Dear AP Chemistry Student,

I'm excited that you are thinking about taking AP Chemistry in the 2023-2024 school year with me and I am so happy that I have an opportunity to teach you for another year! This is a hard class that requires dedication, a fair amount of work and a love for chemistry. I know that with your passion and effort, we'll have a great time learning this advanced material in chemistry . AP Chemistry is meant to be a second-year course….that is, there is a lot of new material to cover and very little time to go over the basics for topics we studied in Honors Chemistry. However, because Chemistry is comprehensive, we can't forget about all the concepts learned in the last school year. To that end, I've put together these notes and problem packets for you to complete during the summer. It includes all of the most important handouts from the last year including some new ones, as well as review worksheets. Don't try to do it all at once – but practicing a little at a time every few days will help to flex those brain muscles over the summer. This packet will form the first several units of your AP Chemistry experience. At the end of the first full week of class, I will evaluate your completion of this packet and we can review any questions you have. The packet will be graded on completion, effort and accuracy. Enjoy your summer and I look forward to a new year of AP Chemistry with you!

Cheers,

Mrs. McLaughlin

Unit I: Physical & Chemical Changes, Matter & Energy

Helpful Links for significant figures and matter Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	**Rules for Significant Figures** **Significant Figures in Calculations** **Physical vs Chemical Changes** **Pure Substances vs Mixtures**

1. Label each as either physical or chemical change.
    a. corrosion of aluminum metal by hydrochloric acid
    b. melting wax
    c. pulverizing an aspirin tablet
    d. digesting a Three Musketeers bar
    e. explosion of nitroglycerin
    f. a burning match
    g. metal warming up, due to the burning match
    h. water vapor condensing on the metal
    i. the metal oxidizes, becoming dull and brittle

2. For each process described, state whether the material being discussed (in bold) is a mixture or compound, and state whether the change is physical or chemical.
    a. An **orange liquid** is distilled (boiled to separate components with different boiling points), resulting in the collection of a red solid and a yellow liquid.
    b. A **colorless, crystalline solid** is decomposed, leaving a pale yellow-green gas and a soft, shiny metal.
    c. A **cup of tea** becomes sweeter as sugar is added to it.

3. Classify each as mixture (homogeneous or heterogeneous) or pure substance (elements or compounds).

    a. water

    b. blood

    c. the ocean

    d. iron

    e. brass (an alloy of zinc and copper)

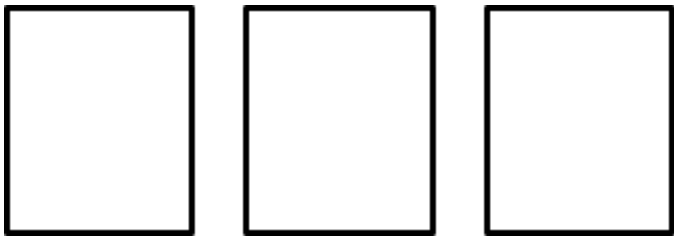
    f. wine

    g. sodium bicarbonate (baking soda)

4. Consider the burning of gasoline and the evaporation of gasoline. Which represents a physical change and represents a chemical change? Explain..

5. Label the arrows on the diagram below with the correct phase change processes. B) Draw a particle diagram representing each phase.

