# AP Chemistry
# Summer Assignment

Welcome to AP Chemistry. You have chosen a rigorous and fast paced course (but also fun ☺). To help you prepare for this course this packet is designed as a review of the concepts from your first year chemistry course. IT IS AN OPTIONAL ASSIGNMENT. It is purely for your benefit. Although, you have been fair warned that we move quickly through the review of first year material. By completing this assignment, you will have a head start.

There are 20 learning targets contained in the assignment, they have been chosen to hit some of the most crucial items from the first year course. Remember, AP Chemistry is a SECOND year course so there is an assumption of prior knowledge of the basic concepts of chemistry.

The learning targets in this packet come from your Chem 1 notes. If you do not find them sufficient or have misplaced the notes, there are online research suggestions provided for each learning target.

You may approach this assignment however you wish. Learning targets 1-13 are non-negotiable in terms of what you should know from Chem 1. Learning targets 14-20 are more challenging and some class time will be spent reviewing these in the beginning of class. However, learn as much as you can because it will significantly help you as we move through them at a rigorous pace during the first few weeks of school.

The good news is that the answers are provided with the assignment. I would work a section at a time before checking your answers. Highlight any problems or concepts that you may struggle with and I would be happy to help your review concepts during tutoring hours in the fall.

Have a fabulous summer and I can't wait to see you in August!

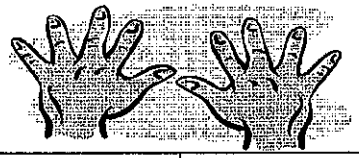
Mrs. Parker

Mrs. Parker ☺

# AP CHEMISTRY

## THE 30 POLYATOMICS

## TO KNOW LIKE THE BACK OF YOUR HAND



| Name | Symbol |
|---|---|
| Ammonium | $NH_4^{+1}$ |
| Nitrite | $NO_2^{-1}$ |
| Nitrate | $NO_3^{-1}$ |
| Sulfite | $SO_3^{-2}$ |
| Sulfate | $SO_4^{-2}$ |
| Hydroxide | $OH^{-1}$ |
| Cyanide | $CN^{-1}$ |
| Phosphate | $PO_4^{-3}$ |
| Hydrogen Phosphate | $HPO_4^{-2}$ |
| Dihydrogen Phosphate | $H_2PO_4^{-1}$ |
| Phosphite | $PO_3^{-3}$ |
| Carbonate | $CO_3^{-2}$ |
| Hydrogen Carbonate | $HCO_3^{-1}$ |
| Hypochlorite | $ClO^{-1}$ |
| Chlorite | $ClO_2^{-1}$ |
| Chlorate | $ClO_3^{-1}$ |
| Perchlorate | $ClO_4^{-1}$ |
| Hypoiodite | $IO^{-1}$ |
| Iodite | $IO_2^{-1}$ |
| Iodate | $IO_3^{-1}$ |
| Periodate | $IO_4^{-1}$ |
| Hypobromite | $BrO^{-1}$ |
| Bromite | $BrO_2^{-1}$ |
| Bromate | $BrO_3^{-1}$ |
| Perbromate | $BrO_4^{-1}$ |
| Acetate | $C_2H_3O_2^{-1}$ |
| Permanganate | $MnO_4^{-1}$ |
| Dichromate | $Cr_2O_7^{-2}$ |
| Chromate | $CrO_4^{-2}$ |
| Oxalate | $C_2O_4^{-2}$ |

**Learning Target 1 – *I can count the number of significant figures in a measurement.***
**Wikipedia: Significant Figures**

1) Count the number of significant figures in the following measurements:

a) 2.71 g_____ b) 0.00047 kg_____ c) $7.0 \times 10^5$ m_____ d) 1,030 L_____

e) 150 pencils _____ f) 37500 g _____ g) 0.1010 cm _____

**Learning Target 2 – *I can convert numbers to scientific notation while applying significant figures.***
**Wikipedia: Significant Figures**

2) Express each of the following in proper scientific notation (Pay attention to sig figs and units)

a) 0.000125 m _____ b) 155.0 mL _____

c) 123,030,000 kg _____ d) $481.9 \times 10^{-9}$ cm _____

**Learning Target 3 - *I can add, subtract, multiply, and divide with the correct number of significant figures.***
**Wikipedia: Significant Figures**

3) Calculate the correct answer with proper units and sig figs for each of the following:

a) 12 g + 0.677 g + 86.33 g = _____

b) (355.78 g) / (0.056 g) = _____

c) 97.34 mL – 34.1 mL = _____

d) $14.68 \times 5$ = _____

4) Perform the following calculations with scientific notation and report your answer with the correct number of significant figures.

a) $0.14 \times (6.02 \times 10^{23})$ = _____

b) $\dfrac{(9.875 \times 10^4) - (9.795 \times 10^4)}{9.875 \times 10^4} \times 100\ \%$ = _____ (assume 100 is exact)

c) $\dfrac{(3.8 \times 10^{-12} + 4.0 \times 10^{-13})}{(4 \times 10^{12} + 6.3 \times 10^{13})}$ = _____

