

The University of the State of New York  
 THE STATE EDUCATION DEPARTMENT  
 Albany, New York 12234

# Reference Tables for Chemistry

**A**

## PHYSICAL CONSTANTS AND CONVERSION FACTORS

Name	Symbol	Value(s)	Units
Angstrom unit	Å	$1 \times 10^{-10}$ m	meter
Avogadro number	$N_A$	$6.02 \times 10^{23}$ per mol	
Charge of electron	$e$	$1.60 \times 10^{-19}$ C	coulomb
Electron volt	eV	$1.60 \times 10^{-19}$ J	joule
Speed of light	$c$	$3.00 \times 10^8$ m/s	meters/second
Planck's constant	$h$	$6.63 \times 10^{-34}$ J·s	joule-second
		$1.58 \times 10^{-37}$ kcal·s	kilocalorie-second
Universal gas constant	$R$	0.0821 L·atm/mol·K	liter-atmosphere/mole-kelvin
		1.98 cal/mol·K	calories/mole-kelvin
		8.31 J/mol·K	joules/mole-kelvin
Atomic mass unit	$\mu$ (amu)	$1.66 \times 10^{-24}$ g	gram
Volume standard, liter	L	$1 \times 10^3$ cm <sup>3</sup> = 1 dm <sup>3</sup>	cubic centimeters, cubic decimeter
Standard pressure, atmosphere	atm	101.3 kPa 760 mmHg 760 torr	kilopascals millimeters of mercury torr
Heat equivalent, kilocalorie	kcal	$4.18 \times 10^3$ J	joules

Physical Constants for H <sub>2</sub> O	
Molal freezing point depression .....	1.86°C
Molal boiling point elevation .....	0.52°C
Heat of fusion .....	79.72 cal/g
Heat of vaporization .....	539.4 cal/g

**B**

## STANDARD UNITS

Symbol	Name	Quantity	Selected Prefixes		
			Factor	Prefix	Symbol
m	meter	length			
kg	kilogram	mass			
Pa	pascal	pressure			
K	kelvin	thermodynamic temperature	$10^6$	mega	M
mol	mole	amount of substance	$10^3$	kilo	k
J	joule	energy, work, quantity of heat	$10^{-1}$	deci	d
			$10^{-2}$	centi	c
s	second	time	$10^{-3}$	milli	m
C	coulomb	quantity of electricity	$10^{-6}$	micro	$\mu$
V	volt	electric potential, potential difference	$10^{-9}$	nano	n
L	liter	volume			

**C**

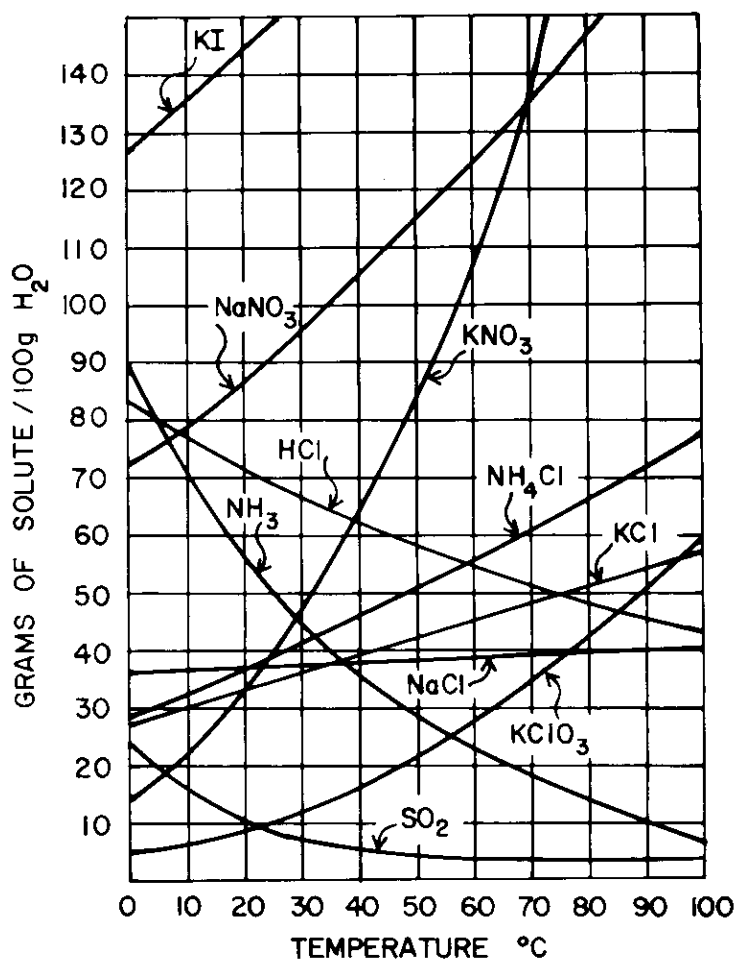
**DENSITY AND BOILING POINTS  
OF SOME COMMON GASES**

Name		Density grams/liter at STP*	Boiling Point (at 1 atm) K
Air	—	1.29	—
Ammonia	NH <sub>3</sub>	0.771	240
Carbon dioxide	CO <sub>2</sub>	1.98	195
Carbon monoxide	CO	1.25	82
Chlorine	Cl <sub>2</sub>	3.21	238
Hydrogen	H <sub>2</sub>	0.0899	20
Hydrogen chloride	HCl	1.64	188
Hydrogen sulfide	H <sub>2</sub> S	1.54	212
Methane	CH <sub>4</sub>	0.716	109
Nitrogen	N <sub>2</sub>	1.25	77
Nitrogen (II) oxide	NO	1.34	121
Oxygen	O <sub>2</sub>	1.43	90
Sulfur dioxide	SO <sub>2</sub>	2.92	263

\*STP is defined as 273K and 1 atm

**D**

**SOLUBILITY CURVES**

**E**

**TABLE OF SOLUBILITIES IN WATER**

	acetate	bromide	carbonate	chloride	chromate	hydroxide	iodide	nitrate	phosphate	sulfate	sulfide
i — nearly insoluble											
ss — slightly soluble											
s — soluble											
d — decomposes											
n — not isolated											
Aluminum	ss	s	n	s	n	i	s	s	i	s	d
Ammonium	s	s	s	s	s	s	s	s	s	s	s
Barium	s	s	i	s	i	s	s	s	i	i	d
Calcium	s	s	i	s	s	ss	s	s	i	ss	d
Copper II	s	s	i	s	i	i	n	s	i	s	i
Iron II	s	s	i	s	n	i	s	s	i	s	i
Iron III	s	s	n	s	i	i	n	s	i	ss	d
Lead	s	ss	i	ss	i	i	ss	s	i	i	i
Magnesium	s	s	i	s	s	i	s	s	i	s	d
Mercury I	ss	i	i	i	ss	n	i	s	i	ss	i
Mercury II	s	ss	i	s	ss	i	i	s	i	d	i
Potassium	s	s	s	s	s	s	s	s	s	s	s
Silver	ss	i	i	i	ss	n	i	s	i	ss	i
Sodium	s	s	s	s	s	s	s	s	s	s	s
Zinc	s	s	i	s	s	i	s	s	i	s	i

**F**

**SELECTED POLYATOMIC IONS**

Hg <sub>2</sub> <sup>2+</sup>	dimercury (I)	CrO <sub>4</sub> <sup>2-</sup>	chromate
NH <sub>4</sub> <sup>+</sup>	ammonium	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	dichromate
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>	} acetate	MnO <sub>4</sub> <sup>2-</sup>	permanganate
CH <sub>3</sub> COO <sup>-</sup>		MnO <sub>4</sub> <sup>2-</sup>	manganate
CN <sup>-</sup>	cyanide	NO <sub>2</sub> <sup>-</sup>	nitrite
CO <sub>3</sub> <sup>2-</sup>	carbonate	NO <sub>3</sub> <sup>-</sup>	nitrate
HCO <sub>3</sub> <sup>-</sup>	hydrogen carbonate	OH <sup>-</sup>	hydroxide
C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	oxalate	PO <sub>4</sub> <sup>3-</sup>	phosphate
ClO <sup>-</sup>	hypochlorite	SCN <sup>-</sup>	thiocyanate
ClO <sub>2</sub> <sup>-</sup>	chlorite	SO <sub>3</sub> <sup>2-</sup>	sulfite
ClO <sub>3</sub> <sup>-</sup>	chlorate	SO <sub>4</sub> <sup>2-</sup>	sulfate
ClO <sub>4</sub> <sup>-</sup>	perchlorate	HSO <sub>4</sub> <sup>-</sup>	hydrogen sulfate
		S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	thiosulfate

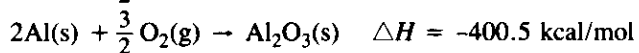
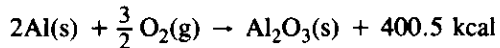
**G**

