**Unit VI     Stoichiometry**

**Lesson            Day                 Date                Topic                                                              Worksheet**

[1.](http://iannonechem.com/Science/Chemistry/Iannone/Chem11/chem11notes/stoichiometry/1.stoichiometry.ppt)                                                                     Stoichiometry                                                              [1](http://iannonechem.com/Sc/workbookanswers/6.answers.htm#b1)

[2.](http://iannonechem.com/Science/Chemistry/Iannone/Chem11/chem11notes/stoichiometry/2.molarvolume.ppt)                                                                     Molar Volume of a Gas at STP Lab                           [2](http://iannonechem.com/Sc/workbookanswers/6.answers.htm#b2)

[3.](http://iannonechem.com/Science/Chemistry/Iannone/Chem11/chem11notes/stoichiometry/3.percentageyieldenergy.ppt)                                                                     Stoichiometry Percentage Yield Energy                     [3](http://iannonechem.com/Sc/workbookanswers/6.answers.htm#b3)

4.                                                                     STP Gas Problems                                                      [4](http://iannonechem.com/Sc/workbookanswers/6.answers.htm%22%20%5Cl%20%22b4)

5.                                                                     Review of moles to STP                                             [5](http://iannonechem.com/Sc/workbookanswers/6.answers.htm%22%20%5Cl%20%22b5)

[6.](http://iannonechem.com/Science/Chemistry/Iannone/Chem11/chem11notes/stoichiometry/4.stoichICEcharts.ppt)                                                                     Limiting and Excess Reactant 1                                 [6](http://iannonechem.com/Sc/workbookanswers/6.answers.htm#b6)

7.                                                                     Limiting and Excess Reactant 2                                 [7](http://iannonechem.com/Sc/workbookanswers/6.answers.htm%22%20%5Cl%20%22b7)

[8.](http://iannonechem.com/Sc/notes/unit5/7.challengestoichiometry.ppt)                                                                     Practice Test 1                                                 [8](http://iannonechem.com/Sc/workbookanswers/6.answers.htm#b8)

9.                                                                     Practice Test 2                                                 [9](http://iannonechem.com/Sc/workbookanswers/6.answers.htm%22%20%5Cl%20%22b9)

10.                                                                   Test

**Worksheet #1 Stoichiometry**

1.       Calculate the number of grams water produced by the complete      reaction of 100. g of hydrogen with excess oxygen (theoretical yield).           2H2   +   O2   →  2H2O

**100. g H2 x 1 mole   x             2 mole H2O     x  18.02 g       =       892 g H2O**

**2.02 g         2 mole H2             1 mole**

2.       Calculate the mass of carbon required to consume 5.67 g of iron III oxide

          2Fe2O3      +     3C     → 4Fe     +3CO2

**5.67 g Fe2O3    x     1 mole   x   3 mole C       x    12.0 g         =       0.639 g C**

**159.6 g     2 mole Fe2O3       1 mole**

3.       Calculate the amount of oxygen in grams produced by the reaction of 69.0 g of water.

          2H2O →      2H2   +   O2

**69.0 g H2O     x   1 mole   x   1 mole O2     x     32.0 g         =      61.3 g O2**

**18.02 g       2 mole H2O          1 mole**

4.       Calculate the theoretical yield in grams of Fe produced by the reaction of 5.67 g of

iron III oxide.

          2Fe2O3      +          3C     →     4Fe     +3CO2

**5.67 g Fe2O3   x      1 mole   x   4 mole Fe   x     55.8 g   =     3.96 g Fe**

**159.6 g     2 mole Fe2O3    1 mole**

5.       Calculate the number of moles CO2 produced by the reaction of 8.45 g of C.

          2Fe2O3      +     3C            →    4Fe     +3CO2

**8.45 g C   x   1 mole   x   3 moles CO2     =         0.704 moles CO2**

**12.0 g         3 mole C**

6.       Calculate the number of Fe atoms consumed in the reaction if 100. g of Fe2O3 react.

          2Fe2O3      +     3C    +    235 KJ   → 4Fe     +3CO2

**100. g Fe2O3   x      1 mole   x   4 mole Fe      x     6.02  x  1023 at      =     7.54  x  1023 at Fe**

**159.6 g     2 mole Fe2O3        1 mole**

7.       Calculate the number of grams water produced by the complete reaction of 14.5 g of oxygen (theoretical yield).

          2H2   +   O2   →  2H2O

**14.5 g O2   x         1 mole   x   2 mole H2O   x     18.02 g         =     16.3 g H2O**

**32.0 g         1 mole O2             1 mole**

8.       Calculate the mass of carbon required to produce 5.67 g of iron.

          2Fe2O3      +     3C     → 4Fe     +3CO2

**5.67 g Fe    x          1 mole   x   3 mole C     x     12.0 g           =     0.915 g C**

**55.8 g       4 mole Fe            1 mole**

9.       Calculate the amount of oxygen in grams produced by the reaction of 125 g of water.

          2H2O          →      2H2   +   O2

**125 g H2O   x       1 mole   x   1 moleO2      x     32.0 g           =     111 g O2**

**18.02 g       2 mole H2O          1 mole**

10.     Calculate the theoretical yield in grams of CO2 produced by the reaction of 15.6 g of iron III oxide.

          2Fe2O3      +     3C           →     4Fe     +3CO2

**15.6 g Fe2O3   x      1 mole   x   3 mole CO2   x    44.0 g           =     6.45 g CO2**

**159.6 g     2 mole Fe2O3       1 mole**

11.     Calculate the number of molecules of CO2 produced by the reaction of 2.45g of

iron III oxide.

          2Fe2O3      +     3C     → 4Fe     +3CO2

**2.45 g Fe2O3   x      1 mole   x   3 mole CO2   x    6.02  x  1023 molecules    =     1.39  x  1022 molecules CO2**

**159.6 g       2 mole Fe2O3      1 mole**

**Worksheet #2**                         **Molar Volume of a Gas at STP Lab**

**Purpose**      To determine the molar volume of H2gas at STP.

**Theory**       The molar volume of a gas is the volume in litres per 1 mole of gas. STP is standard temperature and pressure, which is, 0oC and 101 Kpa. To calculate the molar mass, divide the number of litres by the number of moles.