**Learning Target 4 – *I can use conversions to solve dimensional analysis problems.***

**Google: Dimensional Analysis links 3 or 4**

5) Solve the following problems using conversions and dimensional analysis.

   a) A large railroad car is filled with 1745 gallons of milk. The car springs a leak in the bottom, and milk starts dripping out at a rate of 204.84 mL/sec. If the train is traveling at a speed of 65.4 miles per hour, calculate how many miles it will travel before all the milk has drained out of the car. (1 gal = 3.78 L, 1 mile = 5280 ft, 1 in = 2.54 cm)

   b) The world record for the hundred meter dash is 9.77 seconds. What is the corresponding average speed in units of m/sec, km/hr, ft/sec, and miles/hr?

**Learning Target 5 – *I can explain density and use the density equation to find an unknown.***

**Wikipedia: Density**

6) A rectangular block has dimensions of 2.9 cm x 3.5 cm x 10.0 cm. The mass of the block is 615.0 grams. What are the volume and the density of the block?

7) The density of pure silver is 10.5 g/mL at 20°C. If 5.25 grams of pure silver pellets are added to a graduated cylinder containing 11.2 mL of water, to what volume will the water in the cylinder rise?

**Learning Target 6 – *I can define and explain terms that identify physical/chemical characteristics of matter.***

**Wikipedia: Matter or Wikipedia any of the terms below**

8) Define the following terms:

   a) Solid –

   b) Liquid –

   c) Gas –

d) Pure substance –

e) Homogeneous mixture –

f) Heterogeneous mixture –

g) Chemical change –

h) Physical change –

9) Identify the following as a physical property, physical change, chemical property, or chemical change:

a) Ethanol has a density of 0.697 g/mL. _____

b) The solution turns blue upon mixing water and food coloring. _____

c) Wood burns in an oven. _____

d) Methyl alcohol is highly flammable. _____

e) Ice melts in a beaker. _____

f) Methyl ethanoate smells like apples. _____

g) A car crashes into a wall. _____

h) Sugar dissolves in water. _____

**Learning Target 7 – *I can identify the number of protons, neutrons, and electrons in atoms and isotopes.***

**Wikipedia: Isotopes**

10) What number of protons and neutrons are contained in the nucleus of each of the following atoms? Assuming each atom is uncharged, what number of electrons are present?

| | Protons | Neutrons | Electrons |
|---|---|---|---|
| a) $^{235}_{92}U$ | | | |
| b) $^{13}_{6}C$ | | | |
| c) $^{57}_{26}Fe$ | | | |
| d) $^{208}_{82}Pb$ | | | |

11) Complete the following table:

| Name | Mass # | Atomic # | # of Protons | # of Neutrons | # of Electrons | Symbol |
|---|---|---|---|---|---|---|
| Gallium | 70 | | | | | |
| | | | | | | $^{31}_{15}P^{-3}$ |
| Strontium-80 | | | | | | |
| | | | | | | $^{55}_{25}Mn^{+2}$ |

**Learning Target 8 – *I can define and use the Law of Definite Proportions and the Law of Multiple Proportions.***

**Google: Law of Definite Proportions, Law of Multiple Proportions**

12) Explain:

a) Law of Definite Proportions:

b) Law of Multiple Proportions:

13) Solve the following problem:

| Tin -- Oxygen compound | Tin % by mass | Oxygen % by mass |
|---|---|---|
| **Stannous oxide** | 88.10% | 11.90% |
| **Stannic oxide** | 78.70% | 21.30% |

| Tin – Oxygen compound | Tin mass | Oxygen mass |
|---|---|---|
| **Stannous oxide** | 100.0 grams | |
| **Stannic oxide** | 100.0 grams | |

a) Use the Law of Definite Proportions to determine the mass of oxygen needed to combine with the given masses of tin for stannous oxide and stannic oxide.

b) Does the Law of Multiple Proportions hold true in this case? Explain why or why not.

**Learning Target 9 – *I can name and write formulas for ionic compounds.***

**Wikipedia: IUPAC nomenclature of inorganic compounds**

14) Name or give the formula for the following compounds:

| Name | Formula |
|---|---|
| Sodium fluoride | _____ |
| _____ | $K_2O$ |
| Calcium phosphate | _____ |
| _____ | $FeCl_3$ |
| Iron (II) chloride | _____ |
| _____ | $Hg_2O$ |
| Sodium sulfate | _____ |
| _____ | $CaCO_3$ |
| Lithium phosphate | _____ |
| _____ | $SO_2$ |
| Calcium hydroxide | _____ |
| _____ | $H_2SO_4$ |
| Cupric chloride | _____ |

**Learning Target 10 – *I can write and balance equations.***

**www.chymist.com/Equations.pdf**

Write and balance the following equations:

a) Iron metal reacts with oxygen to form rust, iron (III) oxide.

b) Calcium metal reacts with water to produce aqueous calcium hydroxide and hydrogen gas.

c) Aqueous barium hydroxide reacts with aqueous sulfuric acid to produce solid barium sulfate and water.

