6.5: Mole Calculations

Learning Objectives

- Perform conversions between mass and moles of a compound.

In the previous section, several relationships were written, including:

- 1 mol Al = 26.98 g Al = 6.022×10^{23} atoms Al
- 1 mol $C_{12}H_{22}O_{11}$ = 342.3 g $C_{12}H_{22}O_{11}$ = 6.022×10^{23} molecules $C_{12}H_{22}O_{11}$
- 1 mol NaCl = 58.44 g NaCl = 6.022×10^{23} formula units NaCl

These relationships may be used to convert from grams to moles or vice versa; or from moles to atoms, molecules, or formula units or vice versa. In the next section, we will show how these relationships may also be used to count atoms, molecules, or formula units by weighing.

Conversion Factors

The above relationships allow for a number of possible conversions. Let's start with aluminum, since it provides the simplest conversion. Here are the possible conversions:

mol Al ⇄ g Al	mol Al ⇄ atoms Al	g Al ⇄ atoms Al
$\frac{26.98\ \text{g Al}}{1\ \text{mol Al}}$ or $\frac{1\ \text{mol Al}}{26.98\ \text{g Al}}$	$\frac{6.022\times10^{23}\ \text{atoms Al}}{1\ \text{mol Al}}$ or $\frac{1\ \text{mol Al}}{6.022\times10^{23}\ \text{atoms Al}}$	$\frac{6.022\times10^{23}\ \text{atoms Al}}{26.98\ \text{g Al}}$ or $\frac{26.98\ \text{g Al}}{6.022\times10^{23}\ \text{atoms Al}}$

If converting from moles of aluminum to grams of aluminum, a conversion that places grams of aluminum in the numerator and moles of aluminum in the denominator would be used to enure the proper cancellation of units:

$$\text{mol Al} \xrightarrow{\frac{26.98\ \text{g Al}}{1\ \text{mol Al}}} \text{g Al}$$

This means that the mass of aluminum in 8.36 mol Al may be calculated like this:

$$8.36\ \cancel{\text{mol Al}} \times \frac{26.98\ \text{g Al}}{1\ \cancel{\text{mol Al}}} = \boxed{226\ \text{g Al}}$$

✅ Example 6.5.1

Calculate the mass of 0.220 mol $Cu(NO_3)_2$.

Solution

Steps for Problem Solving	
Identify the "given" information and what the problem is asking you to "find."	Given: 0.220 mol $Cu(NO_3)_2$ Find: g $Cu(NO_3)_2$
List known relationship(s).	1 mol $Cu(NO_3)_2$ = 187.57 g $Cu(NO_3)_2$ = 6.022×10^{23} formula units $Cu(NO_3)_2$
Prepare a concept map and use the proper conversion factor.	$\text{mol Cu(NO}_3)_2 \xrightarrow{\frac{187.57\ \text{g Cu(NO}_3)_2}{1\ \text{mol Cu(NO}_3)_2}} \text{g Cu}$
Calculate the answer.	$0.220\ \cancel{\text{mol Cu(NO}_3)_2} \times \frac{187.57\ \text{g Cu(NO}_3)_2}{1\ \cancel{\text{mol Cu(NO}_3)_2}} = \boxed{41.3\ \text{g Cu(NO}_3)_2}$

Steps for Problem Solving	
Think about your result.	0.220 mol is a little less than ¼ of a mole. Since 1 mole has a mass of 187.57 g, the answer should be a little less than ¼ of this amount. The answer is rounded to three significant figures since the fewest significant figures in the calculation is three.

✅ Example 6.5.2

How many moles are in 0.0114 g Hg?

Solution

Steps for Problem Solving	
Identify the "given" information and what the problem is asking you to "find."	Given: 0.0114 g Hg Find: mol Hg
List known relationship(s).	1 mol Hg = 200.59 g Hg = 6.022×10^{23} atoms Hg
Prepare a concept map and use the proper conversion factor.	g Hg $\xrightarrow{\frac{1\ \text{mol Hg}}{200.59\ \text{g Hg}}}$ mol Hg
Calculate the answer.	$0.0114\ \cancel{\text{g Hg}} \times \frac{1\ \text{mol Hg}}{200.59\ \cancel{\text{g Hg}}} = \boxed{5.68 \times 10^{-5}\ \text{mol Hg}}$
Think about your result.	Since there are 200.59 g Hg in 1 mol Hg, 0.0114 g Hg must be a very small fraction of a mole. The answer is rounded to three significant figures since the fewest significant figures in the calculation is three.

✏️ Exercise 6.5.1

A. What is the mass of 0.27 mol Ne?
B. How many grams are in 386 mol $Fe_3(PO_4)_2$?
C. How many moles are present in 7.0 g of NH_3?
D. Calculate the number of moles in 555 g $CaCO_3$.

Answer A

5.4 g Ne

Answer B

1.38×10^5 g $Fe_3(PO_4)_2$

Answer C

0.41 mol NH_3

Answer D

5.55 mol $CaCO_3$

Summary

- Calculations involving conversions between moles of a material and the mass of that material are described.