**Procedure**

1.     Weigh a 3.9 cm piece of magnesium strip.

2.     Add about 10 mL of concentrated HCl to a gas collecting tube. Caution: HCl is very corrosive! Carefully pour water over the HCl to fill the gas collecting tube.

3.     Fill a 500 mL beaker to 400 mL with water.

4.     Roll the magnesium into a coil that is small to fit into the gas collecting tube. Place it into the tube and allow it to sink down to the acid. When it reaches the acid it will begin to bubble and rise. As soon as it begins to rise, place your thumb on the top of the tube to completely seal the opening, invert the tube and place under the water in the 500 ml beaker. Remove your thumb as soon as the tube is under the surface of the water. Clamp the tube to a ring stand to secure it.

5.     After the reaction is over allow five minutes for the hydrogen gas to reach room temperature. Record the volume of the hydrogen gas.

6.     Clean and put away all of your equipment. Wash your lab bench.

Data

          Mass of Mg          0.470 g

          Volume of H2                 48.6 mL  = 0.0486  L

Calculations

1.       Write a balanced single replacement equation for the reaction between HCl and Mg.

          **Mg    +       2HCl       H2     +       MgCl2**

2.       Covert grams Mg into moles H2 at room pressure and temperature.

 **0.0470 g Mg       x        1 mol          x        1 mol H2              =       1.93 x 10-3mol H2**

**24.3 g                      1 mol Mg**

3.       Convert the volume of H2 in litres to STP conditions by multiplying by the conversion factor **0.894**. This lowers the volume to what it would be at 0 0C and       101 Kpa.

 **0.0486 L H2        x        0.894          =       0.04345 L H2**

4.       Calculate the molar volume by dividing the volume of H2 in litres by the number of mole H2.

 **0.04345 L    =     22.5 L/mol**

**0.00193 mol**

5.       Determine an accepted value from your textbook for the molar volume of a gas at STP.

**Molar volume of gas   =       22.4 L/mol**

6.       Calculate the percentage difference between the accepted value and the experimental value of the molar volume. Take the difference and divide it by the accepted value and then multiple by 100 %.

 **(22.5 –22.4)        x 100 %     = 0.446 %**

**(      22.4      )**

**STP Calculations**

1.       Calculate the volume of F2 gas at STP produced by the electrolysis of 8.2 g of KF.

          2KF             →               2K     +       F2

          8.2 g                                                  ? L

**8.2 g           x        1 mole        x        1 mole F2    x        22.4 L         =       1.6 L**

**58.1 g                   2 mole KF            1 mole**

2.       Calculate the mass of KF required to produce 100. L of F2 gas at STP.

          2KF   →  2K     +     F2

**100. L         x        1 mole        x        2 mole KF  x        58.1  g        =       519 g**

**22.4 L                  1 mole F2              1 mole**

3.       5.31 g of a common gas at STP occupies 4.25 L. Calculate the molar mass of the gas. Determine the gas.

**4.25 L         x        1 mole    =  0.1888 mole         Molar Mass  =     5.31 g         =       28.1 g/mole**

**22.4 L                                                                  0.18888 mole**

4.       2.00 g of a common gas at STP occupies 1.018 L. Calculate the molar mass of the           gas. Determine the gas.

**1.018 L   x  I mole   =    0.04545 mole   Molar Mass   =        2.00 g   =    44.0 g/moleCO2**

**22.4 L                                                         0.04545 mole**

5.       Calculate the volume of  10. lb of CO2 gas at STP (2.21 lb = 1.00Kg).

**10 lb x        1.00 Kg      x        1000 g        x        1 mole        x        22.4 L         =       2.3  x  103 L**

**2.21 lb                  1 Kg                     44.0 g                   1 mole**

6.       Calculate the volume of H2 gas at STP produced by the complete reaction of

          10.0 g Na with water.

          2Na   +       2HOH               H2      +       2NaOH

          10.0 g                                                ? L

**10.0 g Na   x        1 mole        x        1 mole H2   x        22.4 L                  =       4.87 L**

**23.0 g                   2 mole Na            1 mole**

7.       How many litres of 02, measured at STP, will be released on the decomposition of           8.56 g of mercury (II) oxide:                       2HgO          →      2Hg   +    O2

**0.443 L**

8.       Calculate the number of molecules in 10.0 lb of CO2 gas at STP

          (2.21 lb = 1.00Kg).

**6.19 x 1025 molecules**

9.       Calculate the molar mass of Co(NH3)6Cl3.

**267.58 g/mole**

10.     Calculate the number of Cl atoms in 50.0 g Co(NH3)6Cl3.

**50.0 g    x             1 mole        x        6.02  x  1023  FU    x      3 at Cl        =       3.37  x  1023 atoms**

**267.58 g               1mole                             1 FU**

11.     Covert 2.0  x  1026 FU of MgCl2 to Kg.

**2.0  x  1026 FU     x        1 mole        x        95.3 g        x        1 kg            =       32 kg**

                                      **6.02  x  1023                   1 mole                  1000 g**

Name the following:

12.     Co2O3**.**6H2O                             **Cobalt III oxide hexahydrate**

13.     P2O5                               **Diphosphorous Pentoxide**

14.     H2SO4(aq)                        **Sulphuric Acid**

15.     H2SO4(l)                          **Hydrogen Sulphate**

14.     HI(aq)                              **Hydriodic Acid**

15.     HI (l)                               **Hydrogen Iodide**

16.     (NH4)Cr2O7                    **Ammonium Dichromate**

Write the quantum electron configuration for:

17.     Sr                                   **1s22s22p63s23p63d104s24p65s2**

18.     Sr2+                                **1s22s22p63s23p63d104s24p6**

19.     I                                     **1s22s22p63s23p63d104s24p64d105s25p5**

20.     I-                                    **1s22s22p63s23p63d104s24p64d105s25p6**

21.     Give an example of a formula unit    **NaCl**

22.     Give an example of a molecule                   **CO2**

23.     Give an example of an atom             **Mg**

24.     Write the formula eqaution.

H2SO4(aq)     +       2NaOH(aq)                   **Na2SO4(aq) + 2H2O(l)**

**Worksheet #3      Stoichiometry      and Percentage Yield and Energy**

1.       Calculate the energy consumed in the reaction if 150. g of C react.

          2Fe2O3      +     3C    +    235 KJ       →      4Fe     +3CO2

**150. g C     x        1mole         x        235 KJ                 =       979 KJ**

**12.0 g                   3 mole C**

2.       Calculate the energy consumed in the reaction if 250. Kg of C react.

          2Fe2O3      +     3C    +    235 KJ   →                    4Fe     +      3CO2

**250. Kg C  x        1000 g        x        1mole         x        235 KJ                 =       1.63  x  106 KJ**

**1 Kg                     12.0 g                   3 mole C**

3.       Calculate the actual yield in grams of Fe produced by the reaction of 0.22 Kg of C assuming a 85.0% yield.

          2Fe2O3      +          3C     →      4Fe     +      3CO2

**0.22 Kg C  x   1000 g   x   1mole    x      4 mole Fe        x     55.8 g    x   0.850   =  1.2  x  103 g Fe**

**1 Kg         12.0 g             3 mole C                1 mole**

4.       Calculate the number of grams water produced by the complete reaction of 95.5 g of hydrogen with excess oxygen. If the percentage yield is 65.0% calculate the actual yield.

