Homework – Chapter 06 Chemistry 51
Los Angeles Mission College

6.95 Balance each of the following equations and identify the type of reaction:

- a. \( \text{NH}_3(g) + \text{HCl}(g) \rightarrow \text{NH}_4\text{Cl}(s) \)
- b. \( \text{Fe}_3\text{O}_4(s) + \text{H}_2(g) \rightarrow \text{Fe}(s) + \text{H}_2\text{O}(g) \)
- c. \( \text{Sb}(s) + \text{Cl}_2(g) \rightarrow \text{SbCl}_3(g) \)
- d. \( \text{C}_2\text{H}_2(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) \)
- e. \( \text{KBr}(aq) + \text{Cl}_2(aq) \rightarrow \text{KCl}(aq) + \text{Br}_2(l) \)
- f. \( \text{Al}_2(\text{SO}_4)_3(aq) + \text{NaOH}(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + \text{Al(OH)}_3(s) \)

6.96 Balance each of the following equations and identify the type of reaction:

- a. \( \text{Li}_3\text{N}(s) \rightarrow \text{Li}(s) + \text{N}_2(g) \)
- b. \( \text{Mg}(s) + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(s) \)
- c. \( \text{Mg}(s) + \text{H}_3\text{PO}_4(aq) \rightarrow \text{Mg}_3(\text{PO}_4)_2(s) + \text{H}_2(g) \)
- d. \( \text{C}_4\text{H}_6(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) \)
- e. \( \text{Al}(s) + \text{Cl}_2(g) \rightarrow \text{AlCl}_3(s) \)
- f. \( \text{MgCl}_2(aq) + \text{AgNO}_3(aq) \rightarrow \text{Mg(NO}_3)_2(aq) + \text{AgCl}(s) \)

6.97 Predict the products and write a balanced equation for each of the following:

- a. single replacement: \( \text{Zn}(s) + \text{HCl}(aq) \rightarrow \text{__________} + \text{__________} \)
- b. decomposition: \( \text{BaCO}_3(s) \rightarrow \text{__________} + \text{__________} \)
- c. double replacement: \( \text{NaOH}(aq) + \text{HCl}(aq) \rightarrow \text{__________} + \text{__________} \)
- d. combination: \( \text{Al}(s) + \text{F}_2(g) \rightarrow \text{__________} \)

6.98 Predict the products and write a balanced equation for each of the following:

- a. decomposition: \( \text{NaCl}(s) \xrightarrow{\text{Electricity}} \text{__________} + \text{__________} \)
- b. combination: \( \text{Ca}(s) + \text{Br}_2(g) \rightarrow \text{__________} \)
- c. combustion: \( \text{C}_2\text{H}_4(g) + \text{O}_2(g) \rightarrow \text{__________} + \text{__________} \)
- d. double replacement: \( \text{NiCl}_2(aq) + \text{NaOH}(aq) \rightarrow \text{Ni(OH)}_2(s) + \text{__________} \)

6.99 For each of the following reactions, predict which reactant is oxidized and which reactant is reduced:

- a. \( \text{Cu}(s) + 2\text{H}^+(aq) \rightarrow \text{Cu}^{2+}(aq) + \text{H}_2(g) \)
- b. \( \text{Ni}^{2+}(aq) + \text{Fe}(s) \rightarrow \text{Fe}^{2+}(aq) + \text{Ni}(s) \)
- c. \( 2\text{Ag}(s) + \text{Cu}^{2+}(aq) \rightarrow 2\text{Ag}^{+}(aq) + \text{Cu}(s) \)
- d. \( 3\text{Ni}^{2+}(aq) + 2\text{Cr}(s) \rightarrow 3\text{Ni}(s) + 2\text{Cr}^{3+}(aq) \)
- e. \( \text{Zn}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu}(s) \)
- f. \( \text{Pb}^{2+}(aq) + \text{Zn}(s) \rightarrow \text{Pb}(s) + \text{Zn}^{2+}(aq) \)

6.100 For each of the following reactions, predict which reactant is oxidized and which reactant is reduced:

- a. \( 2\text{Ag}(s) + 2\text{H}^+(aq) \rightarrow 2\text{Ag}^{+}(aq) + \text{H}_2(g) \)
- b. \( \text{Mg}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{Cu}(s) \)
- c. \( 2\text{Al}(s) + 3\text{Cu}^{2+}(aq) \rightarrow 2\text{Al}^{3+}(aq) + 3\text{Cu}(s) \)
- d. \( \text{Mg}^{2+}(aq) + \text{Zn}(s) \rightarrow \text{Mg}(s) + \text{Zn}^{2+}(aq) \)
- e. \( \text{Al}^{3+}(aq) + 3\text{Na}(s) \rightarrow \text{Al}(s) + 3\text{Na}^{+}(aq) \)
- f. \( \text{Ni}^{2+}(aq) + \text{Mg}(s) \rightarrow \text{Mg}^{2+}(aq) + \text{Ni}(s) \)

6.101 During heavy exercise and workouts, lactic acid, \( \text{C}_3\text{H}_6\text{O}_3 \), accumulates in the muscles, where it can cause pain and soreness.

- a. What is the molar mass of lactic acid?
- b. How many molecules are in 0.500 mole of lactic acid?
- c. How many atoms of C are in 1.50 moles of lactic acid?
- d. How many grams of lactic acid contain 4.5 x 10^{24} atoms of O?
6.102 Ibuprofen, the anti-inflammatory ingredient in Advil, has the formula C\textsubscript{13}H\textsubscript{18}O\textsubscript{2}.

a. What is the molar mass of ibuprofen?
b. How many molecules are in 0.200 mole of ibuprofen?
c. How many atoms of H are in 0.100 mole of ibuprofen?
d. How many grams of ibuprofen contain \(7.4 \times 10^{25}\) atoms of C?