**Learning Target 11 – *I can do conversions associated with moles.***

**Google: Mole Calculations**

15) Solve the following problems:

a) Calculate the mass of 500. Atoms of iron (Fe).

b) How many formula units are present in 87.2 grams of lead (IV) carbonate?

c) Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed as Nutra-Sweet. The molecular formula of aspartame is $C_{14}H_{18}N_2O_5$.

i. Calculate the molar mass of aspartame.

ii. Calculate the mass, in grams, of 1.56 mol of aspartame.

iii. How many molecules are in 5.0 mg of aspartame?

iv. How many atoms of nitrogen are in 1.2 g aspartame?

v. What is the mass of one molecule of aspartame?

**Learning Target 12 – *I can calculate percent by mass for an element in a compound.***

**Google: percent mass**

16) Calculate the percent by mass for each element in aspartame from the previous problem.

**Learning Target 13 – *I can calculate the average atomic mass of an isotope using percent abundance.***
**Google: average atomic mass**

17) An element consists of 1.40% of an isotope with a mass of 203.973 amu, 24.10% of an isotope with mass 205.9745 amu, 22.10% of an isotope with mass 206.9759 amu, and 52.40% of an isotope with mass 207.9766 amu. Calculate the average atomic mass and identify the element.

**Learning Target 14 – *I can solve stoichiometry problems, include those that use limiting and excess.***
**Google: stoichiometry problems**

18) The reusable booster rockets of the U.S. space shuttle employs a mixture of aluminum and ammonium perchlorate for fuel. A possible reaction for this is:

_____$Al(s)$ + _____$NH_4ClO_4(s)$ → ____$Al_2O_3(s)$ + ____ $AlCl_3(s)$ + ___$NO(g)$ + ____$H_20(g)$

a) Balance the following reaction:

b) If 4.0 g of aluminum reacted with 15.0 g of ammonium perchlorate, what would be the limiting reactant? How much excess of the other reactant would you have?

c) Using the above information, how much aluminum chloride would be produced in grams?

d) If you actually collected 4.18 g of aluminum chloride what would be your percent yield?

19) You add aluminum to a solution of copper (II) chloride and it reacts exothermically. Write and balance the equation below.

a) If you react 1.25 g of Al, how much copper (II) chloride do you need to add for the Al to fully react?

b) How much of <u>each</u> product would you collect?

20) When 125.0 g of ethylene ($C_2H_4$) burns in 60.0 grams of oxygen to give carbon dioxide and water, how many grams of $CO_2$ are formed? (Hint: balance the equation and determine limiting reactant first)

**Learning Target 15 – *I can determine the empirical and molecular formula by calculation.***

**Google: empirical formula**

21) Phenol is a compound that contains 76.57% carbon, 6.43% hydrogen, and 17.0% oxygen.

a) Calculate the empirical formula.

b) If its molecular weight is 188 g/mol, what would be its molecular formula?

25) Describe how to make one concentration from another solution:
   a) Make 50 mL of 1.0 M NaCl from 12.0 M NaCl

   b) Make 350 mL of 0.15 M $FeSO_4$ from 4.0 M $FeSO_4$

**Learning Target 18 - *I can determine substances that will precipitate in a solution.***
**Google: solubility rules**

26) A solution contains $Ca^{2+}$, $Ag^+$ and $Fe^{3+}$ You want to selectively precipitate the $Pb^{2+}$. Describe a procedure that will allow you to separate ALL the ions from the sample:
( HINT : Think about the SOLUTILITY RULES ~~and your Quantitative analysis lab~~!)

**Learning Target 19 - *I can write net ionic equations.***
**Google: net ionic equations**

27) Write molecular equations, predicting the expected products for the following:
   a) silver nitrate is mixed with sodium chloride

   b) magnesium nitrate combines with sodium hydroxide

   c) solid zinc is mixed with hydrochloric acid

28) Write net ionic equations for the preceding examples in question #5. Include symbols for the states for each species- (s), (l), (g), or (aq)
   a)

   b)

   c)

**Learning Target 20 - *I can calculate stoichiometry problems for basic precipitation reactions.***

**Google: Stoichiometry of reactions in solutions**

29) Calculate the mass of solid NaCl that must be added to 1.50 L of a 0.100 M $AgNO_3$ solution to precipitate all the $Ag^+$ ions in the form of AgCl.

30) What mass of $Na_2Cr_2O_4$ is required to precipitate all of the silver ions from 75.0 mL of a 0.100M $AgNO_3$?

