Name: KEY

AP Chemistry Worksheet 1: *Significant Figures and Dimensional Analysis*

For each problem below, write the equation and show your work. Always use units and box your final answer.

1. Round each of the following numbers to four significant figures, and express the result in scientific notation:

a. 300.235800	300.2	3.002×10^{2}
b. 456,500	456500	4.565×10^{5}
c. 0.006543210	0.006543	6.543×10^{-3}
d. 0.000957830	0.0009578	9.578×10^{-4}
e. −0.035000	−0.03500	-3.500×10^{-2}

2. Carry out the following operations, and express the answers with the appropriate number of significant figures:

a. 1.24056 + 75.80	0.01637 OR 1.637×10^{-2}
b. 23/67 - 75	-75
c. 890.00 x 112.3	99950 OR 9.995×10^{4}
d. 78,132 / 2.50	31300 OR 3.13×10^{4}

3. Perform the following conversions: (You need to go online to look up some conversion factors between metric and English units.)

a. 8.60 mi to m $8.60\ \text{mi} \left| \frac{1609.344\ \text{m}}{1\ \text{mi}} \right. =$ 13840.36 m

b. 3.00 days to s $3.00\ \text{days} \left| \frac{24\ \text{hr}}{1\ \text{day}} \right| \frac{60\ \text{min}}{1\ \text{hr}} \left| \frac{60\ \text{s}}{1\ \text{min}} \right. = 259200\ \text{s}$

c. $1.55/gal to dollars per liter $\frac{\$1.55\ \text{dollars}}{\text{gallon}} \left| \frac{1\ \text{gallon}}{3.785\ \text{L}} \right. =$ .410 dollars/L

d. 75.00 mi/hr to m/s $\frac{75.00\ \text{mi}}{\text{hr}} \left| \frac{1609.344\ \text{m}}{1\ \text{mi}} \right| \frac{\text{hr}}{60\ \text{min}} \left| \frac{\text{min}}{60\ \text{s}} \right. =$ 33.53 m/s

e. 55.35 ft³ to cm³ $55.35\ \text{ft}^3 \left| \frac{28316.847\ \text{cm}^3}{1\ \text{ft}^3} \right. =$ $1.567 \times 10^{6}\ \text{cm}^3$

$1\ \text{cm}^3 = 1\ \text{mL}$

4. The density of pure silver is 10.5 g/cm³ at 20°C. If 5.25 g of pure silver pellets are added to a graduated cylinder containing 11.2 mL of water, to what volume level will the water in the cylinder rise?

$D = 10.5\ \text{g/mL}$ $D = \frac{m}{V}$ $10.5 = \frac{5.25}{V}$

$V = .5\ \text{mL}$

$11.2\ \text{mL} + .5\ \text{mL} = \boxed{11.7\ \text{mL}}$

5. The density of air at ordinary atmospheric pressure and 25°C is 1.19 g/L. What is the mass, in kilograms, of the air in a room that measures 12.5 x 15.5 x 8.0 ft?

$V = 1550\ \text{ft}^3 \left| \frac{28.317\ \text{L}}{1\ \text{ft}^3} \right. = 43891.35\ \text{L}$

$D = \frac{m}{V} \rightarrow 1.19 = \frac{m}{43891.35}$ $m = 52231\ \text{g} = \boxed{52.231\ \text{Kg}}$

Name: Key 2

AP Chemistry Worksheet 2: *Structure of the Atom and the Periodic Table*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. What were the main points of Dalton's Atomic Theory? Which of these points are still accepted today? Which ones do we no longer accept, and why?

False - atoms can be divided 1) All matter is made of indivisible particles called atoms

False, isotopes 2) All atoms of a particular element are identical

True 3) Different elements have different atoms

True 4) Atoms combine in certain whole # ratios

True - except nuclear rxns 5) In chem. rxns atoms are not created or destroyed, just rearranged

2. Summarize the evidence used by J.J. Thomson to argue that cathode rays consist of negatively charged particles. used cathode ray tube and generated an electric field around the tube. He noticed the rays were attracted to the positive side of the field.

3. Let's pretend you are holding two atoms of carbon that are isotopes. Describe what the two atoms have in common and what they have different.

