P 9.3 (pg 1 of 4) Stoichiometry – Percent Yield

Name____________________

You will notice that to speed your work, the molar masses for compounds were given for some of the problems. Please put your work on another piece of paper - DO NOT do your work on the calculator until you have it worked out on the page.

1. Write a single replacement reaction that represents the formation of silver and copper(II) nitrate.

MM g/mole
silver nitrate = 169.87
copper = 63.55
silver = 107.87
copper(II) nitrate = 187.55

   a. If you used 1.43 g of silver nitrate, what mass of copper would you need to go with it?

   b. If you used 1.43 g of silver nitrate, (and all the copper you would need) what mass of silver crystal should be produced, and what mass of copper (II) nitrate should be produced?

   c. If you used 1.43 g of silver nitrate, (and all the copper you would need), and you produced 1.12 g of silver in the lab, determine the % yield of silver. If you produced 0.53 g of copper(II) nitrate, determine its percent yield.

2. Write out a balanced equation for the reaction of iron(II) oxide and carbon monoxide to produce iron and carbon dioxide.

MM g/mole
iron(II) oxide = 71.85
carbon monoxide = 28.0
iron = 55.85
carbon dioxide = 44.0

   a. In the lab, you reacted 4.86 g of iron(II) oxide with an excess of carbon monoxide, and were able to produce 3.0 g of iron. Determine the % yield of iron.

3. Write the balanced equation that represents the synthesis of aluminum oxide from its elements.

MM g/mole
Al_2O_3 = 102
O_2 = 32.0
Al = 27.0

   a. Determine the % yield of aluminum oxide if you started with 10.0 g of aluminum and as much oxygen as necessary, and you were able to experimentally produce 14.4 g of aluminum oxide.

4. Write the reaction that represents the formation of carbon disulfide and carbon monoxide by reacting carbon with sulfur dioxide.

MM g/mole
C =12.0
SO_2= 64.1
CS_2 = 76.1
CO = 28.0

   a. Determine the % yield of carbon monoxide, if in the lab you started with 46.5 g of carbon and an unlimited amount of sulfur dioxide and you were able to experimentally produce 68.7 g of carbon monoxide.

5. Answer the following questions for the balanced equation below.

$$2\,SO_2 + O_2 + 2\,H_2O \longrightarrow 2\,H_2SO_4$$

MM g/mole
SO_2 = 64.1
O_2 = 32.0
H_2O = 18.0
H_2SO_4= 98.0

   a. How many grams of sulfuric acid will be theoretically produced from 365 g of sulfur dioxide and an excess amount of the other reactants?

   b. Determine the % yield if you actually did this reaction and experimentally produced 500.0 g of sulfuric acid from the situation described in part a

6. Write out a balanced equation that represents the combustion of isopropyl alcohol. C_3H_7OH
   Beware: there is a small density twist in this problem.

MM g/mole
isopropylalcohol = 60.0
oxygen = 32.0
carbon dioxide = 44.0
water = 18.0

   a. If you were given 5.6 ml of isopropyl alcohol, what mass of oxygen would be needed to go with it to completely burn the alcohol?

   b. If you were given 5.6 ml of the isopropyl alcohol, (and all the oxygen you would need) what mass of carbon dioxide would be produced?

   c. If after doing the combustion in the lab, you measured 7.8 g of carbon dioxide produced, calculate the % yield.

7. For the balanced equation below,

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

Determine the % yield if you actually did this reaction and experimentally produced 4.7 g of water from 10.0 g of glucose.

MM g/mole
$C_6H_{12}O_6$ = 180.0
O_2 = 32.0
CO_2 = 44.0
H_2O = 18.0

8. Answer the following questions for the balanced equation below.

$$2\,CuFeS_2 + 5\,O_2 \rightarrow 2\,Cu + 2\,FeO + 4\,SO_2$$

a. How many kg of copper can be produced from 55.68 kg of oxygen and an excess amount of the copper iron sulfide.

b. Determine the % yield if you actually did this reaction and experimentally produced 43.7 kg of copper from the situation described in part a).

MM g/mole
$CuFeS_2$ = 183.54
O_2 = 32.00
Cu = 63.55
FeO = 87.85
SO_2 = 64.07

9. For the balanced equation below,

$$Fe_2O_3 + 3\,CO \rightarrow 2\,Fe + 6\,CO_2$$

In the lab, when 17.5 g of iron(III) oxide reacted with an excess of carbon monoxide and 10.1 g of iron is produced, calculate the % yield.

