

# Chemistry Reference Tables

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

Thermodynamic Constants	Symbol	Value
Heat of fusion of water	$H_f$ (water)	334 J/g
Heat of vaporization of water	$H_v$ (water)	2,260 J/g
Specific heat of water	$C_p$ (water)	$2.05 \frac{\text{J}}{\text{g}^\circ\text{C}}$ for ice, $2.02 \frac{\text{J}}{\text{g}^\circ\text{C}}$ for steam, $4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}$ for liquid

Metal	Specific Heat $\frac{\text{J}}{\text{g}^\circ\text{C}}$	Density (g/cm <sup>3</sup> )	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
Titanium	0.523	4.5	1660
Zinc	0.388	7.14	420

<b>Organic Substances</b>			
<b>Name</b>	<b>Density</b>	<b>Melting Point (°C)</b>	<b>Boiling Point (°C)</b>
Ethanol (CH <sub>3</sub> CH <sub>2</sub> OH)	0.7893 g/cm <sup>3</sup>	-114	79
Glucose (C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> )	1.56 g/cm <sup>3</sup>	146	Decomposes
Hexane (C <sub>6</sub> H <sub>14</sub> )	0.6603 g/cm <sup>3</sup>	-95	69
Methane (CH <sub>4</sub> )	0.716 g/L	-182	-161
Methanol (CH <sub>3</sub> OH)	0.7914 g/cm <sup>3</sup>	-98	65
Sucrose (C <sub>12</sub> H <sub>22</sub> O <sub>11</sub> )	1.58 g/cm <sup>3</sup>	86	Decomposes

<b>Inorganic Substances</b>			
<b>Name</b>	<b>*Density @ STP</b>	<b>Melting Point (°C)</b>	<b>Boiling Point (°C)</b>
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 carbonate	2.532 g/cm <sup>3</sup>	851	Decomposes
Sodium chloride	2.165 g/cm <sup>3</sup>	801	1413
Sulfur dioxide	2.92 g/L	-73	-10
*Water (at 4°C)	1.00 g/cm <sup>3</sup>	0	100

## Formulas

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

$D$  = density

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

$m$  = mass

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$V$  = volume

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

K = Kelvin

$$M_1V_1 = M_2V_2$$

$P$  = pressure

$$PV = nRT$$

$R$  = gas constant

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

$T$  = temperature

$$q = mC_p\Delta T$$

$M$  = molarity

$$q = mH_v$$

$n$  = number of moles

$$q = mH_f$$

$q$  = quantity of heat energy

$$\text{pH} + \text{pOH} = 14$$

$C_p$  = specific heat

$$\text{pH} = -\log[\text{H}^+]$$

$H_v$  = heat of vaporization

$$\text{pOH} = -\log[\text{OH}^-]$$

$H_f$  = heat of fusion

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

$K_w$  = equilibrium constant for the ionization of water

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

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

# PERIODIC TABLE

1 IA								
1 <b>H</b> Hydrogen 1.008	2 IIA							
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012							
11 <b>Na</b> Sodium 22.99	12 <b>Mg</b> Magnesium 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII B	9 VIII B
19 <b>K</b> Potassium 39.10	20 <b>Ca</b> Calcium 40.08	21 <b>Sc</b> Scandium 44.96	22 <b>Ti</b> Titanium 47.88	23 <b>V</b> Vanadium 50.94	24 <b>Cr</b> Chromium 51.99	25 <b>Mn</b> Manganese 54.94	26 <b>Fe</b> Iron 55.85	27 <b>Co</b> Cobalt 58.93
37 <b>Rb</b> Rubidium 85.47	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.91	40 <b>Zr</b> Zirconium 91.22	41 <b>Nb</b> Niobium 92.91	42 <b>Mo</b> Molybdenum 95.94	43 <b>Tc</b> Technetium (98)	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.91
55 <b>Cs</b> Cesium 132.91	56 <b>Ba</b> Barium 137.38	57 <b>La</b> Lanthanum 138.91	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.95	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.21	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.22
87 <b>Fr</b> Francium (223)	88 <b>Ra</b> Radium (226)	89 <b>Ac</b> Actinium (227)	104 <b>Rf</b> Rutherfordium (261)	105 <b>Db</b> Dubnium (262)	106 <b>Sg</b> Seaborgium (263)	107 <b>Bh</b> Bohrium (264)	108 <b>Hs</b> Hassium (269)	109 <b>Mt</b> Meitnerium (268)