Common - same # p + # e- Different - # n - mass

4. Fill in the gaps in the following table, assuming each column represents a neutral atom:

Symbol	$^{39}_{19}K$	$^{55}_{25}Mn$	$^{112}_{48}Cd$	$^{137}_{56}Ba$	$^{207}_{82}Pb$
Protons	19	25	48	56	82
Neutrons	20	30	64	81	125
Electrons	19	25	48	56	82
Mass #	39	55	112	137	207

5. Write the correct symbol, with both superscripts and subscripts, for each of the following :

(a) the isotope of sodium with mass 23 $^{23}_{11}Na$

(b) the atom of vanadium that contains 28 neutrons $^{51}_{23}V$

(c) the isotope of chlorine with mass 37 $^{37}_{17}Cl$

(d) an atom of magnesium that has an equal number of protons and neutrons $^{24}_{12}Mg$

6. Give the name and the common charge for elements found in each of these groups of the Periodic Table:

(a) Group 1 - alkali metals, +1

(b) Group 2 - alkaline earth metals, +2

(c) Group 17 - Halogens, -1

(d) Group 18 - Noble Gases, 0

7. Describe where each type of element is found on the Periodic Table.

(a) Metals - left of staircase

(b) Non-metals - right of staircase

(c) Transition metals - group 3 → 12

(d) Lanthanides # 57 → 71

(e) Actinides # 89 → 103

Name: KEY 3

AP Chemistry Worksheet 3: *Naming Inorganic Compounds*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. Give the name for each of the following ionic compounds:
   a. AlF_3 – aluminum fluoride
   b. $Fe(OH)_2$ – iron (II) hydroxide
   c. $Cu(NO_3)_2$ – copper (II) nitrate
   d. $Ba(ClO_4)_2$ – barium perchlorate
   e. Li_3PO_4 – lithium phosphate
   f. Hg_2S – mercury (I) sulfide
   g. $Ca(C_2H_3O_2)_2$ – calcium acetate
   h. $Cr_2(CO_3)_3$ – Chromium (III) carbonate
   i. K_2CrO_4 – potassium chromate
   j. $(NH_4)_2SO_4$ – ammonium sulfate

2. Write the chemical formula for each of the following compounds:
   a. copper (I) oxide – Cu_2O
   b. potassium peroxide – K_2O_2
   c. aluminum hydroxide – $Al(OH)_3$
   d. zinc nitrate – $Zn(NO_3)_2$
   e. mercury (I) bromide – Hg_2Br
   f. iron (III) carbonate – $Fe_2(CO_3)_3$
   g. sodium hypobromite – $NaHBrO$

3. Give the name or chemical formula, as appropriate, for each of the following acids:
   a. $HBrO_3$ – bromic acid
   b. HBr – hydrobromic acid
   c. H_3PO_4 – phosphoric acid
   d. hydrochloric acid – HCl
   e. iodic acid – HIO_3
   f. sulfurous acid – H_2SO_3

4. Give the name or chemical formula, as appropriate, for each of the following molecular substances:
   a. SF_6 – sulfur hexafluoride
   b. IF_5 – iodide pentafluoride
   c. XeO_3 – xenon trioxide
   d. dinitrogen tetroxide – N_2O_4
   e. hydrogen cyanide – HCN
   f. tetraphosphorous hexasulfide – P_4S_6

5. Write the balanced chemical equation for each reaction given below.

   a. Zinc carbonate can be heated to form zinc oxide and carbon dioxide

   $ZnCO_3 \longrightarrow ZnO + CO_2$

   b. On treatment with hydrofluoric acid, silicon dioxide forms silicon tetrafluoride and water.

   $4HF + SiO_2 \longrightarrow SiF_4 + 2H_2O$

   c. Sulfur dioxide reacts with water to form sulfurous acid.

   $SO_2 + H_2O \rightarrow H_2SO_3$

   d. Liquid butane fuel (C_4H_{10}) burns in the presence of oxygen gas.

   $C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$

   e. Perchloric acid reacts with cadmium to form cadmium perchlorate and a gas.

   $2HClO_4 + Cd \rightarrow Cd(ClO_4)_2 + H_2$

   f. A solution of sodium bromide reactions with a solution of vanadium (III) nitrate to form a brightly colored precipitate.

   $3NaBr + V(NO_3)_3 \rightarrow VBr_3 + 3NaNO_3$

Name: KEY 5

AP Chemistry Worksheet 4: *Atomic and Molecular Masses*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. What isotope is used as the standard in establishing the atomic mass scale?

   Carbon-12

2. The atomic weight of magnesium is reported as 24.3, yet no atom of magnesium has the mass of 24.3 amu. Explain.

   24.3 is the average atomic mass of all of the isotopes of Mg

3. Only two isotopes of copper occur naturally, Cu-63 (abundance 69.09 percent) and Cu-65 (abundance 30.91 percent). Calculate the average atomic mass of copper.

   $63 \times .6909 = 43.5267$
   $65 \times .3091 = +20.0915$
   63.62 → **63.62 g**

4. Determine the molar mass of each of the following compounds:

   a. N_2O_5 → 94 g/mol
   b. $FeCO_3$ → 115.85 g/mol
   c. $Ca(C_2H_3O_2)_2$ → 158.08 g/mol
   d. $(NH_4)_3PO_4$ → 148.97 g/mol
   e. sodium nitrate → $NaNO_3$ = 84.99 g/mol
   f. copper (II) sulfate → $CuSO_4$ = 159.61 g/mol
   g. disilicon hexabromide → Si_2Br_6 = 535.56 g/mol

5. Calculate the percentage by mass of oxygen in the following compounds:

   a. NO_2 $\frac{32g}{46g} \times 100 = 69.57\%$
   b. CH_3COOCH_3 $\frac{32g}{62g} \times 100 = 51.61\%$
   c. $Cr(NO_3)_3$ $\frac{144g}{238g} \times 100 = 60.50\%$
   d. $(NH_4)_2CO_3$ $\frac{48g}{96g} \times 100 = 50.00\%$

Name: KEY 6

AP Chemistry Worksheet 5: *Balancing Equations & Patterns of Reactivity*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. Balance the following equations:

   a. $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

   b. $N_2O_5(g) + H_2O(l) \rightarrow 2HNO_3(aq)$

   c. $PCl_5(l) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(aq)$

   d. $CH_4(g) + 4Br_2(g) \rightarrow CBr_4(l) + 4HBr(g)$

   e. $C_5H_{10}O_2(l) + \frac{13}{2}O_2(g) \rightarrow 5CO_2(g) + 5H_2O(l)$

   f. $Cr(OH)_3(s) + 3HClO_4(aq) \rightarrow Cr(ClO_4)_3(aq) + 3H_2O(l)$

2. Write balanced chemical equations to correspond to each of the following descriptions:

   a. Solid calcium carbide, CaC_2, reacts with water to form an aqueous solution of calcium hydroxide and acetylene gas, C_2H_2. $CaC_{2(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + C_2H_{2(g)}$

   b. When solid potassium chlorate is heated, it decomposes to form solid potassium chloride and oxygen gas. $2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$

   c. Solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate. $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow H_{2(g)} + ZnSO_{4(aq)}$

   d. When liquid phosphorous trichloride is added to water, it reacts to form a solution of phosphorous acid and hydrochloric acid. $PCl_{3(l)} + 3H_2O_{(l)} \rightarrow H_3PO_{3(aq)} + 3HCl_{(aq)}$

   e. When hydrogen sulfide gas is passed over solid hot iron (III) hydroxide, the reaction produces solid iron (III) sulfide and gaseous water. $3H_2S_{(g)} + 2Fe(OH)_{3(s)} \rightarrow Fe_2S_{3(s)} + 6HOH_{(g)}$

Key 7

3. a. What products form when a hydrocarbon is completely combusted in air?

CO_2 and H_2O

b. Write a balanced chemical equation for the combustion of octane, C_8H_{18} (l), in air.

$C_8H_{18} + \frac{25}{2}O_2 \rightarrow 8CO_2 + 9H_2O$

c. How can you determine the chemical formula of the product formed when the metallic element calcium combines with the nonmetallic element oxygen, O_2?

$2Ca + O_2 \rightarrow 2CaO$

- look at the charges on Ca and O when they become ions

d. Write the balanced chemical equation for the reaction described in (c).

$2Ca + O_2 \rightarrow 2CaO$

4. Write a balanced chemical equation for the reaction that occurs when

a. the hydrocarbon heptane, C_7H_{16} (l), is combusted in air

$C_7H_{16}(\ell) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(\ell)$

b. the gasoline additive MTBE (methyl tertiary-butyl ether), $C_5H_{12}O$ (l), burns in air

$C_5H_{12}O + \frac{15}{2}O_2 \rightarrow 5CO_2 + 6H_2O$

c. Rb (s) reacts with water

$2Rb + 2HOH \rightarrow 2RbOH + H_2$

d. Mg(s) reacts with Cl_2 (g)

$Mg + Cl_2 \rightarrow MgCl_2$

5. Balance the following equations, and indicate what type of reaction each one is:

a. $2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$ — Synthesis

b. $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$ — Combustion

c. $6Li(s) + N_2(g) \rightarrow 2Li_3N(s)$ — Synthesis

d. $PbCO_3(s) \rightarrow PbO(s) + CO_2(g)$ — Decomposition

e. $C_7H_8O_2(l) + 8O_2(g) \rightarrow 7CO_2(g) + 4H_2O(l)$ — Combustion

Name: KEY 8

AP Chemistry Worksheet 6: *The Mole*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. The molecular formula of aspartame, the artificial sweetener marketed as NutraSweet, is $C_{14}H_{18}N_2O_5$.

   a. What is the molar mass of aspartame?

