THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT
ALBANY

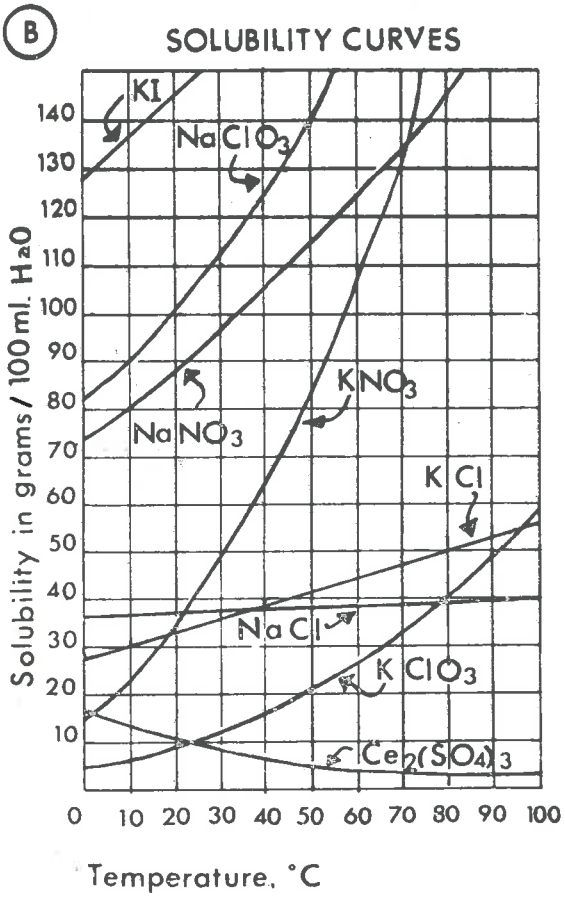
Reference Tables for Chemistry

(A)

DENSITY AND SOLUBILITY OF SOME COMMON GASES		
Name	Density grams/liter 0° C 760 mm.	Solubility*
air	1.29	——
ammonia	0.77	89.5
carbon dioxide	1.98	0.3346
carbon monoxide	1.25	0.0044
chlorine	3.21	0.9972†
nitrogen monoxide	1.34	0.0098
hydrogen	0.09	0.0002
hydrogen chloride	1.64	82.3
hydrogen sulfide	1.54	0.7066
nitrogen	1.25	0.0029
oxygen	1.43	0.0069
sulfur dioxide	2.93	22.83

*weight of gas in grams dissolved in 100 grams of water at 0°C and 760 mm. † at 10°C

(B)



(C)

Charge on Some Radicals			
CH_3COO^-	ClO_4^-	$H_2PO_4^-$	NO_3^-
$CO_3^=$	$Cr_2O_7^=$	H_3O^+	OH^-
$C_2O_4^=$	HCO_3^-	Hg_2^{++}	$PO_3^{\equiv}$
ClO^-	$HPO_4^=$	MnO_4^-	$PO_4^{\equiv}$
ClO_2^-	HSO_3^-	NH_4^+	$SO_3^=$
ClO_3^-	HSO_4^-	NO_2^-	$SO_4^=$

(D)

TABLE OF SOLUBILITIES IN WATER											
i-nearly insoluble ss-slightly soluble s-soluble d-decomposes n-not isolated	acetate	bromide	carbonate	chloride	hydroxide	iodide	nitrate	oxide	phosphate	sulfate	sulfide
aluminum	s	s	n	s	i	s	s	i	i	s	d
ammonium	s	s	s	s	s	s	s	n	s	s	s
barium	s	s	i	s	s	s	s	s	i	i	d
calcium	s	s	i	s	ss	s	s	ss	i	ss	d
copper II	s	s	i	s	i	d	s	i	i	s	i
iron II	s	s	i	s	i	s	s	i	i	s	i
iron III	s	s	n	s	i	s	s	i	i	ss	d
lead	s	ss	i	ss	i	ss	s	i	i	i	i
magnesium	s	s	i	s	i	s	s	i	i	s	d
mercury I	ss	i	i	i	n	i	s	i	i	ss	i
mercury II	s	ss	i	s	i	i	s	i	i	d	i
potassium	s	s	s	s	s	s	s	s	s	s	s
silver	ss	i	i	i	n	i	s	i	i	ss	i
sodium	s	s	s	s	s	s	s	d	s	s	s
zinc	s	s	i	s	i	s	s	i	i	s	i

(E)

