Calculations Used in Analytical Chemistry

A-Some Important Units of Measurement

A-1 International System of Units (SI).

SI Base Units

Physical Quantity	Name of Unit	Abbreviation
Mass	kilogram	kg
Length	meter	m
Time	second	s
Temperature	kelvin	K
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

Prefixes for Units

Prefix	Abbreviation	Multiplier
yotta-	Y	10^{24}
zetta-	Z	10^{21}
exa-	E	10^{18}
peta-	P	10^{15}
tera-	T	10^{12}
giga-	G	10^{9}
mega-	M	10^{6}
kilo-	k	10^{3}
hecto-	h	10^{2}
deca-	da	10^{1}
deci-	d	10^{-1}
centi-	c	10^{-2}
milli-	m	10^{-3}
micro-	µ	10^{-6}
nano-	n	10^{-9}
pico-	p	10^{-12}
femto-	f	10^{-15}
atto-	a	10^{-18}
zepto-	z	10^{-21}
yocto-	y	10^{-24}

- In analytical chemistry, we often determine the amount of chemical species from **mass** measurements.
- For such measurements, metric units of kilograms (kg), grams (g), milligrams (mg), or micrograms (µg) are used.

- **Volumes of liquids** are measured in units of liters (L), milliliters (mL), microliters (µL), and sometimes nanoliters (nL).
- The **liter**, the SI unit of volume, is defined as exactly 10^{-3} m^3. The **milliliter** is defined as 10^{-6} m^3, or 1 cm^3

A-2 The Distinction Between Mass and Weight

Mass *m* is an invariant measure of the quantity of matter.
Weight *w* is the force of gravitational attraction between that matter and Earth.

A chemical analysis is always based on mass so that the results will not depend on Locality

A-3 The Mole

The **mole** (abbreviated mol) is the SI unit for the amount of a chemical substance such as atoms, molecules, ions, electrons, other particles, or specified groups of such particles as represented by a chemical formula.

A **mole** of a chemical species is 6.022×10^{23} atoms, molecules, ions, electrons, ion pairs, or subatomic particles.

The **molar mass** *M* of a substance is the mass in grams of 1 mole of that substance.
We calculate molar masses by summing the atomic masses of all the atoms appearing in a chemical formula. For example, the molar mass of formaldehyde CH_2O is

$$\mathcal{M}_{CH_2O} = \frac{1\ \cancel{\text{mol C}}}{\text{mol CH}_2\text{O}} \times \frac{12.0\ \text{g}}{\cancel{\text{mol C}}} + \frac{2\ \cancel{\text{mol H}}}{\text{mol CH}_2\text{O}} \times \frac{1.0\ \text{g}}{\cancel{\text{mol H}}} + \frac{1\ \cancel{\text{mol O}}}{\text{mol CH}_2\text{O}} \times \frac{16.0\ \text{g}}{\cancel{\text{mol O}}} = 30.0\ \text{g/mol CH}_2\text{O}$$

and that of glucose, $C_6H_{12}O_6$, is

$$\mathcal{M}_{C_6H_{12}O_6} = \frac{6\ \cancel{\text{mol C}}}{\text{mol C}_6\text{H}_{12}\text{O}_6} \times \frac{12.0\ \text{g}}{\cancel{\text{mol C}}} + \frac{12\ \cancel{\text{mol H}}}{\text{mol C}_6\text{H}_{12}\text{O}_6} \times \frac{1.0\ \text{g}}{\cancel{\text{mol H}}} + \frac{6\ \cancel{\text{mol O}}}{\text{mol C}_6\text{H}_{12}\text{O}_6} \times \frac{16.0\ \text{g}}{\cancel{\text{mol O}}} = 180.0\ \text{g/mol C}_6\text{H}_{12}\text{O}_6$$

Thus, 1 mole of formaldehyde has a mass of 30.0 g, and 1 mole of glucose has a mass of 180.0 g

A-4 The Millimole

A-5 Calculating the Amount of a Substance in Moles or Millimoles

Example 1 : Find the number of **moles** and **millimoles** of benzoic acid (M = 122.1 g/mol) that are contained in 2.00 g of the pure acid.

Example 2 ; What is the mass in grams of Na^+ (22.99 g/mol) in 25.0 g of Na_2SO_4 (142.0 g/mol)?