58 <b>Ce</b> Cerium 140.12	59 <b>Pr</b> Praseodymium 140.91	60 <b>Nd</b> Neodymium 144.24	61 <b>Pm</b> Promethium (145)	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.96	64 <b>Gd</b> Gadolinium 157.25
90 <b>Th</b> Thorium 232.04	91 <b>Pa</b> Protactinium 231.04	92 <b>U</b> Uranium 238.04	93 <b>Np</b> Neptunium (237)	94 <b>Pu</b> Plutonium (244)	95 <b>Am</b> Americium (243)	96 <b>Cm</b> Curium (247)

# OF THE ELEMENTS

									18 VIII A
			13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 <b>He</b> Helium 4.003	
			5 <b>B</b> Boron 10.81	6 <b>C</b> Carbon 12.01	7 <b>N</b> Nitrogen 14.01	8 <b>O</b> Oxygen 16.00	9 <b>F</b> Fluorine 19.00	10 <b>Ne</b> Neon 20.18	
10 VIII B	11 IB	12 IIB	13 <b>Al</b> Aluminum 26.98	14 <b>Si</b> Silicon 28.09	15 <b>P</b> Phosphorus 30.97	16 <b>S</b> Sulfur 32.07	17 <b>Cl</b> Chlorine 35.45	18 <b>Ar</b> Argon 39.95	
28 <b>Ni</b> Nickel 58.69	29 <b>Cu</b> Copper 63.55	30 <b>Zn</b> Zinc 65.39	31 <b>Ga</b> Gallium 69.72	32 <b>Ge</b> Germanium 72.61	33 <b>As</b> Arsenic 74.92	34 <b>Se</b> Selenium 78.96	35 <b>Br</b> Bromine 79.90	36 <b>Kr</b> Krypton 83.80	
46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.87	48 <b>Cd</b> Cadmium 112.41	49 <b>In</b> Indium 114.82	50 <b>Sn</b> Tin 118.71	51 <b>Sb</b> Antimony 121.76	52 <b>Te</b> Tellurium 127.60	53 <b>I</b> Iodine 126.90	54 <b>Xe</b> Xenon 131.29	
78 <b>Pt</b> Platinum 195.08	79 <b>Au</b> Gold 196.97	80 <b>Hg</b> Mercury 200.59	81 <b>Tl</b> Thallium 204.38	82 <b>Pb</b> Lead 207.20	83 <b>Bi</b> Bismuth 208.98	84 <b>Po</b> Polonium (209)	85 <b>At</b> Astatine (210)	86 <b>Rn</b> Radon (222)	
110 <b>Ds</b> Darmstadtium (271)	111 <b>Rg</b> Roentgenium (272)	112 <b>Cn</b> Copernicium (285)							

65 <b>Tb</b> Terbium 158.93	66 <b>Dy</b> Dysprosium 162.50	67 <b>Ho</b> Holmium 164.93	68 <b>Er</b> Erbium 167.26	69 <b>Tm</b> Thulium 168.93	70 <b>Yb</b> Ytterbium 173.04	71 <b>Lu</b> Lutetium 174.97
97 <b>Bk</b> Berkelium (247)	98 <b>Cf</b> Californium (251)	99 <b>Es</b> Einsteinium (252)	100 <b>Fm</b> Fermium (257)	101 <b>Md</b> Mendelevium (258)	102 <b>No</b> Nobelium (254)	103 <b>Lr</b> Lawrencium (262)