Solid ⇒ **Liquid** ⇒ **Gas**



6. How many significant figures are in the following numbers:

    a. _____ 1,245 m

    b. _____ 0.030 m

    c. _____ 10,000 m

    d. _____ 1.340×10^{23} m

e. _____ 3.02003×10^{14} m

f. _____ 0.0000001m

g. _____ 1,000. m

h. _____ 0.10000010 m

i. _____ 300 m

7. Convert the following numbers into standard scientific notation:

   a. 96.3×10^{4} g _____

   b. 0.05×10^{23} s _____

   c. 123×10^{-7} m _____

8. Perform the following Calculations and record your answers in the proper number of significant figures and units.

   a. 0.6030s + 0.82s =

   b. 4.1m + 0.3789m – 153.22m =

   c. $\frac{0.307\ g}{1.0 \times 10^{-3} ml}$ =

   d. $\sqrt[3]{5.33 \times 10^{5}\ m}$ =

Unit 1: Metric Conversions

9. Make the following conversions – preserve the number of significant figures in the answer!

   a. 450nm _____ mm

   b. 34km _____cm

   c. 43 000mm _____km

d. 4.0×10^{6} nm _____μm

e. 3.98×10^{-3} km_____μm

f. 456mm _____km

g. 136 000m _____km

h. 4.89×10^{12} mm _____km

i. 2.68×10^{6} m _____km

j. 456 000 μm _____mm

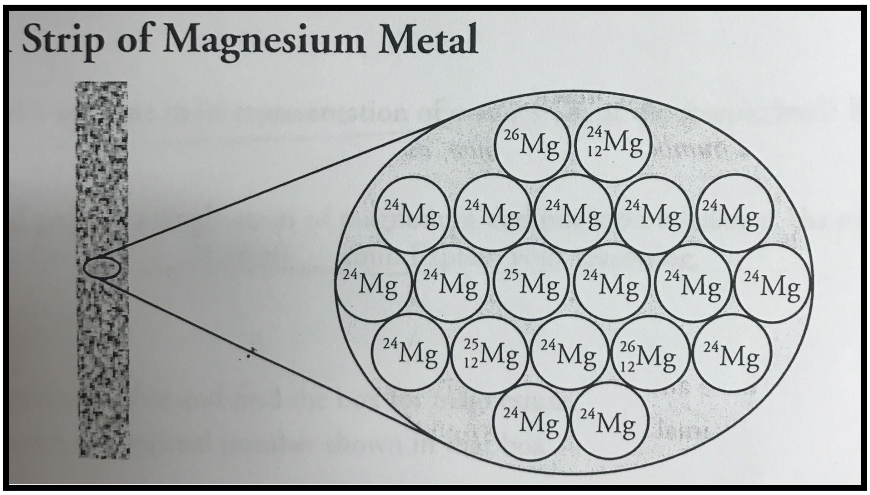
Unit 2: Atomic Structure

Helpful Links for atomic structure & isotopes Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	**Bohr Model of Atom** **Isotopes** **Calculate average atomic mass** $\text{Average atomic mass} = \frac{\sum (\%\text{of each isotope})\,(\text{atomic mass of each isotope})}{100}$

10. Using the periodic table, complete the following;

Isotope Symbol	Atomic Number	Mass Number	# of Protons	# of Neutrons	# of Electrons
	9	18			10
$^{24}_{11}Na$					
			35	44	35
$^{35}_{17}Cl$					
$^{26}_{12}Mg^{+2}$					

11. Using the ***Model: Strip of Magnesium Metal*** below, write a brief C.E.R. to answer the focus question below.



a. For the sample of 20 atoms of magnesium shown in the Model above, indicate the mass numbers of the three isotopes **and** the numbers of atoms of each isotope present.

b. Based on your answer to Question 11a above, what are these amounts expressed as percentages?

c. Calculate the average atomic mass of Magnesium.

12. Calculate the average atomic mass of iridium if the isotope Ir-191 is 37.3% abundant and there is only one other isotope of iridium, Ir - 193.

13. Boron has two isotopes with masses of Boron - 10 and Boron - 11. The isotopes occur

naturally in a 1 : 4 ratio respectively. What is the average relative atomic mass of boron?

14. Chlorine has an average atomic mass of 35.45 and has two isotopes, ^{35}Cl and ^{37}Cl, calculate the percent abundance of each isotope.

Unit 3: Electrons

Electron Wave Equations		
Helpful Links for electrons Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	Electron Wave Calculations Aufbau Diagrams Electron Configurations Noble Gas Configurations	
Speed of Light Equation	$c = \lambda\nu$	$c = speed\ of\ light\ constant\ 3.0\ x\ 10^{8} m/s$ $\lambda = wavelength\ (m)$ $\nu = frequency\ (s^{-1})$
Energy of Wave equation	$E = h\nu$	$E = energy\ (J)$ $h = Planck's\ Constant\ 6.626\ x\ 10^{-34} J \cdot s$ $\nu = frequency\ (s^{-1})$

