CHEMISTRY

Data Booklet

revised **2008**

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	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	OCl^- or ClO^-	peroxide	O_2^{2-}	thiosulfate	$S_2O_3^{2-}$
		persulfide	S_2^{2-}		

1	2	3	4	5	6	7	8	9
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

lanthanide and actinide 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

References

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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

10	11	12	13	14	15	16	17	18
								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+, 3+ 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
$\Delta_{\mathrm{f}} H^{\circ}$	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 of substance	mol
P	pressure	kPa
Q	charge	C
T	temperature (absolute)	K
t	temperature (Celsius)	ºC
t	time	s
V	volume	L
c	amount concentration	mol/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}	=	0.227 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	$x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$		

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)
aluminium 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 cont'd

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^- Br^- I^-**	**SO_4^{2-}**	**CO_3^{2-} PO_4^{3-} SO_3^{2-}**	**IO_3^- $OOCCOO^{2-}$**	**S^{2-}**	**OH^-**
Solubility greater than or equal to 0.1 mol/L **(very soluble)**	most	most	most	most	H^+ Na^+ K^+ NH_4^+	H^+ Na^+ K^+ NH_4^+ Li^+ Ni^{2+} Zn^{2+}	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)**	$RbClO_4$ $CsClO_4$ $AgCH_3COO$ $Hg_2(CH_3COO)_2$	Li^+ Mg^{2+} Ca^{2+} Sr^{2+} Ba^{2+} Fe^{2+} Hg_2^{2+} Pb^{2+}	Cu^+ Ag^+ Hg_2^{2+} Hg^{2+} Pb^{2+}	Ca^{2+} Sr^{2+} Ba^{2+} Hg_2^{2+} Pb^{2+} Ag^+	most **Exception:** Li_2CO_3 is soluble	most **Exceptions:** $Co(IO_3)_2$ $Fe_2(C_2O_4)_3$ are soluble	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 molar mass.

Flame Colour of Elements

Element	Symbol	Colour
lithium	Li	red
sodium	Na	yellow
potassium	K	violet
rubidium	Rb	violet
cesium	Cs	violet
calcium	Ca	yellowish red
strontium	Sr	scarlet red
barium	Ba	yellowish green
copper	Cu	blue to green
boron	B	yellowish green
lead	Pb	blue-white

Note: The flame test can be used to determine the identity of a metal or a metal ion. Blue to green indicates a range of colours that might appear.

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
$SO_4^{2-}(aq) + H_2O(l) + 2e^- \rightleftharpoons SO_3^{2-}(aq) + 2OH^-(aq)$	−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 Name IUPAC / Systematic 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}
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}
nitrous acid aqueous hydrogen nitrite	$HNO_2(aq)$	$NO_2^-(aq)$	5.6×10^{-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(1,2-dihydroxyethyl)-4,5-dihydroxy -furan-3-one	$H_2C_6H_6O_6(aq)$	$HC_6H_6O_6^-(aq)$	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}

Relative Strengths of Acids and Bases at 298.15 K

Common Name IUPAC / Systematic Name	Acid Formula	Conjugate Base Formula	K_a
dihydrogen citrate ion	$C_3H_5O(COOH)_2COO^-(aq)$	$C_3H_5OCOOH(COO)_2^{2-}(aq)$	1.7×10^{-5}
butanoic acid	$C_3H_7COOH(aq)$	$C_3H_7COO^-(aq)$	1.5×10^{-5}
propanoic acid	$C_2H_5COOH(aq)$	$C_2H_5COO^-(aq)$	1.3×10^{-5}
carbonic acid ($CO_2 + H_2O$) aqueous hydrogen carbonate	$H_2CO_3(aq)$	$HCO_3^-(aq)$	4.5×10^{-7}
hydrogen 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 instead of the quadratic formula when the concentration of H_3O^+ produced is less than 5% of the original acid concentration (or the concentration of the acid is 1 000 times greater than the K_a). The same approximation can also be used for weak bases. 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	$\sim 2 \times 10^{-1}$
cresol red	$H_2Cr(aq)$ / $HCr^-(aq)$ $HCr^-(aq)$ / $Cr^{2-}(aq)$	0.0 – 1.0 7.0 – 8.8	red to yellow yellow to red	$\sim 3 \times 10^{-1}$ 3.5×10^{-9}
thymol blue	$H_2Tb(aq)$ / $HTb^-(aq)$ $HTb^-(aq)$ / $Tb^{2-}(aq)$	1.2 – 2.8 8.0 – 9.6	red to yellow yellow to blue	2.2×10^{-2} 6.3×10^{-10}
orange IV	$HOr(aq)$ / $Or^-(aq)$	1.4 – 2.8	red to yellow	$\sim 1 \times 10^{-2}$
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	$\sim 6 \times 10^{-12}$
1,3,5–trinitrobenzene	$HNb(aq)$ / $Nb^-(aq)$	12.0 – 14.0	colourless to orange	$\sim 1 \times 10^{-13}$

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: