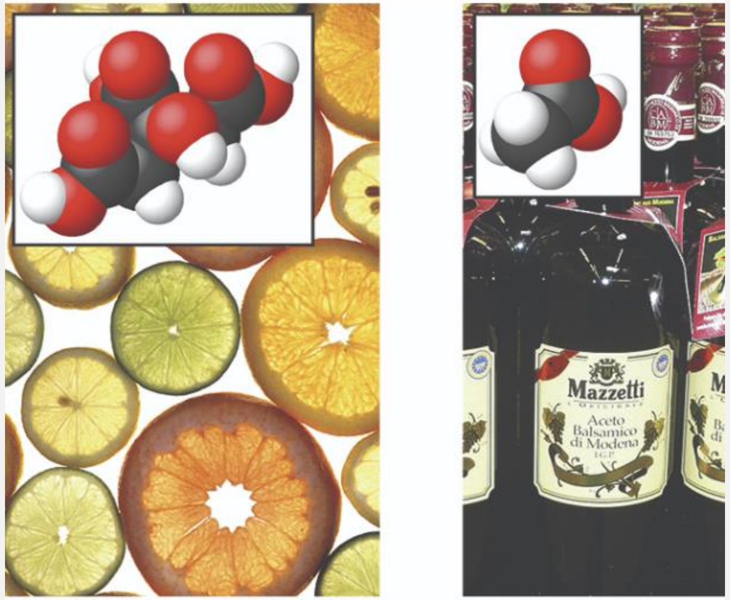
$$HA_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + A^-_{(aq)}$$

Strong Acid = complete dissociation (No $HClO_4$ remains)

$$HClO_{4(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + ClO_4^-{}_{(aq)}$$

Weak Acid = partial dissociation (Some CH_3COOH remains)

$$CH_3COOH + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-$$



(a) (b)

Figure 4.6 (a) Fruits such as oranges, lemons, and grapefruit contain the weak acid citric acid. (b) Vinegars contain the weak acid acetic acid. (credit a: modification of work by Scott Bauer; credit b: modification of work by Brücke-Osteuropa/Wikimedia Commons)

ACID AND BASE REACTIONS: BASES

Produce OH^- ions when dissolved in water.

$$B_{(aq)} + H_2O_{(l)} \rightarrow OH^-_{(aq)} + HB^+_{(aq)}$$

$$BOH_{(aq)} \rightarrow OH^-_{(aq)} + B^+_{(aq)}$$

Strong Base = complete dissociation (No KOH remains)

$$KOH_{(aq)} \rightarrow OH^-_{(aq)} + K^+_{(aq)}$$

Weak base = partial dissociation (Some NH_3 remains)

$$NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons OH^-_{(aq)} + NH^+_{4\,(aq)}$$

(a) (b)

Figure 4.7 Ammonia is a weak base used in a variety of applications. (a) Pure ammonia is commonly applied as an agricultural fertilizer. (b) Dilute solutions of ammonia are effective household cleansers. (credit a: modification of work by National Resources Conservation Service; credit b: modification of work by pat00139)

6 Strong Acids		6 Strong Bases	
$HClO_4$	perchloric acid	$LiOH$	lithium hydroxide
HCl	hydrochloric acid	$NaOH$	sodium hydroxide
HBr	hydrobromic acid	KOH	potassium hydroxide
HI	hydroiodic acid	$Ca(OH)_2$	calcium hydroxide
HNO_3	nitric acid	$Sr(OH)_2$	strontium hydroxide
H_2SO_4	sulfuric acid	$Ba(OH)_2$	barium hydroxide

POLYPROTIC ACIDS

Monoprotic

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

Diprotic

$$H_2SO_{4\,(aq)} + 2\ H_2\,O_{(l)} \rightarrow 2\ H_3O^+_{(aq)} + SO^{2-}_{4(aq)}$$

