Chemistry 20 Review

This is a collection of notes with examples and problems to get you up to speed and ready for the rigors of Chemistry 30.

HHPS Symbols

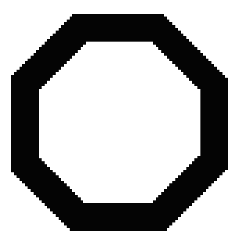
explosive

flammable

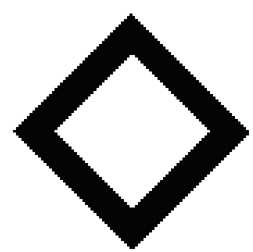
corrosive

toxic

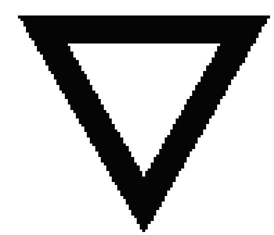
HHPS Borders



DANGER



WARNING



CAUTION

WHMIS Symbols

Biohazardous Infectious

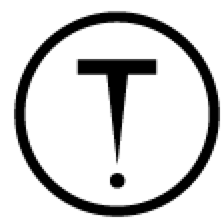
Poisonous and infectious causing immediate /serious toxic effects

Compressed Gas

Flammable/ combustible

Corrosive

Oxidizing



Poisonous and infectious causing other toxic effects

Dangerously reactive

MSDS Sheet

MATERIAL SAFETY DATA SHEET

ADDRESS:
HeatCell
855 NW 17th Avenue
Delray Beach, Fl 33445
(561)243-2008

DATE: 08/21/98
PREPARED BY: Dr. Burch Stewart
EMERGENCY TELEPHONE NUMBER: **CHEMTREC 800-424-9300**

NFPA HAZARD CLASSIFICATIONS
H = HEALTH
F = FLAMMABILITY
R = REACTIVITY
NF = NOT FOUND

H = 1
F = 1
R = 1

I. IDENTIFICATION

LABEL NAME: **FOOD WARMER**

TRADE OR PRODUCT NAME: **Heat Cell**

FDA NO.:

CAS NO.: Diethylene Glycol CAS 00111-46-6

II. FIRE, EXPLOSION AND REACTIVITY DATA

FLASH POINT (METHOD): 246°F (104°C) Cleveland Open Cup

0 = LEAST
1 = SLIGHT
2 = MODERATE
3 = HIGH
4 = EXTREME

EXTINGUISHING MEDIA: DRY CHEMICAL, FOAM OR CO_2

DOT HAZARD CLASSIFICATION: NOT REQUIRED

SPECIAL FIRE FIGHTING PROCEDURES: NONE
UNUSUAL FIRE AND EXPLOSION HAZARDS: UNKNOWN, Believed to be relatively safe.

HAZARDOUS COMBUSTIBLE OR DECOMPOSITION PRODUCTS:
Product consists of a two phase mixture of the two components stabilized by tightly packed fiber wool to give an essentially non-spillable mass. The components are contained in a metal can with a metal lid. The mass is not ignitable at room temperature. To ignite, apply flame directly to glass fibers. Can produce carbon monoxide and some irritants under some burning conditions. Glass fibers caused cancer in animals through unnatural routes of exposure (surgical implantation), but it is not associated with cancer by inhalation. Use of glass fibers has not been shown to cause cancer in humans. If ingestion of glass fibers occur, observe individual for several days to ensure that intestinal blockage does not occur. It is not recommended to induce vomiting if ingested.

STABILITY: Stable CONDITIONS TO AVOID: Excessive Heat. MATERIALS TO AVOID: Strong Oxidizers.

HAZARDOUS POLYMERIZATION PRODUCTS: NA Will not occur.

III. PHYSICAL DATA

ODOR, APPEARANCE AND PHYSICAL STATE:
Slightly opaque colorless liquid with subtle petroleum solvent odor.

BOILING POINT: 433°F 223°C

MELTING POINT: NA

SPECIFIC GRAVITY (H_2O = 1.0): 1.117 @ 68°F (20°C)

EVAPORATION RATE: < 1 (Butyl Acetate = 1)

VAPOR PRESSURE:(mm/Hg) < 1@20°C, DEG = 0.01

VAPOR DENSITY (AIR = 1): > 1

SOLUBILITY IN WATER: Partially Miscible

IV. PROTECTION INFORMATION

RESPIRATORY: Use MSHA or NIOXH respirator for handling vapor or mist.