## SOLUBILITY RULES

### Soluble:

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

### Insoluble (0.10 M or greater):

- All Carbonates and Phosphates except Group 1 (IA) and Ammonium
- All Hydroxides except Group 1 (IA), Strontium, Barium, and Ammonium
- All Sulfides except Group 1 (IA), 2 (IIA), and Ammonium
- All Oxides except Group 1 (IA)

## Guidelines for Predicting the Products of Selected Types of Chemical Reactions

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

### 1. SYNTHESIS:

- a. Formation of binary compound:  $A + B \rightarrow AB$
- b. Metal oxide and water:  $MO + H_2O \rightarrow \text{base}$
- c. Nonmetal oxide and water:  $(NM)O + H_2O \rightarrow \text{acid}$

### 2. DECOMPOSITION:

- a. Binary compounds:  $AB \rightarrow A + B$
- b. Metallic carbonates:  $MCO_3 \rightarrow MO + CO_2$
- c. Metallic hydrogen carbonates:  $MHCO_3 \rightarrow MCO_3 (s) + H_2O (l) + CO_2 (g)$
- d. Metallic hydroxides:  $MOH \rightarrow MO + H_2O$
- e. Metallic chlorates:  $MCIO_3 \rightarrow MCl + O_2$
- f. Oxyacids decompose to nonmetal oxides and water:  $\text{acid} \rightarrow (NM)O + H_2O$

### 3. SINGLE REPLACEMENT:

- a. Metal-Metal replacement:  $A + BC \rightarrow AC + B$
- b. Active metal replaces H from water:  $M + H_2O \rightarrow MOH + H_2$
- c. Active metal replaces H from acid:  $M + HX \rightarrow MX + H_2$
- d. Halide-Halide replacement:  $D + BC \rightarrow BD + C$

### 4. DOUBLE REPLACEMENT: $AB + CD \rightarrow AD + CB$

- a. Formation of a precipitate from solution
- b. Acid-Base neutralization

### 5. COMBUSTION REACTION

Hydrocarbon + oxygen  $\rightarrow$  carbon dioxide + water

## ACTIVITY SERIES of Halogens:

$F_2$   
 $Cl_2$   
 $Br_2$   
 $I_2$

## ACTIVITY SERIES of Metals

Li	↑		
Rb	↑		
K	↑		
Ba	↑		
Sr	↑		
Ca	↑		
Na	↑		
Mg	↑		
Al	↑		
Mn	↑		
Zn	↑		
Cr	↑		
Fe	↑		
Cd	↑		
Co	↑		
Ni	↑		
Sn	↑		
Pb	↑		
[H <sub>2</sub> ]	↑		
Sb	↑		
Bi	↑		
Cu	↑		
Hg	↑		
Ag	↑		
Pt	↑		
Au	↑		