SYMBOLS OF SOME PARTICLES	
electron $_{-1}e^0$	deuteron $_1H^2$
neutron $_0n^1$	triton $_1H^3$
proton $_1H^1$	alpha particle $_2He^4$

(F)

HEAT AND FREE ENERGY OF FORMATION OF COMPOUNDS AT 25° C		
Compound	Heat of Formation kcal/mole(ΔH)*	Free Energy of Formation kcal/mole(ΔG)*
Aluminum oxide (s)	-399.09	-376.77
Ammonia (g)	-11.04	-3.98
Barium sulfate (s)	-350.2	-323.4
Calcium hydroxide (s)	-235.80	-214.33
Carbon dioxide (g)	-94.39	-94.26
Copper (II) sulfate (s)	-184.00	-158.2
Dinitrogen monoxide (g)	19.49	24.76
Ethyne (acetylene) (g)	54.19	50.00
Hydrogen fluoride (g)	-63.99	———
Hydrogen iodide (g)	5.93	———
Hydrogen oxide (ℓ)	-68.32	-56.69
Iron (II, III) oxide(s)	-267.0	-242.4
Lead monoxide (s)	-52.40	-45.25
Magnesium oxide (s)	-143.84	-136.13
Mercury (II) oxide (s)	-21.68	-13.99
Nitrogen monoxide (g)	21.60	20.72
Potassium chloride (s)	-104.18	-97.59
Sodium chloride (s)	-98.23	-91.79
Sulfur dioxide (g)	-70.96	-71.79
Zinc oxide (s)	-83.17	-76.05

(s) = solid (ℓ) = liquid (g) = gas

*Minus sign indicates an exothermic reaction.

(G)

HALF-LIVES OF SOME RADIOISOTOPES	
^{14}C	5,700 yrs.
^{45}Ca	152 days
^{36}Cl	4×10^5 yrs.
^{60}Co	5.3 yrs.
^{137}Cs	33 yrs.
^{131}I	8 days
^{42}K	12.4 hrs.
^{32}P	14.3 days
^{90}Sr	20 yrs.

(H)

ACID-BASE CHART

Conjugate acid	Conjugate base
HCl	Cl^-
HNO_3	NO_3^-
H_2SO_4	HSO_4^-
H_3O^+	H_2O
HSO_4^-	$SO_4^=$
$Al(H_2O)_6^{+++}$	$Al(H_2O)_5(OH)^{++}$
NH_4^+	NH_3
H_2O	OH^-
NH_3	NH_2^-

acid strength decreases ↓ ; base strength decreases ↑

(I)

HEATS OF REACTION	
t = 25°C p = 1 atm.	kcal/mole*
$H_2(g) + \frac{1}{2} O_2(g) = H_2O(g)$	-57.8
$H_2(g) + \frac{1}{2} O_2(g) = H_2O(\ell)$	-68.3
$S(s) + O_2(g) = SO_2(g)$	-71.0
$H_2(g) + S(s) + 2O_2(g) = H_2SO_4(\ell)$	-194.0
$\frac{1}{2} N_2(g) + \frac{1}{2} O_2(g) = NO(g)$	21.6
$\frac{1}{2} N_2(g) + O_2(g) = NO_2(g)$	8.1
$\frac{1}{2} N_2(g) + \frac{3}{2} H_2(g) = NH_3(g)$	-11.0
$C(s) + \frac{1}{2} O_2(g) = CO(g)$	-26.4
$C(s) + O_2(g) = CO_2(g)$	-94.0
$2C(s) + 3H_2(g) = C_2H_6(g)$	-20.2

*of the product formed
(Minus sign indicates an exothermic reation.)

(J)

"REPRESENTATIVE" ELEMENTS

IA	IIA	IIIA	IVA	VA	VIA	VIIA
13.5 H 2.1						
5.4 Li 1.0	9.3 Be 1.5	8.3 B 2.0	11.2 C 2.5	14.5 N 3.0	13.6 O 3.5	17.3 F 4.0
5.1 Na 0.9	7.6 Mg 1.2	6.0 Al 1.5	8.1 Si 1.8	10.9 P 2.1	10.3 S 2.5	13.0 Cl 3.0
4.3 K 0.8	6.1 Ca 1.0	6.0 Ga 1.6	8.1 Ge 1.8	10.5 As 2.0	9.7 Se 2.4	11.8 Br 2.8
4.2 Rb 0.8	5.7 Sr 1.0	5.8 In 1.7	7.3 Sn 1.8	8.5 Sb 1.9	9.0 Te 2.1	10.6 I 2.5
3.9 Cs 0.7	5.2 Ba 0.9	6.1 Tl 1.8	7.4 Pb 1.8	8.0 Bi 1.9	Po 2.0	At 2.2
Fr 0.7	5.3 Ra					

Ionization Energy* — Electronegativity**

*1st. ionization energy in e.V.