2H2   +   O2   →   2H2O

**95.5 g H2   x         1 mole   x    2 mole H2O    x    18.02 g       x        0.650  =      554 g H2O**

**2.02 g         2 mole H2             1 mole**

5.       Calculate the mass of carbon dioxide produced when 5.67 g of iron III oxide reacts with excess C. If the percentage yield is    85.0 % calculate the actual yield.

          2Fe2O3      +     3C     → 4Fe     +     3CO2

**5.67 g Fe2O3   x      1 mole   x   3 mole CO2   x    44.0 g         x        0.850   =     1.99 g CO2**

**159.6 g     2 mole Fe2O3       1 mole**

6.       Calculate the energy in KJ produced by the reaction of 10.0 Kg of hydrogen with excess oxygen.

          2H2   +   O2   →   2H2O     +    213KJ

**10.0 Kg H2    x**     **1000 g         x       1 mole   x             213 KJ       =       5.27  x  105 KJ**

**1 Kg                     2.02 g                   2 mole H2**

7.       Calculate the amount of CO2 produced by the reaction of 8.45 g of iron III oxide. If the percentage yield is 75 %, calculate    the actual yield.

          2Fe2O3      +     3C          →      4Fe     +3CO2

**8.45 g Fe2O3   x      1 mole   x   3 mole CO2   x    44.0 g         x        0.75     =     2.6 g CO2**

**159.6 g     2 mole Fe2O3       1 mole**

8.       Calculate the number of grams water produced by the complete reaction of 100. g of hydrogen with excess oxygen (theoretical yield). If the percentage yield is 65.0 % calculate the actual yield.         2H2   +   O2   →   2H2O

**100. g H2   x         1 mole   x   2 mole H2O    x    18.02 g       x        0.650    =    580 g H2O**

**2.02 g         2 mole H2             1 mole**

9.       Calculate the theorectical mass of iron produced from the reaction of 5.67 g of iron III oxide. If the percentage yield is 85.0 % calculate the actual yield.              2Fe2O3      +     3C    → 4Fe     +3CO2

**5.67 g Fe2O3   x      1 mole     x    3 mole C        x         12.0 g         =     3.96 g Fe      x          0.850      =  0.544 g C**

**159.6 g           2 mole Fe2O3                1 mole**

10.     Calculate the theoretical yield of oxygen in grams produced by the reaction of 69.0 g of water. If the actual yield of O2 is 50.0 g, calculate the percentage yield.     2H2O   →  2H2  +  O2

**69.0 g H2O x        1 mole        x        1 mole O2   x        32.0 g                   =       61.3 g**

**18.02 g                 2 mole H2O                   1 mole**

**% Yield      =       50.0 g             x  100 % =       81.6 %**

**61.1 g**

11.     Calculate the energy in KJ produced by the reaction of 10.0 g of hydrogen with excess oxygen.

          2H2   +   O2           →   2H2O     +    213 KJ

**10.0 g H2    x        1 mole        x        213 KJ       =       527 KJ**

**2.02 g                   2 mole**

12.     Calculate the theoretical yield in grams of Fe produced by the reaction of 5.67 g of iron III oxide. If the actual yield is 2.00 g calculate the percentage yield. 2Fe2O3      +     3C     →     4Fe     +3CO2

**5.67 g Fe2O3   x      1 mole   x   4 mole Fe   x       55.8 g         =      3.96 g Fe**

**159.6 g     2 mole Fe2O3       1 mole**

**% Yield      =       2.00 g         x  100 %    =       50.4 %**

**3.96 g**

13.     Calculate the amount of CO2 produced by the reaction of 8.45 g of iron III oxide. If the percentage yield is 75 %, calculate the actual yield.       2Fe2O3      +     3C     → 4Fe     +3CO2

**8.45 g Fe2O3   x      1 mole   x   3 mole CO2   x    44.0 g  =   3.49 g CO2x     0.75      =       2.6 g CO2**

**159.6 g     2 mole Fe2O3       1 mole**

14.     Calculate the number of moles CO2 produced by the reaction of 8.45 g of C.

          2Fe2O3      +     3C                   →      4Fe     +3CO2

**8.45 g C     x        1mole         x        3 mole CO2           =  0.704 mole CO2**

**12.0 g                   3 mole C**

15.     Calculate the number of Fe atoms consumed in the reaction if 500. J of energy are absorbed.

          2Fe2O3      +     3C    +    235 KJ  → 4Fe     +3CO2

**500. J         x        1 KJ      x    4 mole Fe      x      6.02   x   1023 at    =   5.12  x  1021 at Fe**

**1000 J          235 KJ                  1 mole**

**Worksheet # 4               STP Gas Problems**

1.       Calculate the STP volume of 150. g NH3 gas.

**150. g         x        1 mole        x        22.4 L         =       197 L**

**17.03 g                 1 mole**

2.       Calculate the mass of 350. mL of CO2 at STP.

**350. mL     x        1 L              x        1 mole        x        44.0 g         =       0.688 g**

**1000 mL              22.4 L                  1 mole**

3.       Calculate the mass of carbon required to consume 5.67 g of iron III oxide.

          2Fe2O3      +     3C     → 4Fe     +3CO2

**0.639 g C**

4.       Calculate the volume of oxygen at STP produced by the reaction of 69.0 g of water.

          2H2O   →  2H2   +   O2

**42.9 L**

5.       If the actual volume of oxygen is 40.0 L, what is the % yield?

**93.2 %**

6.       Calculate the energy produced by the reaction of 100. L of hydrogen at STP with excess oxygen.

          2H2   +   O2   →   2H2O     +    213KJ

**475 KJ**

7.       Calculate the volume of CO2 produced at STP by the reaction of 5.67 g of iron III           oxide if the percentage yield is 70.0 %.      2Fe2O3      +     3C     →          4Fe     +3CO2

**0.836 L**

8.       Calculate the density of CO2 gas at STP.

**1.96 g/L**

9.       Calculate the density of NH3 gas at STP

**0.760 g/L**

**Stoichiometry Review**

10.     Chloroform or trichloromethane, CHCl3, may be prepared in the laboratory by the reaction between Chlorine and methane. Calculate the number of grams of chlorine that are required to produce 50.0 g of trichloromethane.

