You are to complete the following problem set prior to the first day of class in September. I will collect your answers, which should be done on separate pages because there is not enough room in this question set unless you reprint them with much more space.

The difficulty of the problems varies, so don't be surprised if you are challenged by several of them. Do give them all a good try, though. I would estimate that this problem set should take 10 to 20 hours, so please do not leave it for the last day before the start of school.

You should use the text book, regents review book, yahoo answers (chemistry), mychemistrytutor.com, my website (kentchemistry.com) or any other resources you find helpful. Please also feel free to contact me at the email above if you have any questions.

1. Memorize the names, formulas and charges for the common <u>anions</u>. Aside from the following table, you can use Table E from the NYS reference table.

Formula	Ion Name	Formula	Ion Name	Formula	Ion Name
-1 Charge					
H^-	Hydride	N_3^-	Azide	ClO^-	Hypochlorite
F^-	Fluoride	CN^-	Cyanide	ClO_2^-	Chlorite
Cl^-	Chloride	OH^-	Hydroxide	ClO_3^-	Chlorate
Br^-	Bromide	$C_2H_3O_2^-$	Acetate	ClO_4^-	Perchlorate
I^-	Iodide	$H_2PO_4^-$	Dihydrogen	SCN^-	Thiocyanate
NO_2^-	Nitrite		Phosphate	HSO_4^-	Hydrogen
NO_3^-	Nitrate	HCO_3^-	Hydrogen		Sulfate
MnO_4^-	Permanganate		Carbonate		
-2 Charge					
O^{2-}	Oxide	CO_3^{2-}	Carbonate	SO_4^{2-}	Sulfate
O_2^{2-}	Peroxide	CrO_4^{2-}	Chromate	$C_2O_4^{2-}$	Oxalate
S^{2-}	Sulfide	$Cr_2O_7^{2-}$	Dichromate	HPO_4^{2-}	Hydrogen
$S_2O_3^{2-}$	Thiosulfate	SO_3^{2-}	Sulfite		Phosphate
-3 Charge					
N^{3-}	Nitride	P^{3-}	Phosphide	PO_4^{3-}	Phosphate

2. Memorize the names, formulas and charges for the common <u>cations</u>. Aside from the following table, you can use Table E from the NYS reference table.

Formula	Ion Name	Formula	Ion Name	Formula	Ion Name
+1 Charge					
H^+	Hydrogen	K^+	Potassium	NH_4^+	Ammonium
Li^+	Lithium	Cs^+	Cesium	H_3O^+	Hydronium
Na^+	Sodium	Ag^+	Silver	Cu^+	Copper(I)
+2 Charge					
Mg^{2+}	Magnesium	Zn^{2+}	Zinc	Fe^{2+}	Iron(II)
Ca^{2+}	Calcium	Cd^{2+}	Cadmium	Co^{2+}	Cobalt(II)
Sr^{2+}	Strontium	Sn^{2+}	Tin(II)	Ni^{2+}	Nickel(II)
Ba^{2+}	Barium	Mn^{2+}	Manganese(II)		
Pb^{2+}	Lead(II)	Hg_2^{2+}	Mercury(I)	Hg^{2+}	Mercury(II)
+3 Charge					
Al^{3+}	Aluminum	Fe^{3+}	Iron(III)		

3. Memorize the solubility rules for compounds that are <u>soluble</u> in water. You can also use reference table F in the NYS reference tables.

Soluble Compounds contain:	Exceptions
Most common acids	-
Group 1 Metals	None
Ammonium	None
Nitrates	None
Acetate	Silver Acetate is slightly soluble
Chlorate	None
Perchlorate	None
Hydrogen Carbonate	None
Halides	Ag^+, Pb^{2+}, Hg_2^{2+}, and CaF_2
Sulfates	Ag^+, Pb^{2+}, Hg_2^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}

4. Memorize the solubility rules for compounds that are <u>insoluble</u> in water. You can also use reference table F in the NYS reference tables.