6.103 Calculate the molar mass of each of the following:

a. ZnSO\textsubscript{4}, zinc sulfate, zinc supplement
b. Ca(IO\textsubscript{3})\textsubscript{2}, calcium iodate, iodine source in table salt
c. C\textsubscript{5}H\textsubscript{8}NNaO\textsubscript{4}, monosodium glutamate, flavor enhancer

6.104 Calculate the molar mass of each of the following:

a. Mg(HCO\textsubscript{3})\textsubscript{2}, magnesium hydrogen carbonate
b. Au(OH)\textsubscript{3}, gold(III) hydroxide, used in gold plating
c. C\textsubscript{18}H\textsubscript{34}O\textsubscript{2}, oleic acid from olive oil

6.105 How many grams are in 0.150 mole of each of the following?

a. K
b. Cl\textsubscript{2}
c. Na\textsubscript{2}CO\textsubscript{3}

6.106 How many grams are in 2.25 moles of each of the following?

a. N\textsubscript{2}
b. NaBr
c. C\textsubscript{6}H\textsubscript{14}

6.107 How many moles are in 25.0 g of each of the following compounds?

a. CO\textsubscript{2}
b. Al(OH)\textsubscript{3}
c. MgCl\textsubscript{2}

6.108 How many moles are in 4.00 g of each of the following compounds?

a. NH\textsubscript{3}
b. Ca(NO\textsubscript{3})\textsubscript{2}
c. SO\textsubscript{3}

6.109 At a winery, glucose (C\textsubscript{6}H\textsubscript{12}O\textsubscript{6}) in grapes undergoes fermentation to produce ethanol (C\textsubscript{2}H\textsubscript{6}O) and carbon dioxide (CO\textsubscript{2}).

\[\text{C}_6\text{H}_12\text{O}_6(\text{aq}) \rightarrow 2\text{C}_2\text{H}_6\text{O}_6(\ell) + 2\text{CO}_2(\text{g})\]

Glucose Ethanol

a. How many grams of glucose are required to form 124 g of ethanol?
b. How many grams of ethanol would be formed from the reaction of 0.240 kg of glucose?

6.110 Gasohol is a fuel that contains ethanol (C\textsubscript{2}H\textsubscript{6}O) which burns in oxygen (O\textsubscript{2}) to give carbon dioxide and water.

a. Write the balanced equation for the combustion of ethanol.
b. How many moles of O\textsubscript{2} are needed to completely react with 4.0 moles of C\textsubscript{2}H\textsubscript{6}O?
c. If a car produces 88 g of CO\textsubscript{2}, how many grams of O\textsubscript{2} are used up in the reaction?
d. If you add 125 g of C\textsubscript{2}H\textsubscript{6}O to your fuel, how many grams of CO\textsubscript{2} and H\textsubscript{2}O can be produced from the ethanol?

6.111 When ammonia (NH\textsubscript{3}) reacts with fluorine, the products are dinitrogen tetrafluoride (N\textsubscript{2}F\textsubscript{4}) and hydrogen fluoride (HF).

a. Write the balanced equation for the reaction.
b. How many moles of each reactant are needed to produce 4.00 moles of HF?
c. How many grams of F\textsubscript{2} are required to react with 25.5 g of NH\textsubscript{3}?
d. How many grams of N\textsubscript{2}F\textsubscript{4} can be produced when 3.40 g of NH\textsubscript{3} reacts?
6.112 When peroxide (H\textsubscript{2}O\textsubscript{2}) is used in rocket fuels, it produces water and oxygen (O\textsubscript{2}).

a. Write the balanced equation for the reaction.

b. How many moles of peroxide are needed to produce 3.00 moles of water?

c. How many grams of peroxide are required to produce 36.5 g of O\textsubscript{2}?

d. How many grams of water can be produced when 12.2 g of peroxide reacts?

6.113 Ethane gas (C\textsubscript{2}H\textsubscript{6}) reacts with chlorine gas (Cl\textsubscript{2}) to form hexachloroethane gas (C\textsubscript{2}Cl\textsubscript{6}) and hydrogen chloride gas (HCl).

a. Write the balanced equation for the reaction.

b. How many moles of chlorine gas must react to produce 1.60 moles of hexachloroethane?

c. How many grams of hydrogen chloride are produced when 50.0 g of ethane reacts?

d. How many grams of hexachloroethane are produced when 50.0 g of ethane reacts?

6.114 Propane gas (C\textsubscript{3}H\textsubscript{8}) a fuel for many barbecues reacts with oxygen to produce water (H\textsubscript{2}O) and carbon dioxide (CO\textsubscript{2}). Propane has a density of 2.02 g/L at room temperature.

a. Write the balanced equation for the reaction.

b. How many grams of water form when 5.00 L of propane gas completely react?

c. How many grams of CO\textsubscript{2} are produced from 18.5 g of oxygen gas and excess propane?

d. How many grams of H\textsubscript{2}O can be produced from the reaction of 8.50 \times 10^{22} molecules of propane gas?

6.115 Acetylene gas (C\textsubscript{2}H\textsubscript{2}) burns in oxygen (O\textsubscript{2}) to produce carbon dioxide (CO\textsubscript{2}) and water. If 62.0 g of CO\textsubscript{2} is produced when 22.5 g of C\textsubscript{2}H\textsubscript{2} reacts with sufficient oxygen, what is the percent yield of CO\textsubscript{2} for the reaction?

