

Chemistry Reference Tables

Name	Value
Avogadro's number	6.022×10^{23} particles/mole
Gas constant (<i>R</i>)	$0.0821 \frac{\text{L atm}}{\text{mole K}}$ $62.4 \frac{\text{L mmHg}}{\text{mole K}}$ $8.314 \frac{\text{L kPa}}{\text{mole K}}$
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 ³)	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

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

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 carbonate	2.532 g/cm ³	851	Decomposes
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

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 H Hydrogen 1.008	2 IIA							
3 Li Lithium 6.941	4 Be Beryllium 9.012							
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII B	9 VIII B
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	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 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91
55 Cs Cesium 132.91	56 Ba Barium 137.38	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 (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)

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 238.04	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)

OF THE ELEMENTS

									18 VIII A
			13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He Helium 4.003	
			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	10 Ne Neon 20.18	
10 VIII B	11 IB	12 IIB	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95	
28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	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 207.20	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)	
110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)							

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 173.04	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 (254)	103 Lr 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:

F₂
Cl₂
Br₂
I₂

ACTIVITY SERIES of Metals

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

Replace hydrogen from cold water

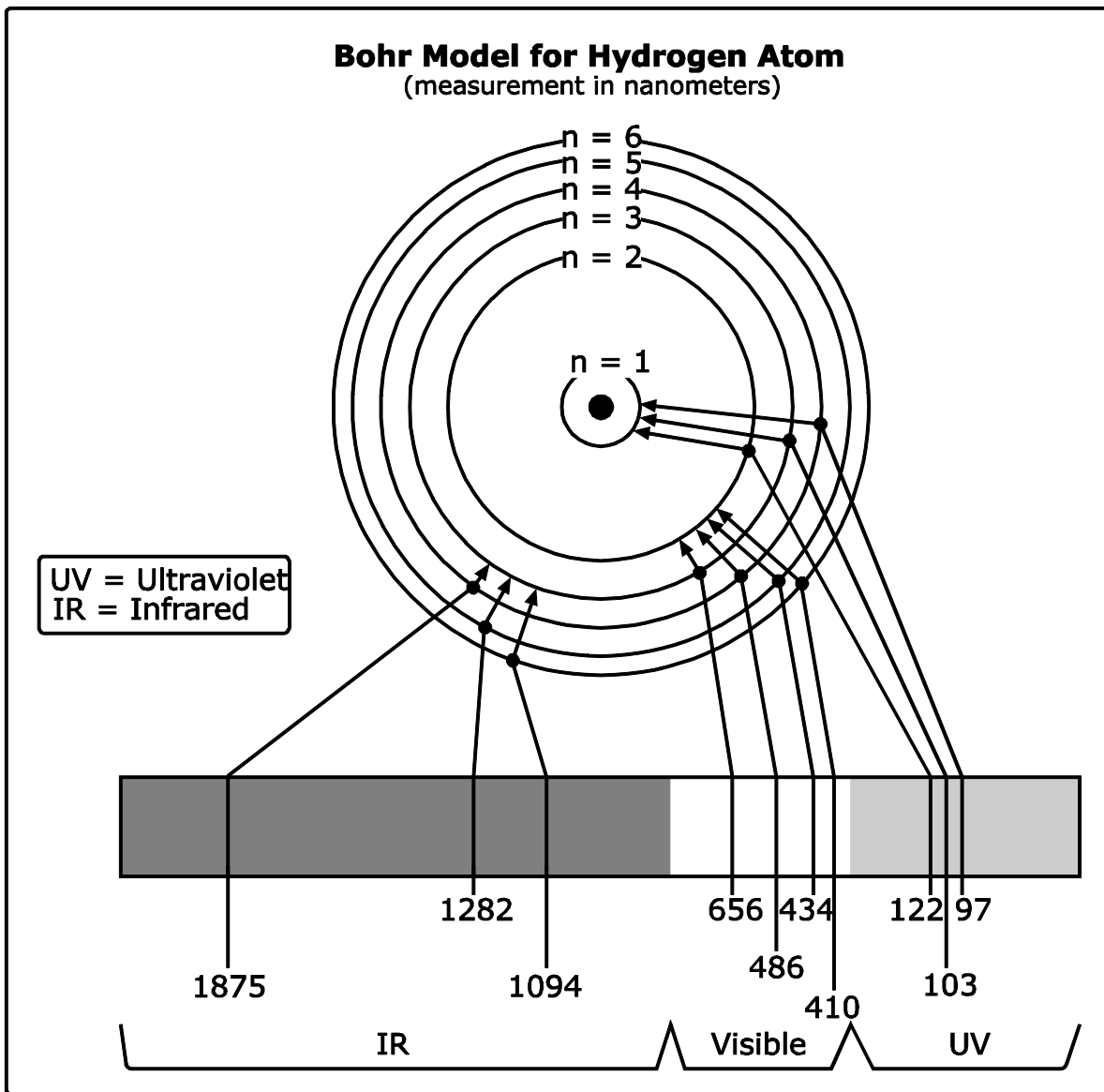
Replace hydrogen from steam

Replace hydrogen from acids

React with oxygen to form oxides

Polyatomic Ions	
NH ₄ ⁺	Ammonium
BrO ₃ ⁻	Bromate
CN ⁻	Cyanide
C ₂ H ₃ O ₂ ⁻	Acetate
(CH ₃ COO ⁻)	
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 ₂ O 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)