Insoluble	Exceptions
Carbonates	Group 1 metals, ammonium and dilute acids
Oxides	Group 1 metals, ammonium and dilute acids
Phosphates	Group 1 metals, ammonium and dilute acids
Sulfides	Group 1 metals, ammonium
Hydroxides	Group 1 metals, ammonium, dilute acids, Ca^{2+}, Ba^{2+}, and Sr^{2+}
Chromates	Group 1 metals, ammonium, dilute acids, Ca^{2+}, Mg^{2+}

5. Use **factor labeling** method to convert the following:
    a. 200 meters = ___ miles.

    b. 650 in = ____ meters

    c. 4 years= _____ seconds.

    d. 200 liters = _____ ml

6. Classify each of the following as units of mass, volume, length, density, energy, or pressure.
a.Kg   b. Liter   c. m^3 d. mm   e. kg/m^3 f. Joule   g. atm   h. cal

            i.Torr   J. g/ml

7. Most laboratory experiments are performed at room temperature at 25˚C. Express this temperature in:

    a.   ˚F

    b.   K

8. How many **significant figures** are in each of the following?
    a.   1.9200 mm   b. 0.0301001 kJ   c. 6.022 x10^{23} atoms
    d.460.000 L   e. 0.000036 cm^3 f. 10000   g.1001   h. 0.001345
    i. i.0.0101   J. 3.02 x 10^4 k. 3.21 x 10^{-2}

9. Write the number 1200 three ways: to 2, 3, and 4 significant figures

10. Record the following in correct **scientific notation**:
    a. 4050,000,000 cal

    b. 0.000123 mol

    c. 0.00345 Å

    d. 700,000,000 atoms

11. Calculate the following to the **correct number** of significant figures.
    a. 1.270 g / 5.296 cm^3
    b. 12.235 g / 1.010 L
    c. 12 g + 0.38 g
    d. 170g + 2.785 g
    e. 2.1 x 3.2102
    f. 200.1 x 120
    g. 17.6 + 2.838 + 2.3 + 200

12. A cylinder rod formed from silicon is 46.0 cm long and has a mass of 3.00 kg. The density of silicon is 2.33 g/cm^3. What is the diameter of the cylinder? (the volume of cylinder is given by πr^2h, where r is the radius and h is the length)

13. Give the **chemical symbols** for the following elements:
    a. Carbon   b. sulfur   c. Titanium   d. Nitrogen   e. Helium

    f. Krypton   g. Fluorine   h. Scandium   I. Arsenic   J. Potassium   K. Sodium

    l. chloride   m. Iron   n. Zinc

14. Write **the latin** names for each of the elements symbols:
    a. Na   e. Fe

    b. Au   f. Hg

    c. Ag   g. K

    d. Sn   h. Pb

15. A container has a volume of 1.05×10^3 cm^3. When filled with gas, the mass of the container + gas is 837.6 g. The mass of the container alone is 836.2 g. To the correct number of significant figures, what is the density of the gas?

16. Classify each of the following as to pure substances or mixtures. If an item is a mixture, specify if it is heterogeneous or homogeneous.

(a) concrete

(b) seawater

(c) magnesium

(d) gasoline

(e) air

(f) tomato juice

(g) iodine crystals

(h) a nickel

17. How would you separate a mixture of granulated sugar and beach sand of comparable grain size?

18. Label each of the following as either a **physical process** or a **chemical process**.

a. Corrosion of aluminum metal.

b. Melting of ice.

c. Pulverizing an aspirin.

d. Digesting a candy bar.

e. Explosion of nitroglycerin.

f. Milk turning sour.

g. Burning of paper.

h. Forming of frost on a cold night.

i. Bleaching of hair with hydrogen peroxide.

j. A copper wire is hammered flat.

19. A solid white substance A is heated strongly in the absence of air. It decomposes to form a new white solid substance B and a gas C. The gas has exactly the same properties as the product obtained when carbon is burned with excess oxygen. What can you say about whether solids A and B and the gas C are elements or compounds?