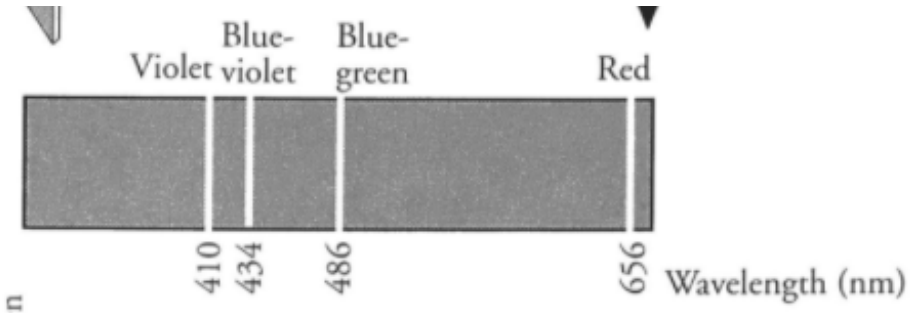
15. What is the wavelength of a wave having a frequency of 3.76 x 10^{14} s^{-1}? What is its energy?

16. What is the frequency of a 6.9×10^{-10} cm wave?

17. What is the wavelength of a wave carrying 8.35×10^{-18} J of energy?

18. Below is the hydrogen atomic emission spectrum. Calculate the energy for the **blue-green light** wave given the wavelength in nanometers below.

    (Speed of light c = 3.0 x 10^{8} m/s Planck's Constant h = 6.63 x 10^{-34} Js)



19. Write the **full electron configuration** of the following elements or ions:

a. Iron, Fe _____

b. Oxide ion, O^{-2} _____

c. Sodium ion, Na^{+} _____

20. Write the **noble gas core configuration** of the following elements or ions:

a. Cesium, Cs _____

b. Gallium, Ga _____

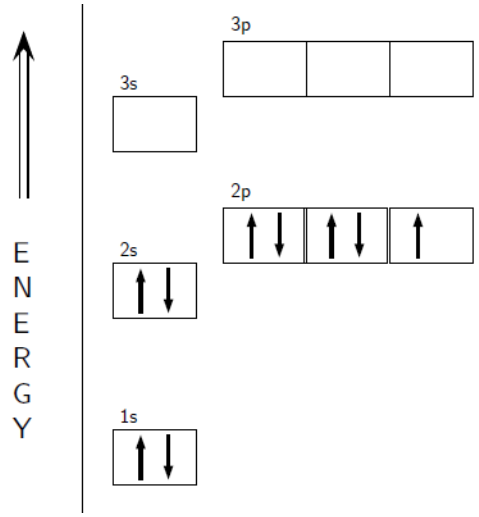
c. Xenon, Xe _____

21. For each of the following identify the unknown **element** using the electron configuration

a. **X** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^7$

b. **Y** [Kr] $5s^2$

c. Aufbau Diagram for **Z**



Unit 4: Nomenclature

Helpful Links for naming compounds and writing chemical formulas of compounds Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	**Rules for Naming Compounds** **Flow Chart Naming Compounds** **Rules for Writing Ionic Formula** **Polyatomic Ion List Sorted Alpha by Name** **Polyatomic Ion List Sorted by Charge**

22. Write the correct name of each **binary ionic compound** below.
    a. SrO _____
    b. $MgCl_2$ _____

Write the formula of the **binary ionic compounds** below.

    c. Calcium Nitride _____
    d. Sodium Oxide _____
    e. Iron (III) Chloride _____
    f. Manganese (II) Oxide _____

Write the name of the **ternary ionic compounds** below.

    g. KNO_3 _____
    h. $Fe(NO_2)_3$ _____

Write the formula of the **ternary ionic compounds**

    i. Cobalt (II) Phosphite _____
    j. Ammonium Carbonate _____

Write the formula of the **binary molecular compounds** listed below.

    k. Difluorine hexiodide _____
    l. Selenium tetrachloride _____

Write the name of the **binary molecular compounds** below.

m. CO _____

n. CO_2 _____

Write the formula or name – this section is **MIXED**.

