

## Molar Relationships-I

Once the molar mass of a substance is known, it is fairly easy to calculate moles from grams or grams from moles.

*Example 1: How many moles are present in 352 g of iron(III) oxide, Fe<sub>2</sub>O<sub>3</sub>?*

Step 1: Calculate the molar mass of iron (III) oxide.

By adding the mass of two moles of iron atoms and three moles of oxygen atoms, the molar mass is calculated to be 160.0 g.

This can be expressed in two ways as a conversion factor. It is either:

160.0 g of Fe<sub>2</sub>O<sub>3</sub> contains 1 mole (160.0 g/1 mol) or

1 mole of Fe<sub>2</sub>O<sub>3</sub> contains 160 g (1 mol/160.0 g)

Step 2: Arrange the molar mass so the original units cancel and the desired units are on top.

$$\text{in } 352 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{160.0 \text{ g Fe}_2\text{O}_3} = 2.20 \text{ mol Fe}_2\text{O}_3$$

*Example 2: How many grams are present in 1.43 moles of magnesium hydroxide, Mg(OH)<sub>2</sub>?*

Step 1: Calculate the molar mass of magnesium hydroxide.

By adding the mass of one mole of magnesium atoms, two moles of oxygen atoms, and two moles of hydrogen atoms, the molar mass is calculated to be 58.312 g.

Step 2: Arrange the molar mass so the original units cancel and the desired units are on top.

$$1.43 \text{ mol Mg(OH)}_2 \times \frac{58.312 \text{ g Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2} = 83.4 \text{ g Mg(OH)}_2$$

Calculate the following.

1. How many grams equal 1.0 mol of Azurite, Cu<sub>3</sub>(CO<sub>3</sub>)<sub>2</sub>(OH)?

Molar Mass

$$\begin{array}{l} 3 \times 63.54 = 190.62 \\ 2 \times 12.011 = 24.022 \\ 8 \times 15.999 = 127.992 \\ 2 \times 1.008 = 2.016 \\ \hline 344.652 \end{array}$$

$$1.0 \text{ mol Azurite} = 344.65 \text{ g Azurite}$$

2. How many grams equal 6.3 mol of N<sub>2</sub>?

Molar Mass

$$2 \times 14.007 = 28.014 \text{ g}$$

$$6.3 \text{ mol N}_2 \times \frac{28.014 \text{ g N}_2}{1 \text{ mol N}_2} = 180 \text{ g N}_2$$

3. How many moles equal 84.6 g of NaCl?

Molar Mass

$$\begin{array}{l} \text{Cl } 35.453 \\ \text{Na } 22.990 \\ \hline 58.443 \text{ g} \end{array}$$

$$84.6 \text{ g NaCl} \times \frac{1 \text{ mol NaCl}}{58.443 \text{ g NaCl}} = 1.45 \text{ mol NaCl}$$

4. How many moles equal 564 g of C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>?

$$564 \text{ g C}_{12}\text{H}_{22}\text{O}_{11} \times \frac{1 \text{ mol C}_{12}\text{H}_{22}\text{O}_{11}}{342.297 \text{ g}} = 1.65 \text{ mol C}_{12}\text{H}_{22}\text{O}_{11}$$

Molar Mass

$$\begin{array}{l} \text{C } 12 \times 12.011 = 144.132 \\ \text{H } 22 \times 1.008 = 22.176 \\ \text{O } 11 \times 15.999 = 175.989 \\ \hline 342.297 \text{ g} \end{array}$$

5. How many grams equal 3.95 mol of  $\text{CuFeS}_2$ ?

$$3.95 \text{ mol} \times \frac{183.518 \text{ g}}{1 \text{ mol}} = 725 \text{ g CuFeS}_2$$

Molar Mass

$$\begin{array}{l} \text{Cu } 63.54 \text{ g} \\ \text{Fe } 55.85 \\ \text{S } 2 \times 32.06 = 64.12 \\ \hline 183.518 \text{ g} \end{array}$$

How many moles equal 0.985 g of  $\text{Cu}_2\text{CO}_3(\text{OH})_2$ ?

$$0.985 \text{ g} \times \frac{1 \text{ mol}}{221.114 \text{ g}} = 4.46 \times 10^{-3} \text{ mol}$$

7. How many grams equal 36.5 mol of  $\text{Cu}(\text{CO}_3)_2(\text{OH})_2$ ?

(molar mass on front)

$$36.5 \text{ mol} \times \frac{344.65 \text{ g}}{1 \text{ mol}} = 1.26 \times 10^4 \text{ g}$$

8. Calculate the number of molecules in 15.7 mol carbon dioxide.

$$9.45 \times 10^{24} \text{ molecules CO}_2$$

9. Calculate the number of molecules in 0.0544 mol  $\text{H}_2\text{O}$ .

$$3.27 \times 10^{22} \text{ molecules H}_2\text{O}$$

10. Calculate the number of moles in  $9.22 \times 10^{23}$  atom iron.

$$1.53 \text{ mol Fe}$$

11. Calculate the number of moles of sucrose in a sample that contains

$2.05 \times 10^{22}$  sucrose molecules

$$3.41 \times 10^{-2} \text{ mol sucrose}$$

12. Calculate the number of atoms in 2.00 g of platinum.

$$6.17 \times 10^{21} \text{ atoms Pt}$$

13. How many sulfur atoms are in a metric ton ( $1.00 \times 10^6$  g) of sulfur?

$$1.88 \times 10^{28} \text{ atoms S}$$

14. How many grams of mercury are in  $1.19 \times 10^{23}$  atoms of mercury? What is the mass in grams of  $3.01 \times 10^{19}$  atoms of iodine?

$$39.7 \text{ g Hg}$$

$$6.35 \times 10^{-2} \text{ g I}$$