   294 g/mol

   b. How many moles of aspartame are present in 1.00 mg of aspartame?

   $1.00\ \text{mg asp.} \left| \frac{1\ \text{g}}{1000\ \text{mg}} \right| \frac{1\ \text{mol asp.}}{294\ \text{g asp}} = \boxed{3.401 \times 10^{-6}\ \text{mol}}$

   c. How many molecules of aspartame are present in 1.00 mg of aspartame?

   $1.00\ \text{mg} \left| \frac{1\ \text{g}}{1000\ \text{mg}} \right| \frac{1\ \text{mol asp.}}{294\ \text{g asp.}} \left| \frac{6.02 \times 10^{23}\ \text{molecules}}{1\ \text{mol asp.}} \right| = \boxed{2.048 \times 10^{18}\ \text{molecules}}$

   d. How many hydrogen atoms are present in 1.00 mg of aspartame?

   $2.048 \times 10^{18}\ \text{molecules asp} \left| \frac{18\ \text{H atoms}}{1\ \text{molecule asp.}} \right| = \boxed{3.686 \times 10^{19}\ \text{H atoms}}$

2. A sample of glucose, $C_6H_{12}O_6$, contains 2.03×10^{21} atoms of carbon.

   a. How many atoms of hydrogen does it contain?

   $2.03 \times 10^{21}\ \text{atoms C} \left| \frac{1\ \text{molecule } C_6H_{12}O_6}{6\ \text{atoms C}} \right| \frac{12\ \text{H atoms}}{1\ \text{molecule } C_6H_{12}O_6} = \boxed{4.06 \times 10^{21}\ \text{atoms H}}$

   b. How many molecules of glucose does it contain?

   $2.03 \times 10^{21}\ \text{atoms C} \left| \frac{1\ \text{molecule } C_6H_{12}O_6}{6\ \text{atoms C}} \right| = \boxed{3.38 \times 10^{20}\ \text{molecules } C_6H_{12}O_6}$

   c. How many moles of glucose does it contain?

   $3.38 \times 10^{20}\ \text{molecules } C_6H_{12}O_6 \left| \frac{1\ \text{mol } C_6H_{12}O_6}{6.02 \times 10^{23}\ \text{molecules}} \right| = 5.62 \times 10^{-4}\ \text{mol } C_6H_{12}O_6$

   d. What is the mass of the sample in grams?

   $5.62 \times 10^{-4}\ \text{mol } C_6H_{12}O_6 \left| \frac{180\ \text{g } C_6H_{12}O_6}{1\ \text{mol } C_6H_{12}O_6} \right| = \boxed{.1012\ \text{g } C_6H_{12}O_6}$

KEY 9

3. Calculate the following amounts:

   a. How many moles of chloride ions are in 0.0750 g of magnesium chloride?

$$.0750\text{ g } MgCl_2 \left|\frac{1\text{ mol } MgCl_2}{95.2\text{ g } MgCl_2}\right|\frac{2\text{ mol } Cl^-}{1\text{ mol } MgCl_2} = \boxed{1.58\times10^{-3}\text{ mol } Cl^-}$$

   b. What is the mass, in grams, of 3.50×10^{-3} mol of aluminum sulfate?

$$3.50\times10^{-3}\text{ mol } Al_2(SO_4)_3 \left|\frac{342.14\text{ g } Al_2(SO_4)_3}{1\text{ mol } Al_2(SO_4)_3}\right. = \boxed{1.197\text{ g } Al_2(SO_4)_3}$$

   c. What is the mass, in grams, of 1.75×10^{20} molecules of caffeine, $C_8H_{10}N_4O_2$?

$$1.75\times10^{20}\text{ molecules } C_8H_{10}N_4O_2 \left|\frac{1\text{ mol } C_8H_{10}N_4O_2}{6.02\times10^{23}\text{ molecules}}\right|\frac{194\text{ g}}{1\text{ mol } C_8H_{10}N_4O_2} = \boxed{.056\text{g}}$$

   d. What is the molar mass of cholesterol if 0.00105 mol weigh 0.406 g?