Triprotic

$$H_3PO_{4\,(aq)} + H_2O_{(l)} \rightarrow 3\ H_3O^+_{(aq)} + PO^{3-}_{4(aq)}$$

POLY-BASIC BASES

Mono-basic

$$NaOH \rightarrow Na^{+} + OH^{-}$$

Diprotic-basic

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2\ OH^{-}$$

Triprotic-basic

$$Al(OH)_3 \rightarrow Al^{3+} + 3\ OH^{-}$$

NEUTRALIZATION REACTION

$$Acid + Base \rightarrow Water + Salt$$

Molecular Equation

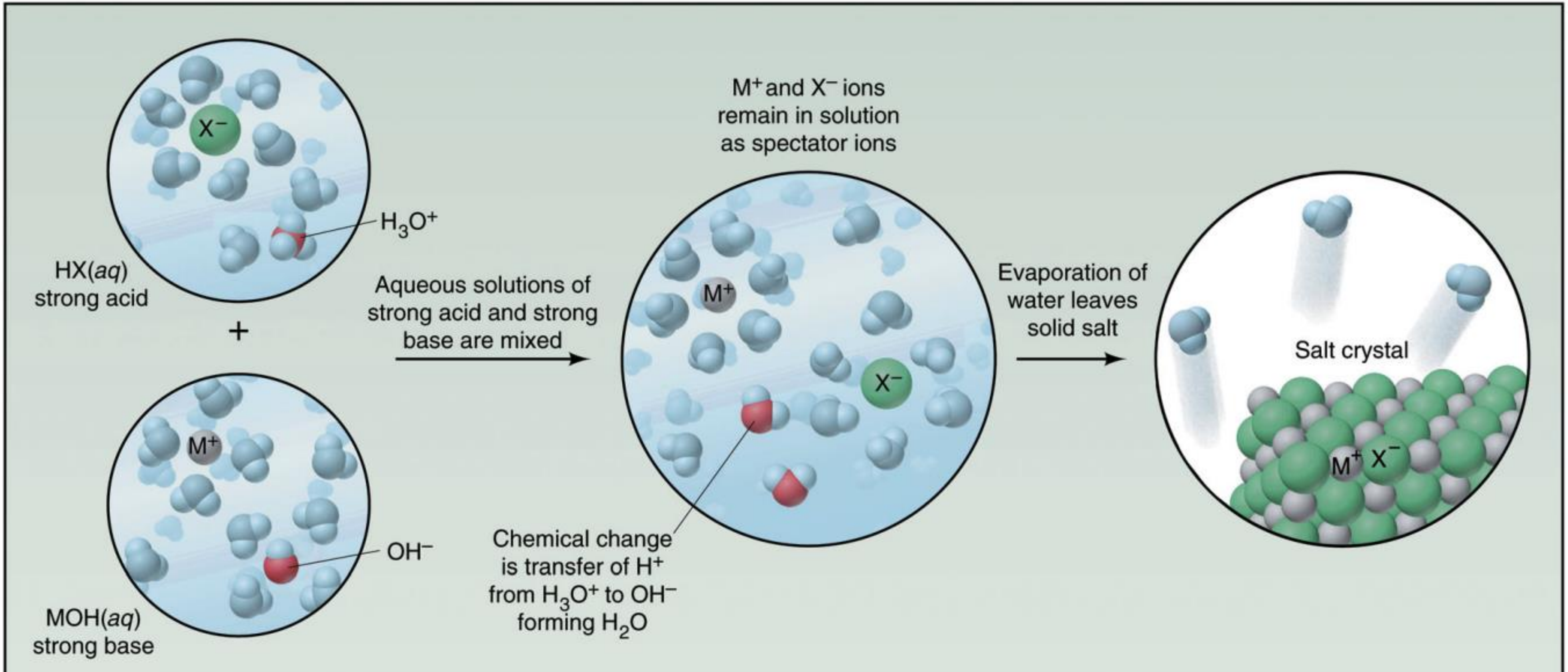
$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$$

Total Ionic Equation

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

Net Ionic Equation

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



$$\begin{array}{c} H_3O^+(aq) + X^-(aq) \\ + \\ M^+(aq) + OH^-(aq) \end{array} \xrightarrow{\text{mix}} 2H_2O(l) + M^+(aq) + X^-(aq) \xrightarrow{\Delta} 2H_2O(g) + MX(s)$$