**Arbitrary scale

(K)

pH VALUES FOR EQUIVALENT (0.1N.) SOLUTIONS

hydrochloric acid	1.1	alum	3.2
sulfuric acid	1.2	boric acid	5.2
phosphoric acid	1.5	pure water	7.0
citric acid	2.2	sodium bicarbonate	8.4
acetic acid	2.9	borax	9.2

ammonium hydroxide	11.1
sodium carbonate	11.6
trisodium phosphate	12.0
sodium hydroxide	13.0
potassium hydroxide	13.0

(L)

STANDARD OXIDATION POTENTIALS

Ionic concentrations 1 molal in water at 25°C

Half cell Reaction	E°(volts)
$Li = Li^+ + e^-$	3.05
$Rb = Rb^+ + e^-$	2.93
$K = K^+ + e^-$	2.93
$Cs = Cs^+ + e^-$	2.92
$Ba = Ba^{++} + 2e^-$	2.90
$Sr = Sr^{++} + 2e^-$	2.89
$Ca = Ca^{++} + 2e^-$	2.87
$Na = Na^+ + e^-$	2.71
$Mg = Mg^{++} + 2e^-$	2.37
$Be = Be^{++} + 2e^-$	1.85
$Al = Al^{+++} + 3e^-$	1.66
$Mn = Mn^{++} + 2e^-$	1.18
$Zn = Zn^{++} + 2e^-$	0.76
$Cr = Cr^{+++} + 3e^-$	0.74
$Fe = Fe^{++} + 2e^-$	0.44
$Cd = Cd^{++} + 2e^-$	0.40
$Co = Co^{++} + 2e^-$	0.28
$Ni = Ni^{++} + 2e^-$	0.25
$Sn = Sn^{++} + 2e^-$	0.14
$Pb = Pb^{++} + 2e^-$	0.13
$H_2 = 2H^+ + 2e^-$	0.00
$Sn^{++} = Sn^{++++} + 2e^-$	-0.15
$Cu^+ = Cu^{++} + e^-$	-0.15
$Cu = Cu^{++} + 2e^-$	-0.34
$2I^- = I_2 + 2e^-$	-0.53
$Fe^{++} = Fe^{+++} + e^-$	-0.77
$2Hg = Hg_2^{++} + 2e^-$	-0.79
$Ag = Ag^+ + e^-$	-0.80
$Hg_2^{++} = 2Hg^{++} + 2e^-$	-0.92
$NO + 2H_2O = NO_3^- + 4H^+ + 3e^-$	-0.96
$2Br^- = Br_2(\ell) + 2e^-$	-1.07
$2H_2O = O_2 + 4H^+ + 4e^-$	-1.23
$2\,Cr^{+++} + 7H_2O = Cr_2O_7^{--} + 14H^+ + 6e^-$	-1.33
$2Cl^- = Cl_2 + 2e^-$	-1.36
$Au = Au^{+++} + 3e^-$	-1.50
$Mn^{+2} + 4H_2O = MnO_4^- + 8H^+ + 5e^-$	-1.51
$2F^- = F_2 + 2e^-$	-2.87

(M)

IONIZATION CONSTANTS OF ACIDS AND BASES AT 25°C

Acetic acid	1.8×10^{-5}
Boric acid	5.8×10^{-10}
Carbonic acid	4.3×10^{-7}
Hypochlorous acid	3.5×10^{-8}
Phosphoric acid	7.5×10^{-3}
Ammonium hydroxide	1.8×10^{-5}
Lead hydroxide	9.6×10^{-4}

Some acids and bases which are completely or nearly completely ionized in dilute solutions at 25°C

Acids	Bases
hydrochloric	potassium hydroxide
nitric	sodium hydroxide
sulfuric	

(N)

SOME EQUILIBRIUM CONSTANTS AT 25°C

$Cu(s) + 2\,Ag^+(aq) = Cu^{+2}(aq) + 2\,Ag(s)$	2×10^{15}
$CH_3COOH(aq) = H^+(aq) + CH_3COO^-(aq)$	1.8×10^{-5}
$AgCl(s) = Ag^+(aq) + Cl^-(aq)$	1.7×10^{-10}