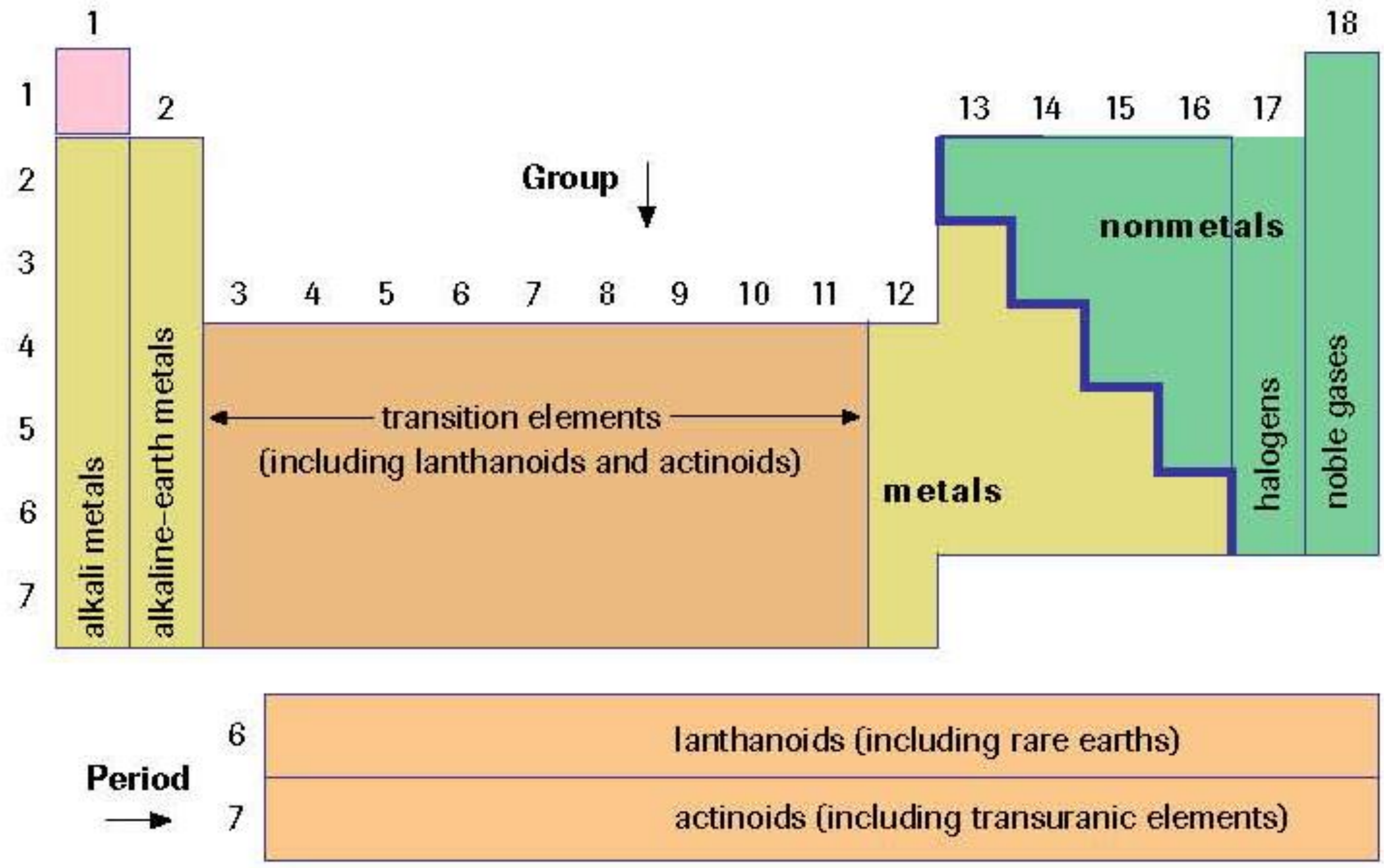
VENTILATION: Always use with Good ventilation.

EYE: Safety glasses for working with vapors or mists.

SKIN: Protective gloves or clothing generally not needed.

OTHER PROTECTIVE DEVICES AND PROCEDURES: Generally not required. Avoid prolonged breathing of mist. Wash hands after handling. Wash soiled work clothing frequently.

+ Periodic Table Review



+ Metals vs. Non-metals

- **Metals –** grouped on the left side of the periodic table (most of the elements are metals)
  - Physical Properties:
    - Shiny solids at SATP
    - High conductivity of heat and electricity
    - Ductile (can be formed into wires)
    - Malleable (bendable and can be beaten into thin sheets)

- **Non-metals** – grouped on the right side of the periodic table
  - Physical Properties:
    - May be solid, liquid or gas at SATP
    - Poor conductors of heat and electricity
    - Solid forms are non-lustrous and brittle

+ Sig Dig Review

1. **For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit.**

    123 0.123 0.00230 2.30×10^3 2.03

    all have 3 significant digits

2. **Leading zeros are not significant. For example**:

    0.12 and 0.012 each have two significant digits

3. **The Learner Assessment Branch considers all trailing zeros to be significant. For example:**

