

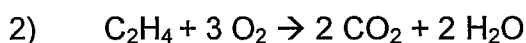
## Mass to Mass Stoichiometry Problems

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



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

$$10.0 \text{ g LiOH} \times \frac{1 \text{ mol LiOH}}{23.9483 \text{ g LiOH}} \times \frac{1 \text{ mol LiBr}}{1 \text{ mol LiOH}} \times \frac{86.845 \text{ g LiBr}}{1 \text{ mol LiBr}} \\ = 36.26 \text{ g LiBr}$$



If you start with 45 grams of ethylene ( $\text{C}_2\text{H}_4$ ), how many grams of carbon dioxide will be produced?

$$45 \text{ g C}_2\text{H}_4 \times \frac{1 \text{ mol C}_2\text{H}_4}{28.0536 \text{ g C}_2\text{H}_4} \times \frac{2 \text{ mol CO}_2}{1 \text{ mol C}_2\text{H}_4} \times \frac{44.0098 \text{ g CO}_2}{1 \text{ mol CO}_2} \\ = 141.19 \text{ g CO}_2$$



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

$$5.5 \text{ g NaF} \times \frac{1 \text{ mol NaF}}{41.9882 \text{ g NaF}} \times \frac{1 \text{ mol MgF}_2}{2 \text{ mol NaF}} \times \frac{62.3018 \text{ g MgF}_2}{1 \text{ mol MgF}_2} \\ = 4.08 \text{ g MgF}_2$$

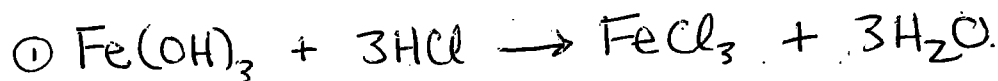


If you start with 20 grams of hydrochloric acid, how many grams of sulfuric acid will be produced?

$$20 \text{ g HCl} \times \frac{1 \text{ mol HCl}}{36.4606 \text{ g HCl}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol HCl}} \times \frac{98.0784 \text{ g H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \\ = 26.90 \text{ g H}_2\text{SO}_4$$

## Molarity Stoich.

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



$\textcircled{2}$  moles

$$\text{mol} = M \times V_L$$

$$= (3.5\text{M})(0.500\text{L})$$

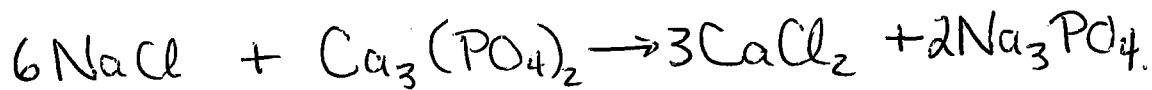
$$= 1.75 \text{ mol HCl}$$

$$\times \frac{3 \text{ mol H}_2\text{O}}{3 \text{ mol HCl}} \times \frac{18.0152 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 31.53 \text{ g H}_2\text{O}$$

$\textcircled{3}$  answer  
Substance

$\textcircled{4}$  answer units

2. What will be the theoretical yield of  $\text{Na}_3\text{PO}_4$  if we react 250mL of 0.56M NaCl according to:



$$\text{moles} = M \times V_L$$

$$(0.56\text{M})(0.250\text{L})$$

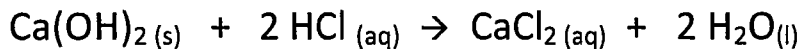
$$= 0.14 \text{ mol NaCl}$$

$$\times \frac{2 \text{ mol Na}_3\text{PO}_4}{6 \text{ mol NaCl}} \times \frac{163.9408 \text{ g Na}_3\text{PO}_4}{1 \text{ mol Na}_3\text{PO}_4}$$

$$= 7.65 \text{ g Na}_3\text{PO}_4$$

## Review Stoichiometry Using Molarity Worksheet

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

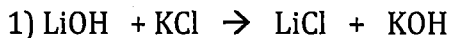


1) What type of chemical reaction is taking place? double replacement

a) If I start the reaction above with 250 mL of 0.50 M HCl, what will be my theoretical yield (in grams) of  $\text{CaCl}_2$ ?

$$\begin{aligned} M &= \frac{\text{mol}}{V_L} \rightarrow \text{mol} = M \times V_L \\ &= (0.50 \text{ M})(0.250 \text{ L}) \\ &= 0.125 \text{ mol HCl} \times \frac{1 \text{ mol CaCl}_2}{2 \text{ mol HCl}} \times \frac{110.985 \text{ g CaCl}_2}{1 \text{ mol CaCl}_2} \\ &= 6.94 \text{ g CaCl}_2 \end{aligned}$$

