Chapter 7 Practice

7.1 Formula Mass and Percent Composition

1. Calculate the formula mass for $BaSO_4$.

$$137.33\text{ u} + 32.06\text{ u} + 4(16.00\text{ u}) = 233.39\text{ u}$$

2. What is the percent by mass of oxygen in sodium nitrate?

$$\%\text{ oxygen} = \frac{\text{mass } O_3}{\text{mass } NaNO_3} = \frac{48.00\text{ u}}{85.00\text{ u}} \times 100\% = 56.47\%$$

7.2 Connecting Atomic Mass to Large-Scale Mass: The Mole Concept

3. Convert the following from grams to moles:

a. 3.21 grams Fe

$$3.21\ \cancel{\text{g Fe}} \times \frac{1\text{ mol Fe}}{55.85\ \cancel{\text{g Fe}}} = 0.0575\text{ moles Fe}$$

b. 50.34 grams CS_2

$$50.34\ \cancel{\text{g } CS_2} \times \frac{1\text{ mol } CS_2}{76.03\text{ g } CS_2} = 0.662\text{ moles } CS_2$$

4. Convert the following from moles to grams:

a. 7.39 moles Cu

$$7.39\ \cancel{\text{mol Cu}} \times \frac{63.55\text{ g Cu}}{1\ \cancel{\text{mol Cu}}} = 470\text{ g Cu}$$

b. 4.35 moles $MgCl_2$

$$4.35\ \cancel{\text{mol Cu}} \times \frac{95.21\text{ g } MgCl_2}{1\ \cancel{\text{mol}}\ MgCl_2} = 414\text{ g } MgCl_2$$

5. Convert the following from particles to moles:

a. 5.93×10^{26} zinc atoms

$$5.93 \times 10^{26}\ \cancel{\text{atoms}} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\ \cancel{\text{atoms}}} = 985\text{ moles}$$

b. 6.92×10^{22} CO_2 molecules

$$6.92 \times 10^{22}\ \cancel{\text{molecules}} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\ \cancel{\text{molecules}}} = 0.115\text{ moles}$$

6. Find the number of atoms in each of the following:

a. 55.3 moles of titanium

$$55.3\ \cancel{\text{mol}} \times \frac{6.02 \times 10^{23}\text{ atoms}}{1\ \cancel{\text{mol}}} = 3.33 \times 10^{25}\text{ atoms}$$

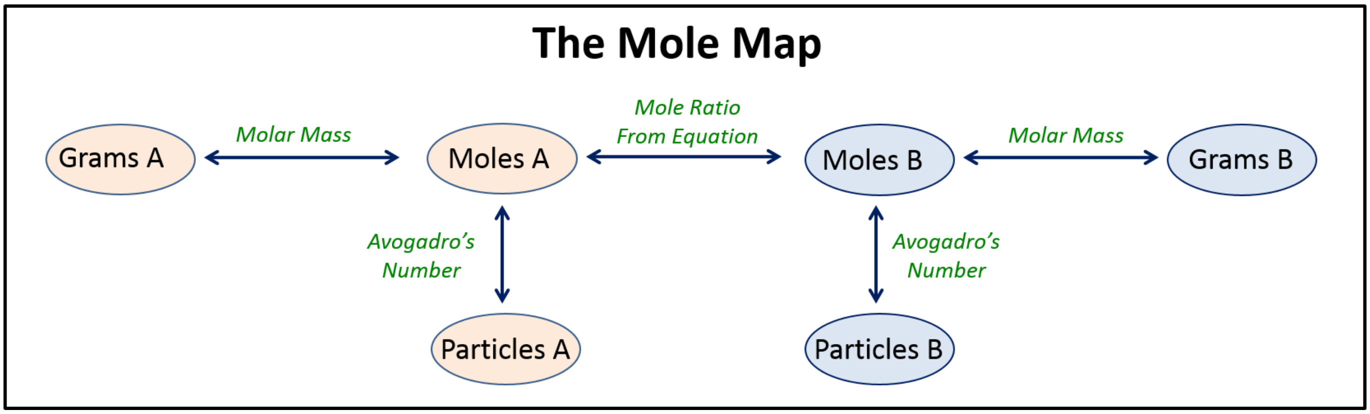
b. 3.13 moles of helium

$$3.13\ \cancel{\text{mol}} \times \frac{6.02 \times 10^{23}\text{ atoms}}{1\ \cancel{\text{mol}}} = 1.88 \times 10^{24}\text{ atoms}$$

7. How many atoms are in a 5.05-gram sample of iron?

$$5.05\ \cancel{\text{mol Fe}} \times \frac{1\ \cancel{\text{mol}}}{55.85\ \cancel{\text{g Fe}}} \times \frac{6.02 \times 10^{23}\text{ atoms}}{1\ \cancel{\text{mol}}} = 5.44 \times 10^{22}\text{ atoms}$$