    200 has three significant digits

    0.123 00 and 20.000 each have five significant digits

4. **For logarithmic values such as pH, any digit to the left of the decimal is <u>not</u> significant. For example:**

    a pH of 1.23 has two significant digits

    a pH of 7 has no significant digits

+ Sig Dig Review

- **Manipulation of Data Rules**

1. For adding and subtracting, round answer to the same degree of **precision** as the least precise number. (If this is the only operation)

   12.3 + 0. 12 + 12.34 = 24.76 rounded to 24.8 (one decimal place)

2. For multiplying and dividing, round answer to the same number of **sig digs** as the number with the fewest sig digs.

   (**1.23**)(54.321) = 66.81483 = round to 66.8 (3 sig digs)

3. When a series of calculations is done, <u>do not round interim answers</u>. The final answer should be rounded to the same number of significant digits as the number with the fewest sig digs in the **original data**.

4. When calculations involve exact numbers (counted and defined values) the calculated answer should be rounded based upon the **precision** of the measured value(s).

   12 eggs x 52.**3** g/egg = 627.**6** g

Practice

Name the number of significant digits present:

a) 12.65 g

b) 0.01 mL

c) 67.8456 L

d) 0.00375 kg

e) 0.21 N

f) 403.00 mg

g) 2.010 J

h) pH 5.67

i) pH 7.5

j) 2.50×10^5 m/s

Practice

2. Perform the following calculations and express the answer to the correct number of sig digs:

a) 87.6 g – 4.36 g =

b) 14.62 g x 2.3 g =

c) (2.53mL x 11.43mL) ÷ (3.4mL - 0.533mL) =

d) (0.33 m x 23 m) ÷ 4.65 m =

e) (1.3 mm + 13.40 mm) x (23.3 mm x 4.06 x 10^{3} mm) =

Multivalent Ions – metals that can form more than one stable ion charge (can be determined from the anion it is joined with)

Ex. Fe has a Fe^{2+} and a Fe^{3+} ion

(***Looking at the periodic table, which is more common?)***

$FeO_{(s)}$ – oxygen has a 2^- charge so Fe must be the 2^+ charge

CHECK: 1(-2) + 1(+2) = 0 the net charge is zero so Fe^{2+} is the correct ion

$Fe_2O_{3(s)}$ – there are 3 oxygen's with the 2- charge = -6

so to be balanced by 2 iron ions, we must be using the Fe^{3+} ion

CHECK: 3 (-2) + 2 (+3) = 0 the net charge is zero so Fe^{3+} is the correct ion

Naming Multivalent Ions:

- Roman numeral numbers are used so that the reader knows which ion to use
  - Ex. Fe^{2+} is the iron(II) ion (no space)

    Fe^{3+} is the iron(III) ion (no space)

+ **Hydrates** – ionic compounds that have water held loosely to the compound

- Decompose at relatively low temp. to produce water and an ionic cmpd
- Water within an ionic crystal is called the "water of hydration"
  - ***Anhydrous*** *– a compound that is usually a hydrate but the water of hydration has been removed*
- Writing the chemical formula for hydrates:

See Figure 7 pg. 31

  - A **large dot** is use in the formula to connect the ionic compound formula unit with the number of water molecules present
  - Ex. $CuSO_4 \cdot 5H_2O_{(s)}$

Naming Hydrates:

- Name the ionic compound first then:
  - a) add "-#- water (no spaces) IUPAC NAME
  - b) add "mono, di, tri, etc. hydrate" Traditional NAME
  - Ex. $CuSO_4 \cdot 5H_2O_{(s)}$
    - IUPAC = copper(II) sulfate-5-water
    - Traditional = copper(II) sulfate pentahydrate

+ Naming Ionic Compounds

1. **If your compound is ionic and you have the formula**:

a) the name of the ***metallic*** element appears first

b) the name of the ***non-metallic*** element appears la

*Its ending is changed to "ide", except if it comes from the ***polyatomic ion table***

c) always use ***lowercase*** letters

d) if you're dealing with a transition metal (***multivalent element***) that can form more than one stable ion, use *Roman Numerals*, in *brackets*, to indicate the charge

Practice:

1) $CaCl_2$ = calcium chloride *change non-metallic ending to "ide"*

2) $Mg_3(PO_4)_2$ = magnesium phosphate *from polyatomic ion table – don't change ending*

3) SnO_2 = tin(IV) oxide *tin has a +2 or +4 ion possible; had to use Roman numerals to show we were dealing with* Sn^{4+}

+ Writing Ionic Formulas

2) If your compound is ionic and you have the name:

a) the symbol for the ***metallic*** element comes first

b) the symbol for the ***non-metallic*** element comes last

c) you need a net charge of zero, so ***subscripts*** are used to indicate the ratio of ions in the compound.

d) if using ***polyatomic ions***, make sure to put ***brackets*** around the ion if there are multiples of it present

e) all ionic compounds are solid at SATP so add a ***(s) subscript***

Practice:

1) barium phosphide = Ba^{2+} P^{3-} = $Ba_3P_{2\,(s)}$

check: 3 (+2) + 2 (-3) = 0 net charge

2) nickel(II) oxide = Ni^{2+} O^{2-} = $NiO_{(s)}$

check: (+2) + (-2) = 0 net charge

3) copper(II) phosphate = Cu^{2+} PO_4^{3-} = $Cu_3(PO_4)_{2\,(s)}$

check: 3 (+2) + 2 (-3) = 0 net charge

+ Memorized Molecular Compounds

Reference Table 3 pg. 34

IUPAC Name	Formula and State at SATP
water	$H_2O_{(l)}$
hydrogen peroxide	$H_2O_{2(l)}$
ammonia	$NH_{3(g)}$
glucose	$C_6H_{12}O_{6(s)}$
sucrose	$C_{12}H_{22}O_{11(s)}$
methane	$CH_{4(g)}$
propane	$C_3H_{8(g)}$
octane	$C_8H_{18(l)}$
methanol	$CH_3OH_{(l)}$
ethanol	$C_2H_5OH_{(l)}$
hydrogen sulfide	$H_2S_{(g)}$

Naming Acids

- **Systematic IUPAC**

1) aqueous hydrogen chloride

   $HCl_{(aq)}$

2) aqueous hydrogen chlorate

   $HClO_{3(aq)}$

3) aqueous hydrogen chlorite

   $HClO_{2(aq)}$

- **Traditional**

1) hydrogen ______ide = hydro______ic acid

   ex. hydrogen *chlor*ide = hydro*chlor*ic acid

2) hydrogen ______ate = __________ic acid

   ex. hydrogen *chlor*ate = *chlor*ic acid

3) hydrogen ______ite = __________ous acid

   ex. hydrogen *chlor*ite = *chlor*ous acid

Remember: acid contains sulfur = you add a *ur* $H_2SO_{4(aq)}$ *sulfuric acid*
acid contains phosphorus = add an *or* $H_3PO_{4(aq)}$ *phorphoric acid*

+

Practice – Naming Acids

	IUPAC	Traditional
$HClO_{4(aq)}$	aqueous hydrogen perchlorate	perchloric acid
$HClO_{(aq)}$	aqueous hydrogen hypochlorite	hypochlorous acid
$HNO_{2(aq)}$	aqueous hydrogen nitrite	nitrous acid
$HNO_{3(aq)}$	aqueous hydrogen nitrate	nitric acid
$H_2SO_{4(aq)}$	aqueous hydrogen sulfate	sulfuric acid
$H_2SO_{3(aq)}$	aqueous hydrogen sulfite	sulfurous acid
$H_3PO_{4(aq)}$	aqueous hydrogen phosphate	phosphoric acid

+

Naming Review

- Read Pages 1-2 of your Chemistry 30:
  Introduction Review Booklet

- Work on:

  Worksheet #1 Naming Ionic Compounds

  Worksheet #2 Naming Mixed Ionic/covalent Compounds

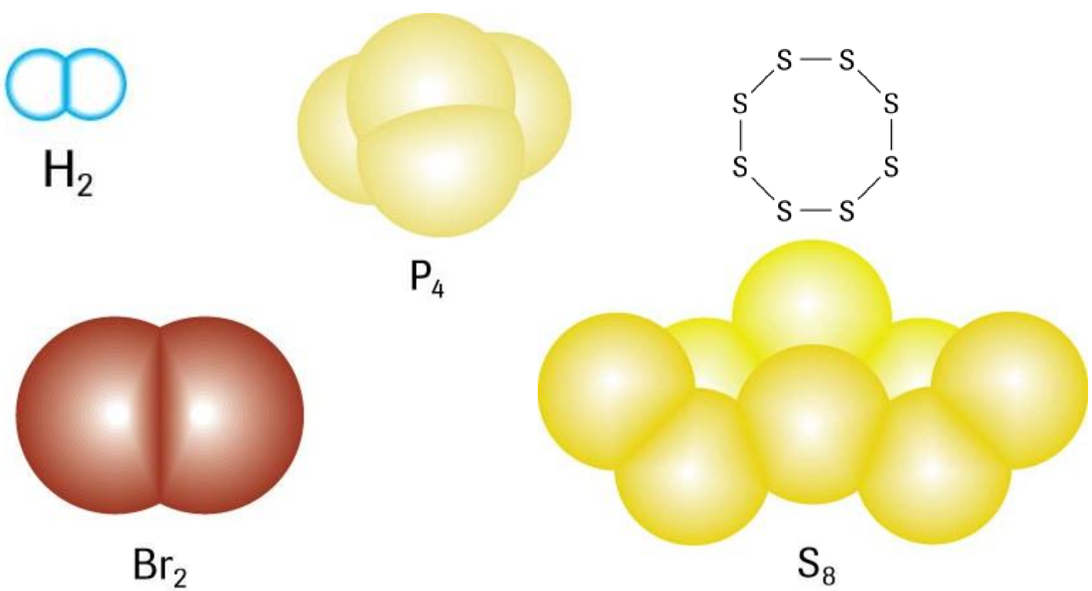
  Worksheet #3 Naming hydrates

  Worksheet #4 Naming Acids

You are encouraged to use you Chemistry Data Booklet.

