# Tutorial 8: Molar Mass, Mole Ratios and Stoichiometry

Goals:

✓ Know Avogadro's number for the mole.

✓ Be able to find a mole ratio from a balanced equation.

✓ Be able to find the molar mass for any element or compound by using the periodic table.

✓ Be able to use molar mass as a conversion factor between grams of a substance and moles of that substance.

✓ Be able to use a mole ratio to relate quantities of different substances in an equation (stoichiometry).

Mole Ratios

- **Stoichiometry:** The branch of chemistry that deals with the quantitative relationship between reactants and products.

- The coefficients in a balanced chemical equation tell us the quantitative relationship between all substances in that equation.

$$2 \text{ Mg (s)} + \text{O}_2 \text{ (g)} \longrightarrow 2 \text{ MgO (s)}$$
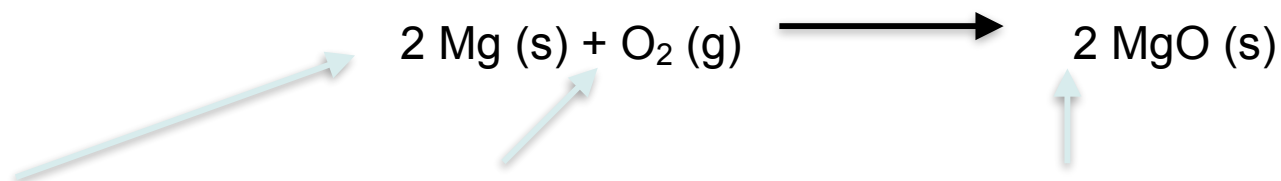
Two atoms of magnesium react with one diatomic molecule of oxygen to form two formula units of magnesium oxide.

- But atoms, molecules and formula units are too small, so we need to think about reactions in terms of moles. One mole is equal to 6.022×10^{23} objects just like one dozen is equal to 12 objects. The number for the mole is known as **Avogadro's number**.

- Using the above equation, you can see that magnesium and oxygen have a 2:1 relationship. That is, two moles of magnesium react with one mole of oxygen. This mole ratio can be written as:

$$\frac{1 \text{ mol O}_2}{2 \text{ mol Mg}} \quad \text{OR} \quad \frac{2 \text{ mol Mg}}{1 \text{ mol O}_2}$$

Molar Mass

- In the lab, our balances measure grams (not moles), so we must have a way to convert between the number of moles of a substance and the mass of that substance in grams.

- The mass of one mole of any substance is the same numerical value as the atomic mass given in the periodic table, but it is expressed in grams rather than amus. The mass of one mole of a substance is known as the **molar mass**.

- **Examples:**
    - The atomic mass of Mg is 24.31 amu. This is the mass of one Mg atom.
    - The molar mass of Mg is 24.31 g/mol. This is the mass of one mole of Mg atoms. More specifically, this is the mass of 6.022×10^{23} Mg atoms.
    - The molar mass of MgO is 40.31 g/mol

Stoichiometry

- The only way to quantitatively relate two different substances in a balanced chemical equation is through the mole ratio.

- Since we measure substances in grams (for solids, anyhow), it is still necessary to be able to calculate the number of grams of a substance rather than the number of moles. Remember that you can convert between grams and moles of a substance by using the molar mass.

- The following chart summarizes the steps that we can use to convert between quantities of different substances in a reaction. The following generic equation is used for simplicity: A + B $\longrightarrow$ C + D

grams of substance A	→ [Molar Mass of A] →	moles of substance A	→ [Mole Ratio of A:C] →	moles of substance C	→ [Molar Mass of C] →	grams of substance C

Use the molar mass to convert between grams and moles of a substance

Use the mole ratio to convert between the moles of any two DIFFERENT substances in a balanced equation.

Use the molar mass to convert between grams and moles of a substance

4