Name KEY Date _____ Period _____

Theoretical and Percent Yield Worksheet

1. Write the equations for calculating % yield and % error in the boxes below:

% yield:	% error:

2. What does a % yield tell you?

3. What does a % error tell you?

Worked example:

Given the following equation, determine the percent yield of KCl if you react 34.5 g of K_2CO_3 with excess HCl and you are able to actually isolate 36.1 g of KCl. Also Calculate the % error.

$$K_2CO_3 + HCl \text{ --------> } H_2O + CO_2 + KCl$$

Steps:

a) Balance the equation.
b) Determine the theoretical yield of KCl if you start with 34.5 g of K_2CO_3.
c) Starting with 34.5 g of K_2CO_3, and you isolate 36.1 g of KCl, what is the percent yield?
d) Calculate the percent error for this reaction.

a) Balanced equation: $K_2CO_3 + \mathbf{2}HCl \text{ --------> } H_2O + CO_2 + \mathbf{2}KCl$

b) $34.5 \text{ g } K_2CO_3 \times \frac{1 \text{ mole } K_2CO_3}{138.21 \text{ g } K_2CO_3} \times \frac{2 \text{ mol KCl}}{1 \text{ mol } K_2CO_3} \times \frac{74.55 \text{ g KCl}}{1 \text{ mol KCl}} = 37.2 \text{ g KCl}$

c) $\%\text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$ so... $\%\text{ yield of KCl} = \frac{36.1 \text{ g KCl}}{37.2 \text{ g KCl}} \times 100 = 97.0\%$

d) $\%\text{ error} = \frac{|(\text{theoretical} - \text{actual})|}{\text{theoretical yield}} \times 100$ so... $\%\text{ error} = \frac{|(37.2-36.1)|}{37.2} \times 100 = 2.96\%$

Now you try...

1. What is the % yield and % error if when 16.22 g of NH_3 is reacted with excess K_2PtCl_4, 265.52 g of $Pt(NH_3)_2Cl_2$ is produced according to the following equation:

$$\_\_\_\ K_2PtCl_4 + \underline{2}\ NH_3 \text{ --------> } \_\_\_\ Pt(NH_3)_2Cl_2 + \underline{2}\ KCl$$

a) Balance the equation.
b) Determine the theoretical yield of ~~KCl~~ $Pt(NH_3)_2Cl_2$ if you start with 16.22 grams of NH_3.
c) Starting with ~~34.5~~ 16.22 g of NH_3, and you isolate ~~265.52~~ 129.1 g of $Pt(NH_3)_2Cl_2$, what is the percent yield?
d) Calculate the percent error for this reaction.

b) $16.22\ g\ NH_3 \times \frac{1\ mol\ NH_3}{17\ g\ NH_3} \times \frac{1\ mol\ Pt(NH_3)_2Cl_2}{2\ mol\ NH_3} \times \frac{299\ g\ Pt(NH_3)_2Cl_2}{1\ mol\ Pt(NH_3)_2Cl_2} = \boxed{143\ g}$

c) $\%\ yield = \frac{129.1\ g}{143\ g} \times 100 = \boxed{90\%\ yield}$

d) $\%\ error = \frac{|143 - 129.1|}{143} \times 100 = \boxed{10\%\ error}$

2. Given the following equation:

$$H_3PO_4 + 3\ KOH \text{ ------> } K_3PO_4 + 3\ H_2O$$

a) If 49.0 g of H_3PO_4 is reacted with excess KOH, determine the percent yield of K_3PO_4 if you isolate 49.0 g of K_3PO_4.
b) Calculate the percent error for this reaction.

a) $49.0\ g\ H_3PO_4 \times \frac{1\ mol\ H_3PO_4}{98\ g\ H_3PO_4} \times \frac{1\ mol\ K_3PO_4}{1\ mol\ H_3PO_4} \times \frac{212\ g\ K_3PO_4}{1\ mol\ K_3PO_4} = \boxed{106\ g}$ theoretical yield

$\%\ yield = \frac{49.0\ g}{106\ g} \times 100 = \boxed{46\%\ yield}$

b) $\%\ error = \frac{|106 - 49.0|}{106} \times 100 = \boxed{54\%\ error}$

3. Given the following equation:

$$Al_2(SO_3)_3 + 6\ NaOH \text{ ------> } 3\ Na_2SO_3 + 2\ Al(OH)_3$$

a) If you start with 389.04 g of $Al_2(SO_3)_3$ and you isolate 212.60 g of Na_2SO_3, what is your percent yield for this reaction?

b) Calculate the percent error for this reaction.

a) $389.04\text{ g } Al_2(SO_3)_3 \times \frac{1\text{ mol } Al_2(SO_3)_3}{294\text{ g}} \times \frac{3\text{ mol } Na_2SO_3}{1\text{ mol } Al_2(SO_3)_3} \times \frac{126\text{ g } Na_2SO_3}{1\text{ mol } Na_2SO_3} = \boxed{500\text{ g}}$ Theo.

