The Mole-Volume Relationship

The volumes of moles of gases, under the same physical conditions, are predictable.

Avagadro's hypothesis states that *equal volumes of gases at the same temperature and pressure contain equal numbers of particles.*

Because the variations of volume are due to temperature and pressure, the volume of a gas is usually measured at a set value.

Standard temperature and pressure (STP) means a temperature of 0^0 C and a pressure of 101.3 kPa (kilo-pascals), or 1 atmosphere (atm).

At STP: 1 mole or 6.02×10^{23} representative particles, of any gas occupies a volume of 22.4 L. This is called a **molar volume** of gas.

Finding Volume at STP

$$\text{volume of gas} = \text{moles of gas} \times \frac{22.4\text{L}}{1\text{ mol}}$$

Suppose you have 0.375 mol of oxygen gas (O_2) and want to know what volume the gas will occupy at STP.

volume of O_2 =

Example:

Sulfur dioxide is a gas produced by burning coal. It is an air pollutant and one of the causes of acid rain. Determine the volume, in liters, of 0.60 mol of sulfur dioxide at STP.

The opposite relationship holds true as well.

$$\text{moles of gas} = \text{volume of gas} \times \frac{1 \text{ mol}}{22.4 \text{ L}}$$

Suppose you collect 0.200 L of hydrogen gas at STP. How many moles is this?

moles of H_2 =

Calculating Molar Mass from Density

Different gases have different densities. Usually the density of a gas is measured in grams per liter (g/L) and at a specific temperature.

We can use this to find the molar mass of a gas.

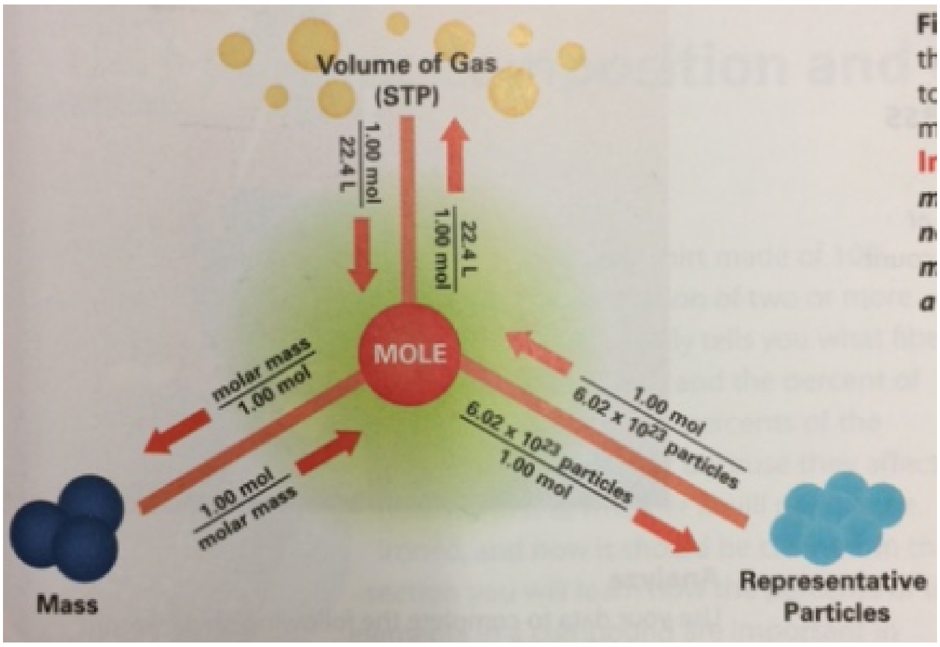
molar mass = density at STP x molar volume at STP

$$\frac{\text{grams}}{\text{mol}} = \frac{\text{grams}}{\text{L}} \times \frac{22.4\ \text{L}}{1\ \text{mole}}$$

Example:

The density of a gaseous compound containing carbon and oxygen is found to be 1.964 g/L at STP. What is the molar mass of the compound?

Copy the chart on page 303 in your book summarizing the different types of conversions we have covered.



Try questions 16-31 on pages 298-303