GRANT MACEWAN CHEMISTRY DATA SHEET

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.00794																	2 **He** 4.002602
3 **Li** 6.941	4 **Be** 9.012182											5 **B** 10.811	6 **C** 12.0107	7 **N** 14.0067	8 **O** 15.9994	9 **F** 18.9984032	10 **Ne** 20.1797
11 **Na** 22.989770	12 **Mg** 24.3050											13 **Al** 26.981538	14 **Si** 28.0855	15 **P** 30.973761	16 **S** 32.065	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.0983	20 **Ca** 40.078	21 **Sc** 44.95591	22 **Ti** 47.867	23 **V** 50.9415	24 **Cr** 51.9961	25 **Mn** 54.938049	26 **Fe** 55.845	27 **Co** 58.9332	28 **Ni** 58.6934	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.64	33 **As** 74.92160	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.4678	38 **Sr** 87.62	39 **Y** 88.90585	40 **Zr** 91.224	41 **Nb** 92.90638	42 **Mo** 95.94	43 **Tc** [97.9072]	44 **Ru** 101.07	45 **Rh** 102.9055	46 **Pd** 106.42	47 **Ag** 107.8682	48 **Cd** 112.411	49 **In** 114.818	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90447	54 **Xe** 131.293
55 **Cs** 132.90545	56 **Ba** 137.327	57 **La*** 138.9055	72 **Hf** 178.49	73 **Ta** 180.9479	74 **W** 183.84	75 **Re** 186.207	76 **Os** 190.23	77 **Ir** 192.217	78 **Pt** 195.078	79 **Au** 196.96655	80 **Hg** 200.59	81 **Tl** 204.3833	82 **Pb** 207.2	83 **Bi** 208.98038	84 **Po** [208.9824]	85 **At** [209.9871]	86 **Rn** [222.0176]
87 **Fr** [223.0197]	88 **Ra** [226.0254]	89 **Ac**** [227.0277]	104 **Rf** [261.1088]	105 **Db** [262.1141]	106 **Sg** [266.1219]	107 **Bh** [264.12]	108 **Hs** [277]	109 **Mt** [268.1388]	110 **Ds** [281]	111 **Rg** [272]	112 **Uub** [285]	113 **Uut** [285]	114 **Uuq** [289]	115 **Uup** [288]	116 **Uuh** [289]	117	118

*	58 **Ce** 140.116	59 **Pr** 140.90765	60 **Nd** 144.24	61 **Pm** [144.9127]	62 **Sm** 150.36	63 **Eu** 151.964	64 **Gd** 157.25	65 **Tb** 158.92534	66 **Dy** 162.50	67 **Ho** 164.93032	68 **Er** 167.259	69 **Tm** 168.93421	70 **Yb** 173.04	71 **Lu** 174.967
**	90 **Th** 232.0381	91 **Pa** 231.03588	92 **U** 238.02891	93 **Np** [237.0482]	94 **Pu** [244.0642]	95 **Am** [243.0614]	96 **Cm** [247.0704]	97 **Bk** [247.0703]	98 **Cf** [251.0796]	99 **Es** [252.0830]	100 **Fm** [257.0951]	101 **Md** [258.0984]	102 **No** [259.1010]	103 **Lr** [262.1097]

Electronegativities

1 2.20																	2 0.00
3 0.98	4 1.57											5 2.04	6 2.55	7 3.04	8 3.44	9 3.98	10 0.00
11 0.93	12 1.31											13 1.50	14 1.80	15 2.19	16 2.58	17 3.16	18 0.00
19 0.82	20 1.00	21 1.36	22 1.54	23 1.63	24 1.66	25 1.55	26 1.83	27 1.88	28 1.91	29 1.90	30 1.65	31 1.81	32 2.01	33 2.18	34 2.55	35 2.96	36 0.00
37 0.82	38 0.95	39 1.22	40 1.33	41 1.60	42 2.16	43 1.90	44 2.20	45 2.28	46 2.20	47 1.93	48 1.69	49 1.78	50 1.96	51 2.05	52 2.10	53 2.66	54 0.00
55 0.79	56 0.89	57 1.10	72 1.30	73 1.50	74 2.36	75 1.90	76 2.20	77 2.20	78 2.28	79 2.54	80 2.00	81 2.04	82 2.33	83 2.02	84 2.00	85 2.20	86 0.00
87 0.70	88 0.90	89 1.10	104 —	105 —	106 —	107 —	108 —	109 —	110 —	111 —	112 —	113 —	114 —	115 —	116 —	117 —	118 —