+ Molecular Elements

- Many molecular elements are *diatomic* and some are *polyatomic*
  - You will need to memorize the formulas of the 9 molecular elements as they will not be given to you:



Name	Symbol
hydrogen	$H_2(g)$
nitrogen	$N_2(g)$
oxygen	$O_2(g)$
fluorine	$F_2(g)$
chlorine	$Cl_2(g)$
iodine	$I_2(g)$
bromine	$Br_2(g)$
phosphorous	$P_4(g)$
sulfur	$S_8(g)$

+ Balancing Review

- When counting elements, don't forget to look at both the subscript and the coefficient.
- For example:

P_2O_5 = has 2 phosphorus atoms and 5 oxygen atoms

$2P_2O_5$ = has 4 phosphorus atoms and 10 oxygen atoms

Because there are 2 molecules (indicated by the coefficient) and 2 atoms in each molecule (indicated by the subscript) –

So you multiply!!

+ Balancing Review

- Never change a subscript to balance an equation!

$O_{2(g)} + H_{2(g)} \rightarrow H_2O_{(l)}$ Is unbalanced – but you can't change it the following way!

$O_{2(g)} + H_{2(g)} \rightarrow H_2O_{2(l)}$ X

- Make sure the coefficients are the lowest whole-number ratio :

$$2O_{2(g)} + 4H_{2(g)} \rightarrow 4H_2O_{(l)}$$

This is a balanced formula *but these are not the lowest numbers you could use:*

$$O_{2(g)} + 2H_{2(g)} \rightarrow 2H_2O_{(l)}$$

Balancing Chemical Equations

1) Write the chemical formulas for the reactants and products including the states

- $Cu_{(s)} + AgNO_{3(aq)} \rightarrow Ag_{(s)} + Cu(NO_3)_{2(aq)}$

2) Balance the element (atom or ion) present in the greatest number by multiplying by the lowest coefficient possible

- $(NO_3)_{\mathbf{2}(aq)}$ = **2** present (lowest coefficient possible to balance = **2**)
- $Cu_{(s)} + \mathbf{2}AgNO_{3(aq)} \rightarrow Ag_{(s)} + Cu(NO_3)_{2(aq)}$

3) Repeat step 2 for the rest of the elements

- Now we have 2 Ag, so balance the other side
- $Cu_{(s)} + \mathbf{2}AgNO_{3(aq)} \rightarrow \mathbf{2}Ag_{(s)} + Cu(NO_3)_{2(aq)}$

4) Count elements on each side of the final equation to ensure they balance:

- $1\,Cu_{(s)} = 1\,Cu_{(s)}$; $2Ag = \mathbf{2}Ag_{(s)}$; $2\,NO_3 = (NO_3)_{2(aq)}$

Predicting Chemical Reactions

Match the five reaction types to the examples provided:

- Composition (Formation)
- Decomposition
- Combustion
- Single Replacement
- Double Replacement

- $CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$
- $Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$
- $Cu_{(s)} + AgNO_{3(aq)} \rightarrow Ag_{(s)} + Cu(NO_3)_{2(g)}$
- $CaCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow CaCO_{3(s)} + NaCl_{(aq)}$
- $H_2O_{(l)} \rightarrow O_{2(g)} + H_{2(g)}$

Balancing and Predicting Chemical Reactions Review

- Work on Page 7 of Review Booklet
  - Topic 2: Balancing Chemical Reactions

+ Mole and Molar mass

- A mole is a counting unit. It tells us how many objects there are.
- A pair = 2 dozen = 12 mole = 6.02×10^{23} objects
- What is the molar mass of methanol CH_3OH?

