Module 3: Representing Amounts of Substances
Density and Molar Volume

Fundamentals of Chemistry Open Course

1.   Explain the significance of Avogadro's number and why the value 6.022×10^{23} mol^{-1}
     is a convenient definition of the mole.

2.   Use average atomic masses to calculate the molar mass of a substance with given chemical formula.

3.   Apply molar mass to determine amount of substance from mass and *vice versa*.

4.   Define mass density and molar volume; apply them in calculations.

5.   Visualize liquid solutions at the submicroscopic level; identify the components of a solution.

6.   Define concentration and recognize common units of concentration.

7.   Define molarity and apply it to calculate amount of solute from volume of a solution and *vice versa*.

8.   Recognize quantities in the ideal gas law and their associated units.

9.   Apply the ideal gas law to calculate the amount of a gas from pressure, volume, and temperature.

Mass Density

- **Mass density**, often simply called **density**, is the mass of a pure substance per unit volume.

- Units are mass per volume, such as grams per milliliter (g/mL) or kilograms per liter (kg/L).

- Generally, solids are more dense than liquids, which are more dense than gases.

- Densities of a gas can vary over a wide range because gas volume is not fixed.

Molar Quantities

- **Extensive properties** depend on the amount of substance present; **intensive properties** do not.

- Intensive properties may be intrinsic to a substance under a given set of conditions or refer to a standard amount of substance.

- Quantities with names like "molar x," such as molar mass, molar volume, molar heat capacity, etc. refer to intensive values per mole of the substance.

Molar Volume

- One example of a molar quantity is **molar volume**, the volume occupied by 1 mole of a substance under specified conditions.

- Typically reported in units of liters per mole (L/mol).

- The molar volume of an ideal gas at standard temperature and pressure (0 °C and 1.00 atm) is 22.4 L/mol.