Module 3: Representing Amounts of Substances

Density and Molar Volume

Fundamentals of Chemistry Open Course

Learning Objectives | Module 3

1. Explain the significance of Avogadro's number and why the value $6.022 \times 10^{23}\ mol^{-1}$ 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.