20. In the process of attempting to characterize a substance, a chemist makes the following observation: The substance is a silvery white, lustrous metal. It burns in air, producing an intense white light. It reacts with chlorine to give a brittle white solid. The substance can be pounded into thin sheets or down into wires. It is a good conductor of electricity. Which of these characteristics are physical and which are chemical properties?

21. Why do we call $Ba(NO_3)_2$ barium nitrate, but we call $Fe(NO_3)_2$ iron(II) nitrate?

22. Write the formula of the following compounds?
    a. Calcium sulfate.   b. Ammonium Phosphate   c. Lithium Nitrite

    d. potassium perchlorate.   e. Barium Oxide   f. Zinc sulfide.

    g. Sodium Perbromate   I. Calcium Iodide   J. Aluminum Carbonate

24. Convert **6.75 atm** to: (Using **factor-labeling** method)
a.torr Hg

b. kilopascals

c. mm of Hg

23. Define the words:

   atomic number

   atomic mass

   mass number

   molecular formula

   structural formula

   empirical formula

   isotopes

   cation

   anion

   metalloid

   allotrope

24. Fill in all the gaps in the table assuming all the atoms are neutral

Symbol	^{39}K				
Protons		25			82
Neutrons		30	64		
Electron			48	56	
Mass #				137	207

25. Fill in the gaps of the table

Symbol	$^{52}Cr^{3+}$	$^{131}I^-$			
Protons			47		33
Neutrons			60	69	42
Electron			46	48	
Net Charge				2+	3-

26. List the following has diatomic molecule, molecular compound, ionic compound, Atomic element.

a. F_2
b. Cl_2
c. C
d. NaCl
e. KF

f. CO_2
g. H_2
h. Ag
i. Rust (Fe_2O_3)
j. MgO

k. O_2
l. I_2
m. CO
n. K_2CO_3

27. White gold is an alloy that typically contains 45.0% by mass gold and the remainder is platinum. If **154 g** of gold are available, how many grams of platinum are required to combine with the gold to form this alloy?

28. What is the empirical formula of a compound that contains 53.73% Fe and 46.27% of S ?

29. Determine the number of molecules present in 4.56 mol of nitrogen (N_2).

Atoms?

30. State the contribution of the following chemist in one line.

a. Democritus

b. Mendeleev

c. Henry Becquerel

d. Roentgen

e. J.J Thompson

f. Faraday

g. Chadwick

h. Millikan

i. Proust

j. Cavendish

k. Madam Curie

30. What is the difference between a. Chlorine and Chloride?   b. Sodium atom and sodium ion.

31. How many grams of methane (CH_4) are present in 5.6 moles of methane gas? (USE factor labeling method)

32. Calculate the **mass in grams** of each of the following:

a. 6.02 x 10^{23} atoms of Mg.

 b. 3.01 x 10^{23} Formula units of $CaCl_2$

c. 12.4 x 10^{15} atoms of neon

33. In an experiment, a student gently heated a hydrated copper compound to remove the water of hydration. The following data was recorded:

1.	Mass of crucible, cover, and contents before heating	23.4 g.
2.	mass of empty crucible and cover	18.82 g.
3.	mass of crucible, cover, and contents after heating to constant mass	20.94 g.

   Calculate the experimental percent of water in the compound.

34. An **extensive property** is one that depends on the amount of the sample. Which of the following properties are extensive?
    a. volume   b. density   c. temperature d. energy   e. melting point.   F. pressure

35. A hydrated compound has an analysis of 18.29% Ca, 32.37% Cl, and 49.34% water. What is its formula?

36. Name the types of **general inorganic reactions** with example of each?

34. Define Acid, base and salt? Give some examples of each.

35. What mass of copper is required to replace silver from 4.00g of silver nitrate dissolved in water?

___Cu(s) + ___AgNO$_3$ → ___Cu(NO$_3$)$_2$ + ___Ag
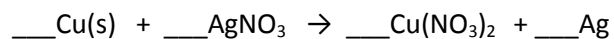
37. Write the chemical formulas for the following compounds:
   a. Calcium Carbonate
   b. Ammonium Phosphate
   c. Sodium Chloride
   d. Sodium Oxide
   e. Calcium Sulfate
   f. Sodium Nitrite
   g. Magnesium Acetate
   h. Potassium cyanide
   i. Zinc(II) Nitrate
   j. Iron(III) Phosphate
   k. Nickel (II) Fluoride

38. Define
   a. Law of conservation of mass

   b. Law of multiple proportion

39. Strontium consists of four isotopes with masses and their percent abundance of 83.9134 amu (0.5%), 85.9094 amu (9.9%) , 86.9089 amu (7.0 %) , and 87.9056 amu (82.6 %). Calculate the atomic mass of Sr ?

40. Nitrogen has two isotopes, N-14 and N-15, with atomic masses of 14.00031 amu and 15.001 amu, respectively. What is the percent abundance of N-15?

41. Write the number of protons and electrons?

   a P_4 molecule

   b. a PCl_5 molecule

   c. a P^{3-} Ion

   d. P^{5+} ion.

42. Mercury has an atomic mass of 200.59 amu. Calculate the

   a.Mass of 3.0×10^{10} atoms.

   b.Number of atoms in one nanogram of Mercury.

43. .Calculate the molar masses (g/ mol) of   a.

   a.Ammonia (NH_3)

   b. Baking soda ($NaHCO_3$)

   c. Osmium Metal (Os)

44. Convert the following to moles
   a.3.86 grams of Carbon dioxide.

   b.6.0 x 10 ^{5}g of Hydrazine ($N_2 H_4$), a rocket propellant.

45. The molecular formula of morphine, a pain-killing narcotic, is $C_{17}H_{19}NO_3$.
   a.What is the molar mass?

   b.What fraction of atoms in morphine is accounted for by carbon?

   c.Which element contributes least to the molar mass?

46. Complete the list ionic compounds (name or formula)
   a.Copper(II) Hydroxide

   b.Strontium Chromate

   c.Ammonium Perchlorate

   d.$NaHCO_3$

   e.$Fe_2 (CO_3)_3$

   f.Sodium Hydroxide.

   g.Potassium Chloride.

47. The hormone, thyroxine is secreted by the thyroid gland, and has the formula: $C_{15}H_{17}NO_4I_4$. How many milligrams of Iodine can be extracted from 15.0 Grams of thyroxine?

48. Determine the **formula weight** for the following:

    a. N_2O_5

    b. $CuSO_4$

    c. $Ca(HCO_3)_2$

    d. $CaSO_4 \cdot 2\,H_2O$
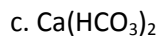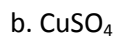
46. Determine the empirical formula of the compounds with the following compositions by mass:

a.10. 4 % C, 27. 8% S , 61. 7 % Cl

b.21.7 % C, 9.6 % O, and 68.7 % F

47. Arsenic reacts with chlorine to form a chloride. If 1.587 g of arsenic reacts with 3.755 g of chlorine, what is the simplest formula of the chloride?

49. Vanillin, a flavoring agent, is made up of carbon, hydrogen, and Oxygen atoms. When a sample of Vanillin weighing 2.500g burns in Oxygen, 5.79 g of carbon dioxide and 1.18 g of water are obtained. What is the empirical formula of Vanillin?

50. Washing soda is a hydrate of sodium carbonate. Its formula is $Na_2CO_3 \cdot x\ H_2O$. A 2.714 g Sample of washing soda is heated until a constant mass of 1.006 g of Na_2CO_3 is reached. What is x ?

51. .What is the molecular formula of each of the following compounds?

a.empirical formula CH_2 , molar mass =84g/mol.

b.Empirical formula NH_2Cl, Molar mass = 51.5 g/ Mol

52. Determine the empirical and molecular formula of each of the following substances:

a.Ibufuren, a headache remedy contains 75.6 % C, 8.80 % H , and 15.5 % O by mass and has a molar mass about 206 g/mol.

b.Epinerphine (adrenaline) a hormone secreted into the bloodstream in times of danger or stress contains 59% C, 7.1% H, 26.2% O, and 7.7% N by mass, its MW is about 180 amu.