(O)

PRESSURE OF WATER VAPOR IN MILLIMETERS OF MERCURY

°C	mm.	°C	mm.	°C	mm.	°C	mm.
0.0	4.6	17.0	14.5	21.0	18.7	25.0	23.8
5.0	6.5	18.0	15.5	22.0	19.8	26.0	25.2
10.0	9.2	19.0	16.5	23.0	21.1	27.0	26.7
15.0	12.8	20.0	17.5	24.0	22.4	28.0	28.3

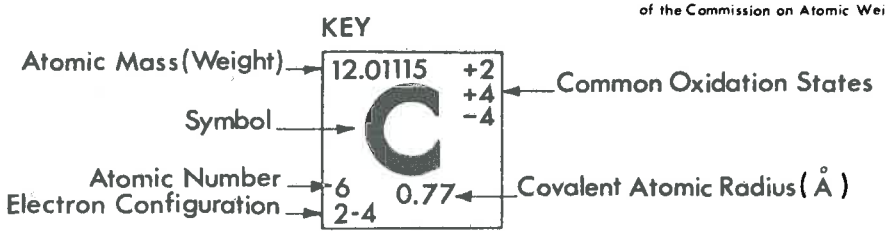
(P)

PHYSICAL CONSTANTS

Name	Symbol	Value
Speed of light	c	3.00×10^{10} cm/sec.
Avogadro's number	N_o	6.02×10^{23}
Universal gas constant	R	0.0821 liter-atm/mole-°K
Planck's constant	h	6.63×10^{-34} joule-sec.
Charge of electron	e	1.60×10^{-19} coulomb
Mass of an electron	m_e	9.11×10^{-28} gm.
Mass of a proton	m_p	1.67×10^{-24} gm.
Mass of a neutron	m_n	1.67×10^{-24} gm.

Periodic Table of the Elements

Atomic weights conform to the 1961 values of the Commission on Atomic Weights.



