

Review and Reinforcement

Stoichiometry

Complete the following sentences by filling in the appropriate word or phrase from the list below. Each word or phrase may be used once, more than once, or not at all.

reactants	actual	coefficients
molar ratio	particles	subscripts
quantitative	conservation of matter	mass

1. Stoichiometry is the study of the _____ relationships that exist in chemical reactions.
2. Stoichiometry can be used to determine how much product will form from a given amount of _____.
3. The _____ in a balanced equation indicate(s) the number of particles of each substance taking place in the reaction.
4. It is possible to interpret the coefficients in a balanced chemical equation as either the number of moles or the number of _____ involved in the reaction.
5. The coefficients in an equation do not show the _____ number of moles, only the relative number involved.
6. You must determine the _____ in a balanced equation before solving any stoichiometry problem.
7. A balanced equation verifies the law of _____.

If the statement is true, write "true." If it is false, change the underlined word or words to make the statement true. Write your answer on the line provided.

- | | |
|-------|---|
| _____ | 8. The term stoichiometry is derived from the <u>Greek</u> words <i>stoicheion</i> , meaning element, and <i>metron</i> , meaning measure. |
| _____ | 9. You can determine the number of moles of any substance produced in a reaction if you know the number of moles of at least <u>two</u> of the reactants. |
| _____ | 10. The molar ratio of hydrogen to oxygen in the equation $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ is <u>1:2</u> . |
| _____ | 11. The total mass of the reactants is <u>equal</u> to the total mass of the products in a chemical reaction. |
| _____ | 12. Mole-mole problems involve conversions from moles of one substance to <u>mass</u> of another. |

11-1 Review and Reinforcement (continued)

Solve each of the following problems as directed. Show all your work.

13. How many moles of magnesium are required to react with 2.0 mol of hydrochloric acid? The equation for this reaction is $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$.
14. Aluminum reacts with HCl to produce aluminum chloride (AlCl_3) and hydrogen gas. Write a balanced equation for the reaction and calculate the number of moles of HCl required to react with 0.87 mol of Al.
15. Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) combines with O_2 in the body to produce carbon dioxide and water. Write a balanced equation for this reaction. How many moles of O_2 are required to combine with 0.25 mol of glucose? How many moles of CO_2 and H_2O would be produced in this reaction?
16. Calcium carbonate (CaCO_3) combines with HCl to produce calcium chloride (CaCl_2), water, and carbon dioxide gas. Write the balanced equation for this reaction. How many moles of HCl are required to react with 2.5 mol of CaCO_3 ? How many moles of CO_2 would be produced?
17. Zinc reacts with H_2SO_4 to yield ZnSO_4 and hydrogen gas. How many moles of hydrogen will be produced if 0.36 mol of zinc react with an equal amount of H_2SO_4 ? Demonstrate that the law of conservation of matter is obeyed in this reaction.

11-2 Practice Problems

- Determine the mass of lithium hydroxide produced when 0.38 g of lithium nitride reacts with water according to the following equation:

$$\text{Li}_3\text{N} + 3\text{H}_2\text{O} \rightarrow \text{NH}_3 + 3\text{LiOH}$$
- What mass of sodium chloride is produced when chlorine reacts with 0.29 g of sodium iodide?
- Determine the mass of carbon dioxide produced when 0.85 g of butane reacts with oxygen according to the following equation:

$$2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$$
- Determine the mass of antimony produced when 0.46 g of antimony(III) oxide reacts with carbon according to the following equation:

$$\text{Sb}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Sb} + 3\text{CO}$$
- What mass of hydrogen peroxide (H_2O_2) must decompose to produce 0.77 g of water?
- What mass of carbon monoxide must react with oxygen to produce 0.69 g of carbon dioxide?
- Determine the mass of sodium nitrate produced when 0.73 g of nickel(II) nitrate reacts with sodium hydroxide according to the following equation:

$$\text{Ni}(\text{NO}_3)_2 + 2\text{NaOH} \rightarrow \text{Ni}(\text{OH})_2 + 2\text{NaNO}_3$$
- Determine the mass of calcium hydroxide produced when calcium carbide reacts with 0.64 g of water according to the following equation:

$$\text{CaC}_2 + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{C}_2\text{H}_2$$
- How many grams of ozone (O_3) must decompose to produce 0.87 g of oxygen?
- Find the mass of sugar ($\text{C}_6\text{H}_{12}\text{O}_6$) required to produce 1.82 L of carbon dioxide gas at STP from the reaction described by the following equation:

$$\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_6\text{O} + 2\text{CO}_2$$
- How many liters of oxygen are necessary for the combustion of 425 g of sulfur, assuming that the reaction occurs at STP? The balanced equation is $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$.
- Find the mass of benzene (C_6H_6) required to produce 2.66 L of carbon dioxide gas at STP from the reaction described by the following equation:

$$2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 12\text{CO}_2$$

11-2 Practice Problems (continued)

13. Find the mass of sodium required to produce 5.68 L of hydrogen gas at STP from the reaction described by the following equation:
$$2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$$
14. How many liters of oxygen are necessary for the combustion of 277 g of carbon monoxide, assuming that the reaction occurs at STP? The balanced equation is
$$2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$$
15. How many liters of oxygen are necessary for the combustion of 134 g of magnesium, assuming that the reaction occurs at STP? The balanced equation is
$$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$$
16. Find the mass of aluminum required to produce 4.72 L of hydrogen gas at STP from the reaction described by the following equation:
$$2\text{Al} + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2$$
17. How many liters of hydrogen are produced if 225 g of iron reacts with hydrochloric acid, assuming that the reaction occurs at STP? The balanced equation is
$$\text{Fe} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$$
18. Find the mass of S_8 required to produce 2.47 L of sulfur dioxide gas at STP from the reaction described by the following equation:
$$\text{S}_8 + 8\text{O}_2 \rightarrow 8\text{SO}_2$$
19. Propane (C_3H_8) burns in oxygen to produce carbon dioxide and water vapor. The balanced equation for this reaction is $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 4\text{H}_2\text{O} + 3\text{CO}_2$. What volume of carbon dioxide is produced when 2.8 L of oxygen are consumed?
20. What volumes of H_2S gas and oxygen are necessary to produce 14.2 L of sulfur dioxide gas? The balanced equation is
$$2\text{H}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{SO}_2 + 2\text{H}_2\text{O}$$
21. What volumes of sulfur dioxide and dihydrogen sulfide gases are necessary to produce 11.4 L of water vapor? The balanced equation is
$$\text{SO}_2 + 2\text{H}_2\text{S} \rightarrow 3\text{S} + 2\text{H}_2\text{O}$$
22. Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) burns in oxygen to produce carbon dioxide and water vapor as described in the following equation: $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 6\text{CO}_2$. What volume of carbon dioxide is produced when 3.7 L of oxygen are consumed?
23. The compound TNT (trinitrotoluene) decomposes explosively into carbon, carbon monoxide, hydrogen, and nitrogen. What volumes of hydrogen and nitrogen are produced if 5.8 L of CO is produced? The balanced equation is
$$2\text{C}_7\text{H}_5(\text{NO}_2)_3 \rightarrow 2\text{C} + 12\text{CO} + 5\text{H}_2 + 3\text{N}_2$$
24. Nitroglycerin decomposes explosively to produce carbon dioxide, water, nitrogen, and oxygen. What volumes of nitrogen and oxygen are produced if 4.3 L of carbon dioxide is produced? The balanced equation is
$$4\text{C}_3\text{H}_5(\text{NO}_3)_3 \rightarrow 12\text{CO}_2 + 10\text{H}_2\text{O} + \text{O}_2 + 6\text{N}_2$$
25. Acetylene (C_2H_2) burns in oxygen to produce carbon dioxide and water. The balanced equation for this reaction is $2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow 2\text{H}_2\text{O} + 4\text{CO}_2$. What volume of carbon dioxide is produced when 1.6 L of oxygen are consumed?