**STANDARD ENERGIES OF FORMATION  
OF COMPOUNDS AT 1 atm AND 298 K**

<i>Compound</i>	<i>Heat (Enthalpy) of Formation* kcal/mol (<math>\Delta H_f^\circ</math>)</i>	<i>Free Energy of Formation kcal/mol (<math>\Delta G_f^\circ</math>)</i>
Aluminum oxide Al <sub>2</sub> O <sub>3</sub> (s)	-400.5	-378.2
Ammonia NH <sub>3</sub> (g)	-11.0	-3.9
Barium sulfate BaSO <sub>4</sub> (s)	-352.1	-325.6
Calcium hydroxide Ca(OH) <sub>2</sub> (s)	-235.7	-214.8
Carbon dioxide CO <sub>2</sub> (g)	-94.1	-94.3
Carbon monoxide CO(g)	-26.4	-32.8
Copper (II) sulfate CuSO <sub>4</sub> (s)	-184.4	-158.2
Ethane C <sub>2</sub> H <sub>6</sub> (g)	-20.2	-7.9
Ethene (ethylene) C <sub>2</sub> H <sub>4</sub> (g)	12.5	16.3
Ethyne (acetylene) C <sub>2</sub> H <sub>2</sub> (g)	54.2	50.0
Hydrogen fluoride HF(g)	-64.8	-65.3
Hydrogen iodide HI(g)	6.3	0.4
Iodine chloride ICl(g)	4.3	-1.3
Lead (II) oxide PbO(s)	-51.5	-45.0
Magnesium oxide MgO(s)	-143.8	-136.1
Nitrogen (II) oxide NO(g)	21.6	20.7
Nitrogen (IV) oxide NO <sub>2</sub> (g)	7.9	12.3
Potassium chloride KCl(s)	-104.4	-97.8
Sodium chloride NaCl(s)	-98.3	-91.8
Sulfur dioxide SO <sub>2</sub> (g)	-70.9	-71.7
Water H <sub>2</sub> O(g)	-57.8	-54.6
Water H <sub>2</sub> O(l)	-68.3	-56.7

\* Minus sign indicates an exothermic reaction.

Sample equations:

**H**

**SELECTED RADIOISOTOPES**

<i>Nuclide</i>	<i>Half-Life</i>	<i>Decay Mode</i>
<sup>198</sup> Au	2.69 d	$\beta^-$
<sup>14</sup> C	5730 y	$\beta^-$
<sup>60</sup> Co	5.26 y	$\beta^-$
<sup>137</sup> Cs	30.23 y	$\beta^-$
<sup>220</sup> Fr	27.5 s	$\alpha$
<sup>3</sup> H	12.26 y	$\beta^-$
<sup>131</sup> I	8.07 d	$\beta^-$
<sup>37</sup> K	1.23 s	$\beta^+$
<sup>42</sup> K	12.4 h	$\beta^-$
<sup>85</sup> Kr	10.76 y	$\beta^-$
<sup>85m</sup> Kr*	4.39 h	$\gamma$
<sup>16</sup> N	7.2 s	$\beta^-$
<sup>32</sup> P	14.3 d	$\beta^-$
<sup>239</sup> Pu	$2.44 \times 10^4$ y	$\alpha$
<sup>226</sup> Ra	1600 y	$\alpha$
<sup>222</sup> Rn	3.82 d	$\alpha$
<sup>90</sup> Sr	28.1 y	$\beta^-$
<sup>99</sup> Tc	$2.13 \times 10^5$ y	$\beta^-$
<sup>99m</sup> Tc*	6.01 h	$\gamma$
<sup>232</sup> Th	$1.4 \times 10^{10}$ y	$\alpha$
<sup>233</sup> U	$1.62 \times 10^5$ y	$\alpha$
<sup>235</sup> U	$7.1 \times 10^8$ y	$\alpha$
<sup>238</sup> U	$4.51 \times 10^9$ y	$\alpha$

y=years; d=days; h=hours; s=seconds

\*m = meta stable or excited state of the same nucleus. Gamma decay from such a state is called an isomeric transition (IT).

Nuclear isomers are different energy states of the same nucleus, each having a different measurable lifetime.

I

HEATS OF REACTION AT 1 atm and 298 K	
Reaction	$\Delta H$ (kcal)
$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$	-212.8
$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\ell)$	-530.6
$\text{CH}_3\text{OH}(\ell) + \frac{3}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$	-173.6
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\ell)$	-669.9
$\text{CO}(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$	-67.7
$\text{C}_8\text{H}_{18}(\ell) + \frac{25}{2}\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 9\text{H}_2\text{O}(\ell)$	-1302.7
$\text{KNO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	+8.3
$\text{NaOH}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$	-10.6
$\text{NH}_4\text{Cl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+3.5
$\text{NH}_4\text{NO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	+6.1
$\text{NaCl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+0.9
$\text{KClO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{K}^+(\text{aq}) + \text{ClO}_3^-(\text{aq})$	+9.9
$\text{LiBr}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Li}^+(\text{aq}) + \text{Br}^-(\text{aq})$	-11.7
$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\ell)$	-13.8

