Mass to Mass Stoichiometry Problems

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

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

If you start with 10.0 grams of lithium hydroxide, how many grams of lithium bromide will be produced?

$$10.0\text{ g LiOH} \times \frac{1\text{ mol LiOH}}{23.9483\text{ g LiOH}} \times \frac{1\text{ mol LiBr}}{1\text{ mol LiOH}} \times \frac{86.845\text{ g LiBr}}{1\text{ mol LiBr}}$$

$= 36.26$ g LiBr

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?

$$45\text{ g } C_2H_4 \times \frac{1\text{ mol } C_2H_4}{28.0536\text{ g } C_2H_4} \times \frac{2\text{ mol } CO_2}{1\text{ mol } C_2H_4} \times \frac{44.0098\text{ g } CO_2}{1\text{ mol } CO_2}$$

$= 141.19$ g CO_2

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

If you start with 5.5 grams of sodium fluoride, how many grams of magnesium fluoride will be produced?

$$5.5\text{ g NaF} \times \frac{1\text{ mol NaF}}{41.9882\text{ g NaF}} \times \frac{1\text{ mol } MgF_2}{2\text{ mol NaF}} \times \frac{62.3018\text{ g } MgF_2}{1\text{ mol } MgF_2}$$

$= 4.08$ g MgF_2

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?

$$20\text{ g HCl} \times \frac{1\text{ mol HCl}}{36.4606\text{ g HCl}} \times \frac{1\text{ mol } H_2SO_4}{2\text{ mol HCl}} \times \frac{98.0784\text{ g } H_2SO_4}{1\text{ mol } H_2SO_4}$$

$= 26.90$ g H_2SO_4

Molarity Stoich

1. What mass of water will be produced if 500mL of 3.5M HCl is reacted according to:

$$\text{① } Fe(OH)_3 + 3HCl \rightarrow FeCl_3 + 3H_2O$$

② moles

mol = $M \times V_L$

= (3.5M)(0.500L

$= 1.75 \text{ mol HCl} \times \frac{3 \text{ mol } H_2O}{3 \text{ mol HCl}} \times \frac{18.0152 \text{ g } H_2O}{1 \text{ mol } H_2O} = 31.53 \text{ g } H_2O$

③ answer substance

④ answer units

2. What will be the theoretical yield of Na_3PO_4 if we react 250mL of 0.56M NaCl according to:

$$6NaCl + Ca_3(PO_4)_2 \rightarrow 3CaCl_2 + 2Na_3PO_4$$

moles = $M \times V_L$

(0.56M)(0.250L)

$= 0.14 \text{ mol NaCl} \times \frac{2 \text{ mol } Na_3PO_4}{6 \text{ mol NaCl}} \times \frac{163.9408 \text{ g } Na_3PO_4}{1 \text{ mol } Na_3PO_4}$

$= 7.65 \text{ g } Na_3PO_4$

Stoichiometry Using Molarity ~~Worksheet~~ Review

For the questions on this worksheet, consider the following equation:

$$Ca(OH)_{2\,(s)} + 2\,HCl_{(aq)} \rightarrow CaCl_{2\,(aq)} + 2\,H_2O_{(l)}$$

1) What type of chemical reaction is taking place? double replacement

a) If I start the reaction above with 250 mL of 0.50 M HCl, what will be my theoretical yield (in grams) of $CaCl_2$?

$M = \frac{mol}{V_L} \rightarrow mol = M \times V_L$

$= (0.50M)(0.250L)$

$= 0.125 \text{ mol } HCl \times \frac{1 \text{ mol } CaCl_2}{2 \text{ mol } HCl} \times \frac{110.985 \text{ g } CaCl_2}{1 \text{ mol } CaCl_2}$

$= 6.94 \text{ g } CaCl_2$

Percent, Actual and Theoretical Yield

1) LiOH + KCl → LiCl + KOH

a) I began this reaction with 20 grams of lithium hydroxide. What is my theoretical yield of lithium chloride?

$20 \text{ g } LiOH \times \frac{1 \text{ mol } LiOH}{23.9483 \text{ g } LiOH} \times \frac{1 \text{ mol } LiCl}{1 \text{ mol } LiOH} \times \frac{42.3937 \text{ g } LiCl}{1 \text{ mol } LiCl}$

$= 35.40 \text{ g } LiCl$

b) I actually produce 6 grams of lithium chloride. What is my percent yield?

$$\% \text{ yield} = \frac{6\text{ g}}{35.40\text{ g}} \times 100 = 16.9\%$$

2) C_3H_8 5 O_2 → 3 CO_2 + 4 H_2O

a) If I start with 5 grams of C_3H_8, what is my theoretical yield of water?

$$5\text{ g } C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44.0962\text{ g } C_3H_8} \times \frac{4 \text{ mol } H_2O}{1 \text{ mol } C_3H_8} \times \frac{18.0152\text{ g } H_2O}{1 \text{ mol } H_2O}$$

$$= 8.17\text{ g } H_2O$$

b) I got a percent yield of 75%. How many grams of water did I make?

