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Molecular or formula mass (*M*) of a compound

Molecular mass (*M*) is the term used when referring to the mass of molecules. Molecules are made up of atoms held together by covalent bonds. Ionic compounds do not form molecules. The term **formula mass (*M*)** is used when referring to the mass of ionic compounds. As you can see the same symbol, *M*, is used to represent both masses.

To calculate the molecular/formula mass of a compound, you need to know its chemical formula. Once you have determined the number and type of elements in the compound, its molecular/formula mass can be calculated by adding the atomic masses of each element.

Examples:

1 Sodium chloride has the chemical formula NaCl.

$1 \times Na = 1 \times 23.0 = 23.0$

$1 \times Cl = 1 \times 35.5 = 35.5$

$M(NaCl) = 58.5$

2 Calcium chloride has the chemical formula $CaCl_2$.

$1 \times Ca = 1 \times 40.0 = 40.0$

$2 \times Cl = 2 \times 35.5 = 71.0$

$M(CaCl_2) = 111.0$

How big is a mole?

When measuring the amount of a substance we have, it has been found useful to use a particular number as a unit for this substance. For example, eggs are sold in lots of 12.

When chemicals interact with each other, we are not able to count individual atoms, molecules or ions; however, we can measure quantities such as mass and volume. In chemistry, amounts of substances are measured in the unit we call the **mole**. One mole of a substance is the amount that contains as many particles as exactly 12 g of carbon-12. This number of particles, known as **Avogadro's number (N_A)**, is 600 000 000 000 000 000 000 000, or is more simply written as 6×10^{23}.

One mole of iron is the amount that contains 6×10^{23} atoms of iron. One mole of water is the amount that contains 6×10^{23} molecules of water, and 0.5 mole of sulfur dioxide is the amount that contains 3×10^{23} molecules of sulfur dioxide.

Figure 2.6 One dozen eggs

Mole calculations

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1 Converting moles to mass

The mass of 1 mole of an element is equal to its atomic mass expressed in grams. The mass of 1 mole of a compound is equal to the molecular/formula mass expressed in grams.

The mass of 1 mole of sodium is equal to its atomic mass:

Mass 1 mole Na = 23 g

The mass of 1 mole of sodium chloride is equal to its formula mass:

Mass 1 mole NaCl = 23 + 35.5

= 58.5 g

Examples:

1 Calculate the mass of 2 moles of calcium.

A(Ca) = 40

∴ Mass of 1 mole = 40 g

∴ Mass of 2 moles = 2 × 40 g

= 80 g

2 Calculate the mass of 2.5 moles of calcium chloride.

$M(CaCl_2)$ = (1 × 40) + (2 × 35.5)

= 111

∴ Mass of 1 mole = 111 g

∴ Mass 2.5 moles = 2.5 × 111 g

= 277.5 g

2 Converting mass to moles

To calculate the number of moles, we divide the known mass of the compound by its molecular/formula mass. The following formula can be used to convert moles to mass.

$$\text{Number of moles } (n) = \frac{\text{mass}}{\text{molecular mass}}$$

or

$$\text{Number of moles } (n) = \frac{\text{mass}}{\text{mass of one mole}}$$

Example:

Calculate the number of moles in 300 g of calcium carbonate $CaCO_3$.

$M(CaCO_3)$ = (1 × 40) + (1 × 12) + (3 × 16)

= 100

1 mole $CaCO_3$ = 100 g

$$\text{Number of moles } (n) = \frac{\text{mass}}{\text{mass of one mole}}$$

$$= \frac{300}{100}$$

= 3 moles

Later in this chapter you will get the opportunity to use the skills you have just learnt to imitate a chemist at work.

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