This is the ***draft*** version of the revised data book to be implemented in 2008–2009. We hope to have the final version of the data book ready for May of 2008.

We appreciate receiving feedback on this document.

Please refer to the Chemistry 30 Subject Bulletin 2006–07, and fill in the on-line survey with your comments.

Thank you.

DRAFT

CHEMISTRY

Data Booklet

revised **2006**

Alberta Education

1	2	3	4	5	6	7	8	9

Table of Common Polyatomic Ions

acetate (ethanoate)	CH_3COO^-	chromate	CrO_4^{2-}	phosphate	PO_4^{3-}
ammonium	NH_4^+	dichromate	$Cr_2O_7^{2-}$	hydrogen phosphate	HPO_4^{2-}
benzoate	$C_6H_5COO^-$	cyanide	CN^-	dihydrogen phosphate	$H_2PO_4^-$
borate	BO_3^{3-}	hydroxide	OH^-	silicate	SiO_3^{2-}
carbide	C_2^{2-}	iodate	IO_3^-	sulfate	SO_4^{2-}
carbonate	CO_3^{2-}	nitrate	NO_3^-	hydrogen sulfate	HSO_4^-
hydrogen carbonate (bicarbonate)	HCO_3^-	nitrite	NO_2^-	sulfite	SO_3^{2-}
perchlorate	ClO_4^-	oxalate	$OOCCOO^{2-}$	hydrogen sulfite	HSO_3^-
chlorate	ClO_3^-	hydrogen oxalate	$HOOCCOO^-$	hydrogen sulfide	HS^-
chlorite	ClO_2^-	permanganate	MnO_4^-	thiocyanate	SCN^-
hypochlorite	ClO^- or OCl^-	peroxide	O_2^{2-}	thiosulfate	$S_2O_3^{2-}$
		persulfide	S_2^{2-}		

1 1.01 1+,1– 2.2 H hydrogen								
3 6.94 1+ 1.0 Li lithium	4 9.01 2+ 1.6 Be beryllium							
11 22.99 1+ 0.9 Na sodium	12 24.31 2+ 1.3 Mg magnesium							
19 39.10 1+ 0.8 K potassium	20 40.08 2+ 1.0 Ca calcium	21 44.96 3+ 1.4 Sc scandium	22 47.87 4+, 3+ 1.5 Ti titanium	23 50.94 5+, 4+ 1.6 V vanadium	24 52.00 3+, 2+ 1.7 Cr chromium	25 54.94 2+, 4+ 1.6 Mn manganese	26 55.85 3+, 2+ 1.8 Fe iron	27 58.93 2+, 3+ 1.9 Co cobalt
37 85.47 1+ 0.8 Rb rubidium	38 87.62 2+ 1.0 Sr strontium	39 88.91 3+ 1.2 Y yttrium	40 91.22 4+ 1.3 Zr zirconium	41 92.91 5+, 3+ 1.6 Nb niobium	42 95.94 6+ 2.2 Mo molybdenum	43 (98) 7+ 2.1 Tc technetium	44 101.07 3+, 4+ 2.2 Ru ruthenium	45 102.91 3+ 2.3 Rh rhodium
55 132.91 1+ 0.8 Cs cesium	56 137.33 2+ 0.9 Ba barium	57 138.91 3+ 1.1 La lanthanum	72 178.49 4+ 1.3 Hf hafnium	73 180.95 5+ 1.5 Ta tantalum	74 183.84 6+ 1.7 W tungsten	75 186.21 7+ 1.9 Re rhenium	76 190.23 4+ 2.2 Os osmium	77 192.22 4+ 2.2 Ir iridium
87 (223) 1+ 0.7 Fr francium	88 (226) 2+ 0.9 Ra radium	89 (227) 3+ 1.1 Ac actinium	104 (261) Rf rutherfordium	105 (262) Db dubnium	106 (266) Sg seaborgium	107 (264) Bh bohrium	108 (277) Hs hassium	109 (268) Mt meitnerium

lanthanides and actinides series begin

58 140.12 3+ 1.1 Ce cerium	59 140.91 3+ 1.1 Pr praseodymium	60 144.24 3+ 1.1 Nd neodymium	61 (145) 3+ — Pm promethium	62 150.36 3+, 2+ 1.2 Sm samarium
90 232.04 4+ 1.3 Th thorium	91 231.04 5+, 4+ 1.5 Pa protactinium	92 238.03 6+, 4+ 1.7 U uranium	93 (237) 5+ 1.3 Np neptunium	94 (244) 4+, 6+ 1.3 Pu plutonium

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10	11	12	13	14	15	16	17	18

Legend for Elements

- Metallic Solids
- Gases
- Non-metallic solids
- Liquids

Note: The legend denotes the physical state of the elements at exactly 101.325 kPa and 298.15 K.