53.Write a **balanced equation** for the following:

a.Reaction of boron trifluoride gas with water to give liquid hydrogen fluoride and solid boric acid,(H_3BO_3).

b.Reaction of magnesium Oxide with Iron to form Iron (III) Oxide and Magnesium.

c.The decomposition of dinitrogen Oxide gas to its elements.

d.The reaction of Calcium Carbide solid with water to form calcium hydroxide and acetylene (C_2H_2) gas.

e.The reaction of solid calcium cyan amide ($CaCN_2$) with water to from calcium carbonate and ammonia gas.

f.Ethane burns in air (Oxygen).

g.Hydrogen reacts with oxygen to from Water.

h.Nitrogen gas reacts with Hydrogen to form Ammonia.

j.Hydrogen reacts with Iodine gas to form Hydrogen Iodide.

k. Sodium reacts with Iodine gas to form Sodium Iodide.

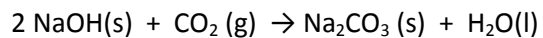l.Sodium Oxide reacts with water to form sodium hydroxide and hydrogen.

54. DEFINE

limiting reagent

theoretical yield

actual yield

55.Sodium hydroxide reacts with carbon dioxide as follows:

$$2\ NaOH(s)\ +\ CO_2\ (g)\ \rightarrow Na_2CO_3\ (s)\ +\ H_2O(l)$$

Which reagent is the limiting reactant when 1.85 mol of sodium hydroxide and 1.00 mol carbondixide are allowed to react? How many moles of sodium carbonate can be produced? How many moles of the excess reactant remain after the completion of the reaction?

$$2\ NaOH(s)\ +\ CO_2\ (g)\ \rightarrow Na_2CO_3\ (s)\ +\ H_2O(l)$$
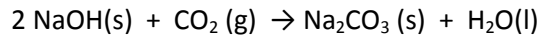
56. WHEN   benzene (C_6H_6) reacts with bromine (Br_2) bromobenzene(C_6H_5Br) is obtained:

$$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$

a.What is the theoretical yield of bromobenzene in this reaction when 30.0g of benzene reacts with 65.0g of bromine?

b. If the actual yield of bromobenzene was 56.7 g what was the percentage yield?

$$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$
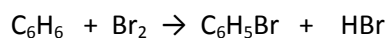
57.One way to remove Nitrogen Oxide (NO) from smokestack emissions is to react it with ammonia:

$$4 NH_3 (g) + 6 NO (g) \text{--------> } 5 N_2 (g) + 6 H_2O (l)$$
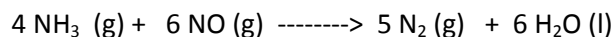
   a. 12.3 mol of NO reacts with _____ mol of ammonia.
   b. 5.87 mol NO yields _____ mol nitrogen.

58. A 2.0g sample of SX_6 (g) has a volume of 329.5 cm^3 at 1.00 atm and 20°C. Identify the element 'X'. Name the compound.

59. When Hydrogen sulfide gas, H_2S, reacts with oxygen, Sulfur dioxide gas and steam are produced.

                                 a.Write the balanced chemical equation for this reaction.

                                 b.How many liters of sulfur dioxide would be produced from 4.0 l of Oxygen? Assume 100% yield and that all gases are measured at the same temperature and pressure.

60. Hydrogen cyanide, HCN is a poisonous gas. It can be formed by the reaction:

       NaCN (s) $+ H^+$ (aq) ---------> HCN (g) $+$ Na^+ (aq)
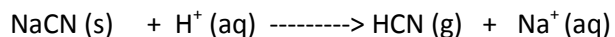
What mass of sodium cyanide is required to make 8.5 L of Hydrogen Cynaide at 22^0C and 751 mmHg?

61. Name the following covalent compounds:

a. CO_2 f. SF_6

b. P_4S_{10} g. CH_4

c. NI_3 h. C_2H_6

d. PCl_5 i. C_3H_8

e. CCl_4

62.Define **Oxidation number**.