### Percent, Actual and Theoretical Yield

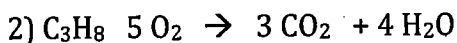


a) I began this reaction with 20 grams of lithium hydroxide. What is my theoretical yield of lithium chloride?

$$\begin{aligned} 20 \text{ g LiOH} \times \frac{1 \text{ mol LiOH}}{23.9483 \text{ g LiOH}} \times \frac{1 \text{ mol LiCl}}{1 \text{ mol LiOH}} \times \frac{42.3937 \text{ g LiCl}}{1 \text{ mol LiCl}} \\ = 35.40 \text{ g LiCl} \end{aligned}$$

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

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



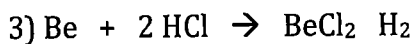
a) If I start with 5 grams of  $\text{C}_3\text{H}_8$ , what is my theoretical yield of water?

$$5 \text{ g } \text{C}_3\text{H}_8 \times \frac{1 \text{ mol } \text{C}_3\text{H}_8}{44.0962 \text{ g } \text{C}_3\text{H}_8} \times \frac{4 \text{ mol } \text{H}_2\text{O}}{1 \text{ mol } \text{C}_3\text{H}_8} \times \frac{18.0152 \text{ g } \text{H}_2\text{O}}{1 \text{ mol } \text{H}_2\text{O}} = 8.17 \text{ g } \text{H}_2\text{O}$$

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

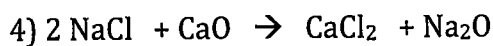
$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 \rightarrow 75\% = \frac{\text{actual}}{8.17 \text{ g}} \times 100$$

$$\text{actual} = \frac{75\% (8.17 \text{ g})}{100} = 6.13 \text{ g } \text{H}_2\text{O}$$



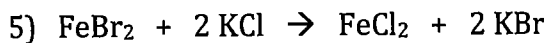
My theoretical yield of beryllium chloride was 10.7 grams. If my actual yield was 4.5 grams, what was my percent yield?

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



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

$$20 \text{ g } \text{CaO} \times \frac{1 \text{ mol } \text{CaO}}{56.0794 \text{ g } \text{CaO}} \times \frac{1 \text{ mol } \text{Na}_2\text{O}}{1 \text{ mol } \text{CaO}} \times \frac{61.979 \text{ g } \text{Na}_2\text{O}}{1 \text{ mol } \text{Na}_2\text{O}} = 22.10 \text{ g } \text{Na}_2\text{O}$$

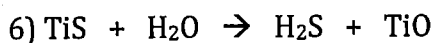


a) What is my theoretical yield of iron (II) chloride if I start out with 34 grams of iron (II) bromide?

$$34 \text{ g } \text{FeBr}_2 \times \frac{1 \text{ mol } \text{FeBr}_2}{215.653 \text{ g } \text{FeBr}_2} \times \frac{1 \text{ mol } \text{FeCl}_2}{1 \text{ mol } \text{FeBr}_2} \times \frac{126.7504 \text{ g } \text{FeCl}_2}{1 \text{ mol } \text{FeCl}_2} = 19.98 \text{ g } \text{FeCl}_2$$

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

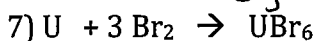
$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{4 \text{ g}}{19.98 \text{ g}} \times 100 = 20.0\%$$



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?

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

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



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

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

$$100 \text{ g U} \times \frac{1 \text{ mol U}}{238.0 \text{ g U}} \times \frac{1 \text{ mol UBr}_6}{1 \text{ mol U}} \times \frac{717.424 \text{ g UBr}_6}{1 \text{ mol UBr}_6} = 301.44 \text{ g UBr}_6 \text{ (theoretical yield)}$$

= 250.19 g actual

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

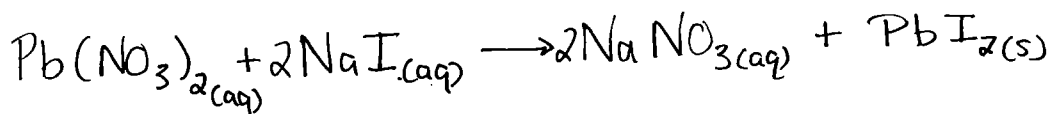
$$89 \text{ g H}_2\text{SO}_4 \times \frac{1 \text{ mol H}_2\text{SO}_4}{98.0784 \text{ g H}_2\text{SO}_4} \times \frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{18.0152 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 16.35 \text{ g H}_2\text{O (theoretical yield)}$$

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

### Limiting Reactant Worksheet

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

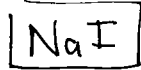
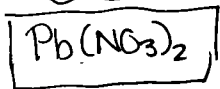
- 1) Write the balanced equation for the reaction of aqueous lead (II) nitrate with aqueous sodium iodide to produce aqueous sodium nitrate and solid lead (II) iodide.