6.116 When 50.0 g of iron(III) oxide reacts with carbon monoxide, 32.8 g of iron is produced. What is the percent yield of Fe for the reaction?

Fe\textsubscript{2}O\textsubscript{3(s)} + 3CO\textsubscript{(g)} \rightarrow 2Fe\textsubscript{(s)} + 3CO\textsubscript{2(g)}
6.95 Balance each of the following equations and identify the type of reaction:

a. \( \text{NH}_3(g) + \text{HCl}(g) \rightarrow \text{NH}_4\text{Cl}(s) \)
   i. \( \text{NH}_3(g) + \text{HCl}(g) \rightarrow \text{NH}_4\text{Cl}(s) \)
   ii. Combination

b. \( \text{Fe}_3\text{O}_4(s) + \text{H}_2(g) \rightarrow \text{Fe}(s) + \text{H}_2\text{O}(g) \)
   i. \( \text{Fe}_3\text{O}_4(s) + 4\text{H}_2(g) \rightarrow 3\text{Fe}(s) + 4\text{H}_2\text{O}(g) \)
   ii. Single Replacement

c. \( \text{Sb}(s) + \text{Cl}_2(g) \rightarrow \text{SbCl}_3(g) \)
   i. \( 2\text{Sb}(s) + 3\text{Cl}_2(g) \rightarrow 2\text{SbCl}_3(g) \)
   ii. Combination

d. \( \text{C}_5\text{H}_12(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) \)
   i. \( 2\text{C}_5\text{H}_12(g) + 8\text{O}_2(g) \rightarrow 5\text{CO}_2(g) + 6\text{H}_2\text{O}(g) \)
   ii. Combustion

e. \( \text{KBr}(aq) + \text{Cl}_2(aq) \rightarrow \text{KCl}(aq) + \text{Br}_2(l) \)
   i. \( 2\text{KBr}(aq) + \text{Cl}_2(aq) \rightarrow 2\text{KCl}(aq) + \text{Br}_2(l) \)
   ii. Single Replacement

f. \( \text{Al}_2(\text{SO}_4)_3(aq) + \text{NaOH}(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + \text{Al(OH)}_3(s) \)
   i. \( 3\text{Al}_2(\text{SO}_4)_3(aq) + 6\text{NaOH}(aq) \rightarrow 3\text{Na}_2\text{SO}_4(aq) + 2\text{Al(OH)}_3(s) \)
   ii. Double Replacement

6.96 Balance each of the following equations and identify the type of reaction:

a. \( \text{Li}_3\text{N}(s) \rightarrow \text{Li}(s) + \text{N}_2(g) \)
   i. \( 2\text{Li}_3\text{N}(s) \rightarrow 6\text{Li}(s) + \text{N}_2(g) \)
   ii. Decomposition

b. \( \text{Mg}(s) + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(s) \)
   i. \( 3\text{Mg}(s) + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(g) \)
   ii. Combination

c. \( \text{Mg}(s) + \text{H}_3\text{PO}_4(aq) \rightarrow \text{Mg}_3(\text{PO}_4)_2(s) + \text{H}_2(g) \)
   i. \( 3\text{Mg}(s) + 2\text{H}_3\text{PO}_4(aq) \rightarrow \text{Mg}_3(\text{PO}_4)_2(s) + 3\text{H}_2(g) \)
   ii. Single Replacement

d. \( \text{C}_4\text{H}_6(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) \)
   i. \( 2\text{C}_4\text{H}_6(g) + 11\text{O}_2(g) \rightarrow 8\text{CO}_2(g) + 6\text{H}_2\text{O}(g) \)
   ii. Combustion

e. \( \text{Al}(s) + \text{Cl}_2(g) \rightarrow \text{AlCl}_3(s) \)
   i. \( 2\text{Al}(s) + 3\text{Cl}_2(g) \rightarrow 2\text{AlCl}_3(s) \)
   ii. Combination

f. \( \text{MgCl}_2(aq) + \text{AgNO}_3(aq) \rightarrow \text{Mg(NO}_3)_2(aq) + \text{AgCl}(s) \)
   i. \( \text{MgCl}_2(aq) + 2\text{AgNO}_3(aq) \rightarrow \text{Mg(NO}_3)_2(aq) + 2\text{AgCl}(s) \)
   ii. Double Replacement
6.97 Predict the products and write a balanced equation for each of the following:

a. single replacement: \( \text{Zn} (s) + 2\text{HCl}_{(aq)} \rightarrow \text{ZnCl}_2_{(aq)} + \text{H}_2(g) \)

b. decomposition: \( \text{BaCO}_3_{(s)} \xrightarrow{\Delta} \text{BaO}_{(s)} + \text{CO}_2(g) \)

c. double replacement: \( \text{NaOH}_{(aq)} + \text{HCl}_{(aq)} \rightarrow \text{H}_2\text{O} (l) + \text{NaCl}_{(aq)} \)

d. combination: \( 2\text{Al}_{(s)} + 3\text{F}_2(g) \rightarrow 2\text{AlF}_3_{(s)} \)