$\%\text{ yield} = \frac{212.60\text{ g}}{500\text{ g}} \times 100 = 42.5\%\text{ yield}$

b) $\%\text{ error} = \frac{|500 - 212.60|}{500} \times 100 = \boxed{57.5\%}\text{ error}$

4. Given the following equation:

$$Al(OH)_3\ (s) + 3\ HCl\ (aq) \text{ -------> } AlCl_3\ (aq) + 3\ H_2O\ (l)$$

a) If you start with 50.3 g of $Al(OH)_3$ and you isolate 39.5 g of $AlCl_3$, what is the percent yield and percent error?

$50.3\text{ g } Al(OH)_3 \times \frac{1\text{ mol } Al(OH)_3}{78\text{ g } Al(OH)_3} \times \frac{1\text{ mol } AlCl_3}{1\text{ mol } Al(OH)_3} \times \frac{133\text{ g } AlCl_3}{1\text{ mol } AlCl_3} = \boxed{85.8\text{ g}}$ Theo.

$\%\text{ yield} = \frac{39.5\text{ g } AlCl_3}{85.8\text{ g } AlCl_3} \times 100 = 46\%\text{ yield}$

$\%\text{ error} = \frac{|85.8\text{ g} - 39.5\text{ g}|}{85.8\text{ g}} \times 100\% = 54\%\text{ error}$

5. Given the following equation:

$$H_2SO_4 + Ba(OH)_2 \text{ ------> } BaSO_4 + H_2O$$

a) If 98.00 g of H_2SO_4 is reacted with excess $Ba(OH)_2$, determine the percent yield of $BaSO_4$ if you isolate 213.17 g of $BaSO_4$.
b) Calculate the percent error for this reaction.

$98.00\,g\,H_2SO_4 \times \frac{1\,mol\,H_2SO_4}{98\,g\,H_2SO_4} \times \frac{1\,mol\,BaSO_4}{1\,mol\,H_2SO_4} \times \frac{233\,g\,BaSO_4}{1\,mol\,BaSO_4} = 233\,g\,BaSO_4$ Theo yield.

$\%\text{ yield} = \frac{213.17\,g}{233\,g} \times 100 = 91.5\%$

$\%\text{ yield} = \frac{|233 - 213.17|}{233} \times 100 = 8.5\%\text{ error}$

6. Given the following equation:

$$3\,CaCl_2 + 2\,Li_3PO_4 \text{ ------> } 6\,LiCl + Ca_3(PO_4)_2$$

a) If you start with 82.4 g of $CaCl_2$ and you isolate 82.4 g of $Ca_3(PO_4)_2$, what is your percent yield for this reaction and the percent error?

$82.4\,g\,CaCl_2 \times \frac{1\,mol\,CaCl_2}{110\,g\,CaCl_2} \times \frac{1\,mol\,Ca_3(PO_4)_2}{3\,mol\,CaCl_2} \times \frac{310\,g\,Ca_3(PO_4)_2}{1\,mol\,Ca_3(PO_4)_2} = 77.4\,g$ Theo.

$\%\text{ yield} = \frac{82.4\,g}{77.4\,g} \times 100 = 106\%\text{ yield}$

$\%\text{ error} = \frac{|77.4 - 82.4|}{77.4} \times 100 = 6.5\%\text{ error}$

7. Given the following equation:

$$Cr(OH)_3 + 3HI \text{ -------> } CrI_3 + 3H_2O$$

a) If you start with 50.3 g of $Cr(OH)_3$ and you isolate 39.5 g of CrI_3, what is the percent yield?
b) Calculate the percent error for this reaction.

$50.3\,g\,Cr(OH)_3 \times \frac{1\,mol\,Cr(OH)_3}{103\,g\,Cr(OH)_3} \times \frac{1\,mol\,CrI_3}{1\,mol\,Cr(OH)_3} \times \frac{433.3\,g}{1\,mol\,CrI_3} = 211\,g$ Theo.

$\%\text{ yield} = \frac{39.5\,g\,CrI_3}{211\,g\,CrI_3} \times 100 = 19\%\text{ yield}$

$\%\text{ error} = \frac{|211 - 39.5|}{211} \times 100 = 81\%\text{ error}$