MM g/mole
iron(II) oxide = 159.7
carbon monoxide = 28.0
iron = 55.85
carbon dioxide = 44.0

10. For the balanced equation below,

$$SiO_2 + 3\,C \rightarrow SiC + 2\,CO$$

a. How many grams of carbon monoxide can be produced from 1.24 g of carbon and an excess amount of silicon dioxide?

b. Determine the % yield if you actually did this reaction and experimentally produced 1.26 g of carbon monoxide from the situation described in part "a"

MM g/mole
SiO_2 = 60.1
C = 12.0
SiC = 40.1
CO = 28

In these problems, conversion of grams to moles is done in green, the ratio that is from the coefficients in the balanced equation highlighted in red, and the conversion of moles to grams is done in purple. The answers are in blue. Ideally you do the complete calculation of these numbers in your calculator and not round them off until the end.

The answers are shown in blue. Each problem is solved solved using dimensional analysis. Put your work on paper and label your final answer with **units**, **identifiers**, and **descriptors**.

1. $Cu + 2\,AgNO_3 \rightarrow 2\,Ag + Cu(NO_3)_2$

   a. $1.43 \text{ g } AgNO_3 \left(\frac{1 mol AgNO_3}{169.87 g AgNO_3}\right)\left(\frac{1 Cu}{2 AgNO_3}\right)\left(\frac{63.55 g Cu}{1 mol Cu}\right) = 0.267 \text{ g}$ copper needed

   b. $1.43 \text{ g } AgNO_3 \left(\frac{1 mol AgNO_3}{169.87 g AgNO_3}\right)\left(\frac{2 Ag}{2 AgNO_3}\right)\left(\frac{107.87 g Ag}{1 mol Ag}\right) = 0.908 \text{ g}$ silver can be produced (theor)

   $1.43 \text{ g } AgNO_3 \left(\frac{1 mol AgNO_3}{169.87 g AgNO_3}\right)\left(\frac{1 Cu(NO_3)_2}{2 AgNO_3}\right)\left(\frac{187.57 g Cu(NO_3)_2}{1 mol Cu(NO_3)_2}\right) = 0.789 \text{ g}$ of $Cu(NO_3)_2$ produced (theoretical)

   c. $\left(\frac{1.12 g Ag(\text{exp})}{0.908 g Ag(theor)}\right) \times 100 = 123\%$ Ag and $\left(\frac{0.53 g Cu(NO_3)_2(\text{exp})}{0.789 g Cu(NO_3)_2(theor)}\right) \times 100 = 67\ \%$ yield $Cu(NO_3)_2$

2. $FeO + CO \rightarrow Fe + CO_2$

   $4.86 \text{ g } FeO \left(\frac{1 mol FeO}{71.85 g FeO}\right)\left(\frac{1 Fe}{1 FeO}\right)\left(\frac{55.85 g Fe}{1 mol Fe}\right) = 3.78 \text{ g}$ iron can be produced (theoretical)

   a. $\left(\frac{3.0 g Fe(\text{exp})}{3.78 g Fe(theor)}\right) \times 100 = 79\ \%$ yield iron

3. $4\,Al + 3\,O_2 \rightarrow 2\,Al_2O_3$

   $10.0 \text{ g } Al \left(\frac{1 mol Al}{27.0 g Al}\right)\left(\frac{2 Al_2O_3}{4 mol Al}\right)\left(\frac{102 g Al_2O_3}{1 mol Al_2O_3}\right) = 18.9 \text{ g } Al_2O_3$

   a. $\left(\frac{14.4 g Al_2O_3(\text{exp})}{18.9 g Al_2O_3(theor)}\right) \times 100 = 76.2\ \%$ yield aluminum oxide

4. $5\,C + 2\,SO_2 \rightarrow CS_2 + 4\,CO$

   $46.5 \text{g } C \left(\frac{1 mol C}{12.0 g C}\right)\left(\frac{4 CO}{5 C}\right)\left(\frac{28.0 g CO}{1 mol CO}\right) = 86.8 \text{ g } CO$ can be produced (theoretical)

   a. $\left(\frac{68.7 g CO(\text{exp})}{86.8 g CO(theor)}\right) \times 100 = 79.1\ \%$ yield carbon monoxide