Period	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	0
1	1.00797 +1 **H** 1 0.30 1																1.00797 −1 **H** 1 0.30 1	4.0026 0 **He** 2 0.93 2
2	6.939 +1 **Li** 3 1.52 2-1	9.0122 +2 **Be** 4 1.12 2-2											10.811 +3 **B** 5 0.88 2-3	12.01115 +2 +4 −4 **C** 6 0.77 2-4	14.0067 +1 +2 +3 +4 +5 −1 −2 −3 **N** 7 0.70 2-5	15.9994 −2 **O** 8 0.66 2-6	18.9984 −1 **F** 9 0.64 2-7	20.183 0 **Ne** 10 1.12 2-8
3	22.9898 +1 **Na** 11 1.86 2-8-1	24.312 +2 **Mg** 12 1.60 2-8-2											26.9815 +3 **Al** 13 1.43 2-8-3	28.086 +2 +4 −4 **Si** 14 1.17 2-8-4	30.9738 +3 +5 −3 **P** 15 1.10 2-8-5	32.064 +4 +6 −2 **S** 16 1.04 2-8-6	35.453 +1 +5 +7 −1 **Cl** 17 0.99 2-8-7	39.948 0 **Ar** 18 1.54 2-8-8
4	39.102 +1 **K** 19 2.31 2-8-8-1	40.08 +2 **Ca** 20 1.97 2-8-8-2	44.956 +3 **Sc** 21 1.60 2-8-9-2	47.90 +2 +3 +4 **Ti** 22 1.46 2-8-10-2	50.942 +2 +3 +4 +5 **V** 23 1.31 2-8-11-2	51.996 +2 +3 +6 **Cr** 24 1.25 2-8-13-1	54.9380 +2 +3 +4 +7 **Mn** 25 1.29 2-8-13-2	55.847 +2 +3 **Fe** 26 1.26 2-8-14-2	58.9332 +2 +3 **Co** 27 1.25 2-8-15-2	58.71 +2 +3 **Ni** 28 1.24 2-8-16-2	63.54 +1 +2 **Cu** 29 1.28 2-8-18-1	65.37 +2 **Zn** 30 1.33 2-8-18-2	69.72 +3 **Ga** 31 1.22 2-8-18-3	72.59 +2 +4 **Ge** 32 1.22 2-8-18-4	74.9216 +3 +5 −3 **As** 33 1.21 2-8-18-5	78.96 +4 +6 −2 **Se** 34 1.17 2-8-18-6	79.909 +1 +5 −1 **Br** 35 1.14 2-8-18-7	83.80 0 **Kr** 36 1.69 2-8-18-8
5	85.47 +1 **Rb** 37 2.44 2-8-18-8-1	87.62 +2 **Sr** 38 2.15 2-8-18-8-2	88.905 +3 **Y** 39 1.80 2-8-18-9-2	91.22 +4 **Zr** 40 1.57 2-8-18-10-2	92.906 +3 +5 **Nb** 41 1.43 2-8-18-12-1	95.94 +6 +3 **Mo** 42 1.36 2-8-18-13-1	(99) +4 +6 +7 **Tc** 43 2-8-18-14-1	101.07 +3 **Ru** 44 1.33 2-8-18-15-1	102.905 +3 **Rh** 45 1.34 2-8-18-16-1	106.4 +2 +4 **Pd** 46 1.38 2-8-18-18	107.870 +1 **Ag** 47 1.44 2-8-18-18-1	112.40 +2 **Cd** 48 1.49 2-8-18-18-2	114.82 +3 **In** 49 1.62 2-8-18-18-3	118.69 +2 +4 **Sn** 50 1.40 2-8-18-18-4	121.75 +3 +5 −3 **Sb** 51 1.41 2-8-18-18-5	127.60 +4 +6 −2 **Te** 52 1.37 2-8-18-18-6	126.9044 +1 +5 +7 −1 **I** 53 1.33 2-8-18-18-7	131.30 0 **Xe** 54 1.90 2-8-18-18-8
6	132.905 +1 **Cs** 55 2.62 2-8-18-18-8-1	137.34 +2 **Ba** 56 2.17 2-8-18-18-8-2	138.91 +3 **La** 57 1.87 2-8-18-18-9-2	178.49 +4 **Hf** 72 1.57 -18-32-10-2	180.948 +5 **Ta** 73 1.43 -18-32-11-2	183.85 +6 **W** 74 1.37 -18-32-12-2	186.2 +4 +6 +7 **Re** 75 1.37 -18-32-13-2	190.2 +3 +4 **Os** 76 1.34 -18-32-14-2	192.2 +3 +4 **Ir** 77 1.35 -18-32-15-2	195.09 +2 +4 **Pt** 78 1.38 -18-32-17-1	196.967 +1 +3 **Au** 79 1.44 -18-32-18-1	200.59 +1 +2 **Hg** 80 1.55 -18-32-18-2	204.37 +1 +3 **Tl** 81 1.71 -18-32-18-3	207.19 +2 +4 **Pb** 82 1.75 -18-32-18-4	208.980 +3 +5 **Bi** 83 1.46 -18-32-18-5	(210) +2 +4 **Po** 84 1.65 -18-32-18-6	(210) **At** 85 1.40 -18-32-18-7	(222) 0 **Rn** 86 2.2 -18-32-18-8
7	(223) +1 **Fr** 87 2.70 -18-32-18-8-1	(226) +2 **Ra** 88 2.20 -18-32-18-8-2	(227) +3 **Ac** 89 2.0 -18-32-18-9-2															

Lanthanide Series

140.12 +3 +4 **Ce** 58 1.82	140.907 +3 **Pr** 59 1.82	144.24 +3 **Nd** 60 1.82	(147) +3 **Pm** 61	150.35 +2 +3 **Sm** 62	151.96 +2 +3 **Eu** 63 2.04	157.25 +3 **Gd** 64 1.79	158.924 +3 **Tb** 65 1.77	162.50 +3 **Dy** 66 1.77	164.930 +3 **Ho** 67 1.76	167.26 +3 **Er** 68 1.75	168.934 +3 **Tm** 69 1.74	173.04 +2 +3 **Yb** 70 1.93	174.97 +3 **Lu** 71 1.74

Actinide Series

232.038 +4 **Th** 90 1.80	(231) +5 +4 **Pa** 91	238.03 +3 +4 +5 +6 **U** 92 1.4	(237) +3 +4 +5 +6 **Np** 93	(242) +3 +4 +5 +6 **Pu** 94	(243) +3 +4 +5 +6 **Am** 95	(247) +3 **Cm** 96	(247) +3 +4 **Bk** 97	(249) +3 **Cf** 98	(254) **Es** 99	(253) **Fm** 100	(256) **Md** 101	(254) **No** 102	(257) **Lw** 103

Numbers in parentheses are mass numbers of most stable or most common isotope.

ET509
X3931-Mr64-100,000