Key

Atomic number → 26
Atomic molar mass (g/mol)* → 55.85
Most stable ion charges → 3+, 2+
Electronegativity → 1.8
Symbol → Fe
Name → iron

* Based on $^{12}_{6}C$
( ) Indicates mass of the most stable isotope

								2 4.00 — — He helium
			5 10.81 — 2.0 B boron	6 12.01 — 2.6 C carbon	7 14.01 — 3.0 N nitrogen	8 16.00 — 3.4 O oxygen	9 19.00 — 4.0 F fluorine	10 20.18 — — Ne neon
			13 26.98 3+ 1.6 Al aluminium	14 28.09 — 1.9 Si silicon	15 30.97 — 2.2 P phosphorus	16 32.07 — 2.6 S sulfur	17 35.45 — 3.2 Cl chlorine	18 39.95 — — Ar argon
28 58.69 2+, 3+ 1.9 Ni nickel	29 63.55 2+, 1+ 1.9 Cu copper	30 65.41 2+ 1.7 Zn zinc	31 69.72 3+ 1.8 Ga gallium	32 72.64 4+ 2.0 Ge germanium	33 74.92 — 2.2 As arsenic	34 78.96 — 2.6 Se selenium	35 79.90 — 3.0 Br bromine	36 83.80 — — Kr krypton
46 106.42 2+, 4+ 2.2 Pd palladium	47 107.87 1+ 1.9 Ag silver	48 112.41 2+ 1.7 Cd cadmium	49 114.82 3+ 1.8 In indium	50 118.71 4+, 2+ 2.0 Sn tin	51 121.76 3+, 5+ 2.1 Sb antimony	52 127.60 — 2.1 Te tellurium	53 126.90 — 2.7 I iodine	54 131.29 — 2.6 Xe xenon
78 195.08 4+, 2+ 2.2 Pt platinum	79 196.97 3+, 1+ 2.4 Au gold	80 200.59 2+, 1+ 1.9 Hg mercury	81 204.38 1+, 3+ 1.8 Tl thallium	82 207.2* 2+, 4+ 1.8 Pb lead	83 208.98 3+, 5+ 1.9 Bi bismuth	84 (209) 2+, 4+ 2.0 Po polonium	85 (210) — 2.2 At astatine	86 (222) — — Rn radon
110 (271) Ds darmstadtium	111 (272) Rg roentgenium							

* The isotopic mix of naturally occurring lead is more variable than other elements preventing precision to greater than tenths of a gram per mole.

63 151.96 3+, 2+ — Eu europium	64 157.25 3+ 1.2 Gd gadolinium	65 158.93 3+ — Tb terbium	66 162.50 3+ 1.2 Dy dysprosium	67 164.93 3+ 1.2 Ho holmium	68 167.26 3+ 1.2 Er erbium	69 168.93 3+ 1.3 Tm thulium	70 173.04 3+, 2+ — Yb ytterbium	71 174.97 2+ 1.0 Lu lutetium
95 (243) 3+, 4+ — Am americium	96 (247) 3+ — Cm curium	97 (247) 3+, 4+ — Bk berkelium	98 (251) 3+ — Cf californium	99 (252) 3+ — Es einsteinium	100 (257) 3+ — Fm fermium	101 (258) 2+, 3+ — Md mendelevium	102 (259) 2+, 3+ — No nobelium	103 (262) 3+ — Lr lawrencium

Chemistry Notation

Symbol	Term	Unit(s)
c	specific heat capacity	J/(g • ºC) or J/(g • K)
C	heat capacity	J/ºC or J/K
E	electrical potential	V or J/C
E_k	kinetic energy	kJ
E_p	potential energy	kJ
ΔH	enthalpy (heat)	kJ
$\Delta_f H^o$	standard molar enthalpy of formation	kJ/mol
I	current	A or C/s
K_c	equilibrium constant	—
K_a	acid ionization (dissociation) constant	—
K_b	base ionization (dissociation) constant	—
M	molar mass	g/mol
m	mass	g
n	amount	mol
P	pressure	kPa
Q	charge	C
T	temperature (absolute)	K
t	temperature (Celsius)	ºC
t	time	s
V	volume	L