o. Cobalt (II) sulfide _____

p. Xenon pentachloride _____

q. $NaMnO_4$ _____

r. N_3F_6 _____

s. $Fe(OH)_2$ _____

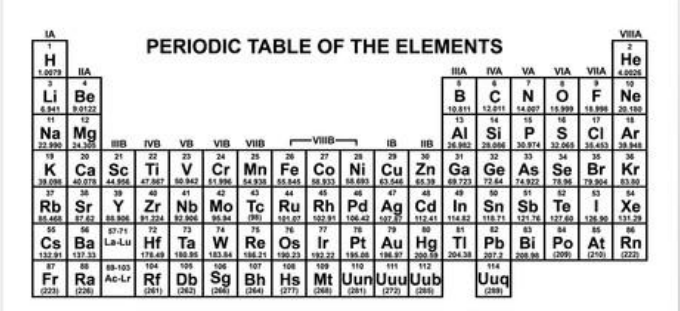
Unit 5: Periodicity

Helpful Links for predicting physical and chemical property patterns on the periodic table. Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	**Coulomb"s law** **Atomic Radius** **Ionization energy** **Electronegativity**

23. ***Atomic Radius***
    a. Define **Atomic Radius** -

    b. What happens to the attractive forces between two oppositely charged particles as the distance between the particles increases?

    c. What happens to the attractive forces between outer valence electrons and the nucleus as more protons are added to the nucleus?



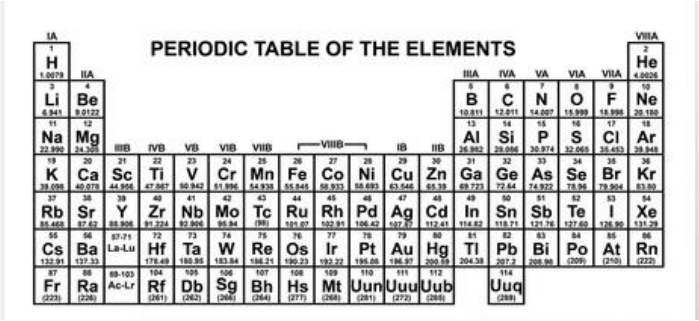
d. Which atom has the largest atomic radius, Li, Na, or K? Explain.

e. Which atom has the smallest radius, Ca, Cu, or As? Explain.

24. ***Ionization Energy***

a. A student claims that F has the smallest radius of O, F, and Cl. Do you agree or disagree? Explain why or why not.

b. Define I**onization Energy** -



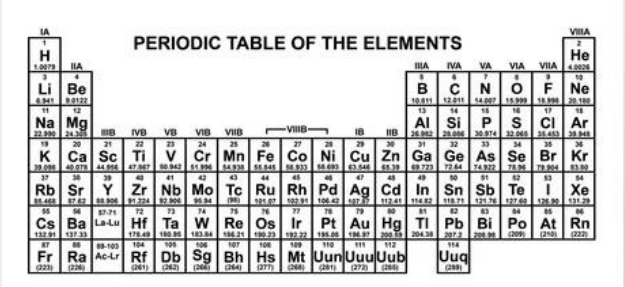
c. Which atom has the smallest ionization energy, Beryllium *Be*, Magnesium *Mg*, or Calcium *Ca*? Explain.

d. Which atom has the largest ionization energy, Phosphorus *P*, Sulfur *S* or Chlorine *Cl*? Explain.

e. A student claims Nitrogen will have the smallest ionization energy of C, N, and P. Do you agree or disagree? Explain why or why not.

25. ***Electronegativity***

a. Define **electronegativity** -



b. Which atom has the largest electronegativity nitrogen, oxygen, or fluorine? Explain.

c. Which atom has the smallest electronegativity Lithium. sodium, or potassium? Explain.

d. Which atom O, F, or Cl has the largest electronegativity? Explain.

26. ***Big Takeaways***

a. Metals tend to (Gain or Lose) electrons to form (Cation or Anions) because they have (Small or Large) atomic Radii

b. Nonmetals tend to (Gain or Lose) electrons to form (Cation or Anions) because they have (Small or Large) atomic Radii

Unit 6 Balancing & Classifying Reactions

Helpful Links for balancing equations and classifying equations by reaction type. Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	**Balancing Equations** **Classifying Equations**

27. $Li + LiNO_3 \rightarrow Li_2O + N_2$

CLASSIFY:

28. $Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$

CLASSIFY:

29. $KNO_3 + BaCl_2 \rightarrow Ba(NO_3)_2 + KCl$

CLASSIFY:

30. $Mg_3P_2 \rightarrow Mg + P$

CLASSIFY:

31. $CH_4 + O_2 \text{ ---> } CO_2 + H_2O$

CLASSIFY:

32. $Pb(NO_2)_2 + KI \rightarrow PbI_2 + KNO_2$

CLASSIFY:

Unit 7: Solubility Rules & Double Displacement Reactions

Helpful Links for predicting products of double displacement reactions and writing net ionic equations. Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	Access Solubility Rules Here Predicting Products of Double Displacement Reactions Recording How to write net ionic equations

33. Write the full, **balanced** whole equation, complete ionic equation AND the net ionic equation (including state symbols) to show the formation of the precipitate and if there is no reaction, write "**No Rxn**"

a. FULL: $MgCl_{2\,(aq)} + K_2CO_{3\,(aq)} \rightarrow MgCO_{3\,(s)} + KCl_{\,(aq)}$

IONIC:

NIE:

b. FULL: $NaI_{\,(aq)} + RbBr_{\,(aq)} \rightarrow RbI_{(aq)} + NaBr_{\,(aq)}$

IONIC:

NIE:

34. For each of the following: **predict BOTH products** of the double replacement reaction, **balance** the equation, **predict the physical state symbols** and write a **net ionic equation**.

a. $AgNO_{3\,(aq)} + NaBr_{(aq)} \rightarrow \quad +$

b. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow \quad +$

c. $Li_3PO_{4\,(aq)} + MgCl_{2\,(aq)} \rightarrow \quad +$

d. $AlCl_{3\,(aq)} + NaOH_{(aq)} \rightarrow \quad +$

Unit 8 Oxidation Reduction

Helpful Links for oxidation numbers and oxidation- reduction reactions Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	Activity Series of Metal Assigning Oxidation Numbers Half Equations

35. Assign oxidation number of each of the atoms listed in the following species

a. Nitrogen in NO_3^-

b. Nitrogen in NO_2^-

c. Manganese in MnO_4^-

d. Manganese in MnO_2

e. Oxygen in K_2O_2

f. Oxygen in LiO_2

g. Oxygen in Na_2O

h. Chromium in $Cr_2O_7^{-2}$

i. Chromium in CrO_4^{-2}

j. Sulfur in SO_4^{-2}

36. Balance each half equation and write the overall net ionic equation.

a. $\mathbf{Sn_{(s)} + Cl_{2(g)} \rightarrow Sn^{+4}_{(aq)} + 2\ Cl^{-}_{(aq)}}$

i. Oxd:

ii. Red:

b. $\mathbf{Mg^{+2}_{(aq)} + H_{2(g)} \rightarrow Mg_{(s)} + 2\ H^{+}_{(aq)}}$

i. Oxd:

ii. Red:

c. $\mathbf{Mg_{(s)} + Fe^{+3}_{(aq)} \rightarrow Mg^{+2}_{(aq)} + Fe_{(s)}}$

i. Oxd:

ii. Red:

37. Write a balanced net ionic equation for the oxidation - reduction reaction between $Cr_{(s)}$ and $Zn^{+2}_{(aq)}$ based on the half equations below. Identify which species is oxidized and which species is reduced?

$Mg^{+2}_{(aq)} + 2\ e^- \rightarrow Mg_{(s)}$

$Fe_{(s)} \rightarrow Fe^{+3}_{(aq)} + 3\ e^-$

38. Write a balanced net ionic equation for the oxidation - reduction reaction between $Cr_{(s)}$ and $Zn^{+2}_{(aq)}$ based on the half equations below. Identify which species is oxidized and which species is reduced?

$Cr_{(s)} \rightarrow Cr^{+4}_{(aq)} + 4\ e^-$

$Zn^{+2}_{(aq)} + 2\ e^- \rightarrow Zn_{(s)}$

39. For each of the following below, **<u>use the activity series</u>** to predict if the reaction will occur. If there is no reaction, write "NR" . If there is a reaction, predict the products, state symbols, and balance the equation.

a. $Ag_{(s)} + MgCl_{2\,(aq)} \rightarrow$

b. $K_{(s)} + Mg(NO_3)_{2\,(aq)} \rightarrow$

c. $Zn_{(s)} + HCl_{(aq)} \rightarrow$

Unit 9 Mole Concepts

1 mole = 22.4 Liters 1 mole = molar mass (g) periodic table 1 mole = 6.02 x 10^{23} representative particles	Avogadro's Number Molar Mass Mole Conversions