Find the **Oxidation number** of

a.Carbon in CO_2.   c.Phosphorus in $PO_4{}^{3-}$

b.Sulfur in H_2SO_4.   d.Manganese in $MnO_4{}^{2-}$

63. Which of the following statements are always true? Never true? Not always true?

a.A compound with the molecular formula C_6H_6 has the same simplest formula.

b.The mass percent of copper in CuO is less than in Cu_2O.

c.The limiting reactant is the one present in the smallest number of grams.

d.Since $C_3H_6O_3$ and $C_6H_{12}O_6$ reduce to the same formula, they represent the same compound.

64. A sample of carbon dioxide gas, CO_2 (g), occupies a volume of 5.75 L at 0.890 atm. If the temperature and the number of moles remain constant, calculate the volume when the pressure

a.increased to 1.25 atm

b.decrease to 0.350 atm

65. A nitrogen sample at 30˚C has a volume of 1.75L. If the pressure and the amount of gas remain unchanged, determine the volume when the Celsius temperature is doubled.

66. Calculate the densities of the following gases at STP:

a.Carbon monoxide

b.Chlorine

67. A volatile liquid (one that evaporates) is put into a jar and the Jar is then sealed. Does the mass of the sealed jar and its contents change upon the vaporization of the liquid?

68. Define the terms:

Exothermic

Endothermic

69. How much heat is required to raise the temperature of 100 grams of water from 25^0C to 82^0C?

70. A piece of unknown metal with mass 14.9 g is heated to 100^0C and dropped into 75.0 g of water at 20^0C. The final temperature of the system is 28 degree Celsius. What is the specific heat of the metal?

71. What is a solute and solvent?

72. Define:

 Molarity

 Molality

Mole-fraction

Mass percent

72. Calculate the molarity of a solution that contains 0.0345 mol NH_4Cl in exactly 400 ml of solution?

73. Calculate the molarity of a solution that contains 20.0grams of sodium hydroxide in 200ml?

74. What volume of 0.100 M HCl solution is needed to neutralize 50.0 ml of 0.350 M KOH in a titration experiment?

(Common mono, di & polyatomic ions.)

I)   Name (Ion)   Symbol(Ion)

   a) Sodium
   b) Potassium
   c) Cesium
   d) Beryllium
   e) Calcium
   f) Strontium
   g) Barium
   h) Gallium
   i) Aluminum
   j) Nitrogen
   k) Arsenic
   l) Bismuth
   m) Oxygen
   n) Fluorine
   o) Chlorine
   p) Bromine
   q) Iodine

Common ions of transition elements

   Ion Name   Ion

a) Chromium(III)

b) Manganese(II)

c) Iron(II) or Ferrous

d) Iron(III) or Ferric

e) Cobalt(II)

f) Nickel(II) or nickel

g) Copper(II) or Cupric

h) Zinc

i) Silver

j) Cadmium

k) Mercury(II) or mercuric

Common Polyatomic Ions

Name	Formula	Name	Formula
a) Acetate		b) Ammonium	
c) Carbonate		d) Chlorate	
e) Chlorite		f) Chromate	
g) Cyanide		h) Dichromate	
i) Dihydrogen Phosphate		j) Dihydrogen Phosphate	
k) Hydrogen Carbonate		l) Hydrogen Sulfate	
m) Hydrogen Sulfite		n) Hypochlorite	
o) Hydroxide		p) Nitrate	
q) Nitrite		r) Oxalate	
s) Perchlorate		t) Permanganate	
u) Perioxide		v) Phosphate	
w) Sulfate		x) Sulfite	
y) Thiosulfate			

Common Acids	Formula	Common Acids	Formula
Hydrochloric Acid		Phosphoric acid	
Perchloric acid		Periodic Acid	
Carbonic acid		Sulfurous Acid	
Nitrous acid		Sulfuric Acid	
Nitric Acid		Hypochlorous Acid	
Chlorous Acid		Chloric Acid	