C = 12.01 g/mol x 1 = 12.01 g/mol

H = 1.01g/mol x 4 = 4.04 g/mol

O = 16.00g/mol x 1 = <u>16.00 g/mol</u>

Molar mass of methanol = 32.05 g/mol

Convert the following:

1) **5.0 mol of NaOH to grams:**

Molar Mass of NaOH: 40g/mol → **1 mol = 40 g**

$$5.0\ \text{mol} \times \frac{40\ \text{g}}{1\ \text{mol}} = 200\ \text{g}$$

2) **360 g of glucose to moles:**

Molar Mass of $C_6H_{12}O_6$: 180.18g/mol → 1 mol = 180.18 g

$$360\ \text{g} \times \frac{1\ \text{mol}}{180.18\ \text{g}} = 1.998\ \text{mol} = 2.0\ \text{mol}$$

Mole Review

- Work on Page 8 and 9 of the Review Booklet

  Topic 3 Mole Review and Mole Conversions

  Determining the number of moles in a sample

SUMMARY

Substance	Process	General Equation
Molecular	Disperse as individual, neutral molecules	$XY\ (s/l/g) \rightarrow XY\ (aq)$
Ionic	Dissociate into individual ions	$MX\ (s) \rightarrow M^{+}{}_{(aq)} + X^{-}{}_{(aq)}$
Base (ionic hydroxide)	Dissociate into positive ions and hydroxide ions	$MOH_{(s)} \rightarrow M^{+}{}_{(aq)} + OH^{-}{}_{(aq)}$
Acid	Ionize to form hydrogen ions and anions	$HX_{(s/l/g)} \rightarrow H^{+}{}_{(aq)} + X^{-}{}_{(aq)}$

Reference pg. 201

Net Ionic Equations

- A chemical reaction equation that includes only reacting entities (molecules, atoms and/or ions) and omits any that do not change

- Writing Net Ionic Equations:
  - 1) Write a complete balanced chemical equation
  - 2) Dissociate all high-solubility ionic compounds, and ionize all strong acids to show the complete ionic equation
  - 3) Cancel identical entities that appear on both the reactant and product sides
  - 4) Write the net ionic equation, reducing coefficients if necessary

+ Practice

When cancelling spectator ions, they must be identical in every way: chemical amount, form (atom, ion, molecule) and state of matter

- Write the net ionic equation for the reaction of aqueous barium chloride and aqueous sodium sulfate. (Refer to the solubility table)
- 1) $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$ (Nonionic equation)
- 2) $Ba^{2+}{}_{(aq)} + 2Cl^-{}_{(aq)} + 2Na^+{}_{(aq)} + SO_4{}^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)} + 2Na^+{}_{(aq)} + 2Cl^-{}_{(aq)}$

  (Total or Complete ionic equation)
- 3) $Ba^{2+}{}_{(aq)} + \cancel{2Cl^-}{}_{(aq)} + \cancel{2Na^+}{}_{(aq)} + SO_4{}^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)} + \cancel{2Na^+}{}_{(aq)} + \cancel{2Cl^-}{}_{(aq)}$
- 4) $Ba^{2+}{}_{(aq))} + SO_4{}^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$ (Net ionic equation)
- Ions that are present but do not take part in (change during) a reaction are called spectator ions (like spectators at a sports game: they are present but do not take part in the game)

Net Ionic Review

- Complete page 10 of the Chemistry Review Booklet

Determining the Mass of Pure Solid for a Standard Solution

- Use conversion factors to determine the values for both the amount in moles and the mass of solid required.
- Because you are working with one substance, you do not need a balanced equation (No need for a mol ratio)
- Volume of the solution and its molar concentration are needed.
- Example: To prepare 250.0mL of 0.100 mol/L solution of sodium carbonate, the mass needed is:

$$0.2500\ \text{L} \times \frac{0.100\ \text{mol}}{1\ \text{L}} \times \frac{105.99\ \text{g}}{1\ \text{mol}} = 2.65\ \text{g}$$

Solution Preparation Review

- Complete pg. 11 and 12 of the Review Booklet

  Topic 5: Solutions and Ion Concentration

Practice #1 (Gravimetric Stoichiometry)

What mass of iron (III) oxide is required to produce 100.0 g of iron?

$$Fe_2O_{3(s)} + 3\,CO_{(g)} \rightarrow 2\,Fe_{(s)} + 3\,CO_{2(g)}$$

$Fe_2O_{3(s)}$		$Fe_{(s)}$	
m = ?		m = 100.0g	
M = 159.70g/mol		M = 55.85 g/mol	

$$m\,Fe_2O_{3(s)}:\ 100.0\,\text{g} \times \frac{1\,\text{mol}}{55.85\,\text{g}} \times \frac{1\,\text{mol}}{2\,\text{mol}} \times \frac{159.70\,\text{g}}{1\,\text{mol}} = 143.0\,\text{g}\ Fe_2O_3$$

Practice #2 (Gas Stoichiometry)

- Hydrogen gas is produced when sodium metal is added to water. What mass of sodium is necessary to produce 20.0L of hydrogen at STP?
- Remember: 22.4L/mol for STP

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

m = ? V = 20.0L

22.99g/mol 22.4L/mol

$$20.0\,\cancel{L} \times \frac{1\,\cancel{mol}}{22.4\,\cancel{L}} \times \frac{2\,\cancel{mol}}{1\,\cancel{mol}} \times \frac{22.99g}{1\,\cancel{mol}} = 41.1\text{ g }Na_{(s)}$$