6.98 Predict the products and write a balanced equation for each of the following:

a. decomposition: \( 2\text{NaCl}_{(s)} \xrightarrow{\text{Electricity}} 2\text{Na}_{(s)} + \text{Cl}_2(g) \)

b. combination: \( \text{Ca}_{(s)} + \text{Br}_2(g) \rightarrow \text{CaBr}_2_{(s)} \)

b. combustion: \( \text{Cu}_2\text{H}_4_{(g)} + 3\text{O}_2(g) \xrightarrow{\Delta} 2\text{CO}_2(g) + 2\text{H}_2\text{O}(l) \)

d. double replacement: \( \text{NiCl}_2_{(aq)} + 2\text{NaOH}_{(aq)} \rightarrow \text{Ni(OH)}_2_{(s)} + 2\text{NaCl}_{(aq)} \)

6.99 For each of the following reactions, predict which reactant is oxidized and which reactant is reduced:

a. \( \text{Cu}_{(s)} + 2\text{H}^+_{(aq)} \rightarrow \text{Cu}^{2+}_{(aq)} + \text{H}_2(g) \)

   i. Oxidized...... \text{Cu to Cu}^{2+} (oxidation is loss of electrons)

   ii. Reduced ...... \text{H}^+ to \text{H}_2 (reduction is gain of electrons)

b. \( \text{Ni}^{2+}_{(aq)} + \text{Fe}_{(s)} \rightarrow \text{Fe}^{2+}_{(aq)} + \text{Ni}_{(s)} \)

   i. Oxidized...... \text{Fe}

   ii. Reduced ...... \text{Ni}^{2+}

c. \( 2\text{Ag}_{(s)} + \text{Cu}^{2+}_{(aq)} \rightarrow 2\text{Ag}^{+}_{(aq)} + \text{Cu}_{(s)} \)

   i. Oxidized...... Ag

   ii. Reduced ...... \text{Cu}^{2+}

d. \( 3\text{Ni}^{2+}_{(aq)} + 2\text{Cr}_{(s)} \rightarrow 3\text{Ni}_{(s)} + 2\text{Cr}^{3+}_{(aq)} \)

   i. Oxidized...... \text{Cr}

   ii. Reduced ...... \text{Ni}^{2+}

e. \( \text{Zn}_{(s)} + \text{Cu}^{2+}_{(aq)} \rightarrow \text{Zn}^{2+}_{(aq)} + \text{Cu}_{(s)} \)

   i. Oxidized...... \text{Zn}

   ii. Reduced ...... \text{Cu}^{2+}

f. \( \text{Pb}^{2+}_{(aq)} + \text{Zn}_{(s)} \rightarrow \text{Pb}_{(s)} + \text{Zn}^{2+}_{(aq)} \)

   i. Oxidized...... \text{Zn}

   ii. Reduced ...... \text{Pb}^{2+}

6.100 For each of the following reactions, predict which reactant is oxidized and which reactant is reduced:

a. \( 2\text{Ag}_{(s)} + 2\text{H}^+_{(aq)} \rightarrow 2\text{Ag}^{+}_{(aq)} + \text{H}_2(g) \)

   i. Oxidized...... \text{Ag to Ag}^+ (oxidation is loss of electrons)

   ii. Reduced ...... \text{H}^+ to \text{H}_2 (reduction is gain of electrons)

b. \( \text{Mg}_{(s)} + \text{Cu}^{2+}_{(aq)} \rightarrow \text{Mg}^{2+}_{(aq)} + \text{Cu}_{(s)} \)

   i. Oxidized...... \text{Mg}

   ii. Reduced ...... \text{Cu}^{2+}

c. \( 2\text{Al}_{(s)} + 3\text{Cu}^{2+}_{(aq)} \rightarrow 2\text{Al}^{3+}_{(aq)} + 3\text{Cu}_{(s)} \)

   i. Oxidized...... \text{Al}

   ii. Reduced ...... \text{Cu}^{2+}

d. \( \text{Mg}^{2+}_{(aq)} + \text{Zn}_{(s)} \rightarrow \text{Mg}_{(s)} + \text{Zn}^{2+}_{(aq)} \)

   i. Oxidized...... \text{Zn}

   ii. Reduced ...... \text{Mg}^{2+}
e. \( \text{Al}^{3+} (aq) + 3\text{Na}(s) \rightarrow \text{Al}(s) + 3\text{Na}^+(aq) \)
   i. Oxidized......Na
   ii. Reduced ......\( \text{Al}^{3+} \)

f. \( \text{Ni}^{2+} (aq) + \text{Mg}(s) \rightarrow \text{Mg}^{2+} (aq) + \text{Ni}(s) \)
   i. Oxidized ......\( \text{Mg} \)
   ii. Reduced ......\( \text{Ni}^{2+} \)

6.101 During heavy exercise and workouts, lactic acid, \( \text{C}_3\text{H}_6\text{O}_3 \), accumulates in the muscles, where it can cause pain and soreness.

a. What is the molar mass of lactic acid?

\[
\begin{align*}
3\text{C} &= 3 \times 12.0 \text{ g/mole} = 36.0 \text{ g/mole} \\
6\text{H} &= 6 \times 1.01 \text{ g/mole} = 6.06 \text{ g/mole} \\
3\text{O} &= 3 \times 16.0 \text{ g/mole} = 48.0 \text{ g/mole} \\
90.1 \text{ g/mole}
\end{align*}
\]

b. How many molecules are in 0.500 mole of lactic acid?

\[
0.500 \text{ moles lactic acid} \times \frac{6.022 \times 10^{23} \text{ molecules lactic acid}}{1 \text{ mole lactic acid}} = 3.01 \times 10^{23} \text{ molecules lactic acid}
\]

c. How many atoms of C are in 1.50 moles of lactic acid?