40. How many representative particles are in 2.96g of sodium chloride, NaCl?

41. What is the mass of 1.28 x 10^{25} atoms of zinc, Zn?

42. A sample of 6.33g of iron (III) oxide, Fe_2O_3, contains how many molecules?

43. A sample of 8.2 x 10^{23} molecules of Na_2SO_4 is what mass?

Helpful Links for percent composition, empirical formula, molecular formula, and hydrate analysis. Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	Percent Composition/ Mass Percent Empirical Formula Molecular Formula Hydrate Analysis

44. What is the mass of methane gas $CH_{4\,(g)}$ if it occupies 12.5 Liters of space at STP?

45. Calculate the mass percent of **SULFUR** in Aluminum Sulfide, Al_2S_3

46. A 29.0g sample of Ag combines completely with 43.0g of sulfur to form a 72.0g sample of Ag_2S compound. What is the percent composition of this compound?

47. Determine the empirical formula of a compound that is usually used as a fertilizer can also be used as a powerful explosive. The compound has the composition, 35.00% nitrogen, 59.96% oxygen and the ***remainder being hydrogen***.
    a. What is its empirical formula?

    b. What is the molecular formula of the same substance if it has a known molar mass of 240.18 g/mol.

48. A 15.67 g sample of a hydrate of magnesium carbonate **$MgCO_3 \cdot xH_2O$** was heated, without decomposing the carbonate, to drive off the water. The mass was reduced to 7.58 g.

a.) How is the water of hydration removed from a hydrate?

b.) Why is it important to heat until a constant mass is achieved?

c.) What is the empirical formula of the hydrate?

Helpful Links for stoichiometry based problems Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	Stoichiometry Mass A -. Mass B Stoichiometry Liter A --> Liter B Percent Yield

49. What mass of water, H_2O is formed when 2.5g of hydrogen, H_2 is consumed?

$2\ H_2 + O_2 \rightarrow 2H_2O$

50. How many moles of N_2 are consumed if 2.09 moles of ammonia, NH_3 form?

$N_2 + 3H_2 \rightarrow 2NH_3$

51. What mass of C is consumed if 15. 5 L of CO_2 are formed at STP?

$C + O_2 \rightarrow CO_2$

52. What mass of water reacts with 2.5 x 10^{23} atoms of Na according to the equation below?

$Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$

53. What volume of water forms when 44.8 L of O_2 is consumed?

$2H_2 + O_2 \rightarrow 2H_2O$

Percent Yield:

54. When 7.5g of N_2 reacts, the theoretical yield of NH_3 is 9.12g. If 1.72g of NH_3 is obtained, what is the percent yield?

55. A student reacts 40.0g H_2 and obtains 300. g of H_2O. What is the percent yield?

$2H_2 + O_2 \rightarrow 2\ H_2O$

Helpful Links for stoichiometry of limiting/excess reactants based problems Go to AP Summer Assignment on google classroom to access summer assignment pdf with active links	**Limiting Reactants Particle Diagrams** **Limiting reactant & Theoretical Yield** **Model Problem Limiting & Excess Reactants**

56. If 18.0g of Na and 23.0g of Cl_2 are allowed to react according to the balanced chemical equation below, then.

$$\mathbf{2Na + Cl_2 \rightarrow 2NaCl}$$

a) Calculate the theoretical yield of NaCl formed

b) Determine the Excess Reactant Left Over

c) Calculate the percent yield if 35.0g of NaCl are actually obtained from this experiment.

57. A chemist allows 1.0 moles of nitrogen, $N_{2\,(g)}$ and 1.0 moles hydrogen, $H_{2\,(g)}$ to react until completion.

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

How much ammonia, $NH_{3\,(g)}$ forms? How much excess reactant is left over?

58. What moles of $ZnCl_2$ can be formed if 2.0 moles of Zn and 3.0 moles of HCl are allowed to react according to the unbalanced chemical equation below?

Unbalanced equation:

$$\mathbf{Zn + HCl \rightarrow ZnCl_2 + H_2}$$