

**Chapter 3 Practice Worksheet:
Formulas, Equations, and Moles: Part II**

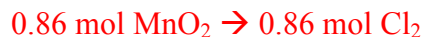
1) Stoichiometry: Chemical Arithmetic

For each equation and starting amount and substance shown, calculate the amount of the product produced.

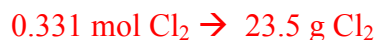
<u>Equation</u>	<u>Starting amount/substance</u>	<u>Product amount/substance</u>
$S(s) + O_2(g) \rightarrow SO_2(g)$	2.35 moles S	moles SO_2 2.35 mol SO_2
$Si(s) + 2Cl_2(g) \rightarrow SiCl_4(l)$	4.1 moles Cl_2	grams $SiCl_4$ 3.5×10^2 g $SiCl_4$
$3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$	0.03445 grams H_2	grams NH_3 0.1952 g NH_3
$KCN(aq) + HCl(aq) \rightarrow KCl(aq) + HCN(g)$	1.09 grams HCl	moles HCN 0.0299 moles HCN
$2NH_3(g) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$	0.00568 grams NH_3	grams $(NH_4)_2SO_4$ 2.21×10^{-2} g $(NH_4)_2SO_4$
$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$	6.50 moles O_2	moles NO_2 13.0 mol NO_2

2) Yields of Chemical Reactions/Limiting Reactants

a. MnO_2 reacts with HCl to produce $MnCl_2$, Cl_2 , and H_2O . Write a balanced equation for this reaction. If 0.86 moles of MnO_2 and 48.2 grams of HCl react, which reagent will be used up first? How many grams of Cl_2 will be produced? How many moles of the excess reagent will be left over? If 19.8 grams of Cl_2 were obtained in lab, what is the percent yield?



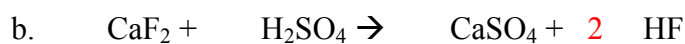
HCl is Limiting Reagent



0.331 mol Cl_2 uses up 0.331 mol MnO_2 ; 0.53 mol MnO_2 left over

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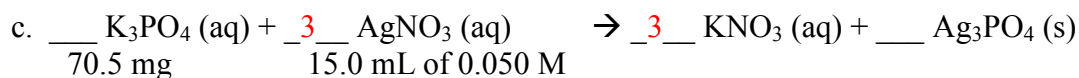
In the reaction above, you begin with 6.00 g of CaF_2 and 12.592 g H_2SO_4 . You obtain 2.86 g of HF as a product. What is the percent yield of HF?

$$6.00 \text{ g CaF}_2 \rightarrow 0.154 \text{ mol HF} \quad (\text{CaF}_2 \text{ is LR})$$

$$12.592 \text{ g H}_2\text{SO}_4 \rightarrow 0.257 \text{ mol HF}$$

$$0.154 \text{ mol HF} \rightarrow 3.08 \text{ g HF}$$

$$(2.86 \text{ g} / 3.08 \text{ g}) \times 100 = 92.9\% \text{ yield}$$



Find the mass of precipitate formed in this reaction.

$$70.5 \text{ mg K}_3\text{PO}_4 \rightarrow 3.32 \times 10^{-4} \text{ mol Ag}_3\text{PO}_4$$

$$15.0 \text{ mL AgNO}_3 \rightarrow 2.5 \times 10^{-4} \text{ mol Ag}_3\text{PO}_4$$

$$2.5 \times 10^{-4} \text{ mol Ag}_3\text{PO}_4 \rightarrow 0.11 \text{ g Ag}_3\text{PO}_4$$

3) Concentrations of Reactants in Solution: Molarity

a. How many moles of solute are in the following solutions?

10.76 mL of 1.54 M HF

$$1.66 \times 10^{-2} \text{ moles HF}$$

250.0 mL of 0.99 M glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)

$$0.25 \text{ moles C}_6\text{H}_{12}\text{O}_6$$

50.1 mL of a 0.145 M solution of H_2SO_4

$$7.26 \times 10^{-3} \text{ moles H}_2\text{SO}_4$$

b. What is the concentration of a solution made by adding 15.5666 g of KOH in a 250.0 mL flask?

$$1.110 \text{ M KOH}$$

c. What mass of AgNO_3 is needed to make 500.0 mL of a 1.500 M solution?

$$127.4 \text{ grams AgNO}_3$$

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d. Calculate the molarity of a solution that contains 0.0345 mol NH_4Cl in 400 mL of solution.

$8.63 \times 10^{-2} \text{ M}$

e. How many grams of HNO_2 are present in 35.0 mL of a 2.20 M solution of nitric acid?

3.62 grams HNO_2

f. What is the concentration of 156 mL of solution made from 2.5 grams of KCl ?

0.21 M KCl

g. How many milliliters of 1.50 M KOH solution are needed to give 0.125 mol of KOH ?

83.3 mL KOH solution

h. How many grams of KMnO_4 are needed to make 500 mL of solution whose concentration is 1.75 M?

138 grams KMnO_4

4) Diluting Concentrated Solutions

a. You have a 1.00 L bottle of 12.0 M HCl on your lab bench. How would you make a 250.0 mL solution of 1.00 M HCl ?

Add **20.8 mL** of the 12.0 M HCl to a 250 mL volumetric flask. Add just enough water to mix the solution. Swirl the flask while adding water to the line.

b. What is the concentration of a solution made by adding 15.0 mL of 18.0 M H_2SO_4 to 100.0 mL of water?

2.35 M H_2SO_4

c. A bottle of 15.0 M HCl has 27.5 mL left. What will the concentration of HCl be if water is added to the bottle to fill it to the 500.0 mL mark?

