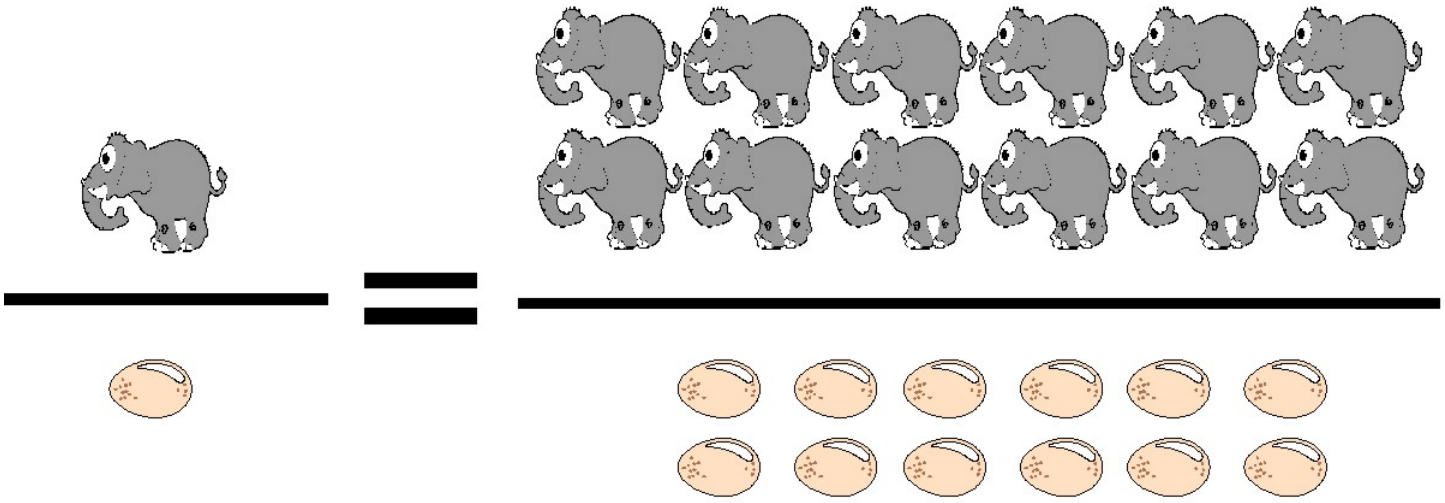
Working With Moles

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. The actual number of particles is not that important. There is a much simpler way to know when you have a mole. A mole is a formula mass expressed in grams. (1 mole = 1 gram formula mass)

Substance	Formula Mass	Gram Formula Mass
carbon	12 amu	12 g
sodium chloride (NaCl)	58 amu	58 g
glucose ($C_6H_{12}O_6$)	180 amu	180 g

Atomic mass units are too small to measure on a laboratory balance, but grams are not. An atom of carbon has a mass of 12 amu and a molecule of glucose has a mass of 180 amu. Each mass represents one particle. Since the mass ratios in formula masses and gram formula masses are the same (12 amu:180 amu::12 g:180 g), the ratio of particles must still be the same (1mole:1 mole). If you think in dozens, this is easy to understand. If we compare the mass of 1 egg to 1 elephant, it has the same mass ratio as 1 dozen eggs and 1 dozen elephants, because the ratio of objects is still 1 to 1.



This is very useful for working with balanced equations. The equation for the formation of ammonia, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, tells us that 1 molecule of nitrogen combines with 3 molecules of hydrogen to form 2 molecules of ammonia. This also means 1 mole of nitrogen combines with 3 moles of hydrogen to form 2 moles of ammonia. The mole amounts can be measured in the laboratory. Of course, it helps to understand the relationship between mass and moles. Based on the definition above, the gram formula mass (GFM) is the number of grams in 1 mole. This results in the mathematical relationships shown to the right.

1. $GFM = \frac{g}{mole}$
2. $g = GFM \times mole$
3. $mole = \frac{g}{GFM}$

Calculate the mass of each of the following as illustrated in the example below:

Example

What is the mass of 2 moles of sodium thiosulfate?

$Na_2S_2O_3$

Na = 23 × 2 = 46
S = 32 × 2 = 64
O = 16 × 3 = 48
158

g = GFM × moles

= 158 $^{g}/_{mole}$ × 2 mole

= 316 g

1. What is the mass of 3 moles of potassium nitrate [KNO_3]?
2. What is the mass of 0.75 moles of aluminum oxide [Al_2O_3]?
3. What is the mass of 3.5 moles of silver acetate [$AgCH_3COO$]?
4. What is the mass of 0.25 moles of calcium sulfate [$CaSO_4$]?

Calculate the number of moles for each of the following as illustrated in the example below:

Example

How many moles are in 390g of calcium chloride?

$CaCl_2$

Ca = 40 × 1 = 40
Cl = 35 × 2 = 70
110

$$moles = \frac{g}{GFM}$$

$$moles = \frac{390}{110}$$

moles = 3.5 moles

5. How many moles are in 484.25 g of ammonium phosphate [$(NH_4)_3PO_4$]?
6. How many moles are in 75.46 g of sulfuric acid? [$H_2SO_4(aq)$]?
7. How many moles are in 270. g of dinitrogen pentoxide [N_2O_5]?
8. How many moles are in 546 g of tin IV fluoride [SnF_4]?