Solubility Product Constants

Compound	K_{sp}(298 K)	Compound	K_{sp}(298 K)
Ag_2CO_3	$8.4\cdot10^{-12}$	$Fe(OH)_2$	$4.9\cdot10^{-17}$
Ag_2CrO_4	$1.1\cdot10^{-12}$	$Fe(OH)_3$	$2.6\cdot10^{-39}$
Ag_2S	$6.7\cdot10^{-50}$	$FeCO_3$	$3.1\cdot10^{-11}$
Ag_2SO_4	$1.2\cdot10^{-5}$	$FePO_4$	$9.9\cdot10^{-29}$
Ag_3PO_4	$8.9\cdot10^{-17}$	FeS	$1.6\cdot10^{-19}$
AgBr	$5.3\cdot10^{-13}$	Hg_2Br_2	$6.4\cdot10^{-23}$
AgCl	$1.8\cdot10^{-10}$	Hg_2Cl_2	$1.4\cdot10^{-18}$
AgCN	$6.0\cdot10^{-17}$	Hg_2I_2	$5.3\cdot10^{-29}$
AgI	$8.5\cdot10^{-17}$	HgS	$6.4\cdot10^{-53}$
$AgIO_3$	$3.2\cdot10^{-8}$	Li_3PO_4	$3.2\cdot10^{-9}$
AgN_3	$2.8\cdot10^{-9}$	Li_2CO_3	$8.1\cdot10^{-4}$
AgSCN	$1.0\cdot10^{-12}$	LiF	$3.8\cdot10^{-3}$
$Al(OH)_3$	$1.3\cdot10^{-33}$	$Mg(OH)_2$	$5.6\cdot10^{-11}$
$AlPO_4$	$9.8\cdot10^{-21}$	$Mg_3(PO_4)_2$	$9.9\cdot10^{-25}$
$Ba(OH)_2$	$2.6\cdot10^{-4}$	$MgCO_3$	$3.8\cdot10^{-6}$
$BaCO_3$	$5.6\cdot10^{-9}$	MgF_2	$7.4\cdot10^{-11}$
$BaCrO_4$	$1.2\cdot10^{-10}$	$Mn(OH)_2$	$5.6\cdot10^{-12}$
BaF_2	$1.8\cdot10^{-7}$	MnS	$4.6\cdot10^{-14}$
$BaSO_4$	$1.1\cdot10^{-10}$	$Ni(OH)_2$	$5.5\cdot10^{-16}$
Bi_2S_3	$1.8\cdot10^{-99}$	$Ni_3(PO_4)_2$	$4.7\cdot10^{-32}$
$Ca(OH)_2$	$4.7\cdot10^{-6}$	$NiCO_3$	$1.4\cdot10^{-7}$
$Ca_3(PO_4)_2$	$2.1\cdot10^{-33}$	NiS	$1.7\cdot10^{-21}$
$CaCO_3$	$5.0\cdot10^{-9}$	$Pb(N_3)_2$	$2.5\cdot10^{-9}$
$CaCrO_4$	$7.1\cdot10^{-4}$	$Pb(OH)_2$	$1.4\cdot10^{-20}$
CaF_2	$1.5\cdot10^{-10}$	$PbBr_2$	$6.6\cdot10^{-6}$
$CaSO_4$	$7.1\cdot10^{-5}$	$PbCl_2$	$1.2\cdot10^{-5}$
$Cd(OH)_2$	$5.3\cdot10^{-15}$	$PbCO_3$	$1.5\cdot10^{-13}$
CdC_2O_4	$1.4\cdot10^{-8}$	$PbCrO_4$	$2.8\cdot10^{-13}$
$CdCO_3$	$6.2\cdot10^{-12}$	PbF_2	$7.1\cdot10^{-7}$
CdS	$1.4\cdot10^{-29}$	PbI_2	$8.5\cdot10^{-9}$
$Co(OH)_2$	$1.1\cdot10^{-15}$	PbS	$9.0\cdot10^{-29}$
$Co(OH)_3$	$1.6\cdot10^{-44}$	$PbSO_4$	1.810^{-8}
$CoCO_3$	$1.4\cdot10^{-13}$	$Sn(OH)_2$	$5.4\cdot10^{-27}$
$Cr(OH)_2$	$2.0\cdot10^{-16}$	SnS	$3.2\cdot10^{-28}$
$Cr(OH)_3$	$6.3\cdot10^{-31}$	$SrCO_3$	$5.6\cdot10^{-10}$
$Cu(OH)_2$	$2.2\cdot10^{-20}$	SrF_2	$4.3\cdot10^{-9}$
CuCl	$1.7\cdot10^{-7}$	$SrSO_4$	$3.4\cdot10^{-7}$
CuCN	$3.2\cdot10^{-20}$	TlCl	$1.7\cdot10^{-4}$
$CuCO_3$	$1.4\cdot10^{-10}$	$Tl(OH)_3$	$6.3\cdot10^{-46}$
$CuCrO_4$	$3.6\cdot10^{-6}$	$Zn(OH)_2$	$4.1\cdot10^{-17}$
CuI	$1.3\cdot10^{-12}$	$Zn_3(PO_4)_2$	$9.0\cdot10^{-33}$
CuS	$1.3\cdot10^{-37}$	ZnC_2O_4	$2.7\cdot10^{-8}$
CuSCN	$1.8\cdot10^{-13}$	$ZnCO_3$	$1.2\cdot10^{-10}$