\[
1.50 \text{ moles lactic acid} \times \frac{3 \text{ molecules carbon}}{1 \text{ molecule lactic acid}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole}} \times \frac{12.0 \text{ g/mole}}{1 \text{ mole}} = 2.71 \times 10^{24} \text{ atoms of C}
\]

d. How many grams of lactic acid contain \( 4.5 \times 10^{24} \) atoms of O?

\[
4.5 \times 10^{24} \text{ atoms oxygen} \times \frac{1 \text{ molecule lactic acid}}{3 \text{ atoms oxygen}} \times \frac{1 \text{ mole lactic acid}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{90.1 \text{ grams lactic acid}}{1 \text{ mole}} = 220 \text{ grams lactic acid}
\]

6.102 Ibuprofen, the anti-inflammatory ingredient in Advil, has the formula \( \text{C}_{13}\text{H}_{18}\text{O}_2 \).

a. What is the molar mass of ibuprofen?

\[
\begin{align*}
13\text{C} &= 13 \times 12.0 \text{ g/mole} = 156 \text{ g/mole} \\
18\text{H} &= 18 \times 1.01 \text{ g/mole} = 18.2 \text{ g/mole} \\
2\text{O} &= 2 \times 16.0 \text{ g/mole} = 32.0 \text{ g/mole} \\
206 \text{ g/mole}
\end{align*}
\]

b. How many molecules are in 0.200 mole of ibuprofen?

\[
0.200 \text{ moles ibuprofen} \times \frac{6.022 \times 10^{23} \text{ molecules ibuprofen}}{1 \text{ mole ibuprofen}} = 1.20 \times 10^{23} \text{ Molecules ibuprofen}
\]

c. How many atoms of H are in 0.100 mole of ibuprofen?

\[
0.100 \text{ moles ibuprofen} \times \frac{18 \text{ molecules hydrogen}}{1 \text{ molecule ibuprofen}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole}} = 1.08 \times 10^{24} \text{ molecules hydrogen}
\]

d. How many grams of ibuprofen contain \( 7.4 \times 10^{25} \) atoms of C?

\[
7.4 \times 10^{25} \text{ atoms carbon} \times \frac{1 \text{ molecule ibuprofen}}{13 \text{ atoms carbon}} \times \frac{1 \text{ mole}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{206 \text{ grams ibuprofen}}{1 \text{ mole}} = 1,900 \text{ grams lactic acid}
\]

6.103 Calculate the molar mass of each of the following:

a. \( \text{ZnSO}_4 \), zinc sulfate, zinc supplement

\[
\begin{align*}
\text{Zn} &= 1 \times 65.4 \text{ g/mole} = 65.4 \text{ g/mole} \\
\text{S} &= 1 \times 32.1 \text{ g/mole} = 32.1 \text{ g/mole} \\
4\text{O} &= 4 \times 16.0 \text{ g/mole} = 64.0 \text{ g/mole} \\
162.5 \text{ g/mole}
\end{align*}
\]
b. Ca(IO₃)₂, calcium iodate, iodine source in table salt
   Ca = 1 * 40.1 g/mole = 40.1 g/mole
   2I = 2 * 126.9 g/mole = 253.8 g/mole
   6O = 6 * 16.0 g/mole = 96.0 g/mole
   389.9 g/mole

c. C₅H₈NNaO₄, monosodium glutamate, flavor enhancer
   5C = 5 * 12.0 g/mole = 60.0 g/mole
   8H = 8 * 1.0 g/mole = 8.0 g/mole
   1N = 1 * 14.0 g/mole = 14.0 g/mole
   1Na = 1 * 23.0 g/mole = 23.0 g/mole
   4O = 4 * 16.0 g/mole = 64.0 g/mole
   169.0 g/mole

6.104 Calculate the molar mass of each of the following:
   a. Mg(HCO₃)₂, magnesium hydrogen carbonate
      1Mg = 1 * 24.3 g/mole = 24.3 g/mole
      2H = 2 * 1.0 g/mole = 2.0 g/mole
      2C = 2 * 12.0 g/mole = 24.0 g/mole
      6O = 6 * 16.0 g/mole = 96.0 g/mole
      146.3 g/mole

b. Au(OH)₃, gold(III) hydroxide, used in gold plating
   1Au = 1 * 197.0 g/mole = 197.0 g/mole
   3O = 3 * 16.0 g/mole = 48.0 g/mole
   3H = 3 * 1.0 g/mole = 3.0 g/mole
   248.0 g/mole

c. C₁₈H₃₄O₂, oleic acid from olive oil
   18C = 18 * 12.0 g/mole = 216.0 g/mole
   34H = 34 * 1.0 g/mole = 34.0 g/mole
   2O = 2 * 16.0 g/mole = 32.0 g/mole
   282.0 g/mole

6.105 How many grams are in 0.150 mole of each of the following?
   a. K
      39.1 grams/mole
      0.150 moles K * \( \frac{39.1 \text{ grams}}{\text{mole}} \) = 5.87 grams

   b. Cl₂
      70.9 grams/mole
      0.150 moles Cl₂ * \( \frac{70.9 \text{ grams}}{\text{mole}} \) = 142 grams

   c. Na₂CO₃
      106 grams/mole
      0.150 moles Na₂CO₃ * \( \frac{106 \text{ grams}}{\text{mole}} \) = 15.9 grams
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6.106  How many grams are in 2.25 moles of each of the following?

