

# General Chemistry Reference Sheet

This reference sheet addresses some of the more popular pieces of information that need to be memorized in a general chemistry course. It also contains a simple set of essential formulas in chemistry with equations, explanations, and general tips.

This sheet is meant to be as concise as possible, and many information in the textbook is left out in favor of reactions and tips. This sheet is, therefore, best used as a supplement to, and a replacement of, the textbook.

## SI Fundamental Units

Mass	Kilogram (kg)
Length	Meter (m)
Time	Second (s)
Temperature	Kelvin (K)
Amount of substance	Mole (mol)
Electric current	Anampere (A)
Luminous intensity	Candela (cd)

## Atomic Experiments and Models

J. J. Thomson	Discovered $e^-$ ; Cathode ray
R. A. Millikan	Measured charge of $e^-$ ; Oil drop
H. Bequerel/M. Curie	Discovered radioactivity
E. Rutherford	Discovered $\alpha$ , $\beta$ , and $\gamma$ rays
	Discovered nucleus; Gold foil experiment
J. Chadwick	Discovered neutrons
N. Bohr	Bohr model (electron orbits)
Quantum mechanics	Quantum model

## Polyatomic Ions

$\text{NH}_4^+$	ammonium	$\text{OH}^-$	hydroxide
$\text{CN}^-$	cyanide	$\text{C}_2\text{O}_4^{2-}$	oxalate
$\text{O}_2^{2-}$	peroxide	$\text{CNO}^-$	cyanoate
$\text{HSO}_4^-$	hydrogen sulfide	$\text{C}_2\text{H}_3\text{O}_2^-$	acetate
$\text{SCN}^-$	thiocyanate	$\text{NO}_3^-$	nitrate
$\text{SO}_3^{2-}$	sulfite	$\text{CIO}_4^-$	perchlorate
$\text{CO}_3^{2-}$	carbonate	$\text{ClO}_3^-$	chlorate
$\text{PO}_4^{3-}$	phosphate	$\text{ClO}_4^-$	hypochlorite
$\text{S}_2\text{O}_3^{2-}$	thiosulfate	$\text{HPO}_4^{2-}$	hydrogen phosphate
$\text{CrO}_4^{2-}$	chromate	$\text{H}_2\text{PO}_4^-$	hydronium
$\text{Cr}_2\text{O}_7^{2-}$	dichromate	$\text{PO}_4^{3-}$	phosphate
$\text{MnO}_4^-$	permanganate	$\text{Hg}_2^{2+}$	mercury (II)
$\text{N}_3^-$	nitide	$\text{C}_2^{2-}$	carbide
$\text{C}_2\text{H}_5\text{O}_2^-$	tartrate	$\text{S}_2^{2-}$	disulfide
$\text{O}_2^-$	superoxide	$\text{AsO}_4^{3-}$	arsenate
$\text{PO}_3^{3-}$	hypophosphate	$\text{AsO}_3^{3-}$	metarsenate
$\text{SiO}_3^{2-}$	silicate	$\text{P}_2\text{O}_7^{4-}$	pyrophosphate

## Ionic Solubility Chart

Soluble	Exceptions
$\text{NO}_3^-$	None
$\text{CH}_3\text{COO}^-$	None
$\text{Cl}^-$	$\text{Ag}^+$ , $\text{Hg}^{2+}$ , $\text{Pb}^{2+}$
$\text{Br}^-$	$\text{Ag}^+$ , $\text{Hg}^{2+}$ , $\text{Pb}^{2+}$
$\text{I}^-$	$\text{Ag}^+$ , $\text{Hg}^{2+}$ , $\text{Pb}^{2+}$
$\text{SO}_4^{2-}$	$\text{Ba}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Pb}^{2+}$
Insoluble	Exceptions
$\text{S}^{2-}$	$\text{NH}_4^+$ , alkali metal cations, $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$
$\text{CO}_3^{2-}$	$\text{NH}_4^+$ , alkali metal cations
$\text{PO}_4^{3-}$	$\text{NH}_4^+$ , alkali metal cations
$\text{OH}^-$	$\text{NH}_4^+$ , alkali metal cations, $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$

## Strong Acids and Bases

Strong acids and bases dissociate in water completely.