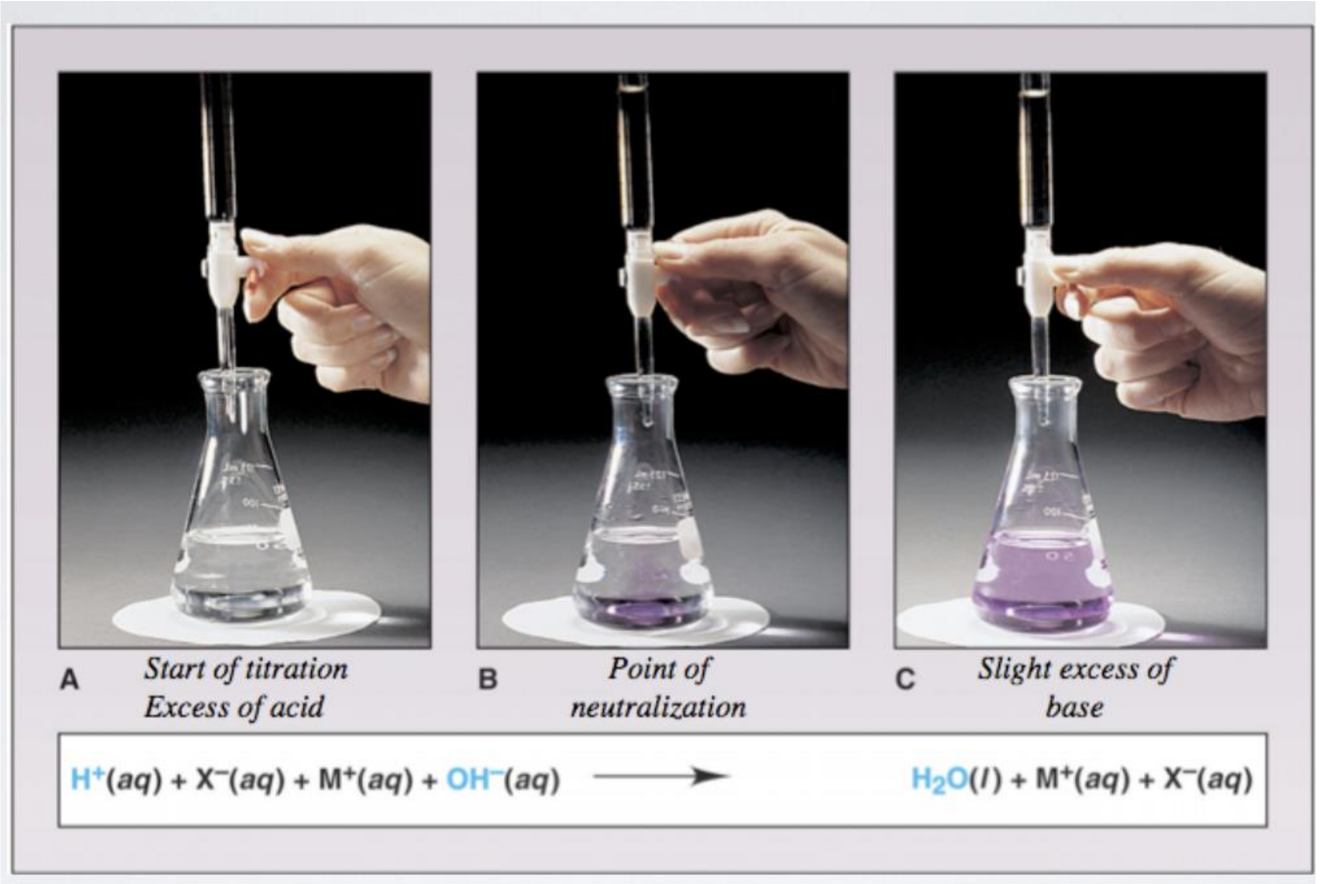
GAS FORMATION DURING AN ACID BASE REACTION

$$Sodium\ bicarbonate + acetic\ acid \rightarrow water + carbon\ dioxide + sodium\ acetate$$

$$NaHCO_{3(aq)} + CH_3COOH_{(aq)} \rightarrow NaCH_3COO_{(aq)} + \cancel{H_2CO_3}_{(aq)}$$

$$NaHCO_{3(aq)} + CH_3COOH_{(aq)} \rightarrow NaCH_3COO_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

ACID BASE TITRATION



TITRATION EXAMPLE 1

Find the concentration of sulfuric acid if 35.89 mL of 0.905 M NaOH is needed to titrate 25.00 mL acid.