J

SYMBOLS USED IN NUCLEAR CHEMISTRY		
alpha particle	${}^4_2\text{He}$	$\alpha$
beta particle (electron)	${}^0_{-1}\text{e}$	$\beta^-$
gamma radiation		$\gamma$
neutron	${}^1_0\text{n}$	n
proton	${}^1_1\text{H}$	p
deuteron	${}^2_1\text{H}$	
triton	${}^3_1\text{H}$	
positron	${}^0_{+1}\text{e}$	$\beta^+$

(K)

IONIZATION ENERGIES AND ELECTRONEGATIVITIES															
1								18							
H	313 2.2	← First Ionization Energy (kcal/mol of atoms) ← Electronegativity*						He	567						
2		13	14	15	16	17									
Li	125 1.0	Be	215 1.5	B	191 2.0	C	260 2.6	N	336 3.1	O	314 3.5	F	402 4.0	Ne	497
Na	119 0.9	Mg	176 1.2	Al	138 1.5	Si	188 1.9	P	242 2.2	S	239 2.6	Cl	300 3.2	Ar	363
K	100 0.8	Ca	141 1.0	Ga	138 1.6	Ge	182 1.9	As	226 2.0	Se	225 2.5	Br	273 2.9	Kr	323
Rb	96 0.8	Sr	131 1.0	In	133 1.7	Sn	169 1.8	Sb	199 2.1	Te	208 2.3	I	241 2.7	Xe	280
Cs	90 0.7	Ba	120 0.9	Tl	141 1.8	Pb	171 1.9	Bi	168 1.9	Po	194 2.0	At		Rn	248
Fr	0.7	Ra	122 0.9	* Arbitrary scale based on fluorine = 4.0											

(L)

**RELATIVE STRENGTHS OF ACIDS IN AQUEOUS SOLUTION AT 1 atm AND 298 K**

Conjugate Pairs		$K_a$
ACID	BASE	
HI	$= H^+ + I^-$	very large
HBr	$= H^+ + Br^-$	very large
HCl	$= H^+ + Cl^-$	very large
HNO <sub>3</sub>	$= H^+ + NO_3^-$	very large
H <sub>2</sub> SO <sub>4</sub>	$= H^+ + HSO_4^-$	large
H <sub>2</sub> O + SO <sub>2</sub>	$= H^+ + HSO_3^-$	$1.5 \times 10^{-2}$
HSO <sub>4</sub> <sup>-</sup>	$= H^+ + SO_4^{2-}$	$1.2 \times 10^{-2}$
H <sub>3</sub> PO <sub>4</sub>	$= H^+ + H_2PO_4^-$	$7.5 \times 10^{-3}$
Fe(H <sub>2</sub> O) <sub>6</sub> <sup>3+</sup>	$= H^+ + Fe(H_2O)_5(OH)^{2+}$	$8.9 \times 10^{-4}$
HNO <sub>2</sub>	$= H^+ + NO_2^-$	$4.6 \times 10^{-4}$
HF	$= H^+ + F^-$	$3.5 \times 10^{-4}$
Cr(H <sub>2</sub> O) <sub>6</sub> <sup>3+</sup>	$= H^+ + Cr(H_2O)_5(OH)^{2+}$	$1.0 \times 10^{-4}$
CH <sub>3</sub> COOH	$= H^+ + CH_3COO^-$	$1.8 \times 10^{-5}$
Al(H <sub>2</sub> O) <sub>6</sub> <sup>3+</sup>	$= H^+ + Al(H_2O)_5(OH)^{2+}$	$1.1 \times 10^{-5}$
H <sub>2</sub> O + CO <sub>2</sub>	$= H^+ + HCO_3^-$	$4.3 \times 10^{-7}$
HSO <sub>3</sub> <sup>-</sup>	$= H^+ + SO_3^{2-}$	$1.1 \times 10^{-7}$
H <sub>2</sub> S	$= H^+ + HS^-$	$9.5 \times 10^{-8}$
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	$= H^+ + HPO_4^{2-}$	$6.2 \times 10^{-8}$
NH <sub>4</sub> <sup>+</sup>	$= H^+ + NH_3$	$5.7 \times 10^{-10}$
HCO <sub>3</sub> <sup>-</sup>	$= H^+ + CO_3^{2-}$	$5.6 \times 10^{-11}$
HPO <sub>4</sub> <sup>2-</sup>	$= H^+ + PO_4^{3-}$	$2.2 \times 10^{-13}$
HS <sup>-</sup>	$= H^+ + S^{2-}$	$1.3 \times 10^{-14}$
H <sub>2</sub> O	$= H^+ + OH^-$	$1.0 \times 10^{-14}$
OH <sup>-</sup>	$= H^+ + O^{2-}$	$< 10^{-36}$
NH <sub>3</sub>	$= H^+ + NH_2^-$	very small

Note:  $H^+(aq) = H_3O^+$   
 Sample equation:  $HI + H_2O = H_3O^+ + I^-$

(M)