Strong Acid	Strong Base
$\text{HCl}$	$\text{HCN}$
$\text{HBr}$	$\text{HNO}_3$
$\text{HI}$	$\text{H}_2\text{SO}_4$
$\text{HClO}_4$	$\text{Ba}(\text{OH})_2$

## Activity Series

Metals below  $\text{H}^+$  cannot react with acids to form  $\text{H}_2$ . More active metals are better reducing agents.

From most active to least active:

$\text{Li}^+$ ,  $\text{K}^+$ ,  $\text{Hg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Cr}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{H}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Ag}^+$ ,  $\text{Hg}^{2+}$ ,  $\text{Pt}^{2+}$ ,  $\text{Au}^+$

## Flame Colors

Calcium	Brick red
Copper (I)	Blue
Copper (II)	Green or blue-green
Potassium	Lilac
Lithium	Dark red
Sodium	Bright yellow
Succinates	Red
Barium	Light green
Iron (III)	Green
Phosphate	Gold
Calcium	Blue-Violet
Sodium	Blue
Lead	Blue
Rubidium	Red-Violet

## Phase Changes

	From solid	From liquid	From gas
To solid	-	Freezing	Deposition
To liquid	Melting	-	Condensation
To gas	Sublimation	Vaporization	-

## Solution Colors

Copper (II)	Blue
Nickel	Green
Permanganate	Purple
Chromate	Yellow
Dichromate	Orange
Iron (II)	Light blue
Iron (III)	Rusty yellow

## Thermodynamic Laws

**First Law:** Energy cannot be created nor destroyed. It can only be transferred in the form of either heat or work.

**Second Law:** Any spontaneous reaction increases the entropy of the universe.

**Third Law:** An ideal solid crystal at 0 K has an entropy of 0.

## Thermodynamic Formulas

Standard thermodynamic conditions	298 K, 1 atm, 1 M
Kinetic energy	$K = mv^2/2$
Electrostatic potential energy	$U_E = k_e Q_1 Q_2/r$
Internal energy	$\Delta E = q + w$
Enthalpy	$H = E + PV$
Specific heat	$s = q/(m \cdot \Delta T)$
Entropy in reversible reaction	$\Delta S_{\text{reversible}} = (\Delta H)/T$
	$\Delta S_{\text{irreversible}} = -(\Delta H)/T$

**Microstate-entropy relationship:**  $S = k \ln W$

**Gibbs free energy:**  $G = H - TS$

**Gibbs free energy change:**  $\Delta G = \Delta H - T\Delta S$

$\Delta G = \Delta H^\circ + RT\ln Q$

**Helmholtz free energy:**  $\Delta A = T\Delta S$

**Constant**

Boltzmann's constant	$k_B = 1.381 \times 10^{-23} \text{ J/K} = 8.614 \times 10^{-54} \text{ erg/K}$
Coulomb's constant	$k_e = 8.988 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
Avogadro's number	$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$
Faraday's constant	$F = 9.649 \times 10^4 \text{ C/mol}$
Planck's constant	$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$
Ideal gas constant	$R = 0.0821 \text{ (L} \cdot \text{atm)} / (\text{mol} \cdot \text{K})$
	$R = 8.314 \text{ J} / (\text{mol} \cdot \text{K})$
Vacuum permittivity	$\epsilon_0 = 1/(\mu_0 c^2) = 8.854 \times 10^{-12} \text{ F/m}$
Vacuum permeability	$\mu_0 = 1.277 \times 10^{-6} \text{ N/A}^2$
Atomic mass	$1 \text{ atom} = 1.661 \times 10^{-27} \text{ g}$
Electron charge	$e = 1.602 \times 10^{-19} \text{ C}$
Electronvolt	$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$
Atmospheric pressure	$1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$
Absolute zero	$0 \text{ K} = -273.15^\circ \text{C}$
Speed of light in vacuum	$c = 2.998 \times 10^8 \text{ m/s}$

## Quantum Mechanical Formulas

Energy of a quantum	$E = \hbar \nu$
Wavelength-frequency relationship	$\nu = c/\lambda$
Probability distribution	$P_x = f(x)/\int f(x, y, z) \, dx \, dy \, dz$

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**Lingsheng Yao**

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