1. Find the balanced equation
2. Find number of moles of base
3. Find number of moles of acid
4. Find concentration

TITRATION EXAMPLE 1

Find the concentration of sulfuric acid if 35.89 mL of 0.905 M NaOH is needed to titrate 25.00 mL acid.

$$H_2SO_{4(aq)} + 2\ NaOH_{(aq)} \rightarrow 2\ H_2O_{(l)} + Na_2SO_{4(aq)}$$

$$35.89\ mL\ \left(\frac{1\ L}{1000\ mL}\right)\left(\frac{0.905\ moles}{L}\right) = 0.0325\ moles\ NaOH$$

TITRATION EXAMPLE 1

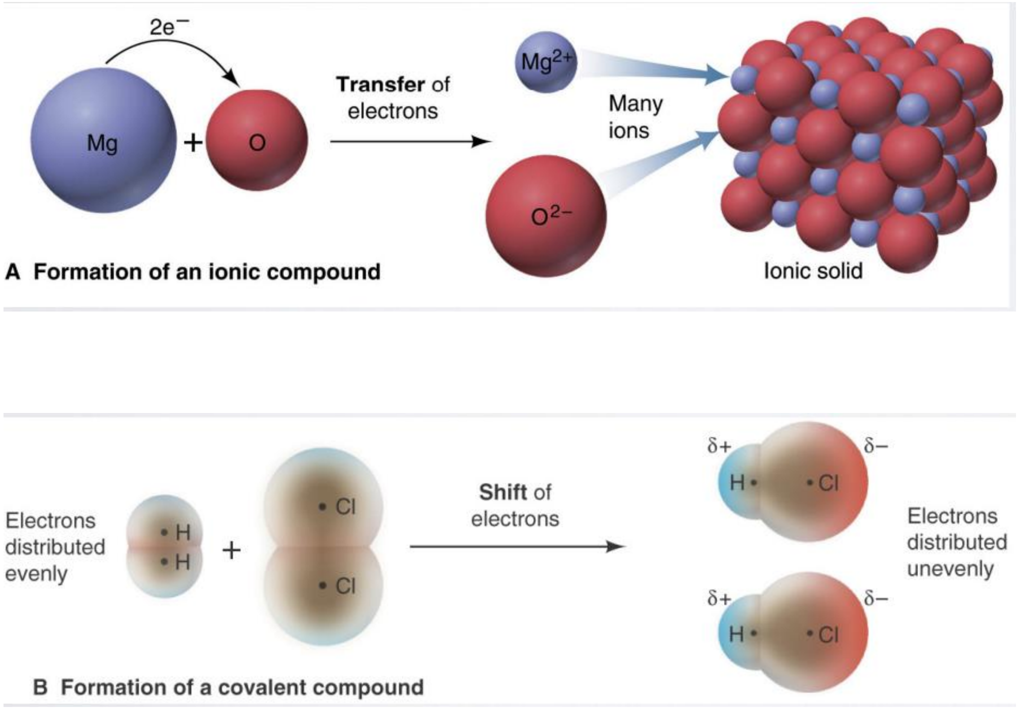
Find the concentration of sulfuric acid if 35.89 mL of 0.905 M NaOH is needed to titrate 25.00 mL acid.

