Chemistry Reference Tables

Name	Value
Avogadro's number	6.022×10^{23} particles/mole
Gas constant (R)	$0.0821 \frac{L \cdot atm}{mol \cdot K}$
	$62.4 \frac{L \cdot mm\ Hg}{mol \cdot K}$
	$8.314 \frac{L \cdot kPa}{mol \cdot K}$
Standard pressure	1.00 *atm* = 101.3 *kPa* = 760. *mm Hg* = 760. *torr*
Standard temperature	0 *°C* or 273*K*
Volume of 1 mol of any gas at STP	22.4 *L*

Thermodynamic Constants	Symbol	Value
Heat of fusion of water	H_f	$334 \frac{J}{g}$
Heat of vaporization of water	H_v	$2{,}260 \frac{J}{g}$
Specific heat of ice	C_{ice}	$2.05 \frac{J}{g\,°C}$
Specific heat of water	C_{water}	$4.18 \frac{J}{g\,°C}$
Specific heat of steam	C_{steam}	$2.02 \frac{J}{g\,°C}$

Metal	Specific Heat $\left(\frac{J}{g\,°C}\right)$	Density $\left(\frac{g}{cm^3}\right)$	Melting Point(*°C*)
Aluminum	0.897	2.702	660
Copper	0.385	8.92	1083
Gold	0.129	19.31	1064
Iron	0.449	7.86	1535
Lead	0.129	11.3437	328
Magnesium	1.023	1.74	649
Mercury	0.140	13.5939	-39
Nickel	0.444	8.90	1455
Tin	0.218	7.31	232
Titanium	0.523	4.5	1660
Zinc	0.388	7.14	420

Organic Substances			
Name	**Density @ STP**	**Melting Point (*°C*)**	**Boiling Point (*°C*)**
Ethanol (CH_3CH_2OH)	0.7893 g/cm^3	-114	79
Hexane (C_6H_{14})	0.6603 g/cm^3	-95	69
Methane (CH_4)	0.716 g/L	-182	-161
Methanol (CH_3OH)	0.7914 g/cm^3	-98	65

Inorganic Substances			
Name	***Density @ STP**	**Melting Point (*°C*)**	**Boiling Point (°*C*)**
Chlorine	3.21 g/L	-101	-35
Hydrogen	0.0899 g/L	-259	-253
Hydrogen chloride	1.640 g/L	-115	-85
Hydrogen sulfide	1.54 g/L	-85	-61
Nitrogen	1.25 g/L	-210	-196
Nitrogen monoxide	1.34 g/L	-164	-152
Oxygen	1.43 g/L	-218	-183
Sodium chloride	2.165 g/cm^3	801	1413
Sulfur dioxide	2.92 g/L	-73	-10
*Water (at 4°C)	1.00 g/cm^3	0	100

Note: 1 mL = 1 cm^3

1000 mL = 1 L

Formulas

$$D = \frac{m}{V}$$

$$K = {}^{\circ}C + 273$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_t = P_1 + P_2 + P_3 + \ldots$$

$$PV = nRT$$

$$q = mC\Delta T$$

$$q = mH_v$$

$$q = mH_f$$

$$M = \frac{\text{moles of solute}}{\text{liters of solution}}$$

$$M_1 V_1 = M_2 V_2$$

$$pH + pOH = 14$$

$$pH = -\log[H^+]$$

$$pOH = -\log[OH^-]$$

$$[H^+][OH^-] = 1\text{x}10^{-14}$$

$$[H^+] = 10^{-pH}$$

$$[OH^-] = 10^{-pOH}$$

$$\text{percent error} = \frac{|\text{experimental amount} - \text{theoretical amount}|}{\text{theoretical amount}} \times 100$$