**CONSTANTS FOR VARIOUS EQUILIBRIA AT 1 atm AND 298 K**

$H_2O(l) = H^+(aq) + OH^-(aq)$	$K_w = 1.0 \times 10^{-14}$
$H_2O(l) + H_2O(l) = H_3O^+(aq) + OH^-(aq)$	$K_w = 1.0 \times 10^{-14}$
$CH_3COO^-(aq) + H_2O(l) = CH_3COOH(aq) + OH^-(aq)$	$K_b = 5.6 \times 10^{-10}$
$NaF(aq) + H_2O(l) = Na^+(aq) + OH^-(aq) + HF(aq)$	$K_b = 1.5 \times 10^{-11}$
$NH_3(aq) + H_2O(l) = NH_4^+(aq) + OH^-(aq)$	$K_b = 1.8 \times 10^{-5}$
$CO_3^{2-}(aq) + H_2O(l) = HCO_3^-(aq) + OH^-(aq)$	$K_b = 1.8 \times 10^{-4}$
$Ag(NH_3)_2^+(aq) = Ag^+(aq) + 2NH_3(aq)$	$K_{eq} = 8.9 \times 10^{-8}$
$N_2(g) + 3H_2(g) = 2NH_3(g)$	$K_{eq} = 6.7 \times 10^5$
$H_2(g) + I_2(g) = 2HI(g)$	$K_{eq} = 3.5 \times 10^{-1}$

Compound	$K_{sp}$	Compound	$K_{sp}$
AgBr	$5.0 \times 10^{-13}$	Li <sub>2</sub> CO <sub>3</sub>	$2.5 \times 10^{-2}$
AgCl	$1.8 \times 10^{-10}$	PbCl <sub>2</sub>	$1.6 \times 10^{-5}$
Ag <sub>2</sub> CrO <sub>4</sub>	$1.1 \times 10^{-12}$	PbCO <sub>3</sub>	$7.4 \times 10^{-14}$
AgI	$8.3 \times 10^{-17}$	PbCrO <sub>4</sub>	$2.8 \times 10^{-13}$
BaSO <sub>4</sub>	$1.1 \times 10^{-10}$	PbI <sub>2</sub>	$7.1 \times 10^{-9}$
CaSO <sub>4</sub>	$9.1 \times 10^{-6}$	ZnCO <sub>3</sub>	$1.4 \times 10^{-11}$