          3Cl2(g)          +       CH4(g)                   →      CHCl3(l)       +       3HCl(g)

**50.0 g CHCl3       x        1 mole        x        3 mole Cl2     x     71.0 g    =   89.1 g Cl2**

**119.51 g               1 mole CHCl3      1 mole**

11.     The purification ability and bleaching action of bleaching activity of chlorine both come from the effective release of oxygen by the reaction below. How many grams of oxygen will be liberated by 255 g of chlorine?

          2H2O(l)        +       2Cl2(g)                   →      4HCl(aq)       +       O2(g)

**255 g Cl2     x        1 mole        x        1 mole O2   x        32.0 g    =   57.5 g O2**

**71.0 g                   2 mole Cl2            1 mole**

12.     Photosynthesis is the process by which carbon dioxide is converted into sugar, C6H12O6, with the help of sunlight and the       chlorophyll of green plants acting as a catalyst. It may be summarized by the equation below. How many grams of sugar    may be produced in the reaction that consumes 6.90 grams of carbon dioxide?

          6CO2 (g)   +      6 H2O (g)→           C6H12O6    +    6 02 (g)

**6.90 g CO2 x        1 mole        x    1 mole C6H12O6       x    180.12 g   =    4.71 g C6H12O6**

**44.0 g                6 mole CO2                  1 mole**

13.     Dinitrogen oxide N2O- Known also as nitrous oxide and laughing gas –was one of early anesthetics, and has recently   regained popularity in this role in the dental field. It is made by the decomposition of ammonium nitrate which equations shown below. How many grams of NH4NO3 (S)are required to prepare 12.8 grams of N2O?

          NH4NO3(s)   →      N2O(g)                   +       2H2O(l)

**12.8 g N2O x        1 mole        x        1 mole NH4NO3   x        80.04 g    =   23.3 g NH4NO3**

**44.0 g                   1 mole N2O                    1 mole**

14.     In the extraction of copper from its sulfide ore, the overall process may be summarized by the equation shown below. If the           percentage yield is 61.2%, how         much copper will result from treatment of 7.00 x 106 grams of Cu2S?

          Cu2S(s)            +   O2(g)   →    2Cu(s)   +    SO2(g)

**7.00  x  106 g Cu2S    x  1 mole   x    2 mole Cu      x    63.5 g     x    0.612  =  3.42  x  106g Cu**

**159.1 g       1 mole Cu2S         1 mole**

15.     One step of the Ostwald process for manufacturing nitric acid involves making nitrogen monoxide by oxidizing ammonia      in the presence of platinum catalyst, which is shown by the equation below. If the percentage yield is 80.3%, how many grams of NO can be produced from 4.00 x 103 grams of NH3?

                                       Pt

          4 NH3(g)   +   502(g)          →      4 NO(g)     +          6 H2O(g)

**4.00 x 103 g NH3  x        1 mole        x        4 moles NO   x     30.0 g         x        0.803   =          5.66  x  103 g NO**

**17.03 g                 4 moles NH3         1 mole**

16.     The direct combination of powdered zinc with powdered sulfur is a spectacular reaction, though not one to be tried by students, with bright light, flame and smoke. The equation is shown below. Calculate the energy released by the reaction of 9.63 grams of zinc.

          Zn(s)   +       S(s)→     ZnS(s)          +   148.5 KJ

**9.63 g Zn   x        1 mole        x        148.5 KJ    =       21.9 KJ**

**65.4 g                   1 mole**

17.     Carbon monoxide is used as a fuel in many industrial processes. How much carbon monoxide must be burned in a process      requiring 183 KJ?

          2CO(g)   +   O2(g)   →   2CO2(g)   +   135 KJ

**183 KJ       x        2 moles CO          x        28 g   =       75.9 g CO**

**135 KJ                          1 mole**

**Worksheet # 5     Review of moles to STP**

1.       Convert 1.65 Kg CO2 to molecules.

          **2.26 x 1025 molecules CO2**

2.       Covert 2.0  x  1026 FU of MgCl2 to Kg.

          **32 Kg MgCl2**

3.       In a propane tank there are 9.0 Kg of C3H8, calculate the number of H atoms. (First calculate molecules and then H atoms).

          **9.8 x 1026 at H**

4.       A certain mass of complex Co(NH3)6Cl3 was found to contain 2.65  x  1021 atoms of H, calculate the mass of cobalt III chloride hexammine (change atoms to FU’s 1st).

          **0.0654 g Co(NH3)6Cl3**

5.       Calculate the percentage composition of Co(NH3)6Cl3 to three significant digits.

          **22.0%  Co, 31.4% N, 6.79% H, and 39.8% Cl**

6.       A compound is 71.6 % C, 6.03 % H, 10.4 % N, and 11.9 % O. If the molecular mass of the compound is 268.16 g/mol, calculate the empirical and the molecular formula.

          **C16H16N2O2**

7.       A compound is 63.55% Ag, 8.23% N, and 28.24% O, calculate the empirical formula.

          **AgNO3**

8.       A volume of a common gas used for welding has a mass of 0.856 g. An equal volume of H2 gas has a mass of 0.0658 g. Calculate the molar mass of the gas and determine its formula.

**26.3g/mol**

9.       Calculate the energy produced by the complete reaction of 150. g H2.

          2H2  +  O2             →     2H2O    +   250 KJ

          **9.28 x 103 KJ**

10.     Calculate the number of grams H2 required to produce 500 J of energy.

          2H2  +  O2             →     2H2O    +   250 KJ

          **0.00808 g**

11.     The fermentation of sugar in the presence of zymase, an enzyme in yeast, can be described by the equation below. If 500. g of sugar is fermented and 200 g of alcohol are produced, calculate the theoretical and percentage yield of     alcohol.