   a. N\textsubscript{2}  
      28.0 grams/mole  
      \[ 2.25 \text{ moles N}_2 \times \frac{28.0 \text{ grams}}{\text{mole}} = 63.0 \text{ grams} \]

   b. NaBr  
      103 grams/mole  
      \[ 2.25 \text{ moles NaBr} \times \frac{103 \text{ grams}}{\text{mole}} = 232 \text{ grams} \]

   c. C\textsubscript{6}H\textsubscript{14}  
      86.2 grams/mole  
      \[ 2.25 \text{ moles C}_6\text{H}_{14} \times \frac{86.2 \text{ grams}}{\text{mole}} = 194 \text{ grams} \]

6.107  How many moles are in 25.0 g of each of the following compounds?

   a. CO\textsubscript{2}  
      44.0 grams/mole  
      \[ 25.0 \text{ grams} \text{ CO}_2 \times \frac{1 \text{ mole}}{44.0 \text{ grams}} = 0.568 \text{ moles} \]

   b. Al(OH)\textsubscript{3}  
      78.0 grams/mole  
      \[ 25.0 \text{ grams Al(OH)}_3 \times \frac{1 \text{ mole}}{78.0 \text{ grams}} = 0.321 \text{ moles} \]

   c. MgCl\textsubscript{2}  
      95.2 grams/mole  
      \[ 25.0 \text{ grams MgCl}_2 \times \frac{1 \text{ mole}}{95.2 \text{ grams}} = 0.263 \text{ moles} \]

6.108  How many moles are in 4.00 g of each of the following compounds?

   a. NH\textsubscript{3}  
      17.0 grams/mole  
      \[ 4.00 \text{ grams} \text{ CO}_2 \times \frac{1 \text{ mole}}{17.0 \text{ grams}} = 0.235 \text{ moles} \]

   b. Ca(NO\textsubscript{3})\textsubscript{2}  
      164 grams/mole  
      \[ 4.00 \text{ grams CO}_2 \times \frac{1 \text{ mole}}{164 \text{ grams}} = 0.0244 \text{ moles} \]

   c. SO\textsubscript{3}  
      80.1 grams/mole  
      \[ 4.00 \text{ grams CO}_2 \times \frac{1 \text{ mole}}{80.1 \text{ grams}} = 0.0499 \text{ moles} \]

6.109  At a winery, glucose (C\textsubscript{6}H\textsubscript{12}O\textsubscript{6}) in grapes undergoes fermentation to produce ethanol (C\textsubscript{2}H\textsubscript{6}O) and carbon dioxide (CO\textsubscript{2}).

   \[ \text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) \rightarrow 2\text{C}_2\text{H}_6\text{O}(\text{l}) + 2\text{CO}_2(\text{g}) \]

   a. How many grams of glucose are required to form 124 g of ethanol?

      \[ \text{C}_6\text{H}_{12}\text{O}_6 - 180.2 \text{ grams/mole} \]
      \[ \text{C}_2\text{H}_6\text{O} - 46.07 \text{ grams/mole} \]
      \[ 124 \text{ g ethanol} \times \frac{1 \text{ mole ethanol}}{46.07 \text{ g ethanol}} \times \frac{1 \text{ mole glucose}}{2 \text{ moles ethanol}} \times \frac{180.2 \text{ grams glucose}}{1 \text{ mole glucose}} = 243 \text{ grams glucose} \]
b. How many grams of ethanol would be formed from the reaction of 0.240 kg of glucose?

\[ \text{C}_6\text{H}_12\text{O}_6 - 180.2 \text{ grams/mole} \]
\[ \text{C}_2\text{H}_5\text{O} = 46.07 \text{ grams/mole} \]
\[ 240 \text{ g glucose} \times \frac{1 \text{ mole glucose}}{180 \text{ grams glucose}} \times 2 \text{ moles ethanol} \times \frac{46.07 \text{ g ethanol}}{1 \text{ mole ethanol}} = 123 \text{ grams ethanol} \]

6.110 Gasohol is a fuel that contains ethanol (C\textsubscript{2}H\textsubscript{6}O) which burns in oxygen (O\textsubscript{2}) to give carbon dioxide and water.

a. Write the balanced equation for the combustion of ethanol.

\[ \text{C}_2\text{H}_6\text{O}(g) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 3\text{H}_2\text{O}(g) \]

b. How many moles of O\textsubscript{2} are needed to completely react with 4.0 moles of C\textsubscript{2}H\textsubscript{6}O?

\[ 4.0 \text{ moles C}_2\text{H}_6\text{O} \times \frac{3 \text{ moles O}_2}{1 \text{ mole C}_2\text{H}_6\text{O}} = 12 \text{ moles O}_2 \]

c. If a car produces 88 g of CO\textsubscript{2}, how many grams of O\textsubscript{2} are used up in the reaction?

\[ \text{CO}_2 = 44.0 \text{ grams/mole} \]
\[ \text{O}_2 = 32.0 \text{ grams/mole} \]
\[ 88 \text{ grams CO}_2 \times \frac{1 \text{ mole CO}_2}{44.0 \text{ grams CO}_2} \times \frac{3 \text{ moles O}_2}{2 \text{ mole CO}_2} \times \frac{32.0 \text{ grams O}_2}{1 \text{ mole O}_2} = 96 \text{ grams O}_2 \]

d. If you add 125 g of C\textsubscript{2}H\textsubscript{6}O to your fuel, how many grams of CO\textsubscript{2} and H\textsubscript{2}O can be produced from the ethanol?