Symbol	Term
Δ	delta (change in)
º	standard
[ ]	amount concentration

Miscellaneous

25.00 °C	equivalent to 298.15 K		
Specific heat capacity	c_{air}	=	1.01 J/(g • °C)
(at 298.15 K and 100.000 kPa)	$c_{polystyrene\ foam\ cup}$	=	1.01 J/(g • °C)
	c_{copper}	=	0.385 J/(g • °C)
	$c_{aluminium}$	=	0.897 J/(g • °C)
	c_{tin}	=	0.228 J/(g • °C)
	c_{water}	=	4.19 J/(g • °C)
Water autoionization constant (Dissociation constant)	$K_w = 1.0 \times 10^{-14}$ at 298.15 K (for ion concentrations in mol/L)		
Faraday constant	$F = 9.65 \times 10^4$ C/mol e^-		
Quadratic formula	$x = -b \pm \frac{\sqrt{b^2 - 4ac}}{2a}$		

Selected SI Prefixes

Prefix	Exponential Symbol	Value
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

Standard Molar Enthalpies of Formation at 298.15 K

Name	Formula	$\Delta_f H°$ (kJ/mol)
aluminum oxide	$Al_2O_3(s)$	– 1 675.7
ammonia	$NH_3(g)$	– 45.9
ammonium chloride	$NH_4Cl(s)$	– 314.4
ammonium nitrate	$NH_4NO_3(s)$	– 365.6
barium carbonate	$BaCO_3(s)$	– 1 213.0
barium chloride	$BaCl_2(s)$	– 855.0
barium hydroxide	$Ba(OH)_2(s)$	– 944.7
barium oxide	$BaO(s)$	– 548.0
barium sulfate	$BaSO_4(s)$	– 1 473.2
benzene	$C_6H_6(l)$	+ 49.1
butane	$C_4H_{10}(g)$	– 125.7
calcium carbonate	$CaCO_3(s)$	– 1 207.6
calcium chloride	$CaCl_2(s)$	– 795.4
calcium hydroxide	$Ca(OH)_2(s)$	– 985.2
calcium oxide	$CaO(s)$	– 634.9
calcium sulfate	$CaSO_4(s)$	– 1 434.5
carbon dioxide	$CO_2(g)$	– 393.5
carbon monoxide	$CO(g)$	– 110.5
chromium(III) oxide	$Cr_2O_3(s)$	– 1 139.7
copper(I) oxide	$Cu_2O(s)$	– 168.6
copper(II) oxide	$CuO(s)$	– 157.3
copper(II) sulfate	$CuSO_4(s)$	– 771.4
copper(I) sulfide	$Cu_2S(s)$	– 79.5
copper(II) sulfide	$CuS(s)$	– 53.1
dinitrogen tetroxide	$N_2O_4(g)$	+ 11.1
ethane	$C_2H_6(g)$	– 84.0
ethanoic acid (acetic acid)	$CH_3COOH(l)$	– 484.3
ethanol	$C_2H_5OH(l)$	– 277.6
ethene (ethylene)	$C_2H_4(g)$	+ 52.4
ethyne (acetylene)	$C_2H_2(g)$	+ 227.4
glucose	$C_6H_{12}O_6(s)$	– 1 273.3
hydrogen bromide	$HBr(g)$	– 36.3
hydrogen chloride	$HCl(g)$	– 92.3
hydrogen fluoride	$HF(g)$	– 273.3
hydrogen iodide	$HI(g)$	+ 26.5
hydrogen perchlorate	$HClO_4(l)$	– 40.6
hydrogen peroxide	$H_2O_2(l)$	– 187.8
hydrogen sulfide	$H_2S(g)$	– 20.6
iron(II) oxide	$FeO(s)$	– 272.0
iron(III) oxide	$Fe_2O_3(s)$	– 824.2
iron(II,III) oxide (magnetite)	$Fe_3O_4(s)$	– 1 118.4
lead(II) bromide	$PbBr_2(s)$	– 278.7
lead(II) chloride	$PbCl_2(s)$	– 359.4
lead(II) oxide (red)	$PbO(s)$	– 219.0
lead(IV) oxide	$PbO_2(s)$	– 277.4
magnesium carbonate	$MgCO_3(s)$	– 1 095.8
magnesium chloride	$MgCl_2(s)$	– 641.3

Standard Molar Enthalpies of Formation at 298.15 K, con't.