          C6H12O6       →     2C2H5OH     +    2CO2

**256g                     78.2%**

12.     Calculate the mass of Fe produced by the reaction of 8.56 g of Fe2O3 if the percentage yield

is 75.0 %.

                   2Fe2O3    +    3C             →               4 Fe           +          3CO2

          **4.49 g**

13.     What is the mass of 3.25 litres of neon at STP?

          **2.93 g**

14.     Find the STP volume of 4.62 grams of ammonia (NH3).

          **6.08 L**

15.     How many moles of ethane, C2H6, are in 16.9 liters at STP?

          **0.754 moles**

16.     How many liters of O2, measured at STP, will be released on the decomposition of 2.65 g of mercury (II) oxide:

          2HgO                   →      2Hg   +       O2

          **0.137 L**

17.     What mass of potassium chlorate must be decomposed to produce 1.50 liters of oxygen at STP?

          2KClO3(s)→      2KCl(s)+      3O2(g)

          **5.47g**

18.     When sodium hydrogen carbonate is treated with sulfuric acid, carbon dioxide bubbles off:

          H2SO4(aq)+ 2NaHCO3(s)→      Na2SO4(aq)+ 2H2O(l) + 2CO2(g)

          What volume of CO2, measured at STP, is available from 8.58 g NaHCO3?

          **2.29L**

19.     What quantity of magnesium must a student react with excess hydrochloric acid to produce

85.0 ml hydrogen, measured at STP?

          Mg(s) + 2HCl(aq)     →      H2(g)+ MgCl2(aq)

          **0.0922g**

**Worksheet # 6     Limiting and Excess Reactant**

Fill in the ICE charts- **all units are in moles**.

1.          1 A                +             2 B                   →                 1 C                +            2 D

I           **8.00                               6.00                                        0.00                            0.00**

C         **3.00                               6.00                                        3.00                             6.00**

E         **5.00                               0.00                                        3.00                             6.00**

2.          3 A                +             4 B                   →                4 C                +            3 D

I           9.00                             14.00                                      0.00                             0.00

C         **9.00                              12.00                                     12.00                            9.00**

E         **0.00                               2.00                                       12.00                            9.00**

3.          3 A                +             2 B                   →                 5 C                +            4 D

I           10.00                             8.00                                 0.00                                 0.00

C          **10.00                            6.667                                16.67                              13.33**

E          **0.00                               1.33                                 16.67                              13.33**

4           3 A                +           5 B                   →                 5 C                +            4 D

I           8.00                            16.00                                     0.00                             0.00

C          **8.00                            13.33                                   13.33                            10.67**

E          **0.00                              2.67                                    13.3                              10.7**

5.                2 Al                      +       3 I2             →                         2 AlI3

I                  9.0 mol                          9.0 mol                                    0

C                 **6 mol                             9 mol                                       6 mol**

E                 **3 mol                             0                                              6 mol**

6.                 C                          +       2Cl2            →                         CCl4

I                  8.0 mol                          6.0 mol                                   0

C                 **3 mol                             6 mol                                       3 mol**

E                 **5 mol                             0                                              3 mol**

7.                4 Fe                     +       3 O2            →                         2 Fe2O3

I                  10.0 mol                        6.0 mol                                    0

C                 **8 mol                             6 mol                                       4 mol**

E                 **2 mol                             0                                              4 mol**

8.                2 NO                    +       O2                →                         2 NO2

                   100.0 g                           100.0g                                      0

I                  **3.3333 mol                    3.1250 mol                              0**

C                 **3.3333 mol                    1.6667 mol                              3.3333 mol**

E                 **0                                    1.4584 mol                              3.3333 mol**

Grams         **0                                    46.7 g                                      153 g     Note the molar masses had 3 sig figs!**

9.                2 Fe            +       3 Cl2                    →               2 FeCl3

                   100.0 g                 120.0 g                                     0

I                  **1.792 mol             1.690 mol                                0**

C                 **1.127 mol             1.690 mol                                1.127 mol**

E                 **0.665 mol             0                                              1.127 mol**

Grams         **37.11 g                 0                                              183.4 g**

10.              Mg              +      2HCl          →      MgCl2                             +       H2

                   45.8 g                             65.4 g                       0                                0

I                  **1.885 mol             1.791 mol             0                                      0**

C                 **0.8955 mol           1.791 mol                      0.8956 mol                    0.8956 mol**

E                 **0.9895 mol           0                           0.8956 mol                    0.8956 mol**

Grams         **24.0 g                                                85.4 g                           1.81 g**

11.     If 75.4 g of Cu is reacted with 189.7 g of I2, then CuI2 is formed.

          **1 Cu           +                 1 I2→               1 CuI2**

**75.4 g                            189.7 g                          0**

I        **1.187 mol                      0.7474 mol                    0**

C**0.7474 mol                    0.7474 mol                    0.7474 mol**

E**0.4396 g                        0 mol                             0.7474 mol**

          Grams **27.9 g                         0 g                                 237g**

(a)     Which reactant is in excess?

**Cu**

(b)     How many grams are in excess?

**27.9 g**

(c)      Calculate the amount of CuI2 produced.

**237 g**

12.     If 15.5 g of Al are reacted with 46.7 g of Cl2, then AlCl3 is formed.

          **2Al             +                 3Cl2            →               2AlCl3**

**15.5 g                                      46.7 g                            0**

I        **0.5741 mol             0.6577 mol                            0**

C       **0.4385 mol                    0.6577 mol                    0.4385 mol**

E       **0.1356 mol                    0 mol                             0.4385 mol**

Grams  **3.66 g                         0 g                                 58.5 g**

(a) Which reactant is in excess?

          **Al**

(b) How many grams are in excess?

          **3.66 g**

(c) Calculate the amount of AlCl3 produced.

          **58.5 g**

13.     If 5.45g of KClO3 are decomposed to form KCl and 1.95g of O2 are collected. Calculate the theoretical and percentage yield.