\[ \text{C}_2\text{H}_6\text{O} = 46.1 \text{ grams/mole} \]
\[ \text{CO}_2 = 44.0 \text{ grams/mole} \]
\[ \text{H}_2\text{O} = 18.0 \text{ grams/mole} \]
\[ 125 \text{ grams C}_2\text{H}_6\text{O} \times \frac{1 \text{ mole C}_2\text{H}_6\text{O}}{46.1 \text{ grams C}_2\text{H}_6\text{O}} = 2.71 \text{ moles C}_2\text{H}_6\text{O} \]
\[ 2.71 \text{ moles C}_2\text{H}_6\text{O} \times \frac{2 \text{ moles CO}_2}{1 \text{ mole C}_2\text{H}_6\text{O}} \times \frac{44.0 \text{ grams CO}_2}{1 \text{ mole CO}_2} = 238 \text{ grams CO}_2 \]
\[ 2.71 \text{ moles C}_2\text{H}_6\text{O} \times \frac{3 \text{ moles H}_2\text{O}}{1 \text{ mole C}_2\text{H}_6\text{O}} \times \frac{18.0 \text{ grams H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = 146 \text{ grams H}_2\text{O} \]

6.111 When ammonia (NH\textsubscript{3}) reacts with fluorine, the products are dinitrogen tetrafluoride (N\textsubscript{2}F\textsubscript{4}) and hydrogen fluoride (HF).

a. Write the balanced equation for the reaction.

\[ 2\text{NH}_3(g) + 5\text{F}_2(g) \rightarrow \text{N}_2\text{F}_4(g) + 6\text{HF}(g) \]

b. How many moles of each reactant are needed to produce 4.00 moles of HF?

\[ 4.0 \text{ moles HF} \times \frac{5 \text{ moles F}_2}{6 \text{ moles HF}} = 3.3 \text{ moles F}_2 \]
\[ 4.0 \text{ moles HF} = \frac{2 \text{ moles NH}_3}{6 \text{ moles HF}} = 1.3 \text{ moles NH}_3 \]

c. How many grams of F\textsubscript{2} are required to react with 25.5 g of NH\textsubscript{3}?

\[ \text{F}_2 = 38.0 \text{ grams/mole} \]
\[ \text{NH}_3 = 17.0 \text{ grams/mole} \]
\[ 25.5 \text{ grams NH}_3 \times \frac{1 \text{ mole NH}_3}{17.0 \text{ grams NH}_3} \times \frac{5 \text{ moles F}_2}{2 \text{ mole NH}_3} \times \frac{38.0 \text{ grams F}_2}{1 \text{ mole F}_2} = 142 \text{ grams F}_2 \]

d. How many grams of N\textsubscript{2}F\textsubscript{4} can be produced when 3.40 g of NH\textsubscript{3} reacts?

\[ \text{N}_2\text{F}_4 = 104 \text{ grams/mole} \]
\[ 3.40 \text{ grams NH}_3 \times \frac{1 \text{ mole NH}_3}{17.0 \text{ grams NH}_3} \times \frac{1 \text{ mole N}_2\text{F}_4}{2 \text{ mole NH}_3} \times \frac{104 \text{ grams N}_2\text{F}_4}{1 \text{ mole N}_2\text{F}_4} = 10.4 \text{ grams N}_2\text{F}_4 \]
6.112 When peroxide (H₂O₂) is used in rocket fuels, it produces water and oxygen (O₂).

a. Write the balanced equation for the reaction.
   \[2\text{H}_2\text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g) + \text{O}_2(g)\]

b. How many moles of peroxide are needed to produce 3.00 moles of water?
   \[3.00 \text{ moles water} \times \frac{2 \text{ moles peroxide}}{2 \text{ moles water}} = 3.00 \text{ moles peroxide}\]

c. How many grams of peroxide are required to produce 36.5 g of O₂?
   \[\text{H}_2\text{O}_2....\text{34.0 grams/mole}\]
   \[\text{H}_2\text{O}....\text{18.0 grams/mole}\]
   \[\text{O}_2....\text{32.0 grams/mole}\]
   \[\frac{36.5 \text{ grams O}_2}{32.0 \text{ grams O}_2} \times \frac{1 \text{ mole O}_2}{2 \text{ mole H}_2\text{O}_2} \times \frac{34.0 \text{ grams H}_2\text{O}_2}{1 \text{ mole H}_2\text{O}_2} = 77.5 \text{ grams H}_2\text{O}_2\]

d. How many grams of water can be produced when 12.2 g of peroxide reacts?
   \[\frac{12.2 \text{ grams H}_2\text{O}_2}{34.0 \text{ grams H}_2\text{O}_2} \times \frac{2 \text{ moles H}_2\text{O}_2}{2 \text{ mole H}_2\text{O}_2} \times \frac{18.0 \text{ grams H}_2\text{O}_2}{1 \text{ mole H}_2\text{O}_2} = 6.46 \text{ grams H}_2\text{O}_2\]

6.113 Ethane gas (C₂H₆) reacts with chlorine gas (Cl₂) to form hexachloroethane gas (C₂Cl₆) and hydrogen chloride gas (HCl).