$$\frac{.406\text{g}}{.00105\text{ mol}} = \boxed{386.67\text{ g/mol}}$$

4. Calculate the number of molecules in:

   a. 0.0666 mol propane, C_3H_8, a hydrocarbon fuel

$$.0666\text{ mol } C_3H_8 \left|\frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } C_3H_8}\right. = \boxed{4.01\times10^{22}\text{ molecules}}$$

   b. A 50.0 mg tablet of acetaminophen, $C_8H_9O_2N$, an analgesic solid under the name of Tylenol

$$50.0\text{ mg } C_8H_9O_2N \left|\frac{1\text{ g}}{1000\text{ mg}}\right|\frac{1\text{ mol } C_8H_9O_2N}{151\text{ g } C_8H_9O_2N}\left|\frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } C_8H_9O_2N}\right. = \boxed{1.99\times10^{20}\text{ molecules}}$$

   c. A tablespoon of table sugar, $C_{12}H_{22}O_{11}$, weighing 10.5 g

$$10.5\text{g } C_{12}H_{22}O_{11} \left|\frac{1\text{mol } C_{12}H_{22}O_{11}}{342\text{ g}}\right|\frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } C_{12}H_{22}O_{11}} = \boxed{1.85\times10^{22}\text{ molecules}}$$

5. The allowable concentration level of vinyl chloride, C_2H_3Cl, in the atmosphere in a chemical plant is 2.0×10^{-6} g/L.

   a. How many moles of vinyl chloride in each liter does this represent?

$$2.0\times10^{-6}\frac{\text{g}}{\text{L}}\left|\frac{1\text{ mol } C_2H_3Cl}{62.45\text{ g } C_2H_3Cl}\right. = \boxed{3.203\times10^{-8}\text{ mol/L}}$$

   b. How many molecules per liter is this?

$$3.203\times10^{-8}\frac{\text{mol}}{\text{L}}\left|\frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } C_2H_3Cl}\right. = \boxed{1.93\times10^{16}\text{ molecules}}$$

% → g
g → mol
by Small
④ x till whole

Name: Key 11

AP Chemistry Worksheet 7: *Empirical and Molecular Formulas*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. Determine the empirical formula of each of the following compounds if a sample contains
   a. 0.104 mol K, 0.052 mol C, and 0.156 mol O

.052 .052 .052

2 1 3

K_2CO_3

   b. 5.28 g Sn and 3.37 g F

$5.28\text{g Sn} \left|\frac{1\text{mol}}{118.7\text{g}}\right. = \frac{.0445}{.0445} = 1$

$3.37\text{g F} \left|\frac{1\text{mol}}{19.00\text{g}}\right. = \frac{.177}{.0445} = 4$

SnF_4

   c. 87.5 percent N and 12.5 percent H by mass

$87.5\text{g N} \left|\frac{1\text{mol}}{14.00\text{g N}}\right. = \frac{6.25\text{g}}{6.25} = 1$

$12.5\text{g H} \left|\frac{1\text{mol}}{1.00\text{g}}\right. = \frac{12.5\text{g}}{6.25} = 2$

NH_2

2. Determine the empirical formulas of the compounds with the following compositions by mass
   a. 10.4 percent C, 27.8 percent S, and 61.7 percent Cl

$10.4\text{g C} \left|\frac{1\text{mol}}{12.01\text{g}}\right. = \frac{.866}{.866} = 1$

$27.8\text{g S} \left|\frac{1\text{mol}}{32.06\text{g}}\right. = \frac{.867}{.866} = 1$

$61.7\text{g Cl} \left|\frac{1\text{mol}}{35.45\text{g}}\right. = \frac{1.741}{.866} = 2$

$CSCl_2$

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

$21.7\text{g C} \left|\frac{1\text{mol}}{12.01\text{g}}\right. = \frac{1.807}{.600} = 3$

$9.6\text{g O} \left|\frac{1\text{mol}}{16.00\text{g}}\right. = \frac{.600}{.600} = 1$

$68.7\text{g F} \left|\frac{1\text{mol}}{19.00\text{g}}\right. = \frac{3.616}{.600} = 6$

COF_6

3. What is the molecular formula of each of the following compounds?
   a. empirical formula CH_2, molar mass = 84 g/mol

14g ↙ $\frac{84}{14} = 6 \rightarrow C_6H_{12}$

   b. empirical formula NH_2Cl, molar mass = 51.5 g/mol

51.45 ↙ $\frac{51.45}{51.45} = 1$ NH_2Cl

KEY 12

4. Determine the empirical and molecular formulas of each of the following substances:
   a. Ibuprofen, a headache remedy contains 75.69 percent C, 8.80 percent H, and 15.51 percent O by mass; molar mass about 206 g

$75.69\text{g C}\left|\frac{1\text{mol}}{12.01\text{g}}\right. = \frac{6.302}{.969} = 6.5 \times 2 = 13$

$8.80\text{g H}\left|\frac{1\text{mol}}{1.01\text{g}}\right. = \frac{8.713}{.969} = 9 \times 2 = 18$

$15.51\text{g O}\left|\frac{1\text{mol}}{16.00\text{g}}\right. = \frac{.969}{.969} = 1 \times 2 = 2$

$C_{13}H_{18}O_2$ - empirical

$\frac{206}{206} = 1$

$C_{13}H_{18}O_2$ - molecular

   b. Benzene contains only carbon and hydrogen and is 7.74% hydrogen by mass. The molar mass of benzene is 78.1 g/mol.