**2KClO3                →               2KCl          +                 3O2**

**5.45 g                                                                            ?g**

**5.45 g KClO3       x        1 mol           x        3 mol O2              x        32.0g          =       2.13 g**

**122.6 g                 2 mol KClO3                 1 mol**

**% Yield =   1.95   x        100%         =       91.4%**

                                      **2.13**

**Worksheet # 7     Limiting Reactants**

          1.                2 Al            +       3 I2             →      2 AlI3

           I                 12 mol                  15 mol                  0

C                 **10 mol                  15 mol                  10 mol**

           E                **2 mol                    0                           10 mol**

          2.                 C                 +       2Cl2   →               CCl4

          I                  13.5 mol               28.6 mol               0

          C                 **13.5 mol               27.0 mol               13.5 mol**

          E                 **0                           1.6 mol                 13.5 mol**

          3.                4 Fe     +               3 O2   →               2 Fe2O3

           I                 15.0 mol               13.2 mol                0

C                 **15.0 mol               11.3 mol               7.50 mol**

          E                 **0                           1.9 mol                 7.50 mol**

          4.                2 NO                    +                 O2                →                         2 NO2

                             **80 g   x        1 mol         50.0g x       1 mol                              0**

**30.0                             32.00**

          I                  **2.667 mol                                1.563 mol                                0**

          C                 **2.667 mol                                1.334 mol                                2.667 mol**

          E                 **0                                              0.230 mol                                2.667 mol**

          Grams         **0                                              7.34 g                                      123 g**

5.                          2 Fe   +                3 Cl2  →              2 FeCl3

                             45.5g                    55.6g                               0

I                  **0.8154 mol           0.7831 mol           0**

C                 **0.5221 mol           0.7831 mol           0.5221 mol**

          E:                **0.2933 mol           0                           0.5221 mol**

          Grams         **16.4 g                   0                           84.7 g**

6.                Mg    +                2HCl           →              MgCl2                   +                 H2

                             22.3 g                             15.6 g                             0                                     0

           I                 **0.9177 mol           0.4273 mol                     0                                    0**

           C                **0.2136 mol           0.4273 mol                     0.2136 mol                    0.2136 mol**

           E                **0.7041 mol           0                                     0.2136 mol                    0.2136 mol**

           Grams        **17.1 g                   0 g                                 20.4 g                            0.431 g**

7. If 100.0 g of Cu is reacted with 150.0 g of I2, then CuI2 is formed.

          **1 Cu           +                 1 I2→               1 CuI2**

**100.0 g                          150.0 g                          0**

I        **1.575 mol                      0.5910 mol                    0**

C**0.5910 mol                    0.5910 mol                    0.5910 mol**

E**0.984 mol                      0 mol                             0.5910 mol**

Grams **62.5 g                         0 g                                 188 g**

(a) Which reactant is in excess?

**Cu**

(b) How many grams are in excess?

**62.5 g**

(c) Calculate the amount of CuI2 produced.

**188 g**

8. If 25.0 g of Al are reacted with 40.0 g of Cl2, then AlCl3 is formed.

          **2Al                       +                 3Cl2                      →               2AlCl3**

**25.0 g x   1 mole            40.0 g  x  1mole                                0**

                         **27.0 g                            71.0 g**

I        **0.9259 mol                              0.5634 mol                              0**

C       **0.3756 mol                              0.5634 mol                              0.3756 mol**

E       **0.5503 mol                              0 mol                                       0.3756 mol**

Grams  **14.9 g                                   0 g                                           50.1 g**

(a) Which reactant is in excess?

          **Al**

(b) How many grams are in excess?

          **14.9 g**

(c) Calculate the amount of AlCl3 produced.

          **50.1 g**

 9.      If  100.0 g of Ca are reacted with 100.0 g of N2, then Ca3N2 is formed.

          Equation:

**3Ca                      +                 N2                                        Ca3N2**

**100.0 g x   1 mole                   100.0 g  x  1mole                              0**

                           **40.1 g                            28.0 g**

I        **2.4938 mol                              3.5714 mol                                       0**

C       **2.4938mol                               0.8313 mol                              0.8313 mol**

E       **0 mol                                       2.7401  mol                                        0.8313 mol**

Grams  **0 g                                        76.7 g                                                123 g**

**Note that the molar masses had 3 sig figs**

(a)     Which reactant is in excess?                                 **N2**

(b)     How many grams are in excess? **76.72 g**

(c)      Calculate the amount of Ca3N2 produced.            **123.3 g**

10.     If 100.0 g of Ca are reacted with 100.0 g of Cl2, then CaCl2 is formed.

          Equation:

**Ca              +                 Cl2                                                CaCl2**

**100.0 g x   1 mole                   100.0 g  x  1mole                              0**

                           **40.1 g                            71.0 g**

I        **2.4938 mol                              1.4085 mol                                       0**

C       **1.4085 mol                              1.4085 mol                              1.4085 mol**

E       **1.0853 mol                                       0  mol                            1.4085 mol**

Grams  **43.52 g                                           0g                                            156.5 g**

(a)     Which reactant is in excess?                                 **Ca**

          (b)     How many grams are in excess? **43.52 g**

          (c)      Calculate the amount of CaCl2 produced.            **156.5 g**

11.     If 25.0 g of Na are reacted with 40.0 g of O2, and one ionic compound is formed.

          Equation:

**4Na                      +                 O2                                        2Na2O**

**25.0 g   x   1 mole                   40.0 g  x  1mole                                0**

                           **23.0 g                            32.0 g**

I        **1.0870 mol                              1.2500 mol                                       0**

C       **1.0870 mol                              0.2718 mol                              0.5435 mol**

E       **0 mol                                       0.9782  mol                             0.5435 mol**

Grams  **0 g                                        31.3g                                       33.7 g**

(a)     Which reactant is in excess?**O2**

(b)     How many grams are in excess?**31.3g**

(c)      Calculate the amount of AlCl3 produced. **33.7 g**

12.     If 32.7 g of KClO3 are decomposed to form KCl and 11.7 g of O2 are collected.

           Calculate the theoretical and percentage yield.

**2KClO3                →               2KCl          +                 3O2**

**32.7 g                                                                            ?g**

**32.7 g KClO3       x        1 mol           x        3 mol O2              x        32.0g          =       12.8 g**

**122.6 g                 2 mol KClO3                 1 mol**

**% Yield =   11.7   x        100%         =       91.4%**

                                      **12.8**

13.     Equal volumes of gas "X" and O2 have weights of 8.75g and 10.0g.

          Calculate the molar mass of gas "X".