# Periodic Table of the Elements

Period	s-block	
	1	IA
1	1.00784 1 1s <sup>1</sup>	+1 -1 <b>H</b>

**KEY**

Atomic Mass → 12.0111

Symbol → **C**

Atomic Number → 6

Electron Configuration → 1s<sup>2</sup>2s<sup>2</sup>2p<sup>2</sup>

Relative atomic mass based on <sup>12</sup>C

Selected Cations: -4, +2, +4

		s-block		d-block														
		GROUP		Transition Elements														
		1	2				GROUP											
		IA	IIA				3	4	5	6	7	8	9					
							IIIB	IVB	VB	VIB	VII B	VIII						
2	6.941 3 1s <sup>2</sup> 2s <sup>1</sup>	+1	9.01218 4 1s <sup>2</sup> 2s <sup>2</sup>	+2														
	<b>Li</b>		<b>Be</b>															
3	22.98977 11 (Ne)3s <sup>1</sup>	+1	24.305 12 (Ne)3s <sup>2</sup>	+2														
	<b>Na</b>		<b>Mg</b>															
4	39.0983 19 (Ar)4s <sup>1</sup>	+1	40.08 20 (Ar)4s <sup>2</sup>	+2	44.9559 21 (Ar)3d <sup>1</sup> 4s <sup>2</sup>	+3	47.88 22 (Ar)3d <sup>2</sup> 4s <sup>2</sup>	+2 +3 +4	50.9415 23 (Ar)3d <sup>3</sup> 4s <sup>2</sup>	+2 +3 +4 +5	51.996 24 (Ar)3d <sup>4</sup> 4s <sup>2</sup>	+2 +3 +4 +6	54.9380 25 (Ar)3d <sup>5</sup> 4s <sup>2</sup>	+2 +3 +4 +7	55.847 26 (Ar)3d <sup>6</sup> 4s <sup>2</sup>	+2 +3 +4 +6	58.9332 27 (Ar)3d <sup>7</sup> 4s <sup>2</sup>	+3 +4 +5
	<b>K</b>		<b>Ca</b>		<b>Sc</b>		<b>Ti</b>		<b>V</b>		<b>Cr</b>		<b>Mn</b>		<b>Fe</b>		<b>Co</b>	
5	85.4678 37 (Kr)5s <sup>1</sup>	+1	87.62 38 (Kr)5s <sup>2</sup>	+2	88.9058 39 (Kr)4d <sup>1</sup> 5s <sup>2</sup>	+3	91.224 40 (Kr)4d <sup>2</sup> 5s <sup>2</sup>	+4	92.9064 41 (Kr)4d <sup>3</sup> 5s <sup>2</sup>	+3 +5	95.94 42 (Kr)4d <sup>4</sup> 5s <sup>2</sup>	+3 +6	(98) 43 (Kr)4d <sup>5</sup> 5s <sup>2</sup>	+4 +6 +7	101.07 44 (Kr)4d <sup>6</sup> 5s <sup>2</sup>	+3 +4 +5	102.906 45 (Kr)4d <sup>7</sup> 5s <sup>2</sup>	+3 +4
	<b>Rb</b>		<b>Sr</b>		<b>Y</b>		<b>Zr</b>		<b>Nb</b>		<b>Mo</b>		<b>Tc</b>		<b>Ru</b>		<b>Rh</b>	
6	132.905 55 (Xe)6s <sup>1</sup>	+1	137.33 56 (Xe)6s <sup>2</sup>	+2	La-Lu 57 71		178.49 72 (Xe)4f <sup>14</sup> 5d <sup>2</sup> 6s <sup>2</sup>	+4	180.948 73 (Xe)4f <sup>14</sup> 5d <sup>3</sup> 6s <sup>2</sup>	+5	183.85 74 (Xe)4f <sup>14</sup> 5d <sup>4</sup> 6s <sup>2</sup>	+6	186.207 75 (Xe)4f <sup>14</sup> 5d <sup>5</sup> 6s <sup>2</sup>	+4 +6 +7	190.2 76 (Xe)4f <sup>14</sup> 5d <sup>6</sup> 6s <sup>2</sup>	+3 +4	192.22 77 (Xe)4f <sup>14</sup> 5d <sup>7</sup> 6s <sup>2</sup>	+3 +4
	<b>Cs</b>		<b>Ba</b>		<b>La-Lu</b>		<b>Hf</b>		<b>Ta</b>		<b>W</b>		<b>Re</b>		<b>Os</b>		<b>Ir</b>	
7	(223) 87 (Rn)7s <sup>1</sup>	+1	226.025 88 (Rn)7s <sup>2</sup>	+2	<b>Ac-Lr</b> 89 103		(261) 104 <b>Unq*</b>		(262) 105 <b>Unp</b>		(263) 106 <b>Unh</b>		(262) 107 <b>Uns</b>		108 <b>Uno</b>		109 <b>Unu</b>	

MASS NUMBERS IN PARENTHESES ARE MASS OF THE MOST STABLE OR COMMON ISOTOPE.

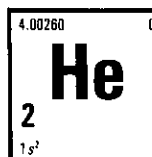
		d-block				
		Transition Elements				
		GROUP				
		VIII				
57	138.906 57 (Xe)5d <sup>1</sup> 6s <sup>2</sup>	+3				
	<b>La</b>					
58	140.12 58 (Xe)5d <sup>1</sup> 6s <sup>2</sup>	+3 +4	140.908 59 (Xe)5d <sup>1</sup> 6s <sup>2</sup>	+3 +4	144.24 60 (Xe)5d <sup>1</sup> 6s <sup>2</sup>	+3 +4
	<b>Ce</b>		<b>Pr</b>		<b>Nd</b>	
61	(244) 61 (Xe)5f <sup>1</sup> 6s <sup>2</sup>	+3 +4	(244) 62 (Xe)5f <sup>1</sup> 6s <sup>2</sup>	+3 +4	(244) 63 (Xe)5f <sup>1</sup> 6s <sup>2</sup>	+3 +4
	<b>Pm</b>		<b>Sm</b>		<b>Eu</b>	
89	227.028 89 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+3				
	<b>Ac</b>					
90	232.038 90 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+4	231.036 91 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+4 +5	238.029 92 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+3 +4 +5 +6
	<b>Th</b>		<b>Pa</b>		<b>U</b>	
93	(244) 93 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+3 +4 +5 +6	(244) 94 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+3 +4 +5 +6	(244) 95 (Rn)6d <sup>1</sup> 7s <sup>2</sup>	+3 +4 +5 +6
	<b>Np</b>		<b>Pu</b>		<b>Am</b>	