**Learning Target 1 – *I can count the number of significant figures in a measurement.***
**Wikipedia: Significant Figures**

1) Count the number of significant figures in the following measurements:

a) 2.71 g 3 b) 0.00047 kg 2 c) $7.0 \times 10^5$ m 2 d) 1,030 L 3

e) 150 pencils 2 f) 37500 g 3 g) 0.1010 cm 4

**Learning Target 2 – *I can convert numbers to scientific notation while applying significant figures.***
**Wikipedia: Significant Figures**

2) Express each of the following in proper scientific notation (Pay attention to sig figs and units)

a) 0.000125 m $1.25 \times 10^{-4}$ m

b) 155.0 mL $1.550 \times 10^2$ mL ↑ significant must be included

c) 123,030,000 kg $1.2303 \times 10^8$ kg

d) $481.9 \times 10^{-9}$ cm 0.000000004819 cm

**Learning Target 3 - *I can add, subtract, multiply, and divide with the correct number of significant figures.***
**Wikipedia: Significant Figures**

3) Calculate the correct answer with proper units and sig figs for each of the following:

a) 12 g + 0.677 g + 86.33 g = 99 g

b) (355.78 g) / (0.056 g) = 6400

c) 97.34 mL – 34.1 mL = 63.2 mL

d) 14.68 x 5 = 70

4) Perform the following calculations with scientific notation and report your answer with the correct number of significant figures.

a) $0.14 \times (6.02 \times 10^{23}) =$ $8.4 \times 10^{22}$

b) $\frac{(9.875 \times 10^4) - (9.795 \times 10^4)}{9.875 \times 10^4} \times 100\ \% =$ 0.8102 (assume 100 is exact)

c) $\frac{(3.8 \times 10^{-12} + 4.0 \times 10^{-13})}{(4 \times 10^{12} + 6.3 \times 10^{13})} =$ $\frac{4.2 \times 10^{-12}}{7 \times 10^{13}} = 6 \times 10^{-26}$

**Learning Target 4 – *I can use conversions to solve dimensional analysis problems.***
**Google: Dimensional Analysis links 3 or 4**

5) Solve the following problems using conversions and dimensional analysis.

exact #

a) A large railroad car is filled with 1745 gallons of milk. The car springs a leak in the bottom, and milk starts dripping out at a rate of 204.84 mL/sec. If the train is traveling at a speed of 65.4 miles per hour, calculate how many miles it will travel before all the milk has drained out of the car. (1 gal = 3.78 L, 1 mile = 5280 ft, 1 in = 2.54 cm)

$$\frac{1745\text{ gallons}}{1}\left|\frac{3.78\text{ L}}{1\text{ gallon}}\right|\frac{1000\text{ mL}}{1\text{ L}}\left|\frac{1\text{ sec}}{204.84\text{ mL}}\right|\frac{1\text{ hr}}{3600\text{ sec}}\left|\frac{65.4\text{ mile}}{1\text{ hr}}\right| = \boxed{585\text{ miles}}$$

b) The world record for the hundred meter dash is 9.77 seconds. What is the corresponding average speed in units of m/sec, km/hr, ft/sec, and miles/hr?

10.2 m/s

$$\frac{100\text{ m}}{9.77\text{ s}}\left|\frac{1\text{ km}}{1000\text{ m}}\right|\frac{3600\text{ s}}{1\text{ hr}} = \boxed{36.7\frac{\text{km}}{\text{hr}}}$$

$$\frac{10.2\text{ m}}{\text{s}}\left|\frac{3.28\text{ ft}}{\text{m}}\right. = \boxed{33.6\text{ ft/s}}$$

$$\frac{10.2\text{ m}}{\text{s}}\left|\frac{1\text{ mile}}{1609\text{ m}}\right|\frac{3600\text{ s}}{1\text{ hr}} = \boxed{22.9\text{ mi/hr}}$$

**Learning Target 5 – *I can explain density and use the density equation to find an unknown.***
**Wikipedia: Density**

$D = \frac{\text{mass}}{\text{volume}}$

6) A rectangular block has dimensions of 2.9 cm x 3.5 cm x 10.0 cm. The mass of the block is 615.0 grams. What are the volume and the density of the block?

2 SF in answer

$V = 2.9\text{ cm} \times 3.5\text{ cm} \times 10.0\text{ cm} = 100\text{ cm}^3$ or $1.0\times10^2\text{ cm}^3$

$$D = \frac{615.0\text{ g}}{1.0\times10^2\text{ cm}^3} = 6.2\text{ g/cm}^3$$

7) The density of pure silver is 10.5 g/mL at 20°C. If 5.25 grams of pure silver pellets are added to a graduated cylinder containing 11.2 mL of water, to what volume will the water in the cylinder rise?

$$5.25\text{ g Ag} \times \frac{\text{mL}}{10.5\text{ g}} = 0.5\text{ mL}$$

$$11.2 + 0.5 = \boxed{11.7\text{ mL}}$$

**Learning Target 6 – *I can define and explain terms that identify physical/chemical characteristics of matter.***
**Wikipedia: Matter or Wikipedia any of the terms below**

8) Define the following terms:

a) Solid –

b) Liquid –

c) Gas –

See textbook glossary for definitions

They are important

d) Pure substance –

e) Homogeneous mixture – SLL textbook

f) Heterogeneous mixture –

g) Chemical change –

h) Physical change –

9) Identify the following as a physical property, physical change, chemical property, or chemical change:

a) Ethanol has a density of 0.697 g/mL. physical prop.

b) The solution turns blue upon mixing water and food coloring. physical chg.