**Gas x          =       8.75             x        32.0 g/ mol           =       28.0 g/mol            N2**

**O210.0 g**

**Worksheet # 8     Practice Test #1**

1.       Change 8.75 moles of H2O to molecules.

          **5.27 x 1024 molecules H2O**

2.       Change 9.7x1019 atoms Fe to moles.

          **1.6 x10-4 mol Fe**

3.       Convert 800. g AgNO3 to formula units and then to atoms of O.

          **2.83 x1024 FU AgNO3**

          **8.50 x 1024 atoms O**

4.       Convert 3.8 x 1025 H2 molecules to grams.

          **1.3x102g H**

**B       Percentage Composition**

5.       Calculate the percentage composition of Na2SO4.

          **32.4% Na            22.6%S                45.0%O**

**C Molecular Formula and Empirical Formula**

6.       Calculate the empirical formula of a compound that is 62.2 % Pb,

          8.454 % N, and 28.8 % O.  Is this compound ionic or covalent?

          **Pb (NO3)2   ionic**

7.       A compound is 42.3 % C, 5.94 % H, 32.9 % N, and 18.8 % O and has a molecular mass of 425.25 g/mol. Calculate the empirical and molecular formula.

**C3H5N2O              C15H25N10O5**

**D       Stoichiometry**

8.       How many grams of O2 are required to consume 100. g Al?

                   4Al       +    302→      2Al2O3

          **88.9g O**

9.       How many moles of Al2O3 are produced by the reaction 200. g Al?

4Al       +      302→       2Al2O3

          **3.70 moles Al2O3**

10.     How many moles Al are required to produce 300. g Al2O3?

                   4Al       +      302→       2Al2O3

          **5.88 moles Al**

11.     How many litres of O2 gas are required to produce 100. g Al2O3?

                   4Al       +      302→       2Al2O3

**32.9 L**

**E       Percentage Yiel**d

12.     100. g Al reacts with excess O2 to produce 150. g Al2O3 according to

          Calculate the theoretical and percentage yield. 4Al        +  302→      2  Al2O3.

**Theoretical Yield = 189g Al2O3**

**F       Energy Calculations**

13.     Calculate the energy produced by the complete reaction of 150.g H2.

          2H2+      O2→      2H2O  +  130KJ

          **4.83  x  103KJ**

14.     How many grams of H2 would be needed to produce 260. KJ of energy?

          2H2+   O2→   2H2O  +  130KJ

**8.08 g of H2**

**G Limiting Reactants**

15.     20. mol H2 reacts with 8.0 mol O2 to produce H2O.  Determine the number of grams reactant in excess and number of grams H2O produced. Identify the limiting reactant.

          **8.0 g excess H2               2.9 x 102 g H2O in excess                 O2 is limiting**

16.     128g of Al reacts with 128g of O2 to produce Al2O3.  How many grams of Al2O3are produced?  Determine the mass of the reactant in excess and the limiting reactant.

          **Al is limiting        14.1g O2 are in excess             241g Al2O3**

17.     13.6 g of Al reacts with 8.33 g O2 to produce Al2O3.How many grams of Al2O3 are produced?  Determine the mass of the reactant in excess and the limiting reactant.

**O2 is limiting                 4.23 g Al are in excess   17.7 g of Al2O3 are produced**

18.     A gas weighs 21.9 g. An equal volume of He weighs 1.991 g. Determine the      molar mass and formula of the gas (hint- the gas can cook a steak).

**44.0 g/mole propane**

19.     Calculate the molar mass of a gas that weighs 19.43 g and has a STP volume of 9.894 L. If the gas is a very funny one containing nitrogen and used by the dentist, determine the molar mass and molecular formula for the gas.

          **44.0 g/mole N2O**

20.A 45.0 gsample of bronze, a Cu and Sn alloy, is completely reacted with concentrated HNO3 according to the following equations. A total of 59.978 g of NO2 was isolated. Assuming a 100 % yield of NO2, determine the mass of Cu and Sn in the alloy.

Cu(s)    +    4HNO3(aq)       →     Cu(NO3)2(aq)+          2NO2(g)+     2H2O(l)

**Ω g Cu   x    1 mole   x    2 mole NO2   x   46.0 g    =    1.4488 Ω**

**63.5 g           1 mole Cu          1 mole**

Sn(s)    +    4HNO3(aq)       →     Sn(NO3)2(aq)+          2NO2(g)+     2H2O(l)

**(45.0  -  Ω) g Sn   x    1 mole   x    2 mole NO2   x   46.0 g    =   34.878  -  0.77506 Ω**

**118.7 g       1 mole Sn           1 mol**

**1.4488 Ω   +   34.878  -  0.7751 Ω   =   59.978**

**0.6737 Ω  =   25.1**

**Ω   =   Cu  =  37.3 g**

**Sn  =  45.0  -   37.3  =   7.7 g**

Sn(s)    +    4HNO3(aq)       →     Sn(NO3)2(aq)+          2NO2(g)+     2H2O(l)

21.     A **80.0 g**sample of brass, a Cu/Zn alloy, is completely reacted with concentrated HNO3 according to the following equations. A total of **115.232 g**of NO2 was isolated. Assuming a 100 % yield of NO2, determine the mass of Cu and Zn in the alloy.

Cu(s)    +    4HNO3(aq)       →     Cu(NO3)2(aq)+          2NO2(g)+     2H2O(l)

**Ω g Cu   x    1 mole   x    2 mole NO2   x   46.0 g    =    1.4488 Ω**

**63.5 g           1 mole Cu          1 mole**

Zn(s)    +    4HNO3(aq)       →     Zn(NO3)2(aq)+          2NO2(g)+     2H2O(l)

**(80.0  -  Ω) g Zn   x    1 mole   x    2 mole NO2   x    46.0 g    =   112.54  -  1.4067 Ω**

**65.4 g           1 mole Cu          1 mol**

**1.4488 Ω   +   112.54  -  1.4067 Ω =   115.232**

**0.042072 Ω  =   2.692**

**Ω   =   Cu  =  64.0 g**

**Zn  =  16.0 g**

**Worksheet # 9     Practice Test**2

1.       Covert 200. g NaCl to formula units.

**200 g          x        1 mole        x        6.02  x  1023 FU   =    2.06  x  1024 FU**

**58.5 g                   1 mole**

2.       Convert 5.99 x 1025 H2O molecules to grams.

**5.99 x 1025 H2O molecules      x        1 mole                  x        18.02 g       =       1.79  x  103 g H2O**

**6.02  x  1023 molecules  1 mole**

3.       A certain mass of CH4 contains 2.00 x 1025 atoms of H. Calculate the mass of CH4.

**2.00 x 1025 atoms H**    **x          1 molecule CH4    x   1 mole             x           16.04 g    =          133 g CH4**

**4 at H              6.02  x  1023 molecules       1 mole**

4.       Calculate the number of grams SO2 in 250. L @ STP.

**250.   L SO2x        1 mole        x        64.1  g        =       715 g SO2**

**22.4 L                1 mole**

5.       The mass of a diatomic gas is 15.13 g. The mass of an equal volume of He is

1.593 g. What is the molar mass of the diatomic gas and what is the gas?