# lements

masses are  
2.00000

ation States

s-block  
18  
0



										p-block GROUP					
										13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 0
										10.81 5 <b>B</b> 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>1</sup>	12.0111 6 <b>C</b> 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>2</sup>	14.0067 7 <b>N</b> 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>3</sup>	15.9994 8 <b>O</b> 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>4</sup>	16.998403 9 <b>F</b> 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>5</sup>	20.179 10 <b>Ne</b> 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup>
										26.98154 13 <b>Al</b> [Ne]3s <sup>2</sup> 3p <sup>1</sup>	28.0855 14 <b>Si</b> [Ne]3s <sup>2</sup> 3p <sup>2</sup>	30.97376 15 <b>P</b> [Ne]3s <sup>2</sup> 3p <sup>3</sup>	32.06 16 <b>S</b> [Ne]3s <sup>2</sup> 3p <sup>4</sup>	35.453 17 <b>Cl</b> [Ne]3s <sup>2</sup> 3p <sup>5</sup>	39.948 18 <b>Ar</b> [Ne]3s <sup>2</sup> 3p <sup>6</sup>
10	11 IB		12 IIB												
58.69 28 <b>Ni</b> [Ar]3d <sup>8</sup> 4s <sup>2</sup>	63.546 29 <b>Cu</b> [Ar]3d <sup>10</sup> 4s <sup>1</sup>	65.39 30 <b>Zn</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup>	69.72 31 <b>Ga</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>1</sup>	72.59 32 <b>Ge</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup>	74.9216 33 <b>As</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup>	78.96 34 <b>Se</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup>	79.904 35 <b>Br</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup>	83.80 36 <b>Kr</b> [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup>							
106.42 46 <b>Pd</b> [Kr]4d <sup>10</sup> 5s <sup>0</sup>	107.868 47 <b>Ag</b> [Kr]4d <sup>10</sup> 5s <sup>1</sup>	112.41 48 <b>Cd</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup>	114.82 49 <b>In</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>1</sup>	118.71 50 <b>Sn</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>2</sup>	121.75 51 <b>Sb</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>3</sup>	127.60 52 <b>Te</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>4</sup>	126.905 53 <b>I</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>5</sup>	131.29 54 <b>Xe</b> [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>6</sup>							
195.08 78 <b>Pt</b> [Xe]4f <sup>14</sup> 5d <sup>9</sup> 6s <sup>1</sup>	196.967 79 <b>Au</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>1</sup>	200.59 80 <b>Hg</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup>	204.383 81 <b>Tl</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>1</sup>	207.2 82 <b>Pb</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>2</sup>	208.980 83 <b>Bi</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>3</sup>	(209) 84 <b>Po</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>4</sup>	(210) 85 <b>At</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>5</sup>	(222) 86 <b>Rn</b> [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>6</sup>							
* The systematic names and symbols for elements of atomic numbers greater than 103 will be used until the approval of trivial names by IUPAC.															

UMBERS

f-block									
151.96 63 <b>Eu</b> +2 +3	157.25 64 <b>Gd</b> +3	158.925 65 <b>Tb</b> +3	162.50 66 <b>Dy</b> +3	164.930 67 <b>Ho</b> +3	167.26 68 <b>Er</b> +3	168.934 69 <b>Tm</b> +3	173.04 70 <b>Yb</b> +2 +3	174.967 71 <b>Lu</b> +3	Lanthanoid Series
(243) 95 <b>Am</b> +3 +4 +5 +6	(247) 96 <b>Cm</b> +3	(247) 97 <b>Bk</b> +3 +4	(251) 98 <b>Cf</b> +3	(252) 99 <b>Es</b> +3	(257) 100 <b>Fm</b> +3	(258) 101 <b>Md</b> +3	(259) 102 <b>No</b> +3	(260) 103 <b>Lr</b> +3	Actinoid Series



**N****STANDARD ELECTRODE POTENTIALS****Ionic Concentrations 1 M Water At 298 K, 1 atm**

<i>Half-Reaction</i>	<i>E<sup>0</sup></i> (volts)
$F_2(g) + 2e^- \rightarrow 2F^-$	+2.87
$8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.51
$Au^{3+} + 3e^- \rightarrow Au(s)$	+1.50
$Cl_2(g) + 2e^- \rightarrow 2Cl^-$	+1.36
$14H^+ + Cr_2O_7^{2-} + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.23
$4H^+ + O_2(g) + 4e^- \rightarrow 2H_2O$	+1.23
$4H^+ + MnO_2(s) + 2e^- \rightarrow Mn^{2+} + 2H_2O$	+1.22
$Br_2(l) + 2e^- \rightarrow 2Br^-$	+1.09
$Hg^{2+} + 2e^- \rightarrow Hg(l)$	+0.85
$Ag^+ + e^- \rightarrow Ag(s)$	+0.80
$Hg_2^{2+} + 2e^- \rightarrow 2Hg(l)$	+0.80
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77
$I_2(s) + 2e^- \rightarrow 2I^-$	+0.54
$Cu^+ + e^- \rightarrow Cu(s)$	+0.52
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	+0.34
$4H^+ + SO_4^{2-} + 2e^- \rightarrow SO_2(aq) + 2H_2O$	+0.17
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	+0.15
$2H^+ + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+} + 2e^- \rightarrow Pb(s)$	-0.13
$Sn^{2+} + 2e^- \rightarrow Sn(s)$	-0.14
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	-0.26
$Co^{2+} + 2e^- \rightarrow Co(s)$	-0.28
$Fe^{2+} + 2e^- \rightarrow Fe(s)$	-0.45
$Cr^{3+} + 3e^- \rightarrow Cr(s)$	-0.74
$Zn^{2+} + 2e^- \rightarrow Zn(s)$	-0.76
$2H_2O + 2e^- \rightarrow 2OH^- + H_2(g)$	-0.83
$Mn^{2+} + 2e^- \rightarrow Mn(s)$	-1.19
$Al^{3+} + 3e^- \rightarrow Al(s)$	-1.66
$Mg^{2+} + 2e^- \rightarrow Mg(s)$	-2.37
$Na^+ + e^- \rightarrow Na(s)$	-2.71
$Ca^{2+} + 2e^- \rightarrow Ca(s)$	-2.87
$Sr^{2+} + 2e^- \rightarrow Sr(s)$	-2.89
$Ba^{2+} + 2e^- \rightarrow Ba(s)$	-2.91
$Cs^+ + e^- \rightarrow Cs(s)$	-2.92
$K^+ + e^- \rightarrow K(s)$	-2.93
$Rb^+ + e^- \rightarrow Rb(s)$	-2.98
$Li^+ + e^- \rightarrow Li(s)$	-3.04