Variables

D = density

m = mass

V = volume

K = Kelvin

P = pressure

R = gas constant

T = temperature

n = number of moles

q = quantity of heat energy

C = specific heat constant

H_v = heat of vaporization

H_f = heat of fusion constant

M = molarity

PERIODIC TABLE

1								
1 **H** Hydrogen 1.008	2							
3 **Li** Lithium 6.94	4 **Be** Beryllium 9.012							
11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31	3	4	5	6	7	8	9
19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93
37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.95	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91
55 **Cs** Cesium 132.91	56 **Ba** Barium 137.33	57 ***La** Lanthanum 138.91	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.95	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.22
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **†Ac** Actinium (227)	104 **Rf** Rutherfordium (267)	105 **Db** Dubnium (268)	106 **Sg** Seaborgium (269)	107 **Bh** Bohrium (270)	108 **Hs** Hassium (269)	109 **Mt** Meitnerium (277)

*	58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.91	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25
†	90 **Th** Thorium 232.04	91 **Pa** Protactinium 231.04	92 **U** Uranium 238.03	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)

( ) represents the most stable isotope

OF THE ELEMENTS

			13	14	15	16	17	18
			5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	2 **He** Helium 4.003
10	11	12	13 **Al** Aluminum 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.06	17 **Cl** Chlorine 35.45	10 **Ne** Neon 20.18
28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.38	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.63	33 **As** Arsenic 74.92	34 **Se** Selenium 78.97	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29
78 **Pt** Platinum 195.08	79 **Au** Gold 196.97	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.38	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (282)	112 **Cn** Copernicium (285)	113 **Nh** Nihonium (286)	114 **Fl** Flerovium (290)	115 **Mc** Moscovium (290)	116 **Lv** Livermorium (293)	117 **Ts** Tennessine (294)	118 **Og** Oganesson (294)

65 **Tb** Terbium 158.93	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93	70 **Yb** Ytterbium 173.05	71 **Lu** Lutetium 174.97
97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

Adapted from IUPAC version 4 May 2022 @ https://iupac.org

SOLUBILITY RULES

Soluble:

- All Acetates, Ammonium, Chlorates, Nitrates, and Group 1 salts
- All Chlorides, Bromides, and Iodides, except Silver, Lead, and Mercury(I)
- All Fluorides except Group 2, Lead(II), and Iron(III)
- All Sulfates except Calcium, Strontium, Barium, Mercury, Lead(II), and Silver

Insoluble (0.10 *M* or greater):

- All Carbonates, Chromates, Oxides, and Phosphates except Group 1, and Ammonium
- All Hydroxides except Group 1, Strontium, Barium, and Ammonium
- All Sulfides except Group I, Group 2, and Ammonium

Guidelines for Predicting the Products of Selected Types of Chemical Reactions

Key: **M** = Metal
NM = Nonmetal

1. **SYNTHESIS:**
   a. Formation of a binary compound: **A + B → AB**
   b. Metal oxide and water: **MO + H_2O → base**
   c. Nonmetal oxide and water: **(NM)O + H_2O → acid**

2. **DECOMPOSITION**
   a. Binary compounds: **AB → A + B**
   b. Metallic carbonates: **MCO_3 → MO + CO_2**
   c. Metallic hydrogen carbonates: **$MHCO_3$ → MCO_3** (*s*) **+ H_2O** (*l*) **+ CO_2** (*g*)
   d. Metallic hydroxides: **MOH → MO + H_2O**
   e. Metallic chlorates: **$MClO_3$ → MCl + O_2**
   f. Oxyacids decompose to nonmetal oxides and water: **acid → (NM)O + H_2O**