**Gas  X        =       15.13 g       x        4.0 g/mole  =       38 g/mole             F2**

**1.593 g**

6.       Calculate the volume of F2 gas at STP produced by the reaction of 15.6 g of KF.

          2KF    →     2K      +      F2

**15.6 g KF   x        1 mole        x        1 mole F2    x        22.4 L         =       3.01 L F2**

**58.1 g                   2 mole KF            1 mole**

7.       A compound was found to be composed of 6.89 g Si and 5.89 g O. If the molecular mass of the compound is 417 g/mol, what is the molecular formula of the compound?

**6.89 g Si     x        1 mole        =       0.2452 mole         =       1                 x        2        =       2**

**28.1 g                   0.2452 mole**

**5.89 g O     x        1 mole        =       0.3681 mole         =       1.501          x        2        =       3**

**16.0 g                   0.2452 mole**

          **Si2O3                    104.2 g/mole**

**Si8O12                   417 g/mole**

8.       Calculate the energy produced by the complete reaction of 25.0 g of C4H10 .

          2C4H10    +     13O2   →   8CO2      +      10H2O    +   256 KJ

**25.0 g C4H10        x        1 mole        x        256 KJ                 =       55.1 KJ**

**58.1 g                   2 mole C4H10**

9.       Calculate the mass of C4H10 required to produce 2.06 x 106 J of energy.

          2C4H10    +     13O2        →    8CO2      +      10H2O    +   256KJ

**2.06  x  106 J        x        1 KJ           x        2 mole C4H10        x        58.1 g         =       935 g**

**1000 J                  256 KJ                          1 mole**

10.     500. g of Fe2O3 are refined to produce 200. g of Fe. Calculate the percentage yield of Fe.

                   2Fe2O3        +    3C          →    4Fe      +     3CO2

**500. g Fe2O3         x        1 mole        x        4 mole Fe    x        55.8 g         =       350 g**

                                      **159.6 g**                 **2 mole Fe2O3**        **1 mole**

**Percentage Yield =        200 g           x        100%         =       57.1 %**

**350 g**

11.     500. g of Fe2O3 are refined to produce Fe at a 78.0 % yield, calculate the actual yield of Fe.

                   2Fe2O3                  +    3C   →    4Fe      +     3CO2

**500 g Fe2O3   x     1 mole   x   4 mole Fe    x        55.8 g    x   0.780          =       273 g**

**159.6 g       2 mole Fe2O3        1 mole**

12.     Calculate the molar mass of Cr2(H20)6(SO4)3.

                             **500.42 g/mole**

13.     Calculate the mass of 3.25 L of SO2 gas at STP.

**3.25 L         x        1 mole        x        64.1 g                   =       9.30 g**

**22.4 L                  1 mole**

14.     What mass of magnesium must react with excess hydrochloric acid to produce 85.0 ml hydrogen, measured at STP?

                   Mg(s)     +   2HCl(aq)       →      H2(g)    +      MgCl2(aq)

**85.0 ml H2           x        1L               x        1 mole    x  1 mole Mg  x        24.3 g         =          0.0922 g**

**1000ml                 22.4 L         1 mole H2             1 mole**

15.                        2 Al                      +       3 I2             →                 2 AlI3

          Initial:                   12 mol                           15 mol                            0

          Changes:     **10mol                            15mol                            10mol**

          End:            **2 mol                             0                                    10 mol**

16.     12.8 g of Al reacts with 12.8 g of O2 to produce Al2O3.  How many grams of Al2O3 are produced?  Determine the mass of the reactant in excess and the limiting reactant.

          **27.0 g                                      32.0g                                       102.0g**

**4Al    +                                    3O2             →                         2Al2O3**

**12.8g                                       12.8g                                       0**

**I        0.4741mol                               0.4000mol                               0**

**C       0.4741                                     0.3555 mol                             0.2371mol**

**E       0                                              0.0445 mol                              0.237mol**

**Grams                                                                                              24.2 g**

**Limiting Reactant         Al= 0g**

**Excess Reactant            O2=1.42g**

17.Calculate the molar mass of a gas that weighes 38.87 g and has a STP molar volume of 19.789 L. If the gas is one used in cars in the Fast and Furious determine the molar mass of the gas and the formula.

**44.0 g/mole       N2O**

18.100. g of an aqueous compound that is 62.2 % Pb, 8.454 % N, and 28.8 % O reacts with another compound that is 28.16 % N, 8.13 % H, 20.79 % P, and 42.91 % O. If the actual yield of the product containing lead is 60.0 g, calculate the percentage yield.  And you thought the last challenge question was tough!!!!

**3Pb(NO3)2(aq)        +       2(NH4)3PO4(aq)      →      Pb3(PO4)2(s)           +       6NH4NO3(aq)**

**100. g**

**? g**

**Theoretical Yield** **=       81.7 g         Percentage Yield           =       60.0 g    x  100 %           =       73.4 %**

                                                                                                                   **81.7 g**

19.     A 10.0 g sample of a Cu/Ag alloy reacted with concentrated HNO3 according to the following equations.

          A total of 7.3307g of NO2 was isolated. Assuming a 100 % yield of NO2, determine the mass of Cu

          and Ag in the alloy.

Cu(s)    +    4HNO3(aq)       →     Cu(NO3)2(aq)+       2NO2(g)+     2H2O(l)

2Ag(s)+    4HNO3(aq)      →       2AgNO3(aq)+       2NO2(g)+     2H2O(l)

                                              **7.00 g Ag and 3.00 g Cu**