CHEM 160. CHEMICAL REACTIONS WORKSHEET (Chapter 10)

Using your text book and these descriptions of chemical reactions, complete this worksheet Parts 1,2 and 3.

DESCRIPTIONS:

1. COMBINATION REACTION: Two reactants combine to form a single product.

2. DECOMPOSITION REACTION: One reactant decomposes into two or more products.

3. COMBUSTION REACTION: A reactant (a carbon compound made of C, H and sometimes O) combines with oxygen to give CO_2 and H_2O as the only products.

4. SINGLE DISPLACEMENT (REPLACEMENT) REACTION: Reactants are an element and a compound. Products are an element and compound. The reactant element replaces a similar element in the compound and the replaced element becomes the product element.

5. DOUBLE DISPLACEMENT (REPLACEMENT) REACTION. Two reactant compounds and two product compounds. One of the product compounds has to be a covalent compound, a gas, or a solid (precipitate).

Balancing Combustion Reactions

1. Balance carbon first
2. Balance hydrogen second
3. Sum the number of oxygens from water and CO_2 the right side.
   - 3a) Subtract any oxygens in the carbon compound on the left (reactant) side of the equation from the total number of oxygens on the right.
4. Put this number of oxygen atoms divided by 2 in front of O_2 as the coefficient.
5. If the coefficient is divisible by 2 then divide and place that number in front of the oxygen as the coefficient.
   - 5a) If the coefficient is not divisible by 2 then multiply the whole equation by 2 to clear the X/2 in the oxygen coefficient.
6. Write the balanced equation.

Example 1. Write a balanced equation for the combustion of C_4H_{10}

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

Step 4 | Step 2 | Step 1

Step 3 Total oxygen = 5 $_{(5H2O)}$ + 8 $_{(4CO2)}$ = 13 oxygen

Step 5a Multiply the whole equation by 2:

$2\,[C_4H_{10} + \frac{13}{2} O_2 \rightarrow 5H_2O + 4CO_2] =$ $2C_4H_{10} + 13\,O_2 \rightarrow 10H_2O + 8\,CO_2$

Step 6

Example 2. Write a balanced equation for the combustion of $C_4H_{10}O$

$C_4H_{10}O + 6\,O_2 \rightarrow 5H_2O + 4CO_2$ ←——balanced Step 6

Steps 4 & 5 | Step 2 | Step 1

Step 3 Total oxygen = 5 $_{(5H2O)}$ + 8 $_{(4CO2)}$ = 13 oxygen – 1 oxygen = 12 oxygen

Step 3a

PART 1. Match the following reactions with the type reaction (draw a line from one to the other):

$CH_{4\,(g)} + O_{2\,(g)} \rightarrow CO_{2\,(g)} + H_2O_{(l)}$	combination reaction
$CuSO_{4\,(aq)} + Al_{(s)} \rightarrow Al_2(SO_4)_{3\,(aq)} + Cu_{(s)}$	decomposition reaction
$HgO_{(s)} \rightarrow Hg_{(l)} + O_{2\,(g)}$	combustion reaction
$Fe_{(s)} + O_{2\,(g)} \rightarrow Fe_2O_{3\,(s)}$	single replacement reaction
$NaOH_{(aq)} + HNO_{3\,(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$	double replacement reaction

PART 2. Rewrite each of the equations above so they are balanced.

PART 3. FOR EACH OF THE FOLLOWING WORD REACTIONS, WRITE A BALANCED EQUATION AND GIVE THE NAME OF TYPE REACTION

1. Solid carbon reacts with oxygen gas to produce carbon dioxide gas.

2. Water reacts with sodium metal to produce hydrogen gas and aqueous sodium hydroxide

3. Aqueous aluminum chloride reacts with aqueous sodium hydroxide to produce solid aluminum hydroxide and aqueous sodium chloride.

4. Propane (C_3H_8) reacts with oxygen gas to produce carbon dioxide gas and water.

5. Hydrogen peroxide produces water and oxygen gas.

Balancing Chemical Equations

Balance the equations below:

1) ____ N_2 + ____ H_2 → ____ NH_3

2) ____ $KClO_3$ → ____ KCl + ____ O_2

3) ____ NaCl + ____ F_2 → ____ NaF + ____ Cl_2

4) ____ H_2 + ____ O_2 → ____ H_2O

5) ____ $Pb(OH)_2$ + ____ HCl → ____ H_2O + ____ $PbCl_2$

6) ____ $AlBr_3$ + ____ K_2SO_4 → ____ KBr + ____ $Al_2(SO_4)_3$

7) ____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

8) ____ C_3H_8 + ____ O_2 → ____ CO_2 + ____ H_2O

9) ____ C_8H_{18} + ____ O_2 → ____ CO_2 + ____ H_2O

10) ____ $FeCl_3$ + ____ NaOH → ____ $Fe(OH)_3$ + ____NaCl

11) ____ P + ____O_2 → ____P_2O_5

12) ____ Na + ____ H_2O → ____ NaOH + ____H_2

13) ____ Ag_2O → ____ Ag + ____O_2

14) ____ S_8 + ____O_2 → ____ SO_3

15) ____ CO_2 + ____ H_2O → ____ $C_6H_{12}O_6$ + ____O_2

16) ____ K + ____ MgBr → ____ KBr + ____ Mg

17) ____ HCl + ____ $CaCO_3$ → ____ $CaCl_2$ + ____H_2O + ____ CO_2

18) ____ HNO_3 + ____ $NaHCO_3$ → ____ $NaNO_3$ + ____ H_2O + ____ CO_2

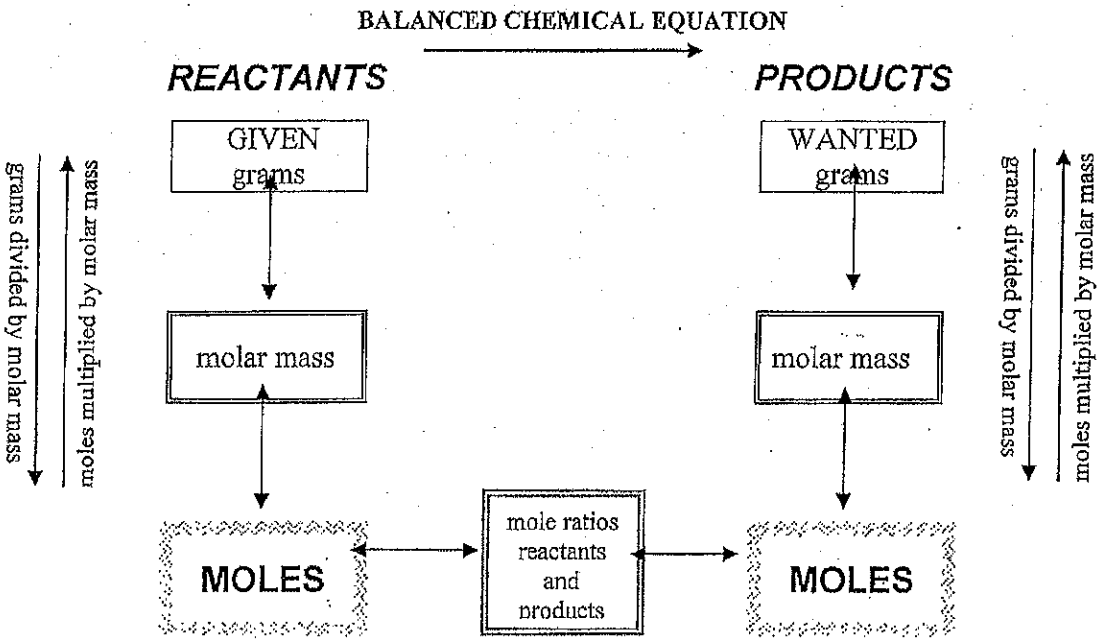
19) ____ H_2O + ____ O_2 → ____ H_2O_2

20) ____ NaBr + ____ CaF_2 → ____ NaF + ____ $CaBr_2$

21) ____ H_2SO_4 + ____ $NaNO_2$ → ____ HNO_2 + ____ Na_2SO_4

STOICHIOMETRY MAP FOR CHEMICAL REACTIONS

Double lined boxes are Conversion Factors to convert from one quantity to another.



$$xA \rightarrow yB + zC$$

GIVEN: WANTED:

$$\text{Grams A} \times \underbrace{\frac{1 \text{ mole A}}{g \text{ A}}}_{\text{molar mass A}} \times \underbrace{\frac{y \text{ mole B}}{x \text{ mole A}}}_{\text{balanced reaction}} \times \underbrace{\frac{g \text{ B}}{1 \text{ mole B}}}_{\text{molar mass B}} = \text{Gram B}$$

Stoichiometric Calculations

1. Sodium metal burns in air according to the balanced reaction shown below.

$$4\ Na_{(s)} + O_{2\,(g)} \rightarrow 2\ Na_2O_{(g)}$$

Complete the setups with the correct factors to answer the following questions:

(a) How many moles of oxygen are needed to completely react with 9.5 g of sodium?

$$\square\ g\ Na \times \frac{1\ mol\ Na}{\square\ g\ Na} \times \frac{\square\ mol\ O_2}{\square\ mol\ Na} = \square\ mol\ O_2$$

(b) How many grams of sodium are needed to produce 12.5 g of sodium oxide?

$$12.5\ g\ Na_2O \times \frac{1\ mol\ Na_2O}{62.0\ g\ Na_2O} \times \frac{mol\ Na \times}{mol\ Na_2O} \frac{g\ Na}{mol\ Na} =$$

2. Acetylene gas C_2H_2 undergoes combustion to form carbon dioxide and water when it is used in the oxyacetylene torch for welding. Balance the reaction and answer the following questions.

$$C_2H_{2\,(g)} + O_{2\,(g)} \rightarrow CO_{2\,(g)} + H_2O_{(g)}$$

(a) How many grams of water can form if 113 g of acetylene is burned?

(b) How many grams of acetylene react if 1.10 mol of CO_2 are produced?

Mass to Mass Stoichiometry Problems

g → mole → mole → gram

In the following problems, calculate how much of the indicated product is made. Show all your work.