$$H_2SO_{4(aq)} + 2\ NaOH_{(aq)} \rightarrow 2\ H_2O_{(l)} + Na_2SO_{4(aq)}$$

$$0.0325\ moles\ NaOH\ \left(\frac{1\ mole\ H_2SO_4}{2\ moles\ NaOH}\right) = 0.0162\ moles\ H_2SO_4$$

$$\frac{0.0162\ moles\ H_2SO_4}{0.02500\ L} = 0.650\ M\ H_2SO_4$$

REDOX REACTIONS



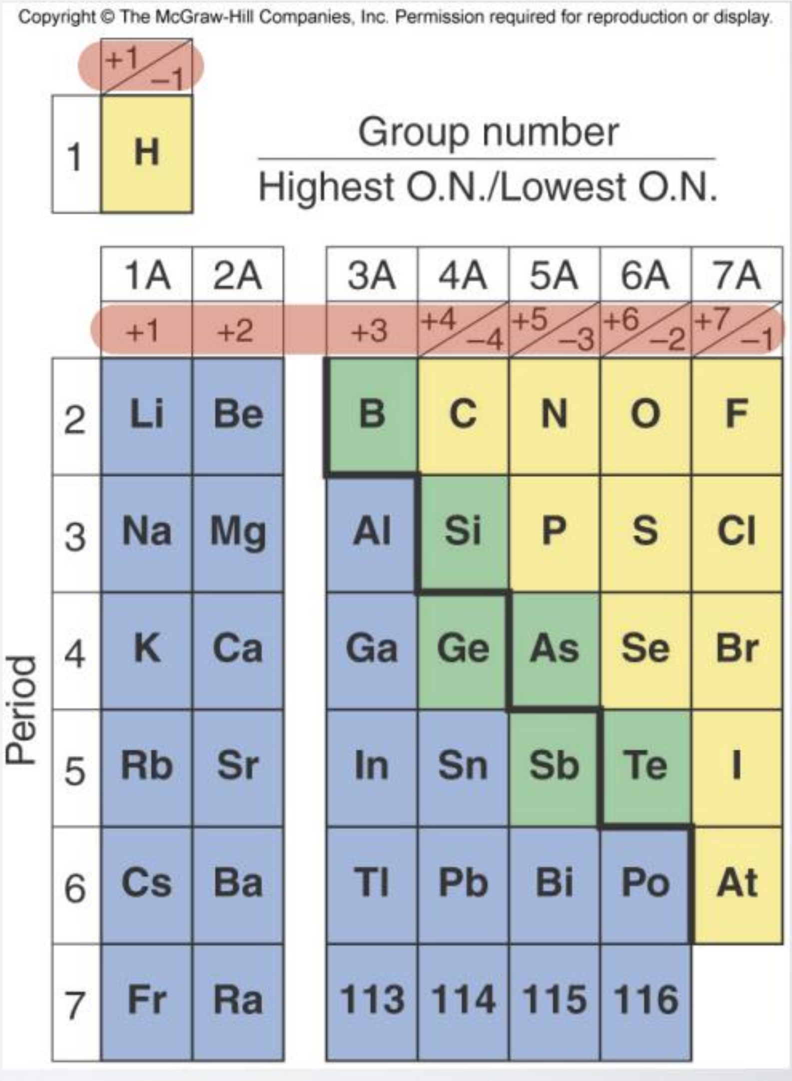
OXIDATION NUMBER: KEEPING TRACK OF YOUR ELECTRONS

General Rules

1. For an atom in its elemental form (e.g. Na, O_2, Cl_2,...) the O.N. = 0.
2. For a monoatomic ion (e.g. Br^-, Cu^{2+},...) the O.N. = ion charge.
3. The sum of the O.N. values for atoms in a compound equals zero. For polyatomic ions the sum equals the charge of the ion.

Specific Rules

1. For Group 1(A)1 - O.N. is +1 in all compounds
2. For Group 2(A)2 - O.N. is +2 in all compounds
3. For hydrogen - O.N. is +1 when bound to nonmetals
4. For fluorine - O.N. is -1 when bound to metals & boron
5. For oxygen - O.N. is -1 when in peroxides (e.g. H_2O_2)
   - O.N. is -2 for all others (except with fluorine)
6. For Group 7(A)17 - O.N. is -1 when with metals, nonmetals (except O) & for other halogens lower in group



FIND THE OXIDATION NUMBER OF EACH ATOM IN THE COMPOUND

(a) H_2S
(b) SO_3^{2-}
(c) Na_2SO_4
(d) KNO_3
(e) AlH_3
(f) NH_4^+
(g) $H_2PO_4^-$