****Remember – molar volume is the conversion factor for gases just like molar mass is the conversion factor in gravimetric stoichiometry**

Example #3 (Gas Stoichiometry)

If the conditions are not STP or SATP, the molar volume cannot be used! You must use the ideal gas law to find the gas values using moles determined from stoichiometry

- What volume of ammonia at 450kPa and 80°C can be obtained from the complete reaction of 7.5kg of hydrogen with nitrogen?

$$2N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$$

$2N_{2(g)}$	$3H_{2(g)}$	$2NH_{3(g)}$
	m = 7500g	m = ?
	M = 2.02 g/mol	P = 450kPA
		T = 353.13K

$$7500\,g \times \frac{1\ mol}{2.02\ g} \times \frac{2\ mol}{3\ mol} = 2475.2475\ mol\ NH_{3(g)}$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(2475.2475\ mol)(8.314\ ^{kpa\cdot L}/_{mol\cdot K})(353.15K)}{(450kPa)}$$

$$= 16150.10L \rightarrow \mathbf{1.6 \times 10^4\ L\ of\ NH_{3(g)}}$$

+ Example #4 (Solution Stoichiometry)

- Ammonia and phosphoric acid solutions are used to produce ammonium hydrogen phosphate fertilizer. What volume of 14.8mol/L $NH_{3(aq)}$ is needed to react with 1.00kL of 12.9mol/L of $H_3PO_{4(aq)}$?

$2NH_{3(aq)}$	+	$H_3PO_{4(aq)}$	$\rightarrow$	$(NH_4)_2HPO_{4(aq)}$
V = ?		V = 1.00kL		
14.8mol/L		12.9 mol/L		

$$1.00\,k\cancel{L} \times \frac{12.9\,\cancel{mol}}{1\,\cancel{L}} \times \frac{2\,\cancel{mol}}{1\,\cancel{mol}} \times \frac{1\,L}{14.8\,\cancel{mol}} = 1.74\,kL = 1.74 \times 10^3\,L$$

Stoichiometry Review

- Complete pg. 13 and 14 of the Review Booklet
  - Gravimetric Stoichiometry
  - Gas Stoichiometry
  - Solution Stoichiometry
  - Limiting Reagents
  - Theoretical and Percent Yield

+ Summary of Bonding Theory:

Chemical Bond = competition for bonding electrons

1)Atoms with equal EN = electrons shared equally

If both have high EN = **covalent bond** (equal = **non-polar**)

If both have a low EN = **metallic bond**

2) Atoms with unequal EN = **covalent bond** (unequal = **polar**)

3) Atoms with unequal EN = **ionic bond**

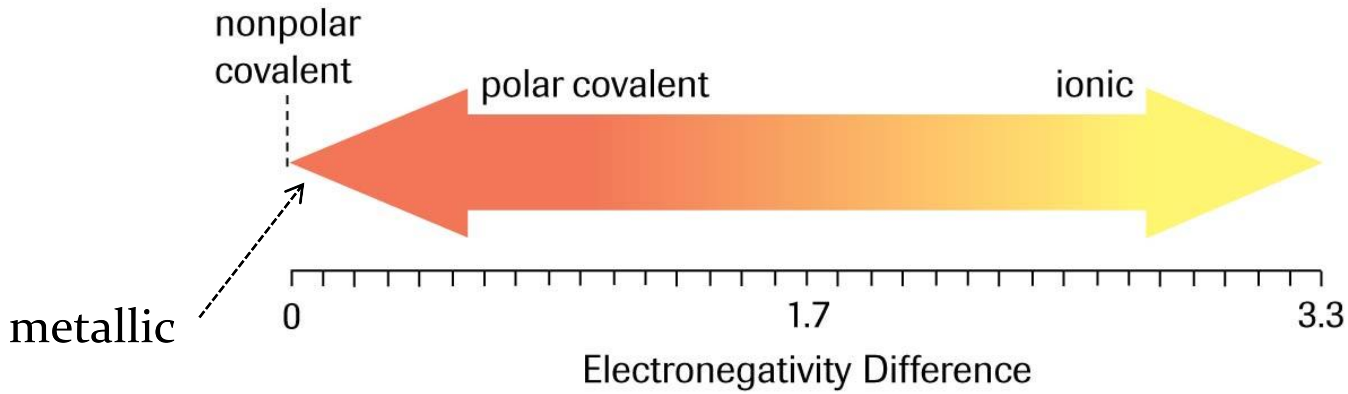
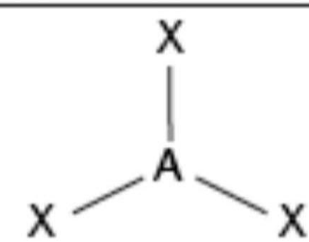
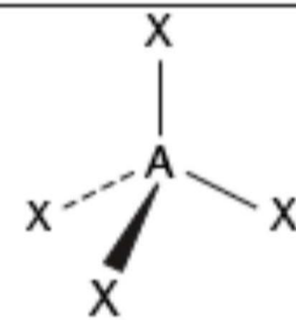
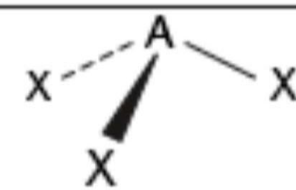
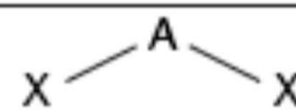