Name	Formula	$\Delta_f H°$ (kJ/mol)
magnesium hydroxide	$Mg(OH)_2(s)$	– 924.5
magnesium oxide	$MgO(s)$	– 601.6
magnesium sulfate	$MgSO_4(s)$	– 1 284.9
manganese(II) oxide	$MnO(s)$	– 385.2
manganese(IV) oxide	$MnO_2(s)$	– 520.0
mercury(II) oxide (red)	$HgO(s)$	– 90.8
mercury(II) sulfide (red)	$HgS(s)$	– 58.2
methanal (formaldehyde)	$CH_2O(g)$	– 108.6
methane	$CH_4(g)$	– 74.6
methanoic acid (formic acid)	$HCOOH(l)$	– 425.0
methanol	$CH_3OH(l)$	– 239.2
nickel(II) oxide	$NiO(s)$	– 240.6
nitric acid	$HNO_3(l)$	– 174.1
nitrogen dioxide	$NO_2(g)$	+ 33.2
nitrogen monoxide	$NO(g)$	+ 91.3
octane	$C_8H_{18}(l)$	– 250.1
pentane	$C_5H_{12}(l)$	– 173.5
phosphorus pentachloride	$PCl_5(s)$	– 443.5
phosphorus trichloride (liquid)	$PCl_3(l)$	– 319.7
phosphorus trichloride (vapour)	$PCl_3(g)$	– 287.0
potassium bromide	$KBr(s)$	– 393.8
potassium chlorate	$KClO_3(s)$	– 397.7
potassium chloride	$KCl(s)$	– 436.5
potassium hydroxide	$KOH(s)$	– 424.6
propane	$C_3H_8(g)$	– 103.8
silicon dioxide (α-quartz)	$SiO_2(s)$	– 910.7
silver bromide	$AgBr(s)$	– 100.4
silver chloride	$AgCl(s)$	– 127.0
silver iodide	$AgI(s)$	– 61.8
sodium bromide	$NaBr(s)$	– 361.1
sodium chloride	$NaCl(s)$	– 411.2
sodium hydroxide	$NaOH(s)$	– 425.8
sodium iodide	$NaI(s)$	– 287.8
sucrose	$C_{12}H_{22}O_{11}(s)$	– 2 226.1
sulfur dioxide	$SO_2(g)$	– 296.8
sulfuric acid	$H_2SO_4(l)$	– 814.0
sulfur trioxide (liquid)	$SO_3(l)$	– 441.0
sulfur trioxide (vapour)	$SO_3(g)$	– 395.7
tin(II) chloride	$SnCl_2(s)$	– 325.1
tin(IV) chloride	$SnCl_4(l)$	– 511.3
tin(II) oxide	$SnO(s)$	– 280.7
tin(IV) oxide	$SnO_2(s)$	– 577.6
water (liquid)	$H_2O(l)$	– 285.8
water (vapour)	$H_2O(g)$	– 241.8
zinc oxide	$ZnO(s)$	– 350.5
zinc sulfide (sphalerite)	$ZnS(s)$	– 206.0

Solubility of Some Common Ionic Compounds in Water at 298.15 K

Ion	**H^+, Na^+, NH_4^+, NO_3^-, ClO_3^-, ClO_4^-, CH_3COO^-**	**F^-**	**Cl^-, I^-, Br^-**	**SO_4^{2-}**	**CO_3^{2-}, PO_4^{3-}, SO_3^{2-},**	**IO_3^-, $C_2O_4^{2-}$**	**S^{2-}**	**OH^-**
Solubility greater than or equal to 0.1 mol/L **(very soluble)**	most Except: $RbClO_4$, $CsClO_4$, $AgCH_3COO$, $Hg_2(CH_3COO)_2$	most	most	most	H^+, Na^+, K^+, NH_4^+ Except: Li_2CO_3	H^+, Na^+, K^+, NH_4^+, Li^+, Ni^{2+}, Zn^{2+}, Except: $Co(IO_3)_2$, $Fe_2(C_2O_4)_3$	H^+, Na^+, K^+, NH_4^+, Li^+, Mg^{2+}, Ca^{2+}	H^+, Na^+, K^+, NH_4^+, Li^+, Sr^{2+}, Ca^{2+}, Ba^{2+}
Solubility less than 0.1 mol/L **(slightly soluble)**	none	Li^+, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Fe^{2+}, Hg_2^{2+}, Pb^{2+}	Cu^+, Ag^+, Hg_2^{2+}, Hg^{2+}, PbI_2	Ca^{2+}, Sr^{2+}, Ba^{2+}, Hg_2^{2+}, Pb^{2+}, Ag^+	most	most	most	most

Note: This solubility table is only a guideline that is established using the K_{sp} values. A concentration of 0.1 mol/L corresponds to approximately 10 g/L to 30 g/L depending on molecular mass.