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 \rightarrow 75\% = \frac{\text{actual}}{8.17\text{ g}} \times 100$$

$$\text{actual} = \frac{75\%(8.17\text{g})}{100} = 6.13\text{g } H_2O$$

3) Be + 2 HCl → $BeCl_2$ H_2

My theoretical yield of beryllium chloride was 10.7 grams. If my actual yield was 4.5 grams, what was my percent yield?

$$\% \text{ yield} = \frac{4.5\text{ g}}{10.7\text{ g}} \times 100 = 42.1\%$$

4) 2 NaCl + CaO → $CaCl_2$ + Na_2O

What is my theoretical yield of sodium oxide if I start with 20 grams of calcium oxide?

$$20\text{ g CaO} \times \frac{1 \text{ mol CaO}}{56.0794\text{ g CaO}} \times \frac{1 \text{ mol } Na_2O}{1 \text{ mol CaO}} \times \frac{61.979\text{ g } Na_2O}{1 \text{ mol } Na_2O} = 22.10\text{ g } Na_2O$$

5) $FeBr_2$ + 2 KCl → $FeCl_2$ + 2 KBr

a) What is my theoretical yield of iron (II) chloride if I start out with 34 grams of iron (II) bromide?

$$34\text{g } FeBr_2 \times \frac{1 \text{ mol } FeBr_2}{215.653\text{ g } FeBr_2} \times \frac{1 \text{ mol } FeCl_2}{1 \text{ mol } FeBr_2} \times \frac{126.7504\text{g } FeCl_2}{1 \text{ mol } FeCl_2}$$

$$= 19.98\text{ g } FeCl_2$$

b) What is my percent yield of iron (II) chloride if my actual yield is 4 grams?

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 \qquad \frac{4\text{ g}}{19.98\text{ g}} \times 100 = 20.0\%$$

6) TiS + H_2O → H_2S + TiO

What is my percent yield of titanium (II) oxide if I start with 20 grams of titanium (II) sulphide and my actual yield of titanium (II) oxide is 22 grams?

$$20\,g\ TiS \times \frac{1\ mol\ TiS}{79.932\,g\ TiS} \times \frac{1\ mol\ TiO}{1\ mol\ TiS} \times \frac{63.8664\,g\ Ti}{1\ mol\ TiO} = 15.98\,g\ TiO\ \text{(theoretical)}$$

$$\%\ yield = \frac{22\,g}{15.98\,g} \times 100 = 137.7\%$$

7) $U + 3\,Br_2 \rightarrow UBr_6$

What is my actual yield of uranium hexabromide if I start with 100grams of uranium and get a percent yield of 83%?

$$\%\ yield = \frac{actual}{theoretical} \times 100 \qquad actual = \frac{\%\ yield\,(theoretical)}{100} = \frac{83\%\,(301.44\,g)}{100} = 250.19\,g\ \text{actual}$$

$$100\,g\ U \times \frac{1\ mol\ U}{238.0\,g\ U} \times \frac{1\ mol\ UBr_6}{1\ mol\ U} \times \frac{717.424\,g\ UBr_6}{1\ mol\ UBr_6} = 301.44\,g\ UBr_6\ \text{theoretical yield.}$$

8) $H_2SO_4 \rightarrow H_2O + SO_3$

If I start with 89 grams of sulphuric acid and produce 7.1 grams of water, what is my percent yield?

$$89\,g\ H_2SO_4 \times \frac{1\ mol\ H_2SO_4}{98.0784\,g\ H_2SO_4} \times \frac{1\ mol\ H_2O}{1\ mol\ H_2SO_4} \times \frac{18.0152\,g\ H_2O}{1\ mol\ H_2O}$$

$$= 16.35\,g\ H_2O\ \text{(theoretical yield)}$$

$$\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{7.1\,g}{16.35\,g} \times 100 = 43.4\%$$

Limiting Reactant Worksheet

Using your knowledge of stoichiometry and limiting reactants, answer the following questions:

1) Write the balanced equation for the reaction of aqueous lead (II) nitrate with aqueous sodium iodide to produce aqueous sodium nitrate and solid lead (II) iodide.

$$Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow 2NaNO_{3(aq)} + PbI_{2(s)}$$

2) If I start with 25.0 grams of lead (II) nitrate and 15.0 grams of sodium iodide, how many grams of sodium nitrate can be formed?