a. Write the balanced equation for the reaction.
   \[\text{C}_2\text{H}_6(g) + 6\text{Cl}_2(g) \rightarrow \text{C}_2\text{Cl}_6(g) + 6\text{HCl}(g)\]

b. How many moles of chlorine gas must react to produce 1.60 moles of hexachloroethane?
   \[1.60 \text{ moles C}_2\text{Cl}_6 \times \frac{6 \text{ moles Cl}_2}{1 \text{ mole C}_2\text{Cl}_6} = 9.60 \text{ moles Cl}_2\]

c. How many grams of hydrogen chloride are produced when 50.0 g of ethane reacts?
   \[\text{C}_2\text{H}_6....\text{30.1 grams/mole}\]
   \[\text{Cl}_2....\text{70.9 grams/mole}\]
   \[\text{C}_2\text{Cl}_6....\text{237 grams/mole}\]
   \[\text{HCl}....\text{36.5 grams/mole}\]
   \[\frac{50.0 \text{ g C}_2\text{H}_6}{30.1 \text{ grams C}_2\text{H}_6} \times \frac{6 \text{ moles HCl}}{1 \text{ mole C}_2\text{H}_6} \times \frac{36.5 \text{ g HCl}}{1 \text{ mole HCl}} = 364 \text{ grams HCl}\]

d. How many grams of hexachloroethane are produced when 50.0 g of ethane reacts?
   \[\frac{50.0 \text{ g C}_2\text{H}_6}{30.1 \text{ grams C}_2\text{H}_6} \times \frac{1 \text{ mole C}_2\text{H}_6}{1 \text{ mole C}_2\text{H}_6} \times \frac{237 \text{ g C}_2\text{H}_6}{1 \text{ mole C}_2\text{H}_6} = 394 \text{ grams C}_2\text{H}_6\]

6.114 Propane gas (C₃H₈) a fuel for many barbecues reacts with oxygen to produce water (H₂O) and carbon dioxide (CO₂). Propane has a density of 2.02 g/L at room temperature.

a. Write the balanced equation for the reaction.
   \[\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 4\text{H}_2\text{O} + 3\text{CO}_2\]

b. How many grams of water form when 5.00 L of propane gas completely react?
   \[\text{C}_3\text{H}_8....\text{44.1 grams/mole}\]
   \[\text{O}_2....\text{32.0 grams/mole}\]
   \[\text{H}_2\text{O}....\text{18.0 grams/moles}\]
   \[\text{CO}_2....\text{44.0 grams/mole}\]
   \[\frac{5.00 \text{ L C}_3\text{H}_8}{1 \text{ Liter C}_3\text{H}_8} \times \frac{2.02 g \text{ C}_3\text{H}_8}{44.1 \text{ grams C}_3\text{H}_8} \times \frac{1 \text{ mole C}_3\text{H}_8}{1 \text{ moles C}_3\text{H}_8} \times \frac{4 \text{ moles H}_2\text{O}}{1 \text{ mole C}_3\text{H}_8} \times \frac{18.0 g \text{ H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = 16.5 \text{ grams H}_2\text{O}\]
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Los Angeles Mission College

Mallory

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6.115 Acetylene gas (C₂H₂) burns in oxygen (O₂) to produce carbon dioxide (CO₂) and water. If 62.0 g of CO₂ is produced when 22.5 g of C₂H₂ reacts with sufficient oxygen, what is the percent yield of CO₂ for the reaction?

\[
\text{C}_2\text{H}_2(g) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + \text{H}_2\text{O}(g)
\]

\[
\begin{align*}
\text{C}_2\text{H}_2 & \quad \text{26.0 grams/mole} \\
\text{O}_2 & \quad \text{32.0 grams/mole} \\
\text{H}_2\text{O} & \quad \text{18.0 grams/moles} \\
\text{CO}_2 & \quad \text{44.0 grams/mole}
\end{align*}
\]

\[
\frac{22.5 \text{ g C}_2\text{H}_2 \times 1 \text{ mole C}_2\text{H}_2}{26.0 \text{ g C}_2\text{H}_2 \times 1 \text{ mole C}_2\text{H}_2} \times \frac{2 \text{ mole CO}_2}{1 \text{ mole C}_2\text{H}_2} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mole CO}_2} = 76.2 \text{ g CO}_2
\]

\[
\% \text{ Yield CO}_2 = \frac{\text{experimental mass CO}_2}{\text{theoretical CO}_2} \times 100\%
\]

\[
\% \text{ Yield CO}_2 = \frac{22.5 \text{ g CO}_2}{76.2 \text{ g CO}_2} \times 100\% = \text{The yield of CO}_2 = 29.5\%
\]

6.116 When 50.0 g of iron(III) oxide reacts with carbon monoxide, 32.8 g of iron is produced. What is the percent yield of Fe for the reaction?

\[
\text{Fe}_2\text{O}_3(s) + 3\text{CO}(g) \rightarrow 2\text{Fe}(s) + 3\text{CO}_2(g)
\]

\[
\begin{align*}
\text{Fe}_2\text{O}_3 & \quad \text{159.7 grams/mole} \\
\text{CO} & \quad \text{28.1 grams/mole} \\
\text{Fe} & \quad \text{55.9 grams/moles} \\
\text{CO}_2 & \quad \text{44.0 grams/mole}
\end{align*}
\]

\[
\frac{50.0 \text{ g Fe}_2\text{O}_3 \times 1 \text{ mole Fe}_2\text{O}_3}{159.7 \text{ g Fe}_2\text{O}_3 \times 1 \text{ mole Fe}_2\text{O}_3} \times \frac{2 \text{ mole Fe}}{1 \text{ mole Fe}_2\text{O}_3} \times \frac{55.9 \text{ g Fe}}{1 \text{ mole Fe}} = 35.0 \text{ g Fe}
\]

\[
\% \text{ Yield Fe} = \frac{\text{experimental mass Fe}}{\text{theoretical Fe}} \times 100\%
\]

\[
\% \text{ Yield Fe} = \frac{32.8 \text{ g Fe}}{35.0 \text{ g Fe}} \times 100\% = \text{The yield of Fe is 93.7%}
\]