5. Using the balanced equation: $2\,SO_2 + O_2 + 2\,H_2O \rightarrow 2\,H_2SO_4$

   a. $365 \text{ g } SO_2 \left(\frac{1 mol SO_2}{64.1 g SO_2}\right)\left(\frac{2 H_2SO_4}{2 SO_2}\right)\left(\frac{98.0 g H_2SO_4}{1 mol H_2SO_4}\right) = 558 \text{ g}$ of sulfuric acid can be produced

   b. $\left(\frac{500 g H_2SO_4(\text{exp})}{558 g H_2SO_4(theor)}\right) \times 100 = 89.6\ \%$ yield sulfuric acid

6. $2\ C_3H_7OH + 9\ O_2 \rightarrow 6\ CO_2 + 8\ H_2O$
Alert this problem has a twist – 5.6 ml of alcohol does NOT equal 5.6 g. You must first change 5.6 ml to grams using the density equation $D = \frac{M}{V}$ thus D × V = M The density of the alcohol is 0.78 g/ml × 5.6 ml = 4.4 g

a. $4.368\text{ g } C_3H_7OH \left(\frac{1 mol C_3H_7OH}{60.0 g C_3H_7OH}\right)\left(\frac{9 O_2}{2 C_7H_7OH}\right)\left(\frac{32.0 g O_2}{1 mol O_2}\right)$ = 10.4 g but only 2 sf , so 1.0×10^1 g oxygen is needed

b. $4.368\text{ g } C_3H_7OH \left(\frac{1 mol C_3H_7OH}{60.0 g C_3H_7OH}\right)\left(\frac{6 CO_2}{2 C_7H_7OH}\right)\left(\frac{44.0 g CO_2}{1 mol CO_2}\right)$ = 9.6 g carbon dioxide can be produced

c. $\left(\frac{7.8 g CO_2(\exp)}{9.6 g CO_2(theor)}\right)\times 100$ = 81 % yield of carbon dioxide

7. Using the equation: $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$
$10.0\text{ g } C_6H_{12}O_6 \left(\frac{1 mol C_6H_{12}O_6}{180.0 g C_6H_{12}O_6}\right)\left(\frac{6 H_2O}{1 C_6H_{12}O_6}\right)\left(\frac{18.0 g H_2O}{1 mol H_2O}\right)$ = 6.00 g of water can be produced(theoretical)

thus $\left(\frac{4.7 g H_2O(\exp)}{6.0 g H_2O(theor)}\right)\times 100$ = 78 % yield water.

8. Using the balanced equation $2\ CuFeS_2 + 5\ O_2 \rightarrow 2\ Cu + 2\ FeO + 4\ SO_2$
In this problem, you are given kilograms, but since the answer is also requested in kilograms, you may do allyour mole conversions in grams and they will cancel with each other, leaving kilograms at the end
$55.68\text{ kg } O_2 \left(\frac{1 mol O_2}{32.0 g O_2}\right)\left(\frac{2 Cu}{5 O_2}\right)\left(\frac{63.55 g Cu}{1 mol Cu}\right)$ = 44.23 kg of Cu can be produced (theor)

a. $\left(\frac{43.7 kg Cu(\exp)}{44.23 kg Cu(theor)}\right)\times 100$ = 98.8 % yield copper

9. Use the equation: $Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 6\ CO_2$
$17.5\text{ g } Fe_2O_3 \left(\frac{1 mol Fe_2O_3}{159.7 g Fe_2O_3}\right)\left(\frac{2 Fe}{1 Fe_2O_3}\right)\left(\frac{55.85 g Fe}{1 mol Fe}\right)$ = 12.24 g iron may be produced(theor)

$\left(\frac{10.1 g Fe(\exp)}{12.24 g Fe(theor)}\right)\times 100$ = 82.5 % yield iron

10. Using the balanced equation: $SiO_2 + 3\ C \rightarrow SiC + 2\ CO$

a. $1.24\text{ g C} \left(\frac{1 mol C}{12.0 g C}\right)\left(\frac{2 CO}{1 C}\right)\left(\frac{28.0 g CO}{1 mol CO}\right)$ = 1.93 g of carbon monoxide may be produced

b. $\left(\frac{1.26 g CO(\exp)}{1.93 g CO(theor)}\right)\times 100$ = 65.3 % yield carbon monoxide