$25.0\ g\ Pb(NO_3)_2 \times \frac{1\ mol\ Pb(NO_3)_2}{331.20989\ Pb(NO_3)_2} = 0.0755\ mol\ Pb(NO_3)_2$ *excess (HAVE)

$15.0\ g\ NaI \times \frac{1\ mol\ NaI}{149.8938\ g\ NaI} = 0.1001\ mol\ NaI$ *limiting

Pb(NO3)2

$0.1001\ mol\ NaI \times \frac{1\ mol\ Pb(NO_3)_2}{2\ mol\ NaI}$

(NEED) $= 0.0500\ mol\ Pb(NO_3)_2$

NaI

$0.0755\ mol\ Pb(NO_3)_2 \times \frac{2\ mol\ NaI}{1\ mol\ Pb(NO_3)_2}$

$= 0.151\ mol\ NaI$

$0.1001\ mol\ NaI \times \frac{2\ mol\ NaNO_3}{2\ mol\ NaI} \times \frac{84.9947\ g\ NaNO_3}{1\ mol\ NaNO_3} = 8.51\ g\ NaNO_3$

3) What is the limiting reactant in the reaction described in #2?

NaI

4) How many grams of the excess reactant will be leftover from the reaction in #2?

$0.0755\ mol\ Pb(NO_3)_2 - 0.0500\ mol\ Pb(NO_3)_2$

$= 0.0255\ mol\ Pb(NO_3)_2 \times \frac{331.2098\ g}{1\ mol} = 8.45\ g\ Pb(NO_3)_2$

Mixed Stoichiometry Problems

1) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

If the reaction is to produce 4.67×10^{24} particles of CO_2, how many litres of O_2 gas would be required (at STP)?

$4.67 \times 10^{24}\ part.\ CO_2 \times \frac{1\ mol\ CO_2}{6.02 \times 10^{23}\ part.\ CO_2} \times \frac{6\ mol\ O_2}{6\ mol\ CO_2} \times \frac{22.4\ L\ O_2}{1\ mol\ O_2}$

$= 173.77\ L\ O_2$

2) $6KMnO_4 + Fe_2(SO_4)_3 \rightarrow 3K_2SO_4 + 2Fe(MnO_4)_3$

Calculate how many particles of K_2SO_4 are produced when the reaction begins with 1.34×10^{24} particles of $KMnO_4$.

$$1.34 \times 10^{24} \text{ part. } KMnO_4 \times \frac{1 \text{ mol } KMnO_4}{6.02 \times 10^{23} \text{ part. } KMnO_4} \times \frac{3 \text{ mol } K_2SO_4}{6 \text{ mol } KMnO_4} \times \frac{6.02 \times 10^{23} \text{ part. } K_2SO_4}{1 \text{ mol } K_2SO_4}$$

$$= 6.7 \times 10^{23} \text{ particles } K_2SO_4$$

3) $2H_2O \rightarrow 2H_2 + O_2$

10.34L of H_2 gas are produced at STP. How many particles of O_2 were also produced?

$$10.34L\ H_2 \times \frac{1 \text{ mol } H_2}{22.4 \text{ L } H_2} \times \frac{1 \text{ mol } O_2}{2 \text{ mol } H_2} \times \frac{6.02 \times 10^{23} \text{ part. } O_2}{1 \text{ mol } O_2}$$

$$= 1.39 \times 10^{23} \text{ particles } O_2.$$

Answers to Practice Sheets

Mass to Mass Stoichiometry:

1) 36.3 grams
2) ~~141.4~~ grams 141.19g
3) ~~72 grams***~~ 4.08g MgF_2
4) 26.9 grams

Stoichiometry Using Molarity:

1) Double replacement (or more specifically an acid-base reaction)

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~~*** 6.94g~~ $CaCl_2$

Mixed Stoichiometry Problems:

1) 173.7L
2) 6.7 x 10^{23}
3) 1.39 x 10^{23}

Percent, Actual, and Theoretical Yield:

1 a) 35.4 grams b) 16.9%

2 a) 8.2 grams b) 6.1 grams

3) 42.1%

4) 22.1 grams

5 a) 20.0 grams. b) 20%

6) 137.7%

~~7) 301.4 grams~~

8) ~~250.2~~ 16.35 g ; 43.4%

Limiting Reactant:

1) $Pb(NO_3)_{2\,(aq)} + 2\ NaI_{(aq)} \rightarrow PbI_{2\,(s)} + 2\ NaNO_{3\,(aq)}$
2) 8.51 grams
3) NaI
4) 8.~~38~~ 43 grams

Stoichiometry Using Molarity:

1) Double Replacement ; 6.937 g $CaCl_2$

Molarity Stoich

1. 31.53 g H_2O
2. 7.65 g Na_3PO_4