Monoprotic Acid Dissociation Constants

Common Name	Formula	K_a(298 K)
acetic acid	CH_3COOH	$1.76\cdot10^{-5}$
ammonium ion	NH_4^+	$5.62\cdot10^{-10}$
anilinium ion	$C_6H_5NH_3^+$	$1.35\cdot10^{-5}$
benzoic acid	C_6H_5COOH	$6.31\cdot10^{-5}$
chloroacetic acid	$CH_2ClCOOH$	$1.46\cdot10^{-3}$
dichloroacetic acid	$CHCl_2COOH$	$5.48\cdot10^{-2}$
trichloroacetic acid	CCl_3COOH	$3.01\cdot10^{-1}$
chlorous acid	$HClO_2$	$1.12\cdot10^{-2}$
ethanol	CH_3CH_2OH	$1.31\cdot10^{-14}$
formic acid	HCOOH	$1.77\cdot10^{-4}$
hydrazinium ion	$N_2H_5^+$	$3.30\cdot10^{-9}$
hydrocyanic acid	HCN	$6.21\cdot10^{-10}$
hydrofluoric acid	HF	$6.63\cdot10^{-4}$
hydroxylammonium ion	NH_3OH^+	$9.10\cdot10^{-7}$
hypochlorous acid	HClO	$2.95\cdot10^{-8}$
hypoiodous acid	HIO	$2.30\cdot10^{-11}$
iodic acid	HIO_3	$1.61\cdot10^{-1}$
lactic acid	C_2H_5OCOOH	$1.38\cdot10^{-4}$
methylammonium ion	$H_3CNH_3^+$	$2.39\cdot10^{-11}$
nitrous acid	HNO_2	$7.22\cdot10^{-4}$
propanoic acid	C_2H_5COOH	$1.33\cdot10^{-5}$
pyridinium ion	$C_5H_5NH^+$	$6.60\cdot10^{-6}$

Complex-Ion Formation Constants

Compound	K_f(298 K)	Compound	K_f(298 K)
$[Ag(CN)_2]^-$	$5.62\cdot10^{18}$	$[Fe(CN)_6]^{4-}$	$4.21\cdot10^{37}$
$[Ag(NH_3)_2]^+$	$1.62\cdot10^{7}$	$[Fe(SCN)]^{2+}$	$8.90\cdot10^{2}$
$[AgCl_2]^-$	$1.38\cdot10^{5}$	$[Fe(C_2O_4)_3]^{3-}$	$1.60\cdot10^{20}$
$[Ag(S_2O_3)_2]^{3-}$	$1.71\cdot10^{13}$	$[Fe(C_2O_4)]^+$	$1.00\cdot10^{8}$
$[AlF_6]^{3-}$	$5.02\cdot10^{23}$	$[HgCl_4]^{2-}$	$1.21\cdot10^{15}$
$[Al(OH)_4]^-$	$1.10\cdot10^{33}$	$[Hg(CN)_4]^{2-}$	$2.81\cdot10^{41}$
$[Cd(CN)_4]^{2-}$	$5.94\cdot10^{18}$	$[Hg(SCN)_4]^{2-}$	$4.97\cdot10^{21}$
$[CdCl_4]^{2-}$	$6.30\cdot10^{2}$	$[HgI_4]^{2-}$	$6.84\cdot10^{29}$
$[Cd(NH_3)_4]^{2+}$	$1.28\cdot10^{7}$	$[Ni(CN)_4]^{2-}$	$2.02\cdot10^{31}$
$[CoCl_4]^{2-}$	$1.00\cdot10^{3}$	$[Ni(NH_3)_6]^{2+}$	$5.53\cdot10^{8}$
$[Co(NH_3)_6]^{2+}$	$1.34\cdot10^{5}$	$[PbCl_3]^-$	$2.40\cdot10^{1}$
$[Co(NH_3)_6]^{3+}$	$4.53\cdot10^{33}$	$[Pb(OH)_3]^-$	$3.82\cdot10^{13}$
$[Cr(OH)_4]^-$	$8.20\cdot10^{29}$	$[SnCl_6]^{2-}$	$1.00\cdot10^{25}$
$[CuCl_3]^{2-}$	$5.02\cdot10^{5}$	$[Sn(OH)_3]^-$	$3.05\cdot10^{25}$
$[Cu(CN)_4]^{2-}$	$2.05\cdot10^{30}$	$[Zn(CN)_4]^{2-}$	$1.03\cdot10^{18}$
$[Cu(NH_3)_4]^{2+}$	$1.10\cdot10^{13}$	$[Zn(NH_3)_4]^{2+}$	$4.13\cdot10^{8}$
$[Fe(CN)_6]^{3-}$	$4.08\cdot10^{42}$	$[Zn(OH)_4]^{2-}$	$4.61\cdot10^{17}$