3. **COMBUSTION**
   hydrocarbon + O_2 → CO_2 + H_2O

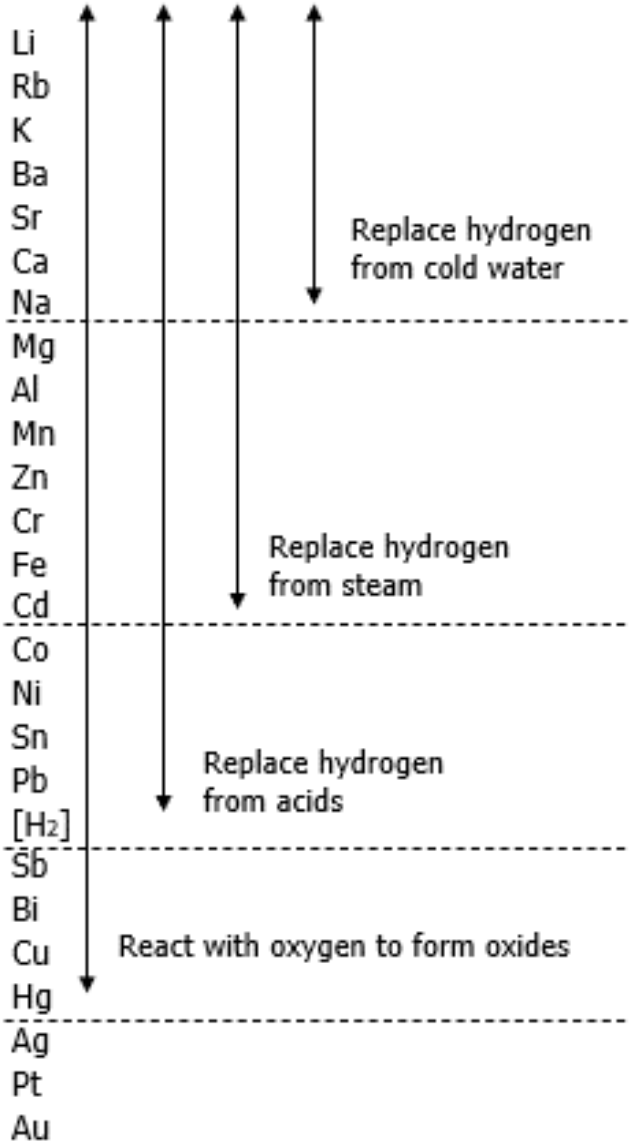
4. **SINGLE REPLACEMENT**
   a. Metal-metal replacement: **A+ BC → AC + B**
   b. Active metal replaces H from water: **M + H_2O → MOH + H_2**
   c. Active metal replaces H from acid: **M + HX → MX + H_2**
   d. Halide-halide replacement: **D + BC → BD + C**

5. **DOUBLE REPLACEMENT AB + CD → AD + CB**
   a. Formation of a precipitate from solution
   b. Acid-Base neutralization

Activity Series of Halogens

F_2
Cl_2
Br_2
I_2

Activity Series of Metals



Polyatomic Ions

NH_4^+	ammonium
BrO_3^-	bromate
$C_2H_3O_2^-$	acetate
ClO_4^-	perchlorate
ClO_3^-	chlorate
ClO_2^-	chlorite
ClO^-	hypochlorite
CN^-	cyanide
$C_2O_4^{2-}$	oxalate
CO_3^{2-}	carbonate
CrO_4^{2-}	chromate
$Cr_2O_7^{2-}$	dichromate
HCO_3^-	hydrogen carbonate
HSO_4^-	hydrogen sulfate
IO_3^-	iodate
MnO_4^-	permanganate
NO_3^-	nitrate
NO_2^-	nitrite
OH^-	hydroxide
O_2^{2-}	peroxide
SCN^-	thiocyanate
SO_4^{2-}	sulfate
SO_3^{2-}	sulfite
PO_4^{3-}	phosphate
PO_3^{3-}	phosphite

Number	Roman Numeral	Greek Prefix
1	I	mono-
2	II	di-
3	III	tri-
4	IV	tetra-
5	V	penta-
6	VI	hexa-
7	VII	hepta-
8	VIII	octa-
9	IX	nona-
10	X	deca-

Solubility of Various Compounds