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?

$$25.0 \text{ g Pb(NO}_3)_2 \times \frac{1 \text{ mol Pb(NO}_3)_2}{331.2098 \text{ g Pb(NO}_3)_2} = 0.0755 \text{ mol Pb(NO}_3)_2 \text{ *excess}$$

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

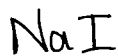


$$0.1001 \text{ mol NaI} \times \frac{1 \text{ mol Pb(NO}_3)_2}{2 \text{ mol NaI}} = 0.0500 \text{ mol Pb(NO}_3)_2$$

$$0.0755 \text{ mol Pb(NO}_3)_2 \times \frac{2 \text{ mol NaI}}{1 \text{ mol Pb(NO}_3)_2} = 0.151 \text{ mol NaI}$$

$$0.1001 \text{ mol NaI} \times \frac{2 \text{ mol NaNO}_3}{2 \text{ mol NaI}} \times \frac{84.9947 \text{ g NaNO}_3}{1 \text{ mol NaNO}_3} = 8.51 \text{ g NaNO}_3$$

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

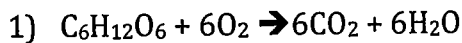


4) How many grams of the excess reactant will be leftover from the reaction in #2?

$$0.0755 \text{ mol Pb(NO}_3)_2 - 0.0500 \text{ mol Pb(NO}_3)_2 = 0.0255 \text{ mol Pb(NO}_3)_2$$

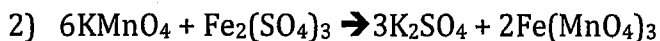
$$0.0255 \text{ mol Pb(NO}_3)_2 \times \frac{331.2098 \text{ g}}{1 \text{ mol}} = 8.45 \text{ g Pb(NO}_3)_2$$

### Mixed Stoichiometry Problems



If the reaction is to produce  $4.67 \times 10^{24}$  particles of  $\text{CO}_2$ , how many litres of  $\text{O}_2$  gas would be required (at STP)?

$$4.67 \times 10^{24} \text{ part. CO}_2 \times \frac{1 \text{ mol CO}_2}{6.02 \times 10^{23} \text{ part. CO}_2} \times \frac{6 \text{ mol O}_2}{6 \text{ mol CO}_2} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 173.77 \text{ L O}_2$$



Calculate how many particles of  $\text{K}_2\text{SO}_4$  are produced when the reaction begins with  $1.34 \times 10^{24}$  particles of  $\text{KMnO}_4$ .

$$1.34 \times 10^{24} \text{ part. KMnO}_4 \times \frac{1 \text{ mol KMnO}_4}{6.02 \times 10^{23} \text{ part. KMnO}_4} \times \frac{3 \text{ mol K}_2\text{SO}_4}{6 \text{ mol KMnO}_4} \times \frac{6.02 \times 10^{23} \text{ part. K}_2\text{SO}_4}{1 \text{ mol K}_2\text{SO}_4} = 6.7 \times 10^{23} \text{ particles K}_2\text{SO}_4$$



10.34L of  $\text{H}_2$  gas are produced at STP. How many particles of  $\text{O}_2$  were also produced?

$$10.34 \text{ L H}_2 \times \frac{1 \text{ mol H}_2}{22.4 \text{ L H}_2} \times \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2} \times \frac{6.02 \times 10^{23} \text{ part. O}_2}{1 \text{ mol O}_2} = 1.39 \times 10^{23} \text{ particles O}_2$$

### Answers to Practice Sheets

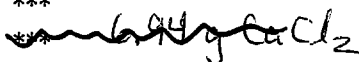
Mass to Mass Stoichiometry:

- 1) 36.3 grams
- 2) ~~141.4~~ grams 141.19g
- 3) ~~22.9g~~ <sup>\*\*\*</sup> 4.08g  $\text{MgF}_2$
- 4) 26.9 grams

Stoichiometry Using Molarity:

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

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Mixed Stoichiometry Problems:

- 1) 173.7L
- 2)  $6.7 \times 10^{23}$
- 3)  $1.39 \times 10^{23}$

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) 301.1 grams~~
- 8) ~~250.2 g~~ ; 43.4%  
16.35g

Limiting Reactant:

- 1)  $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{NaNO}_3(\text{aq})$
  - 2) 8.51 grams
  - 3) NaI
  - 4) 8.38 grams
- 43

Stoichiometry Using Molarity:

- 1) Double Replacement ; 6.937 g  $\text{CaCl}_2$

Molarity Stoich

1. 31.53 g  $\text{H}_2\text{O}$
2. 7.65 g  $\text{Na}_3\text{PO}_4$