$7.74\text{g H}\left|\frac{1\text{mol}}{1.01\text{g}}\right. = \frac{7.663}{7.663} = 1$

$92.26\text{g C}\left|\frac{1\text{mol}}{12.01\text{g}}\right. = \frac{7.682}{7.663} = 1$

CH - empirical

$\frac{78.1}{13.01} = 6$

C_6H_6 - molecular

5. Many homes in rural America are heated by propane gas, a compound that contains only carbon and hydrogen. Complete combustion of a sample of propane produced 2.641 g of carbon dioxide and 1.442 g of water as the only products. Find the empirical formula of propane. (Hint: Figure out how many moles of C and H were produced. They all came from the fuel.)

$2.641\text{g } CO_2\left|\frac{1\text{mol } CO_2}{44\text{g}}\right|\frac{1\text{mol C}}{1\text{mol } CO_2}\left. = \frac{.0600}{.0600}\text{mol C} = 1 \times 3 = 3\right.$

$1.442\text{g } H_2O\left|\frac{1\text{mol } H_2O}{18.00\text{g}}\right|\frac{2\text{mol H}}{1\text{mol } H_2O}\left. = \frac{.1602\text{ mol H}}{.0600} = 2.67 \times 3 = 8\right.$

C_3H_8

6. (This is probably the hardest problem in the whole packet!) Menthol, the substance we can smell in mentholated cough drops, is composed of C, H, and O. A 0.1005 g sample of menthol is combusted, producing 0.2829 g of CO_2 and 0.1159 g of H_2O.
   a. What is the empirical formula for menthol?

$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$

.1005g .2829g .1159g

$.2829\text{g } CO_2\left|\frac{1\text{mol } CO_2}{44\text{g } CO_2}\right|\frac{1\text{mol C}}{1\text{mol } CO_2}\left|\frac{12.01\text{g}}{1\text{mol C}}\right. = .0772\text{g C}\left|\frac{1\text{mol}}{12.01\text{g}}\right. = \frac{.00643}{.00065} = 10$

$.1159\text{g } H_2O\left|\frac{1\text{mol } H_2O}{18.00\text{g } H_2O}\right|\frac{2\text{mol H}}{1\text{mol } H_2O}\left|\frac{1.00\text{g}}{1\text{mol H}}\right. = .0129\text{g H}\left|\frac{1\text{mol}}{1.00\text{g}}\right. = \frac{.0129}{.00065} = 20$

$C_{10}H_{20}O$

$.0901\text{g}$

$.1005 - .0901 = .0104\text{g O}\left|\frac{1\text{mol}}{16.00\text{g}}\right. = \frac{.00065}{.00065} = 1$

   b. If the compound has a molar mass of 156 g/mol, what is its molecular formula?

Empirical Molar Mass of $C_{10}H_{20}O$ = 156

$\frac{156}{156} = 1$

Molecular formula = $C_{10}H_{20}O$

Name: KEY 13

AP Chemistry Worksheet 8: *Chemical Equations and Calculations*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. Why is it essential to use balanced chemical equations in solving stoichiometry problems?

- to obtain the correct mole to mole ratios

2. The fermentation of glucose, $C_6H_{12}O_6$, produces ethyl alcohol, C_2H_5OH, and CO_2 as shown here:

$$C_6H_{12}O_6\,(aq) \;\longrightarrow\; 2\,C_2H_5OH(aq) + 2\,CO_2\,(g)$$

a. How many moles of CO_2 are produced when 0.300 mol of $C_6H_{12}O_6$ reacts in this fashion?

$$.300\ mol\ C_6H_{12}O_6 \left|\frac{2\ mol\ CO_2}{1\ mol\ C_6H_{12}O_6}\right. = \boxed{.600\ mol\ CO_2}$$

b. How many grams of $C_6H_{12}O_6$ are needed to form 2.00 g of C_2H_5OH?

$$2.00\ g\ C_2H_5OH \left|\frac{1\ mol\ C_2H_5OH}{46\ g\ C_2H_5OH}\right| \frac{1\ mol\ C_6H_{12}O_6}{2\ mol\ C_2H_5OH} \left|\frac{180\ g\ C_6H_{12}O_6}{1\ mol\ C_6H_{12}O_6}\right. = \boxed{3.91\ g\ C_6H_{12}O_6}$$

c. How many molecules of CO_2 form when 2.00 g of C_2H_5OH are produced?