0.825 M HCl

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d. 260.0 mL of water are added to 37.8 mL of 1.66 M HCl. What is the concentration of the diluted solution?

0.211 M HCl

e. How many milliliters of 3.0 M H₂SO₄ are required to make 450 mL of 0.10 M H₂SO₄?

15 mL of 3.0 M H₂SO₄ are needed

f. How would you prepare 1.45 x 10³ mL of a 1.45 M HNO₃ solution using 12.0 M stock solution of HNO₃? (How much water must be added to the stock solution?)

Add 175 mL of stock solution to a beaker and carefully measure 1275 mL of water to add to the solution. Thoroughly mix the solution.

5) Solution Stoichiometry

a. ___ CaCO₃ (s) + 2 HCl (aq) → ___ CaCl₂ (aq) + ___ H₂O (l) + ___ CO₂ (g)

What mass of CaCO₃ is required to react with 25.0 mL of 0.750 M HCl?

0.01875 mol HCl → 0.009375 mol CaCO₃ → 0.938 g CaCO₃

b. ___ HNO₃ (aq) + ___ NaOH (aq) → ___ NaNO₃ (aq) + ___ H₂O (l)

250.0 mL of 0.100 M HNO₃ is combined with an excess of NaOH. How much H₂O (in g) will be produced by this reaction?

0.0250 mol HNO₃ → 0.0250 mol H₂O → 0.450 g H₂O

c. You add 500 mL of 0.100 M AgNO₃ solution to a solution containing an excess of NaCl. How many grams of AgCl precipitate will you form? (Hint: Write a net ionic equation for the precipitation of AgCl.)

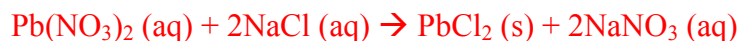
Ag⁺ (aq) + Cl⁻ (aq) → AgCl (s)

0.0500 mol AgNO₃ → 0.0500 mol AgCl → 7.16 g AgCl

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d. If you mix 0.200 L of 0.100 M $\text{Pb}(\text{NO}_3)_2$ and 0.300 L of 0.200 M NaCl , how much PbCl_2 precipitate will you form? (Hint: Limiting reactant problem!)



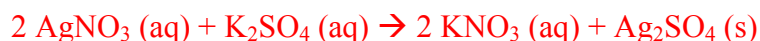
5.56 g PbCl_2 produced

f. A 156.7 mL solution of 1.50 M AgNO_3 is mixed with a 4.22 g of solid K_3PO_4 . When mixed together, a new solid forms. Identify the precipitate. Determine what mass of precipitate will form. Calculate the percent yield if only 6.045 g of precipitate was formed in lab.



$$6.045 \text{ g} / 8.32 \text{ g} * 100 = 72.6\% \text{ yield}$$

g. Calculate the mass of the precipitate formed when 2.27 L of 0.0820 M AgNO_3 are mixed with 3.06 L of 0.0664 M K_2SO_4 .



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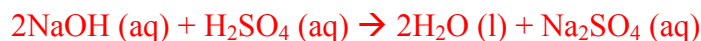
6) **Titration**

a. How many milliliters of 0.155 M HCl are needed to neutralize completely 35.0 mL of 0.101 M Ba(OH)₂ solution? (Hint: Write a balanced equation first.)



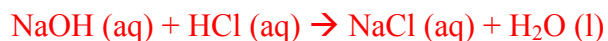
Find moles Ba(OH)₂, convert to moles HCl, divide by concentration to find liters, convert to mL
45.6 mL HCl needed to neutralize

b. How many milliliters of 2.50 M H₂SO₄ are needed to neutralize 75.0 g of NaOH? (Hint: Write a balanced equation first.)



375 mL H₂SO₄

c. What is the molarity of a hydrochloric acid solution if it took 30.0 mL to neutralize 48.0 mL of 0.100 M NaOH? (Hint: Write a balanced equation first.)



0.160 M HCl

d. 25.0 mL of 0.050 M Ba(OH)₂ neutralized 40.0 mL of nitric acid (HNO₃). Determine the concentration of the acid.

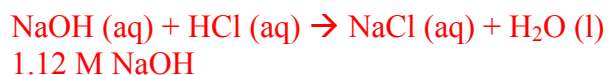


0.063 M HNO₃ (aq)

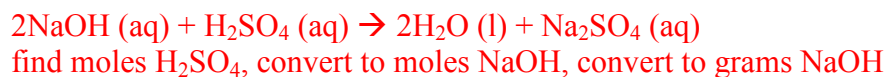
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e. What is the concentration of NaOH if it takes 25 mL of 0.75 M HCl to neutralize 16.7 mL of NaOH? (Write a balanced equation first.)



f. How many grams of solid NaOH are required to neutralize 48.2 mL of 1.25 M H₂SO₄? (Write a balanced equation first.)



4.82 g NaOH

Percent Composition and Empirical Formulas

7) What is the mass percent of each element in the following compounds?

a. CaCl₂ 110.99 g/mol; Ca: 36.1% Cl: 63.9%

b. Fe₂O₃ 159.70 g/mol; Fe: 69.9% O: 30.1%

c. C₆H₁₀S₂O 162.00 g/mol; C: 44.4% H: 6.2% S: 39.5% O: 9.9%

8) Calculate the empirical formulas of compounds containing the following percentages of elements. Use the molar mass to calculate the molecular formula for that compound as well.

a. 44.4% C, 6.21% H, 39.5% S, and 9.86% O; molar mass = 486.39 g/mol



b. 20.2% Al, 79.8% Cl; molar mass = 266.6 g/mol



c. 2.1% H, 65.2% O, 32.6% S; molar mass = 195.95 g/mol



d. 19.8% C, 2.50% H, 11.6% N, 66.1% O; molar mass = 360 g/mol