c) Wood burns in an oven. chem chg.

d) Methyl alcohol is highly flammable. chem. prop.

e) Ice melts in a beaker. phys. chg

f) Methyl ethanoate smells like apples. phys. prop

g) A car crashes into a wall. phys. chg

h) Sugar dissolves in water. phys. chg

**Learning Target 7 – *I can identify the number of protons, neutrons, and electrons in atoms and isotopes.***

**Wikipedia: Isotopes**

10) What number of protons and neutrons are contained in the nucleus of each of the following atoms? Assuming each atom is uncharged, what number of electrons are present?

| | Protons | Neutrons | Electrons |
|---|---|---|---|
| a) $^{235}_{92}U$ | 92 | 235-92 → 143 | 92 |
| b) $^{13}_{6}C$ | 6 | 13-6 → 7 | 6 |
| c) $^{57}_{26}Fe$ | 26 | 57-26 → 31 | 26 |
| d) $^{208}_{82}Pb$ | 82 | 208-82 → 126 | 82 |

11) Complete the following table:

| Name | Mass # | Atomic # | # of Protons | # of Neutrons | # of Electrons | Symbol |
|---|---|---|---|---|---|---|
| Gallium | 70 | 31 | 31 | 39 | 31 | $^{70}_{31}Ga$ |
| Phosphorus | 31 | 15 | 15 | 16 | 18 | $^{31}_{15}P^{-3}$ |
| Strontium-80 | 80 | 38 | 38 | 42 | 38 | $^{80}_{38}Sr$ |
| Manganese | 55 | 25 | 25 | 30 | 23 | $^{55}_{25}Mn^{+2}$ |

**Learning Target 8 – *I can define and use the Law of Definite Proportions and the Law of Multiple Proportions.***

**Google: Law of Definite Proportions, Law of Multiple Proportions**

12) Explain:

a) Law of Definite Proportions: every pure substance always contains the same elements combined in the same whole number ratio (same proportions by mass)

b) Law of Multiple Proportions: when two elements can combine to form more than one compound the amounts of one of them that combines with a fixed amount of the other will exhibit a simple multiple relationship. ex. CO and $CO_2$

13) Solve the following problem:

| Tin -- Oxygen compound | Tin % by mass | Oxygen % by mass |
|---|---|---|
| **Stannous oxide** | 88.10% | 11.90% |
| **Stannic oxide** | 78.70% | 21.30% |

| Tin – Oxygen compound | Tin mass | Oxygen mass |
|---|---|---|
| **Stannous oxide** | 100.0 grams | 13.5 g |
| **Stannic oxide** | 100.0 grams | 27.1 g |

a) Use the Law of Definite Proportions to determine the mass of oxygen needed to combine with the given masses of tin for stannous oxide and stannic oxide.

Stannous oxide SnO MM = 134.71 g/mol Sn 88.10% = O = 11.90%

$\frac{88.1}{100} = \frac{11.9}{x}$ $x = 13.5\,g$

Stannic oxide $SnO_2$ Sn 78.7% O 21.30%

$\frac{78.7}{100} = \frac{21.30}{x}$ $x = 27.1\,g$

b) Does the Law of Multiple Proportions hold true in this case? Explain why or why not.

yes! the same amount of Sn (100 grams) but oxygen varied.

**Learning Target 9 – *I can name and write formulas for ionic compounds.***

**Wikipedia: IUPAC nomenclature of inorganic compounds**

14) Name or give the formula for the following compounds:

| Name | Formula |
|---|---|
| Sodium fluoride | NaF |
| potassium oxide | $K_2O$ |
| Calcium phosphate | $Ca_3(PO_4)_2$ |
| iron (III) chloride | $FeCl_3$ |
| Iron (II) chloride | $FeCl_2$ |
| mercury (I) oxide | $Hg_2O$ |
| Sodium sulfate | $Na_2SO_4$ |
| calcium carbonate | $CaCO_3$ |
| Lithium phosphate | $Li_3PO_4$ |
| sulfur dioxide | $SO_2$ |
| Calcium hydroxide | $Ca(OH)_2$ |
| sulfuric acid | $H_2SO_4$ |
| Cupric chloride ↑ copper II | $CuCl_2$ |

**Learning Target 10 – *I can write and balance equations.***

Remember Br I N Cl H O F www.chymist.com/Equations.pdf Diatomics

Write and balance the following equations:

a) Iron metal reacts with oxygen to form rust, iron (III) oxide.

$$4\,Fe_{(s)} + 3O_{2(g)} \rightarrow 2\,Fe_2O_{3(s)}$$

b) Calcium metal reacts with water to produce aqueous calcium hydroxide and hydrogen gas.

$$Ca_{(s)} + 2\,H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$$

c) Aqueous barium hydroxide reacts with aqueous sulfuric acid to produce solid barium sulfate and water.

$$Ba(OH)_{2(aq)} + H_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + H_2O_{(l)}$$