Table of Selected Standard Electrode Potentials*

Reduction Half-Reaction			Electrical Potential $E°$ (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-(aq)$	+2.87
$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^-$	$\rightleftharpoons$	$PbSO_4(s) + 2H_2O(l)$	+1.69
$MnO_4^-(aq) + 8H^+(aq) + 5e^-$	$\rightleftharpoons$	$Mn^{2+}(aq) + 4H_2O(l)$	+1.51
$Au^{3+}(aq) + 3e^-$	$\rightleftharpoons$	$Au(s)$	+1.50
$ClO_4^-(aq) + 8H^+(aq) + 8e^-$	$\rightleftharpoons$	$Cl^-(aq) + 4H_2O(l)$	+1.39
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-(aq)$	+1.36
$2HNO_2(aq) + 4H^+(aq) + 4e^-$	$\rightleftharpoons$	$N_2O(g) + 3H_2O(l)$	+1.30
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$	$\rightleftharpoons$	$2Cr^{3+}(aq) + 7H_2O(l)$	+1.23
$O_2(g) + 4H^+(aq) + 4e^-$	$\rightleftharpoons$	$2H_2O(l)$	+1.23
$MnO_2(s) + 4H^+(aq) + 2e^-$	$\rightleftharpoons$	$Mn^{2+}(aq) + 2H_2O(l)$	+1.22
$Br_2(l) + 2e^-$	$\rightleftharpoons$	$2Br^-(aq)$	+1.07
$Hg^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Hg(l)$	+0.85
$OCl^-(aq) + H_2O(l) + 2e^-$	$\rightleftharpoons$	$Cl^-(aq) + 2OH^-(aq)$	+0.84
$2NO_3^-(aq) + 4H^+(aq) + 2e^-$	$\rightleftharpoons$	$N_2O_4(g) + 2H_2O(l)$	+0.80
$Ag^+(aq) + e^-$	$\rightleftharpoons$	$Ag(s)$	+0.80
$Fe^{3+}(aq) + e^-$	$\rightleftharpoons$	$Fe^{2+}(aq)$	+0.77
$O_2(g) + 2H^+(aq) + 2e^-$	$\rightleftharpoons$	$H_2O_2(l)$	+0.70
$I_2(s) + 2e^-$	$\rightleftharpoons$	$2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^-$	$\rightleftharpoons$	$4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Cu(s)$	+0.34
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^-$	$\rightleftharpoons$	$H_2SO_3(aq) + H_2O(l)$	+0.17
$Sn^{4+}(aq) + 2e^-$	$\rightleftharpoons$	$Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^-$	$\rightleftharpoons$	$H_2S(aq)$	+0.14
$AgBr(s) + e^-$	$\rightleftharpoons$	$Ag(s) + Br^-(aq)$	+0.07
$2H^+(aq) + 2e^-$	$\rightleftharpoons$	$H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Pb(s)$	−0.13
$Sn^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Sn(s)$	−0.14
$AgI(s) + e^-$	$\rightleftharpoons$	$Ag(s) + I^-(aq)$	−0.15
$Ni^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Ni(s)$	−0.26
$Co^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Co(s)$	−0.28
$PbSO_4(s) + 2e^-$	$\rightleftharpoons$	$Pb(s) + SO_4^{2-}(aq)$	−0.36
$Se(s) + 2H^+(aq) + 2e^-$	$\rightleftharpoons$	$H_2Se(aq)$	−0.40
$Cd^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Cd(s)$	−0.40
$Cr^{3+}(aq) + e^-$	$\rightleftharpoons$	$Cr^{2+}(aq)$	−0.41
$Fe^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Fe(s)$	−0.45
$NO_2^-(aq) + H_2O(l) + e^-$	$\rightleftharpoons$	$NO(g) + 2OH^-(aq)$	−0.46
$Ag_2S(s) + 2e^-$	$\rightleftharpoons$	$2Ag(s) + S^{2-}(aq)$	−0.69
$Zn^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Zn(s)$	−0.76
$2H_2O(l) + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-(aq)$	−0.83
$Cr^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Cr(s)$	−0.91
$Se(s) + 2e^-$	$\rightleftharpoons$	$Se^{2-}(aq)$	−0.92
$SO4^{2-}(aq) + H_2O(l) + 2e^-$	$\rightleftharpoons$	$SO_3^{2-}(aq) + 2OH^-(aq)$	−0.93
$Al^{3+}(aq) + 3e^-$	$\rightleftharpoons$	$Al(s)$	−1.66
$Mg^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Mg(s)$	−2.37
$Na^+(aq) + e^-$	$\rightleftharpoons$	$Na(s)$	−2.71
$Ca^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Ca(s)$	−2.87
$Ba^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Ba(s)$	−2.91
$K^+(aq) + e^-$	$\rightleftharpoons$	$K(s)$	−2.93
$Li^+(aq) + e^-$	$\rightleftharpoons$	$Li(s)$	−3.04