Table 7 Using VSEPR Theory to Predict Molecular Shape

General formula*	Bond pairs	Lone pairs	Total pairs	Molecular shape	
				Geometry**	Stereochemical formula
AX_2	2	0	2	linear (linear)	X — A — X
AX_3	3	0	3	trigonal planar (trigonal planar)	
AX_4	4	0	4	tetrahedral (tetrahedral)	
AX_3E	3	1	4	trigonal pyramidal (tetrahedral)	
AX_2E_2	2	2	4	angular (tetrahedral)	
AXE_3	1	3	4	linear (tetrahedral)	A — X

*A is the central atom; X is another atom; E is a lone pair of electrons.

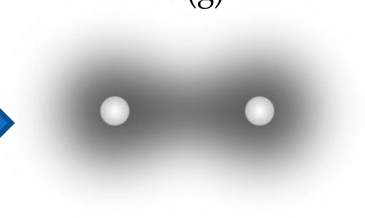
**The electron pair arrangement is in parentheses.

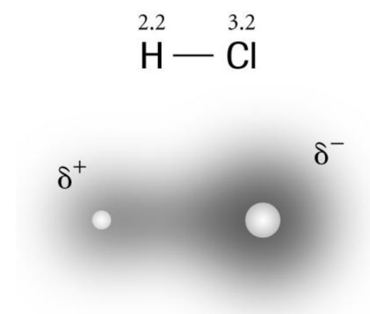
Pg. 95

Predicting and Explaining Polarity

- Pauling explained the polarity of a **covalent bond** as the difference in electronegativity of the bonded atoms.
  - If the bonded atoms have the same electronegativity, they will attract any shared electrons equally and form a **nonpolar covalent bond**.
  - If the atoms have different electronegativities, they will form a **polar covalent bond**.
  - The greater the electronegativity difference, the more polar the bond will be.

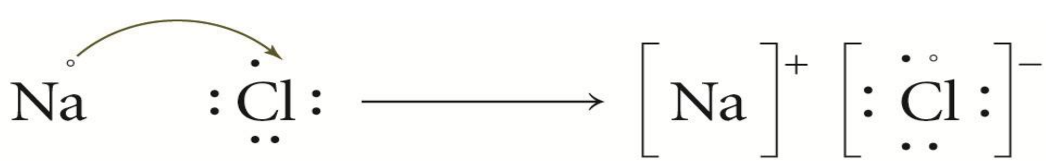
$Cl_{2(g)}$





We use the Greek symbol delta to show partial charges

- For a very large electronegativity difference, the difference in attraction may transfer one or more electrons resulting in **ionic bonding**.



+ Intermolecular Forces

- There are three types of forces in matter:
  1) Intranuclear force (bond) – bonds within the nucleus between protons and neutrons (very strong)

  2) Intramolecular force (bond) – bonds between atoms **within** the molecule or between ions **within** the crystal lattice (quite strong)

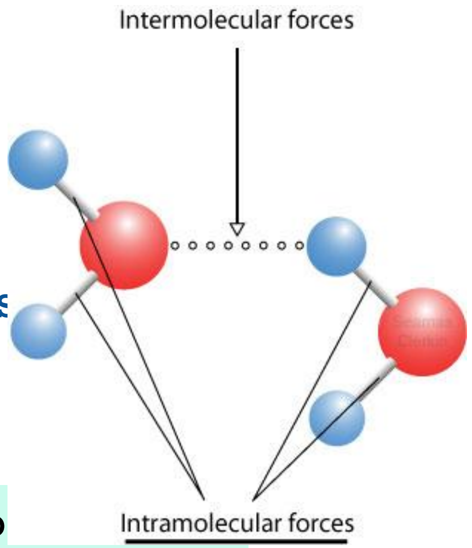
  3) Intermolecular force (bond) – bonds **between** molecules (quite weak); are electrostatic (involve positive and negative charges)

There are 3 types of intermolecular bonds:

Weakest a) Dipole-Dipole Forces (a.k.a. Polar Forces)

Medium b) London Force (a.k.a. London Dispersion Force, Dis

Strongest c) Hydrogen Bonding



Note: "Van der Walls force" – includes London and dipole-dip