**Learning Target 11 – *I can do conversions associated with moles.***

**Google: Mole Calculations**

15) Solve the following problems:

a) Calculate the mass of 500. Atoms of iron (Fe). (3SF)

$$500.\text{ atom Fe} \left| \frac{1\text{ mol Fe}}{6.02\times10^{23}\text{ atoms}} \right| \frac{55.85\text{ g}}{1\text{ mol Fe}} = 4.64\times10^{-20}\text{ g Fe}$$

b) How many formula units are present in 87.2 grams of lead (IV) carbonate?

$$87.2\text{ g } Pb(CO_3)_2 \left| \frac{1\text{ mol } Pb(CO_3)_2}{327.19\text{ g}} \right| \frac{6.02\times10^{23}\text{ form. units}}{1\text{ mol } Pb(CO_3)_2} = 1.60\times10^{23}\text{ form unit}$$

c) Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed as Nutra-Sweet. The molecular formula of aspartame is $C_{14}H_{18}N_2O_5$.

i. Calculate the molar mass of aspartame.

294.34 g/mol

ii. Calculate the mass, in grams, of 1.56 mol of aspartame.

$$1.56\text{ mol Asp.} \left| \frac{294.34\text{ g}}{1\text{ mol Asp}} \right. = 459\text{ g}$$

iii. How many molecules are in 5.0 mg of aspartame?

$$5.0\text{ mg} \left| \frac{1\text{ g}}{1000\text{ mg}} \right| \frac{1\text{ mol}}{294.34\text{ g}} \left| \frac{6.02\times10^{23}\text{ molec.}}{1\text{ mol}} \right. = 1.0\times10^{19}\text{ molecules}$$

iv. How many atoms of nitrogen are in 1.2 g aspartame?

$$1.2\text{ g} \left| \frac{1\text{ mol}}{294.34\text{ g}} \right| \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol}} \left| \frac{2\text{ atoms of nitrogen}}{1\text{ molecule}} \right. = 4.9\times10^{21}\text{ atoms of Nitrogen}$$

v. What is the mass of one molecule of aspartame?

$$1\text{ molecule} \left| \frac{1\text{ mol}}{6.02\times10^{23}\text{ mol}} \right| \frac{294.34\text{ g}}{\text{mol}} = 5\times10^{-22}\text{ grams}$$

**Learning Target 12 – *I can calculate percent by mass for an element in a compound.***

**Google: percent mass**

16) Calculate the percent by mass for each element in aspartame from the previous problem.

$C_{14}H_{18}N_2O_5$

C: $\frac{14(12.01)}{294.34}\times100$ = 57.1%

H: $\frac{18(1.01)}{294.34}\times100$ = 6.2%

N: $\frac{2(14.01)}{294.34}\times100$ = 9.5%

O: $\frac{5(16)}{294.34}\times100$ = 27.2%

equals 100% ✓

**Learning Target 13 – *I can calculate the average atomic mass of an isotope using percent abundance.***
**Google: average atomic mass**

17) An element consists of 1.40% of an isotope with a mass of 203.973 amu, 24.10% of an isotope with mass 205.9745 amu, 22.10% of an isotope with mass 206.9759 amu, and 52.40% of an isotope with mass 207.9766 amu. Calculate the average atomic mass and identify the element.

$(.0140)(203.973\ amu)$
$(.2410)(205.9745\ amu)$
$(.2210)(206.9759\ amu)$
$+\ (.5240)(207.9766\ amu)$

Pb

207.2169 amu or g/mol ⇒ lead

**Learning Target 14 – *I can solve stoichiometry problems, include those that use limiting and excess.***
**Google: stoichiometry problems**

18) The reusable booster rockets of the U.S. space shuttle employs a mixture of aluminum and ammonium perchlorate for fuel. A possible reaction for this is:

3 Al(s) + 3 $NH_4ClO_4$(s) → 1 $Al_2O_3$(s) + 1 $AlCl_3$(s) + 3 NO(g) + 6 $H_2O$(g)

a) Balance the following reaction: See above ↑ ↑ product to solve for.

b) If 4.0 g of aluminum reacted with 15.0 g of ammonium perchlorate, what would be the limiting reactant? How much excess of the other reactant would you have?

$4.0g\ Al \left|\frac{1mol\ Al}{26.98g\ Al}\right|\frac{1mol\ AlCl_3}{3mol\ Al}\left|\frac{133.33g\ AlCl_3}{1mol}\right. = 6.6g\ AlCl_3$

$15.0g\ NH_4ClO_4 \left|\frac{mol}{117.45g}\right|\frac{1mol}{3mol}\left|\frac{133.33\ AlC}{1mol}\right.$

$= 5.67g$

$NH_4ClO_4$ limiting

c) Using the above information, how much aluminum chloride would be produced in grams?

See above

5.67g $AlCl_3$

d) If you actually collected 4.18 g of aluminum chloride what would be your percent yield?

$\%\ yield = \frac{Actual}{Theoretical} \times 100$

$\frac{4.18g}{5.67g} \times 100 =$ 73.7% yield

19) You add aluminum to a solution of copper (II) chloride and it reacts exothermically. Write and balance the equation below.