1) $LiOH + HBr \rightarrow LiBr + H_2O$

10.0 g

If you start with ten grams of lithium hydroxide, how many grams of lithium bromide will be produced?

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

If you start with 45 grams of ethylene (C_2H_4), how many grams of carbon dioxide will be produced?

3) $Mg + 2\ NaF \rightarrow MgF_2 + 2\ Na$

sodium fluoride magnesium

If you start with 5.5 grams of ~~lithium chloride~~, how many grams of ~~calcium~~ ~~chloride~~ will be produced?

fluoride

4) $2\ HCl + Na_2SO_4 \rightarrow 2\ NaCl + H_2SO_4$

If you start with 20. grams of hydrochloric acid, how many grams of sulfuric acid will be produced?

Stoichiometry Worksheet

Go to solutions

1. Silver sulfide (Ag_2S) is the common tarnish on silver objects. What weight of silver sulfide can be made from 1.23 mg of hydrogen sulfide (H_2S) obtained from a rotten egg? The reaction of formation of silver sulfide is given below:

   $Ag(s) + H_2S(g) + O_2(g) \rightarrow Ag_2S(s) + H_2O(l)$ ***(Equation must first be balanced.)***

2. A somewhat antiquated method for preparing chlorine gas involves heating hydrochloric acid with pyrolusite (manganese dioxide), a common manganese ore. (Reaction given below.) How many kg of HCl react with 5.69 kg of manganese dioxide?

   $HCl(aq) + MnO_2(s) \rightarrow H_2O(l) + MnCl_2(aq) + Cl_2(g)$ ***(Equation must first be balanced.)***

3. Given the following equation: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$, show what the following molar ratios should be.

   a. C_4H_{10} / O_2 b. O_2 / CO_2 c. O_2 / H_2O
   d. C_4H_{10} / CO_2 e. C_4H_{10} / H_2O

4. Given the following equation: $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

   How many moles of O_2 can be produced by letting 12.00 moles of $KClO_3$ react?

5. Given the following equation: $2\ K + Cl_2 \rightarrow 2\ KCl$

   How many grams of KCl is produced from 2.50 g of K and excess Cl_2. From 1.00 g of Cl_2 and excess K?

6. Given the following equation: $Na_2O + H_2O \rightarrow 2\ NaOH$

   How many grams of NaOH is produced from 1.20×10^2 grams of Na_2O? How many grams of Na_2O are required to produce 1.60×10^2 grams of NaOH?

7. Given the following equation: $8\ Fe + S_8 \rightarrow 8\ FeS$

   What mass of iron is needed to react with 16.0 grams of sulfur? How many grams of FeS are produced?

8. Given the following equation: $2\ NaClO_3 \rightarrow 2\ NaCl + 3\ O_2$

   12.00 moles of $NaClO_3$ will produce how many grams of O_2? How many grams of NaCl are produced when 80.0 grams of O_2 are produced?

Percent Yield Calculations

1) Balance this equation and state which of the six types of reaction is taking place:

$$\_\_\_\_ Mg + \_\_\_\_ HNO_3 \rightarrow \_\_\_\_ Mg(NO_3)_2 + \_\_\_\_ H_2$$

Type of reaction: _____

2) If I start this reaction with 40 grams of magnesium and an excess of nitric acid, how many grams of hydrogen gas will I produce?

3) If 1.7 grams of hydrogen is actually produced, what was my percent yield of hydrogen?

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4) Balance this equation and state what type of reaction is taking place:

$$\_\_\_\_ NaHCO_3 \rightarrow \_\_\_\_ NaOH + \_\_\_\_ CO_2$$

Type of reaction: _____

5) If 25 grams of carbon dioxide gas is produced in this reaction, how many grams of sodium hydroxide should be produced?

6) If 50 grams of sodium hydroxide are actually produced, what was my percent yield?

Limiting Reagent Worksheet

For the following reactions, find the following:

a) Which of the reagents is the limiting reagent?
b) What is the maximum amount of each product that can be formed?
c) How much of the other reagent is left over after the reaction is complete?

1) Consider the following reaction:

$$3\ NH_4NO_3 + Na_3PO_4 \rightarrow (NH_4)_3PO_4 + 3\ NaNO_3$$

Answer the questions above, assuming we started with 30 grams of ammonium nitrate and 50 grams of sodium phosphate.

2) Consider the following reaction:

$$3\ CaCO_3 + 2\ FePO_4 \rightarrow Ca_3(PO_4)_2 + Fe_2(CO_3)_3$$

Answer the questions at the top of this sheet, assuming we start with 100 grams of calcium carbonate and 45 grams of iron (III) phosphate.

Answer the following stoichiometry-related questions:

12) Write the balanced equation for the reaction of acetic acid with aluminum hydroxide to form water and aluminum acetate:

13) Using the equation from problem #12, determine the mass of aluminum acetate that can be made if I do this reaction with 125 grams of acetic acid and 275 grams of aluminum hydroxide.

14) What is the limiting reagent in problem #13?

15) How much of the excess reagent will be left over in problem #13 after the reaction is complete?