*For 1.0 mol/L solutions at 298.15 K (25.00 °C) and a pressure of 101.325 kPa

Relative Strengths of Acids and Bases at 298.15 K

Common Acid Name IUPAC Acid Name	Acid Formula	Conjugate Base Formula	K_a
perchloric acid aqueous hydrogen perchlorate	$HClO_4(aq)$	$ClO_4^-(aq)$	very large
hydroiodic acid aqueous hydrogen iodide	$HI(aq)$	$I^-(aq)$	very large
hydrobromic acid aqueous hydrogen bromide	$HBr(aq)$	$Br^-(aq)$	very large
hydrochloric acid aqueous hydrogen chloride	$HCl(aq)$	$Cl^-(aq)$	very large
sulfuric acid aqueous hydrogen sulfate	$H_2SO_4(aq)$	$HSO_4^-(aq)$	very large
nitric acid aqueous hydrogen nitrate	$HNO_3(aq)$	$NO_3^-(aq)$	very large
hydronium ion	$H_3O^+(aq)$	$H_2O(l)$	1
oxalic acid	$HOOCCOOH(aq)$	$HOOCCOO^-(aq)$	5.6×10^{-2}
sulfurous acid aqueous hydrogen sulfite	$H_2SO_3(aq)$	$HSO_3^-(aq)$	1.4×10^{-2}
hydrogen sulfate ion	$HSO_4^-(aq)$	$SO_4^{2-}(aq)$	1.0×10^{-2}
phosphoric acid aqueous hydrogen phosphate	$H_3PO_4(aq)$	$H_2PO_4^-(aq)$	6.9×10^{-3}
butanoic acid	$C_3H_7COOH(aq)$	$C_3H_7COO^-(aq)$	1.5×10^{-4}
nitrous acid aqueous hydrogen nitrite	$HNO_2(aq)$	$NO_2^-(aq)$	5.6×10^{-4}
citric acid 2-hydroxy-1,2,3-propanetricarboxylic acid	$C_3H_5O(COOH)_3(aq)$	$C_3H_5O(COOH)_2COO^-(aq)$	7.4×10^{-4}
hydrofluoric acid aqueous hydrogen fluoride	$HF(aq)$	$F^-(aq)$	6.3×10^{-4}
formic acid methanoic acid	$HCOOH(aq)$	$HCOO^-(aq)$	1.8×10^{-4}
hydrogen oxalate ion	$HOOCCOO^-(aq)$	$OOCCOO^{2-}(aq)$	1.5×10^{-4}
lactic acid 2-hydroxypropanoic acid	$C_2H_5OCOOH(aq)$	$C_2H_5OCOO^-(aq)$	1.4×10^{-4}
ascorbic acid 2-oxo-L-threo-hexono-1,4 lactine-2,3 enediol	$H_2C_6H_6O_6(aq)$	$HC_6H_6O_6^-(aq)$	9.1×10^{-5}
benzoic acid benzenecarboxylic acid	$C_6H_5COOH(aq)$	$C_6H_5COO^-(aq)$	6.3×10^{-5}
acetic acid ethanoic acid	$CH_3COOH(aq)$	$CH_3COO^-(aq)$	1.8×10^{-5}
dihydrogen citrate ion	$H_2C_6H_5O_7^-(aq)$	$HC_6H_5O_7^{2-}(aq)$	1.7×10^{-5}