$2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3Cu + heat$

a) If you react 1.25 g of Al, how much copper (II) chloride do you need to add for the Al to fully react?

$$1.25\,g\,Al \left| \frac{1\,mol\,Al}{26.98\,g\,Al} \right| \frac{3\,mol\,CuCl_2}{2\,mol\,Al} \left| \frac{134.35\,g\,CuCl_2}{1\,mol} \right| = 9.34\,g\,CuCl_2$$

b) How much of each product would you collect?

$$1.25\,g\,Al \left| \frac{1\,mol\,Al}{26.98\,g} \right| \frac{2\,mol\,AlCl_3}{2\,mol\,Al} \left| \frac{133.18\,g\,AlCl_3}{1\,mol} \right| = 6.17\,g\,AlCl_3$$

$$1.25\,g\,Al \left| \frac{1\,mol\,Al}{26.98\,g\,Al} \right| \frac{3\,mol\,Cu}{2\,mol\,Al} \left| \frac{63.5\,g}{1\,mol\,Cu} \right| = 4.42\,g\,Cu$$

20) When 125.0 g of ethylene ($C_2H_4$) burns in 60.0 grams of oxygen to give carbon dioxide and water, how many grams of $CO_2$ are formed? (Hint: balance the equation and determine limiting reactant first)

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

$$125.0\,g\,C_2H_4 \left| \frac{1\,mol\,C_2H_4}{28.06\,g} \right| \frac{2\,mol\,CO_2}{1\,mol\,C_2H_4} \left| \frac{44.01\,g}{1\,mol\,CO_2} \right| = 385\,g\,CO_2$$

$O_2$ is limiting

$$60.0\,g\,O_2 \left| \frac{1\,mol}{32\,g\,O_2} \right| \frac{2\,mol\,CO_2}{3\,mol\,O_2} \left| \frac{44.01\,g}{1\,mol\,CO_2} \right| = 55.0\,g\,CO_2$$

Answer

**Learning Target 15 – *I can determine the empirical and molecular formula by calculation.***

**Google: empirical formula**

21) Phenol is a compound that contains 76.57% carbon, 6.43% hydrogen, and 17.0% oxygen.

a) Calculate the empirical formula.

Assume 100 g

C $\frac{76.56\,g}{12.01\,g\,/\,mol} = 6.374\,mol \div 1.06 = 6$

H $\frac{6.43\,g}{1.01\,g\,/\,mol} = 6.362\,mol \div 1.06 = 6$

O $\frac{17.0\,g}{16\,g\,/\,mol} = 1.063\,mol \div 1.06 = 1$

Divide by smaller

$(C_6H_6O)_n$ emp. form

b) If its molecular weight is 188 g/mol, what would be its molecular formula?

$n = \frac{\text{molar mass}}{\text{emp. mass}}$

$C_6H_6O = 94\,g/mol$

$\frac{188}{94} = 2$

$C_{12}H_{12}O_2$

**Learning Target 16 - *I can calculate the empirical formula of an unknown hydrocarbon through a combustion reaction and calculation.***

**Google: combustion analysis**

22) One killer of a problem -- a GOLD STAR if you can get this one:

18

Menthol, the substance we can smell in mentholated cough drops, is composed of carbon, hydrogen, and oxygen. A 0.1005 gram sample of menthol is combusted producing 0.2829 g of $CO_2$ and 0.1159 g of $H_2O$. What is the empirical formula for menthol? Show work.

$$.2829\text{g } CO_2 \left|\frac{1\text{mol}}{44.01\text{g } CO_2}\right|\frac{1\text{mol C}}{1\text{mol } CO_2}\left|\frac{12.01\text{g C}}{\text{mol C}}\right. = 0.0772\text{g C}$$

$$.1159\text{g } H_2O \left|\frac{1\text{mol}}{18.02\text{g } H_2O}\right|\frac{2\text{mol H}}{1\text{mol } H_2O}\left|\frac{1.01\text{g H}}{\text{mol}}\right. = 0.013\text{g H}$$

.1005 g sample
− .0772
− .013
.0103 g O

Law Cons. Mass

C $\frac{.0772\text{g C}}{12.01\text{g}}\left|\frac{1\text{mol}}{}\right. = .00643 \frac{\text{mol}}{6.44\times10^{-4}} = 10$

$\frac{.0103\text{g}}{16\text{g}}\left|\frac{\text{mol}}{}\right. = \frac{6.44\times10^{-4}\text{ mol}}{6.44\times10^{-4}} = 1$

H. $\frac{.013\text{g H}}{1.01\text{g}}\left|\frac{\text{mol}}{}\right. \frac{.0129\text{ mol}}{6.44\times10^{-4}} = 20$

divide by smallest

$C_{10}H_{20}O$

whew!