7.3 The Mole Concept in Balanced Equations



8. Consider the following generic reaction: **3 A + B → 2 C**
   If a chemist carries out this reaction using 11.0 moles of **A**,

   a. how many moles of **B** are needed? $11.0 \text{ mol A} \times \frac{1 \text{ mol B}}{3 \text{ mol A}} = 3.67 \text{ mol B}$

   b. how many moles of **C** can form? $11.0 \text{ mol A} \times \frac{2 \text{ mol C}}{3 \text{ mol A}} = 7.33 \text{ mol C}$

9. Potassium metal reacts with water according to the balanced equation shown: **2 K + 2 H_2O → 2 KOH + H_2**

   a. If one mole of potassium reacts in this manner, how many moles of water are consumed?

   $$1 \cancel{\text{mol K}} \times \frac{2 \text{ mol } H_2O}{2 \cancel{\text{mol K}}} = 1 \text{ mol } H_2O$$

   b. If one mole of potassium reacts in this manner, how many moles of H_2 will form?

   $$1 \cancel{\text{mol K}} \times \frac{1 \text{ mol } H_2}{2 \cancel{\text{mol K}}} = 0.5 \text{ mol } H_2$$

   c. How many moles of potassium are required to produce 14.0 moles of H_2?

   $$14.0 \cancel{\text{mol } H_2} \times \frac{2 \text{ mol K}}{1 \cancel{\text{mol } H_2}} = 28.0 \text{ mol K}$$

   d. How many moles of KOH would be produced if 3,014.2 moles of H_2O are consumed?

   $$3{,}014.2 \cancel{\text{mol}} \, H_2O \times \frac{2 \text{ mol KOH}}{2 \cancel{\text{mol}} \, H_2O} = 3{,}014.2 \text{ mol KOH}$$

10. Copper(I) bromide reacts with magnesium metal: **2 CuBr + Mg → 2 Cu + $MgBr_2$**
    If 0.253 moles of magnesium react in this way,

    a. how many grams of CuBr are consumed? $0.253 \cancel{\text{mol Mg}} \times \frac{2 \cancel{\text{mol CuBr}}}{1 \cancel{\text{mol Mg}}} \times \frac{143.45 \text{ g CuBr}}{1 \cancel{\text{mol CuBr}}} = 72.6 \text{ g CuBr}$

    b. how many grams of Cu are produced? $0.253 \cancel{\text{mol Mg}} \times \frac{2 \cancel{\text{mol Cu}}}{1 \cancel{\text{mol Mg}}} \times \frac{63.55 \text{ g Cu}}{1 \cancel{\text{mol Cu}}} = 32.2 \text{ g Cu}$

c. how many grams of $MgBr_2$ are produced?

$$0.253\ \cancel{\text{mol Mg}} \times \frac{1\ \cancel{\text{mol MgBr}_2}}{1\ \cancel{\text{mol Mg}}} \times \frac{184.11\ \text{g MgBr}_2}{1\ \cancel{\text{mol MgBr}_2}} = 46.6\ \text{g MgBr}_2$$

11. Consider the following generic reaction: **3 A + B → C + D**

A chemist carries out this reaction using 8.0 moles of **A** and 3.0 moles of **B**.

a. What is the limiting reagent in the reaction?

$$8.0\ \text{mol A} \times \frac{1\ \text{mol C}}{3\ \text{mol A}} = \boxed{2.7\ \text{mol C}}$$

Since less product can form from A, it is the limiting reagent.

$$3.0\ \text{mol B} \times \frac{1\ \text{mol C}}{1\ \text{mol B}} = 3.0\ \text{mol C}$$

b. How many moles of C can form from this reaction? 2.7 moles

12. Potassium reacts aggressively with water, as shown in this equation: **2 K + 2 H_2O → 2 KOH + H_2**

If 0.200 grams of potassium are added to 15.0 grams of water, what mass of KOH can form in this reaction?

K is the limiting reagent

$$0.200\ \text{g K} \times \frac{1\ \text{mol K}}{39.10\ \text{g K}} \times \frac{2\ \text{mol KOH}}{2\ \text{mol K}} \times \frac{56.02\ \text{g KOH}}{1\ \text{mol KOH}} = 0.287\ \text{g KOH}$$

7.4 Theoretical and Percent Yield

13. A chemist carries out the following reaction: **C_6H_6 + Br_2 → C_6H_5Br + HBr**

a. If he reacts 14.2 grams of C_6H_6 with an excess of Br_2, what is the theoretical yield of C_6H_5Br?

$$14.2\ \cancel{\text{g C}_6\text{H}_6} \times \frac{1\ \cancel{\text{mol C}_6\text{H}_6}}{78.12\ \text{g C}_6\text{H}_6} \times \frac{1\ \cancel{\text{mol C}_6\text{H}_5\text{Br}}}{1\ \cancel{\text{mol C}_6\text{H}_6}} \times \frac{157.01\ \text{g C}_6\text{H}_5\text{Br}}{1\ \cancel{\text{mol C}_6\text{H}_5\text{Br}}} = 28.5\ \text{g C}_6\text{H}_5\text{Br}$$

b. If he isolated 16.3 grams of C_6H_5Br, what is his percent yield for this reaction?

$$\%\ \text{yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\% = \frac{16.3\ \text{g}}{28.5\ \text{g}} \times 100\% = 57.2\%$$