Relative Strengths of Acids and Bases at 298.15 K

Common Acid Name IUPAC Acid Name	Acid Formula	Conjugate Base Formula	K_a
propanoic acid	$C_2H_5COOH(aq)$	$C_2H_5COO^-(aq)$	1.3×10^{-5}
hydrogen citrate ion	$C_3H_5O(COOH)_2COO^-(aq)$	$C_3H_5OCOOH(COO)_2^{2-}(aq)$	4.0×10^{-7}
carbonic acid ($CO_2 + H_2O$) aqueous hydrogen carbonate	$H_2CO_3(aq)$	$HCO_3^-(aq)$	4.5×10^{-7}
dihydrogen citrate ion	$C_3H_5OCOOH(COO)_2^{2-}(aq)$	$C_3H_5O(COO)_3^{3-}(aq)$	4.0×10^{-7}
hydrosulfuric acid aqueous hydrogen sulfide	$H_2S(aq)$	$HS^-(aq)$	8.9×10^{-8}
hydrogen sulfite ion	$HSO_3^-(aq)$	$SO_3^{2-}(aq)$	6.3×10^{-8}
dihydrogen phosphate ion	$H_2PO_4^-(aq)$	$HPO_4^{2-}(aq)$	6.2×10^{-8}
hypochlorous acid aqueous hydrogen hypochlorite	$HOCl(aq)$	$OCl^-(aq)$	4.0×10^{-8}
hydrocyanic acid aqueous hydrogen cyanide	$HCN(aq)$	$CN^-(aq)$	6.2×10^{-10}
ammonium ion	$NH_4^+(aq)$	$NH_3(aq)$	5.6×10^{-10}
hydrogen carbonate ion	$HCO_3^-(aq)$	$CO_3^{2-}(aq)$	4.7×10^{-11}
hydrogen ascorbate ion	$HC_6H_6O_6^-(aq)$	$C_6H_6O_6^{2-}(aq)$	2.0×10^{-12}
hydrogen phosphate ion	$HPO_4^{2-}(aq)$	$PO_4^{3-}(aq)$	4.8×10^{-13}
water	$H_2O(l)$	$OH^-(aq)$	1.0×10^{-14}

Note: An approximation may be used when the concentration of the acid is 1000 times greater than the K_a.
The formula of the carboxylic acids have been written so that the COOH group can be easily recognized.
Either the common or IUPAC name is acceptable.