$$2.00\ g\ C_2H_5OH \left|\frac{1\ mol\ C_2H_5OH}{46\ g\ C_2H_5OH}\right| \frac{2\ mol\ CO_2}{2\ mol\ C_2H_5OH} \left|\frac{6.02\times10^{23}\ molecules}{1\ mol\ CO_2}\right. = \boxed{2.62\times10^{22}\ molecules}$$

3. Aluminum sulfide reacts with water to form aluminum hydroxide and hydrogen sulfide.
   a. Write the balanced chemical equation for this reaction.

$$Al_2S_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2S$$

b. How many grams of aluminum hydroxide are obtained from 10.5 g of aluminum sulfide?

$$10.5\ g\ Al_2S_3 \left|\frac{1\ mol\ Al_2S_3}{150.14\ g\ Al_2S_3}\right| \frac{2\ mol\ Al(OH)_3}{1\ mol\ Al_2S_3} \left|\frac{77.98\ g\ Al(OH)_3}{1\ mol\ Al(OH)_3}\right. = \boxed{10.9\ g\ Al(OH)_3}$$

KEY 14

4. Automotive air bags inflate when sodium azide, NaN_3, rapidly decomposes to its component elements:

$$2\ NaN_3\ (s) \rightarrow Na(s) + 3\ N_2\ (g)$$

a. How many moles of N_2 are produced by the decomposition of 1.50 moles of NaN_3?

$$1.50\ mol\ NaN_3 \left| \frac{3\ mol\ N_2}{2\ mol\ NaN_3} \right. = \boxed{2.25\ mol\ N_2}$$

b. How many grams of NaN_3 are required to form 5.00 g of nitrogen gas?

$$5.00\ g\ N_2 \left| \frac{1\ mol\ N_2}{28.00\ g\ N_2} \right| \frac{2\ mol\ NaN_3}{3\ mol\ N_2} \left| \frac{65.00\ g\ NaN_3}{1\ mol\ NaN_3} \right. = \boxed{7.74\ g\ NaN_3}$$

c. How many grams of NaN_3 are required to produce 10.0 L of nitrogen gas if the gas has a density of 1.25 g/L?

$D = \frac{m}{V}$

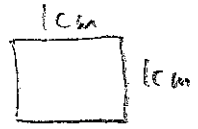
$1.25 = \frac{m}{10.0}$

$$m = 12.5\ g\ N_2 \left| \frac{1\ mol\ N_2}{28\ g\ N_2} \right| \frac{2\ mol\ NaN_3}{3\ mol\ N_2} \left| \frac{65.00\ g\ NaN_3}{1\ mol\ NaN_3} \right. = \boxed{19.35\ g\ NaN_3}$$

5. A piece of aluminum foil 0.550 mm thick and 1.00 cm square is allowed to react with bromine to form aluminum bromide.

a. How many moles of aluminum were used? (The density of aluminum is 2.699 g/cm^3.)

$2Al + 3Br_2 \rightarrow 2AlBr_3$



$$.550\ mm \left| \frac{1\ m}{1000\ mm} \right| \frac{100\ cm}{1\ m} =$$

$V = L \times w \times h$

$V = 1cm \times 1cm \times .055cm$

$V = .055\ cm^3$

$D = \frac{m}{V}$ $\quad 2.699 = \frac{m}{.055}$

$$m = .148\ g\ Al \left| \frac{1\ mol\ Al}{26.98\ g\ Al} \right. = \boxed{.0055\ mol\ Al}$$

b. How many grams of aluminum bromide form, assuming that the aluminum reacts completely?

$$.0055\ mol\ Al \left| \frac{2\ mol\ AlBr_3}{2\ mol\ Al} \right| \frac{266.69\ g\ AlBr_3}{1\ mol\ AlBr_3} = \boxed{1.47\ g\ AlBr_3}$$

Name: KEY 15

AP Chemistry Worksheet 9: *Limiting Reactants & Theoretical Yield*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. A manufacturer of bicycles has 50 wheels, 30 frames, and 24 seats.
   a. How many bicycles can be manufactured using these parts?

1 bicycle = 2 wheels, 1 frame, 1 seat

25 bikes 30 bikes **24 bikes**

   b. How many parts of each kind are left over?

