

6.7: Conversions Between Moles and Mass



Figure 6.7.1 (Credit: User:Estormiz/Wikimedia Commons; Source: http://commons.wikimedia.org/wiki/File:Fermion_Plant_Oulu_2007_01_20.JPG(opens in new window); License: Public Domain)

How can we get more product?

Chemical manufacturing plants are always seeking to improve their processes. One way that improvement comes about is through measuring the amount of material produced in a reaction. By knowing how much is made, the scientists and engineers can try different ways of getting more product at less cost.

Conversions Between Moles and Mass

The molar mass of any substance is the mass in grams of one mole of representative particles of that substance. The representative particles can be atoms, molecules, or formula units of ionic compounds. This relationship is frequently used in the laboratory. Suppose that for a certain experiment, you need 3.00 moles of calcium chloride (CaCl_2). Since calcium chloride is a solid, it would be convenient to use a balance to measure the mass that is needed. The molar mass of CaCl_2 is 110.98 g/mol. The conversion factor that can be used is then based on the equality that 1 mol = 110.98 g CaCl_2 . Dimensional analysis will allow you to calculate the mass of CaCl_2 that you should measure.

$$3.00 \text{ mol CaCl}_2 \times \frac{110.98 \text{ g CaCl}_2}{1 \text{ mol CaCl}_2} = 333 \text{ g CaCl}_2$$

When you measure the mass of 333 g of CaCl_2 , you are measuring 3.00 moles of CaCl_2 .



Figure 6.7.2: Calcium chloride is used as a drying agent and as a road deicer. (Credit: Martin Walker (User:Walkerma/Wikimedia Commons); Source: http://commons.wikimedia.org/wiki/File:Calcium_chloride.jpg(opens in new window); License: Public Domain)

Example 6.7.1: Converting Moles to Mass

Chromium metal is used for decorative electroplating of car bumpers and other surfaces. Find the mass of 0.560 moles of chromium.

Solution

Step 1: List the known quantities and plan the problem.

Known

- Molar mass of Cr = 52.00 g/mol
- 0.560 mol Cr

Unknown

- 0.560 mol Cr = ? g

One conversion factor will allow us to convert from the moles of Cr to mass.

Step 2: Calculate.

$$0.560 \text{ mol Cr} \times \frac{52.00 \text{ g Cr}}{1 \text{ mol Cr}} = 29.1 \text{ g Cr}$$

Step 3: Think about your result.

Since the desired amount was slightly more than one half of a mole, the mass should be slightly more than one half of the molar mass. The answer has three significant figures because of the 0.560 mol

A similar conversion factor utilizing molar mass can be used to convert from the mass of a substance to moles. In a laboratory situation, you may perform a reaction and produce a certain amount of a product which can be massed. It will often then be necessary to determine the number of moles of the product that was formed. The next problem illustrates this situation.

Example 6.7.2: Converting Mass to Moles

A certain reaction produces 2.81 g of copper (II) hydroxide, $\text{Cu}(\text{OH})_2$. Determine the number of moles produced in the reaction.

Step 1: List the known quantities and plan the problem.

Known

- mass = 2.81 g

Unknown

- mol $\text{Cu}(\text{OH})_2$

One conversion factor will allow us to convert from mass to moles.

Step 2: Calculate.

First, it is necessary to calculate the molar mass of $\text{Cu}(\text{OH})_2$ from the molar masses of Cu, O, and H. The molar mass is 97.57 g/mol

$$2.81 \text{ g Cu}(\text{OH})_2 \times \frac{1 \text{ mol Cu}(\text{OH})_2}{97.57 \text{ g Cu}(\text{OH})_2} = 0.0288 \text{ mol Cu}(\text{OH})_2$$

Step 3: Think about your result.

The relatively small mass of product formed results in a small number of moles.



Summary

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

Review

1. You have 19.7 grams of a material and wonder how many moles were formed. Your friend tells you to multiply the mass by grams/mole. Is your friend correct?
2. How many grams of MgO are in 3.500 moles?
3. How many moles of H₂O are in 15.2 grams of pure ice?

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