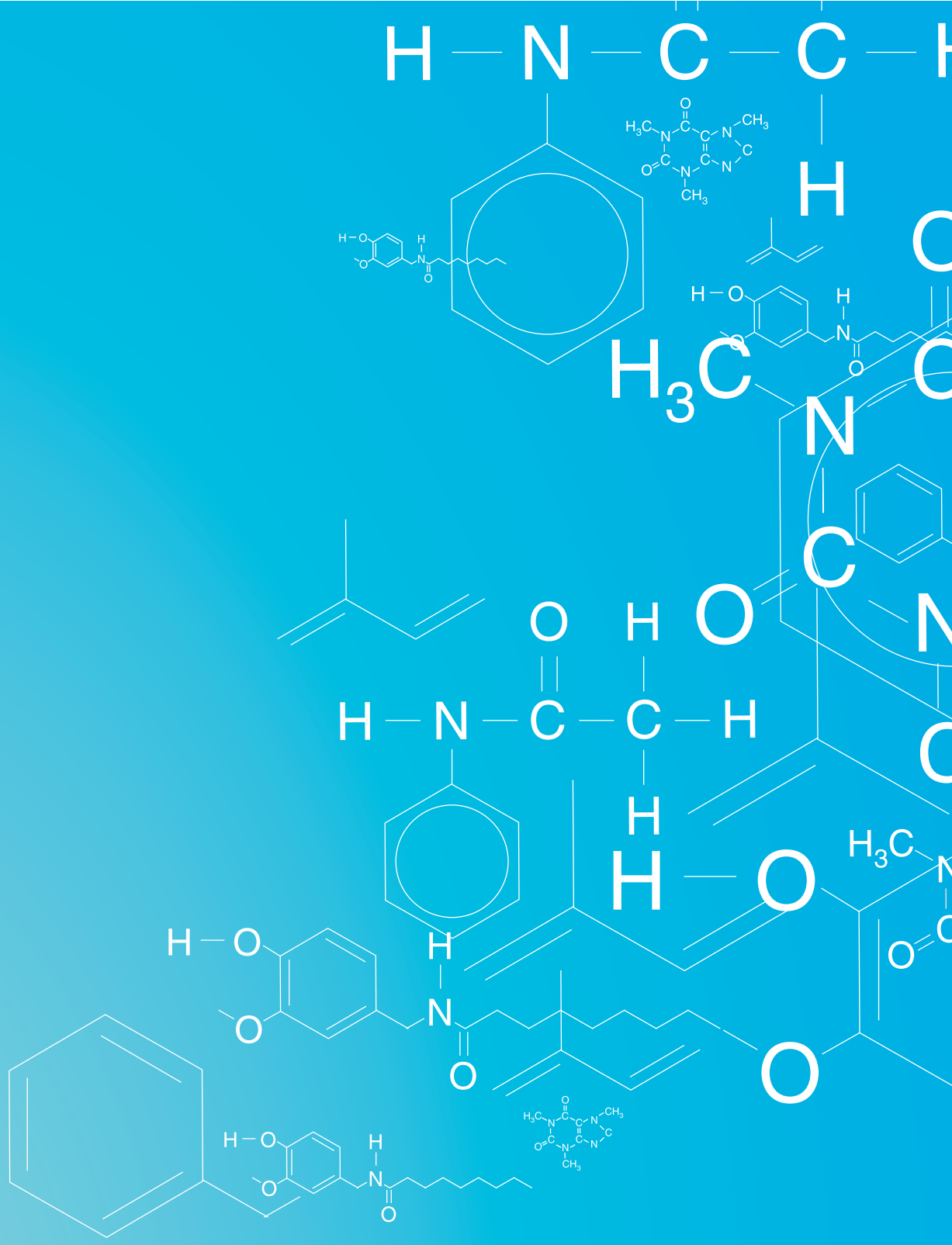
Acid–Base Indicators at 298.15 K

Indicator	Suggested Abbreviation(s)	pH Range	Colour Change as pH Increases	K_a
methyl violet	HMv(aq) / Mv^-(aq)	0.0– 1.6	yellow to blue	~2×10^{-1}
cresol red	H_2Cr(aq) / HCr^-(aq)	0.0 – 1.0	red to yellow	~3×10^{-1}
	HCr^-(aq) / Cr^{2-}(aq)	7.0 – 8.8	yellow to red	3.5×10^{-9}
thymol blue	H_2Tb(aq) / HTb^-(aq)	1.2 – 2.8	red to yellow	2.2×10^{-2}
	HTb^-(aq) / Tb^{2-}(aq)	8.0 – 9.6	yellow to blue	6.3×10^{-10}
orange IV	HOr(aq) / Or^-(aq)	1.4 – 2.8	red to yellow	~1×10^{-2}
methyl orange	HMo(aq) / Mo^-(aq)	3.2 – 4.4	red to yellow	3.5×10^{-4}
bromocresol green	HBg(aq) / Bg^-(aq)	3.8 – 5.4	yellow to blue	1.3×10^{-5}
methyl red	HMr(aq) / Mr^-(aq)	4.8 – 6.0	red to yellow	1.0×10^{-5}
chlorophenol red	HCh(aq) / Ch^-(aq)	5.2 – 6.8	yellow to red	5.6×10^{-7}
bromothymol blue	HBb(aq) / Bb^-(aq)	6.0 – 7.6	yellow to blue	5.0×10^{-8}
phenol red	HPr(aq) / Pr^-(aq)	6.6 – 8.0	yellow to red	1.0×10^{-8}
phenolphthalein	HPh(aq) / Ph^-(aq)	8.2 – 10.0	colourless to pink	3.2×10^{-10}
thymolphthalein	HTh(aq) / Th^-(aq)	9.4 – 10.6	colourless to blue	1.0×10^{-10}
alizarin yellow R	HAy(aq) / Ay^-(aq)	10.1 – 12.0	yellow to red	6.9×10^{-12}
indigo carmine	HIc(aq) / Ic^-(aq)	11.4 – 13.0	blue to yellow	~6×10^{-12}
1,3,5–trinitrobenzene	HNb(aq) / Nb^-(aq)	12.0 – 14.0	colourless to orange	~1×10^{-13}

Colours of Common Aqueous Ions

Ionic Species	Solution Concentration	
	1.0 mol/L	0.010 mol/L
chromate	yellow	pale yellow
chromium(III)	blue-green	green
chromium(II)	dark blue	pale blue
cobalt(II)	red	pink
copper(I)	blue-green	pale blue-green
copper(II)	blue	pale blue
dichromate	orange	pale orange
iron(II)	lime green	colourless
iron(III)	orange-yellow	pale yellow
manganese(II)	pale pink	colourless
nickel(II)	blue-green	pale blue-green
permanganate	deep purple	purple-pink

Notes:



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