

A close-up photograph of a mole's head and hands. The mole has greyish-brown fur and a prominent pink nose. Its hands are extended, showing long, sharp claws. The background is a soft, out-of-focus green.

Moles

The Mathematics of Chemistry

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Introducing Moles

- The mole is a very useful concept in chemistry. It is a quantity, just as a dozen is a quantity, but it is much more than a dozen.
- The number of objects in a mole is 6.02×10^{23} .
- The importance of the mole as a quantity in chemistry comes from the fact that all moles, just like all dozens, have the same number of particles.

Actually, the word *mole* comes from the word *molecule*. It has nothing to do with you, so feel free to dig your way back to wherever you came from!



A Practical Definition

- A mole is a formula mass expressed in grams.
 - 1 mole = 1 gram formula mass (1 mol = 1 GFM)

Substance	Formula Mass	Gram Formula Mass
Carbon	12 amu	12 g
Sodium Chloride (NaCl)	58 amu	58 g
Glucose (C ₆ H ₁₂ O ₆)	180 amu	180 g

- Atomic mass units are too small to measure on a laboratory balance, but grams are not.

Calculating with Moles

- The gram formula mass (GFM) is the number of grams per mole.

- $\text{GFM} = \frac{\text{g}}{\text{mol}}$

- $\text{g} = \text{GFM} \times \text{mol}$

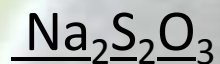
- $\text{mol} = \frac{\text{g}}{\text{GFM}}$

- Basic mole calculations can be done with these equations or by the factor label method.

Mole Problems

What is the mass of 2 moles of sodium thiosulfate?

- **Step 1:** Find the formula mass of the substance and express it in grams



$$\text{Na} = 23 \times 2 = 46$$

$$\text{S} = 32 \times 2 = 64$$

$$\text{O} = 16 \times 3 = \underline{48}$$

158 g

- **Step 2:** Apply the factor label method

$$(2 \text{ mol}) \left[\frac{158 \text{ g}}{1 \text{ mol}} \right] = 316 \text{ g}$$

- *or* **Step 2:** Apply the formula

$$g = \text{GFM} \times \text{moles}$$

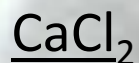
$$= 158 \text{ g/mol} \times 2 \text{ mol}$$

$$= 316 \text{ g}$$

More Mole Problems

How many moles are in 390g of calcium chloride?

- **Step 1:** Find the formula mass of the substance and express it in grams



$$\text{Ca} = 40 \times 1 = 40$$

$$\text{Cl} = 35 \times 2 = \underline{70}$$

110 g

- **Step 2:** Apply the factor label method

$$(290 \text{ g}) \left[\frac{1 \text{ mol}}{110 \text{ g}} \right] = 3.5 \text{ mol}$$

- *or* **Step 2:** Apply the formula

$$\text{mol} = \frac{\text{g}}{\text{GFM}}$$

$$\text{mol} = \frac{290 \text{ g}}{110 \text{ g/mol}} = 3.5 \text{ mol}$$