**O****VAPOR PRESSURE OF WATER**

$^{\circ}C$	torr (mmHg)	$^{\circ}C$	torr (mmHg)
0	4.6	26	25.2
5	6.5	27	26.7
10	9.2	28	28.3
15	12.8	29	30.0
16	13.6	30	31.8
17	14.5	40	55.3
18	15.5	50	92.5
19	16.5	60	149.4
20	17.5	70	233.7
21	18.7	80	355.1
22	19.8	90	525.8
23	21.1	100	760.0
24	22.4	105	906.1
25	23.8	110	1074.6

# RADI OF ATOMS

## KEY

H	0.37
(-)	(-)
(-)	(-)
(-)	1.2

He	(-)
(-)	(-)
(-)	(-)
(-)	1.22

Covalent Radius, Å → 0.64  
 Atomic Radius in Metals, Å → (-)  
 Van der Waals Radius, Å → 1.35

A dash (-) indicates data are not available.

Li	1.23	Be	0.89	B	0.88	C	0.77	N	0.70	O	0.66	F	0.64	Ne	(-)
(-)	1.52	(-)	1.13	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Na	1.57	Mg	1.36	Al	1.25	Si	1.17	P	1.10	S	1.04	Cl	0.99	Ar	(-)
1.54	1.60	(-)	(-)	1.43	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
2.31	(-)	K	2.03	(-)	(-)	(-)	(-)	1.90	1.85	1.81	1.91	(-)	(-)	(-)	(-)
(-)	1.74	Ca	1.74	Sc	1.44	Ti	1.32	V	1.22	Cr	1.17	Mn	1.17	Fe	1.17
2.27	1.97	(-)	1.61	(-)	1.45	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
2.31	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Rb	2.16	Sr	1.92	Y	1.62	Zr	1.45	Nb	1.34	Mo	1.29	Tc	1.24	Ru	1.24
2.48	2.15	(-)	1.81	(-)	1.60	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
2.44	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Cs	2.35	Ba	1.98	La-Lu	(-)	Hf	1.44	Ta	1.34	W	1.30	Re	1.28	Os	1.26
2.65	2.17	(-)	2.17	(-)	1.56	(-)	1.43	(-)	1.37	(-)	1.34	(-)	1.34	(-)	1.36
2.62	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Fr	(-)	Ra	(-)	Ac-Lr	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
2.7	(-)	(-)	2.20	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

La	1.69	Ce	1.65	Pr	1.65	Nd	1.64	Pm	(-)	Sm	1.66	Eu	1.85	Gd	1.61	Tb	1.59	Dy	1.59	Ho	1.58	Er	1.57	Tm	1.56	Yb	1.70	Lu	1.56
(-)	1.88	(-)	1.83	(-)	1.83	(-)	1.82	(-)	1.81	(-)	1.80	2.04	(-)	1.80	(-)	1.78	(-)	1.77	(-)	1.77	(-)	1.76	(-)	1.75	(-)	1.94	(-)	1.73	
(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	
Ac	(-)	Th	(-)	Pa	(-)	U	(-)	Np	(-)	Pu	(-)	Am	(-)	Cm	(-)	Bk	(-)	Cf	(-)	Es	(-)	Fm	(-)	Md	(-)	No	(-)	Lr	(-)
(-)	1.88	(-)	1.80	(-)	1.61	(-)	1.39	(-)	1.31	(-)	1.51	(-)	1.84	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	