**Learning Target 17 - *I can calculate the concentration of solutions***

**Google: molarity**

$M = \frac{\text{mol solute}}{\text{L of solution}}$

23) Calculate the molarity of the following solutions:

a) 28.92 g of $HNO_3$ in enough water to make 250 mL of solution

↳ .250 L 2SF

$$\frac{28.92\text{g } HNO_3}{63.02\text{g}}\left|\frac{\text{mol}}{}\right. = \frac{1}{.250\text{L}} = 1.8\text{M}$$

b) 57.61 g of KOH in enough water to make 1250 mL of solution 3SF

↳ 1.250 L

$$\frac{57.61\text{g KOH}}{56.11\text{g KOH}}\left|\frac{1\text{mol}}{1.250\text{L}}\right. = 0.823\text{M}$$

24) Describe how to prepare the following solutions from solid reagents and water:

a) 750 mL of 0.5 M $K_2Cr_2O_7$

Remember Volume × molarity = mol solute

$$\frac{.5\text{ mol } K_2Cr_2O_7}{\text{L}}\left|\frac{.750\text{L}}{}\right.\left|\frac{294.2\text{g}}{1\text{mol } K_2Cr_2O_7}\right. = 110\text{g } K_2Cr_2O_7$$

dissolved volumetric in water into a flask and fill with water to the 750 mL mark

b) 1 L of 6.0 M $Na_2SO_4$

$$\frac{6.0\text{ mol } Na_2SO_4}{1\text{L}}\left|\frac{1\text{L}}{}\right.\left|\frac{142.05\text{g } Na_2SO_4}{1\text{mol } Na_2SO_4}\right. =$$

852 g $Na_2SO_4$ in a 1 L volumetric flask and fill to 1L mark

Dilution $M_1V_1 = M_2V_2$

25) Describe how to make one concentration from another solution:

a) Make 50 mL of 1.0 M NaCl from 12.0 M NaCl

$V_1 = \frac{M_2V_2}{M_1} \quad \frac{(1.0M)(50mL)}{12.0M} =$ take 4.2 mL of 12M NaCl solution and dilute to 50mL mark in a volumetric flask

b) Make 350 mL of 0.15 M $FeSO_4$ from 4.0 M $FeSO_4$

$V_1 = \frac{M_2V_2}{M_1} \quad \frac{(.15M)(350mL)}{4M} =$ take 13mL of 4M $FeSO_4$ and dilute to 350mL mark in a volumetric flask

**Learning Target 18 - *I can determine substances that will precipitate in a solution.***

**Google: solubility rules**

26) A solution contains ~~$Pb^{2+}$~~ $Ca^{2+}$, $Ag^+$ and $Fe^{3+}$ You want to selectively precipitate the $Pb^{2+}$. Describe a procedure that will allow you to separate ALL the ions from the sample:
(HINT: Think about the SOLUTILITY RULES ~~and your Quantitative analysis lab~~!!)

- First add NaCl solution which precipitate AgCl
- Then add NaOH which would precipitate $Fe(OH)_3$
- Lastly add $Na_2SO_4$ which would precipitate $CaSO_4$.

**Learning Target 19 - *I can write net ionic equations.***

**Google: net ionic equations**

27) Write molecular equations, predicting the expected products for the following:

a) silver nitrate is mixed with sodium chloride

Double Replacement $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$

b) magnesium nitrate combines with sodium hydroxide

Double $Mg(NO_3)_{2(aq)} + 2NaOH_{(aq)} \rightarrow Mg(OH)_{2(s)} + 2NaNO_{3(aq)}$

c) solid zinc is mixed with hydrochloric acid

Single $Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

28) Write net ionic equations for the preceding examples in question #5. Include symbols for the states for each species- (s), (l), (g), or (aq)

a) $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

b) $Mg^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg(OH)_{2(s)}$

c) $Zn_{(s)} + 2H^+_{(aq)} \rightarrow Zn^{2+}_{(aq)} + H_{2(g)}$

**Learning Target 20 - *I can calculate stoichiometry problems for basic precipitation reactions.***

**Google: Stoichiometry of reactions in solutions**

Volume × Molarity = mol solute

29) Calculate the mass of solid NaCl that must be added to 1.50 L of a 0.100 M $AgNO_3$ solution to precipitate all the $Ag^+$ ions in the form of AgCl.

$$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$$

$$1.50\,L \left| \frac{0.100\,mol\,AgNO_3}{L} \right| \frac{1\,mol\,NaCl}{1\,mol\,AgNO_3} \left| \frac{58.44\,g\,NaCl}{1\,mol\,NaCl} \right. = 8.77\,g\,NaCl$$

30) What mass of $Na_2Cr_2O_4$ is required to precipitate all of the silver ions from 75.0 mL of a 0.100M $AgNO_3$?

$$Na_2Cr_2O_4 + 2AgNO_3 \rightarrow Ag_2Cr_2O_4 + 2NaNO_3$$

$$.075\,L \left| \frac{.100\,mol\,AgNO_3}{1\,L} \right| \frac{1\,mol\,Na_2Cr_2O_4}{2\,mol\,AgNO_3} \left| \frac{213.98\,g\,Na_2Cr_2O_4}{1\,mol} \right.$$

$$= 0.802\,g\,Na_2Cr_2O_4$$