Stoichiometry

What does ‘equal amounts’ mean in the following reaction?

\[ \text{Fe} \,(s) + \text{S} \,(s) \rightarrow \text{FeS} \,(s) \]

- Mass? No
- Volume? No
- Atoms? Yes

Relative Atomic Mass \((A_r)\)

“The average mass of all the atoms of an element compared with the mass of the Carbon 12 Isotope which is defined as having a mass value of 12.000”

Relative atomic mass is the atomic mass number that we find on the periodic table. \(A_r\) is a ratio. It has no units

Relative Molar Mass \((M_r)\)

“The mass of a molecule compared with the mass of the carbon 12 isotope. This is obtained by finding the sum of the relative atomic masses of all the individual atoms in a molecule”

Examples.

\(A_r(\text{H}) = 1, A_r(\text{O}) = 16, A_r(\text{C}) = 12\)

- \(M_r(\text{H}_2\text{O}) = 2 \times A_r(\text{H}) \text{ (Hydrogen)} + 1 \times A_r(\text{O}) \text{ (Oxygen)}\)
  = \((2 \times 1) + 16\)
  = 18.0
- \(M_r(\text{CO}_2) = 1 \times A_r(\text{C}) \text{ (Carbon)} + 2 \times A_r(\text{O}) \text{ (Oxygen)}\)
  = 12 + \((2 \times 16)\)
  = 44.0

Avogadro’s Number \((6.02 \times 10^{23})\)

The mass number of hydrogen is 1 and oxygen is 16.

Therefore, in 1 gram of hydrogen there is the same number of atoms as in 16 grams of oxygen.

In 4 grams of hydrogen there is the same number of atoms as in 64 grams of oxygen.

But just how many atoms is this?

\begin{align*}
1 \text{ g of H} &= 6.02 \times 10^{23} \text{ atoms} \\
16 \text{ g of O} &= 6.02 \times 10^{23} \text{ atoms} \\
4 \text{ g of H} &= 4(6.02 \times 10^{23}) = 24.08 \times 10^{23} \text{ atoms} \\
64 \text{ g of O} &= 4(6.02 \times 10^{23}) = 24.08 \times 10^{23} \text{ atoms}
\end{align*}
The Mole (n)

“1 mole (‘n’) is the number of carbon atoms in 12.000 grams of carbon 12. 1 mol of anything has 6.02 x 10^{23} atoms”
The unit of moles is ‘mol’

Avogadro’s number tells you the number of atoms in 1 mol of a substance.

1 mol of hydrogen weighs 1 g and has 6.02 x 10^{23} atoms

4 mol of hydrogen weighs 4 g and has 24.08 x 10^{23} atoms

1 mol of chlorine weighs 35.5 g and has 6.02 x 10^{23} atoms

2 mol of chlorine weighs 71 g and has 12.04 x 10^{23} atoms

4 mol of chlorine weighs 116.5 g and has 24.08 x 10^{23} atoms

Show 1 mole of a few substances (in jars)