11-3 Practice Problems

1. Identify the limiting reactant when 1.22 g of O_2 reacts with 1.05 g of H_2 to produce water.
2. Identify the limiting reactant when 4.68 g of Fe reacts with 2.88 g of S to produce FeS.
3. Identify the limiting reactant when 5.87 g of $Mg(OH)_2$ reacts with 12.84 g of HCl to form $MgCl_2$ and water.
4. Identify the limiting reactant when 6.25 g of $AgNO_3$ reacts with 4.12 g of NaCl to form $NaNO_3$ and AgCl.
5. Identify the limiting reactant when 7.81 g of HCl reacts with 5.24 g of NaOH to produce NaCl and H_2O .
6. Identify the limiting reactant when 6.33 g of H_2SO_4 reacts with 5.92 g of NaOH to produce Na_2SO_4 and water.
7. Identify the limiting reactant when 43.25 g of CaC_2 reacts with 33.71 g of water to produce $Ca(OH)_2$ and C_2H_2 .
8. Identify the limiting reactant when 65.14 g of $CaCl_2$ reacts with 74.68 g of Na_2CO_3 to produce $CaCO_3$ and NaCl.
9. Identify the limiting reactant when 4.687g of SF_4 reacts with 6.281 g of I_2O_5 to produce IF_5 and SO_2 .
10. If 4.1 g of Cr is heated with 9.3 g of Cl_2 , what mass $CrCl_3$ will be produced?
11. What mass of SO_2 is produced from the reaction between 31.5 g of S_8 and 8.65 g of O_2 ?
12. What mass of SO_3 is produced from the reaction of 12.4 g of SO_2 and 3.45 g of O_2 ?
13. What mass of H_2SO_4 is produced from the reaction of 6.58 g of SO_3 and 1.64 g of H_2O ?
14. What mass of CdS is produced if 8.47 g of cadmium reacts with 2.51 g of sulfur?

6

11-3 Practice Problems (continued)

15. If 21.4 g of aluminum is reacted with 91.3 g of Fe_2O_3 , the products will be Al_2O_3 and iron. What mass of iron will be produced?
16. If 41.6 g of N_2O_4 reacts with 20.8 g of N_2H_4 , the products will be nitrogen and water. What mass of water will be produced?
17. If 16.8 g of CO is mixed under high pressure with 1.78 g of H_2 , what mass of methanol (CH_3OH) will be produced?
18. What mass of NaCl will be produced by the reaction of 58.7 g of NaI with 29.4 g of Cl_2 gas if the products are sodium chloride and I_2 ?
19. Determine the percent yield for the reaction between 3.74 g of Na and excess O_2 if 5.34 g of Na_2O_2 is recovered.
20. Determine the percent yield for the reaction between 6.92 g of K and 4.28 g of O_2 if 7.36 g of K_2O is produced.
21. Determine the percent yield for the reaction between 82.4 g of Rb and 11.6 g of O_2 if 39.7 g of Rb_2O is produced.
22. Determine the percent yield for the reaction between 46.1 g of Cs and 13.4 g of O_2 if 28.3 g of Cs_2O is produced.
23. Determine the percent yield for the reaction between 28.1 g of Sb_4O_6 and excess C if 17.3 g of Sb is recovered along with an unknown amount of CO.
24. Determine the percent yield for the reaction between 45.9 g of NaBr and excess chlorine gas to produce 12.8 g of NaCl and an unknown quantity of bromine gas.
25. Determine the percent yield for the reaction between 15.8 g of NH_3 and excess oxygen to produce 21.8 g of NO gas and water.
26. Determine the percent yield for the reaction between 98.7 g of Sb_2S_3 and excess oxygen if 72.4 g of Sb_4O_6 is recovered along with an unknown amount of sulfur dioxide gas.
27. Determine the percent yield for the reaction between 46.5 g of ZnS and 13.3 g of oxygen if 18.4 g of ZnO is recovered along with an unknown quantity of sulfur dioxide.