The Mole

A common way to specify a quantity of material is to state its mass. The mass of an object is a measure of its resistance to acceleration. The SI base unit for mass is the kilogram (kg).

There is a second way to specify a quantity of material. If the material is known to consist of discrete units or entities, we can specify the amount of material as the number of entities

We use both methods of specifying quantity almost every day. If you buy some apples, you can either indicate the mass or the amount: 2.3 kg of apples or 24 apples, for instance. By custom, one method is more widely used than the other in specific situations. We buy eggs by amount (dozen). We buy grapes by mass (kg).

In chemistry we designate quantities in either units of mass or units of amount. Chemical substances consist of identifiable basic units, or entities — usually molecules, atoms, or ions. But counting molecules is much more difficult than counting the number of grapes in a bunch. There is an enormous number of molecules in any sample that is big enough to be visible. When we deal with eggs, we talk about <u>dozens</u>. When we deal with pencils, we are likely to use the <u>gross</u> as the unit of amount (144). When we deal with molecules, we use the <u>mole</u>.

The mole is the SI unit for amount. It can be defined thus:

> The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in exactly 12g of C^{12}

1 mole of of substance contains

> 602 209 780 000 000 000 000 000 entities.

This number is called <u>Avogadro's number</u>

1 mole of Fe contains 6.02×10^{23} atoms of Fe

1 mole of CO_2 contains 6.02×10^{23} molecules of CO_2

1 mole of eggs contains 6.02×10^{23} eggs

1 mole of cars contains →

$$6.02 \times 10^{23} \text{ cars} \times \frac{4 \text{ wheels}}{1 \text{ car}} = 24.08 \times 10^{23} \text{ wheels}$$

↗ This conversion factor allows us to convert from cars to wheels

1 mole of CO_2 contains how many atoms?

$$6.02 \times 10^{23} \text{ molecules } CO_2 \times \frac{3 \text{ atoms}}{1 \text{ molecule } CO_2} = 18.06 \times 10^{23} \text{ atoms}$$