↓ Replace hydrogen from cold water

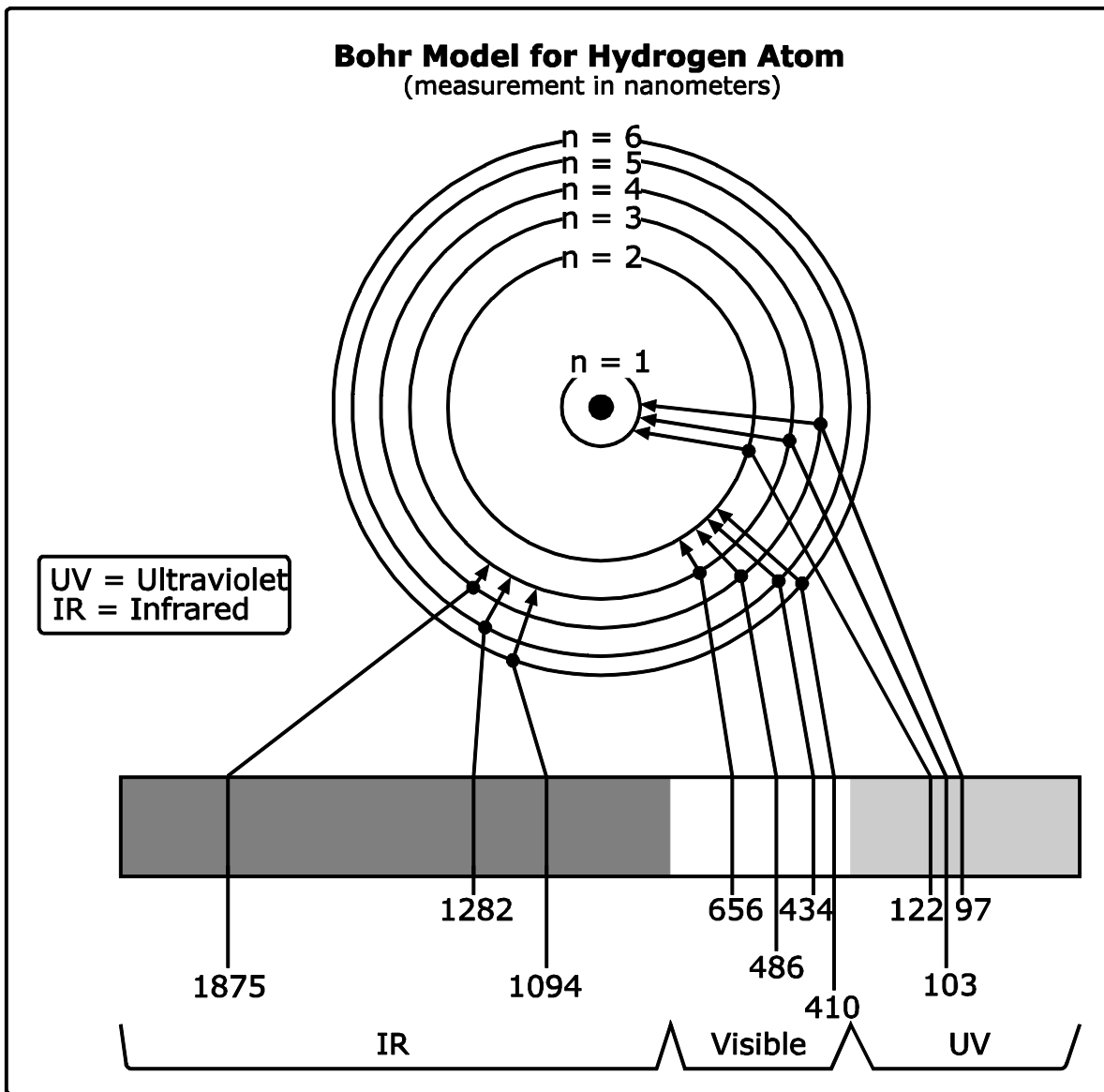
↓ Replace hydrogen from steam

↓ Replace hydrogen from acids

↓ React with oxygen to form oxides

Polyatomic Ions	
$NH_4^+$	Ammonium
$BrO_3^-$	Bromate
$CN^-$	Cyanide
$C_2H_3O_2^-$	Acetate
$(CH_3COO^-)$	
$ClO_4^-$	Perchlorate
$ClO_3^-$	Chlorate
$ClO_2^-$	Chlorite
$ClO^-$	Hypochlorite
$IO_3^-$	Iodate
$MnO_4^-$	Permanganate
$NO_3^-$	Nitrate
$NO_2^-$	Nitrite
$OH^-$	Hydroxide
$HCO_3^-$	Hydrogen carbonate
$HSO_4^-$	Hydrogen sulfate
$SCN^-$	Thiocyanate
$CO_3^{2-}$	Carbonate
$Cr_2O_7^{2-}$	Dichromate
$CrO_4^{2-}$	Chromate
$SO_4^{2-}$	Sulfate
$SO_3^{2-}$	Sulfite
$PO_4^{3-}$	Phosphate

### Bohr Model for Hydrogen Atom (measurement in nanometers)



### Electromagnetic Spectrum (measurement in meters)