2 wheels & 1 frame

   c. Which part is like a limiting reactant in that it limits the production of bicycles?

seats

2. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate, $NaHCO_3$, and citric acid, $H_3C_6H_5O_7$:

$$3\ NaHCO_3\ (aq) + H_3C_6H_5O_7\ (aq) \rightarrow 3\ CO_2\ (g) + 3\ H_2O(l) + Na_3C_6H_5O_7\ (aq)$$

In a certain experiment 1.00 g of sodium bicarbonate and 1.00 g of citric acid are allowed to react.

   a. Which reactant is the limiting reactant? You must show work to support your answer.

$$1.00\text{g } NaHCO_3 \left|\frac{1\text{ mol } NaHCO_3}{84\text{g } NaHCO_3}\right|\frac{3\text{ mol } CO_2}{3\text{ mol } NaHCO_3}\left|\frac{44\text{g } CO_2}{1\text{ mol } CO_2}\right| = .524\text{g } CO_2$$

$$1.00\text{g } H_3C_6H_5O_7 \left|\frac{1\text{ mol } H_3C_6H_5O_7}{192\text{ g } H_3C_6H_5O_7}\right|\frac{3\text{ mol } CO_2}{1\text{ mol } H_3C_6H_5O_7}\left|\frac{44\text{g } CO_2}{1\text{ mol } CO_2}\right| = .688\text{g } CO_2$$

$NaHCO_3$ is the limiting reactant

   b. How many grams of carbon dioxide form?

.524 g CO_2 (see part a)

   c. How much of the limiting reactant is left when the reaction is complete?

0 g

   d. How much of the excess reactant remains after the reaction is complete?

$$.524\text{g } CO_2 \left|\frac{1\text{ mol } CO_2}{44\text{g } CO_2}\right|\frac{1\text{ mol } H_3C_6H_5O_7}{3\text{ mol } CO_2}\left|\frac{192\text{ g } H_3C_6H_5O_7}{1\text{ mol } H_3C_6H_5O_7}\right| = .762\text{ g } H_3C_6H_5O_7$$

KEY 16

3. When hydrogen sulfide gas is bubbled into a solution of sodium hydroxide, the reaction forms sodium sulfide and water. How many grams of sodium sulfide are formed if 2.50 g of hydrogen sulfide is bubbled into a solution containing 1.85 g of sodium hydroxide, assuming that the limiting reagent is completely consumed?

$$H_2S + 2NaOH \rightarrow Na_2S + 2H_2O$$

$$2.50\text{ g } H_2S \left|\frac{1\text{ mol } H_2S}{34.06\text{ g } H_2S}\right|\frac{1\text{ mol } Na_2S}{1\text{ mol } H_2S}\left|\frac{55.06\text{ g } Na_2S}{1\text{ mol } Na_2S}\right| = 4.04\text{ g } Na_2S$$

$$1.85\text{ g NaOH} \left|\frac{1\text{ mol NaOH}}{40\text{ g NaOH}}\right|\frac{1\text{ mol } Na_2S}{2\text{ mol NaOH}}\left|\frac{55.06\text{ g } Na_2S}{1\text{ mol } Na_2S}\right| = \boxed{1.27\text{ g } Na_2S}$$

4. Solutions of sulfuric acid and lead (II) acetate react to form solid lead (II) sulfate and a solution of acetic acid. If 10.0 g of sulfuric acid and 10.0 g of lead (II) acetate are mixed, calculate the number of grams of sulfuric acid, lead (II) acetate, lead (II) sulfate, and acetic acid present in the mixture after the reaction is complete.

$$\underset{10.0\text{g}}{H_2SO_4} + \underset{10.0\text{g}}{Pb(CH_3COO)_2} \rightarrow PbSO_4 + 2CH_3COOH$$

SKIP

5. A student reacts benzene, C_6H_6, with bromine, Br_2, to prepare bromobenzene, C_6H_5Br, and HBr.

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

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

$$30.0\text{ g } C_6H_6 \left|\frac{1\text{ mol } C_6H_6}{78\text{ g } C_6H_6}\right|\frac{1\text{ mol } C_6H_5Br}{1\text{ mol } C_6H_6}\left|\frac{156.9\text{ g } C_6H_5Br}{1\text{ mol } C_6H_5Br}\right| = \boxed{60.35\text{ g } C_6H_5Br}$$

$$65.0\text{ g } Br_2 \left|\frac{1\text{ mol } Br_2}{159.8\text{ g } Br_2}\right|\frac{1\text{ mol } C_6H_5Br}{1\text{ mol } Br_2}\left|\frac{156.9\text{ g } C_6H_5Br}{1\text{ mol } C_6H_5Br}\right| = 63.82\text{ g } C_6H_5Br$$

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

$$\%\text{ Yield} = \frac{\text{actual}}{\text{theor.}} \times 100 = \frac{56.7\text{ g}}{60.35\text{ g}} \times 100 = \boxed{93.95\%}$$