Polyprotic Acid Dissociation Constants

Common Name	Formula	K_{ai} (298 K)
arsenic acid	H_3AsO_4	$K_{a1} = 5.65\cdot10^{-3}$
	$H_2AsO_4^-$	$K_{a2} = 1.05\cdot10^{-7}$
	$HAsO_4^{2-}$	$K_{a3} = 3.15\cdot10^{-12}$
carbonic acid	H_2CO_3	$K_{a1} = 4.40\cdot10^{-7}$
	HCO_3^-	$K_{a2} = 4.71\cdot10^{-11}$
ascorbic acid	$H_2C_6H_6O_6$	$K_{a1} = 7.90\cdot10^{-5}$
	$HC_6H_6O_6^-$	$K_{a2} = 1.61\cdot10^{-12}$
hydrosulfuric acid	H_2S	$K_{a1} = 9.80\cdot10^{-8}$
	HS^-	$K_{a2} = 1.03\cdot10^{-19}$
hydroselenic acid	H_2Se	$K_{a1} = 1.31\cdot10^{-4}$
	HSe^-	$K_{a2} = 1.01\cdot10^{-11}$
hydrotelluric acid	H_2Te	$K_{a1} = 2.31\cdot10^{-3}$
	HTe^-	$K_{a2} = 1.58\cdot10^{-11}$
oxalic acid	HOOCCOOH	$K_{a1} = 5.40\cdot10^{-2}$
	$HOOCCOO^-$	$K_{a2} = 5.33\cdot10^{-5}$
phosphoric acid	H_3PO_4	$K_{a1} = 7.12\cdot10^{-3}$
	$H_2PO_4^-$	$K_{a2} = 6.29\cdot10^{-8}$
	HPO_4^{2-}	$K_{a3} = 4.22\cdot10^{-13}$
phosphorus acid	H_3PO_3	$K_{a1} = 3.60\cdot10^{-2}$
	$H_2PO_3^-$	$K_{a2} = 2.13\cdot10^{-7}$
selenous acid	H_2SeO_3	$K_{a1} = 2.32\cdot10^{-3}$
	$HSeO_3^-$	$K_{a2} = 5.42\cdot10^{-9}$
sulfuric acid	H_2SO_4	$K_{a1} >> 1$
	HSO_4^-	$K_{a2} = 1.11\cdot10^{-2}$
sulfurous acid	H_2SO_3	$K_{a1} = 1.30\cdot10^{-2}$
	HSO_3^-	$K_{a2} = 6.20\cdot10^{-8}$

Acid–Base Indicators (298 K)

Indicator	pH Range	pK_{in}	Acid	Base
thymol blue	1.2 – 2.8	1.6	red	yellow
methyl yellow	2.9 – 4.0	3.3	red	yellow
methyl orange	3.1 – 4.4	4.2	red	yellow
bromocresol green	3.8 – 5.4	4.7	yellow	blue
methyl red	4.2 – 6.2	5.0	red	yellow
chlorophenol red	4.8 – 6.4	6.0	yellow	red
bromothymol blue	6.0 – 7.6	7.1	yellow	blue
phenol red	6.4 – 8.0	7.4	yellow	red
cresol purple	7.4 – 9.0	8.3	yellow	purple
thymol blue	8.0 – 9.6	8.9	yellow	blue
phenolphthalein	8.0 – 9.8	9.4	colorless	red
thymolphthalein	9.3 – 10.5	9.9	colorless	blue

Thermodynamic Data (Elements)

Element	$S°$(298 K) /(J/(mol K))	Element	$S°$(298 K) /(J/(mol K))
Ag(s)	42.6	Fe(s)	27.3
Al(s)	28.3	H_2(g)	130.7
Au(s)	47.4	I_2(s)	116.1
Br_2(l)	152.2	N_2(g)	191.6
C(s, graphite)	5.7	Na(s)	51.2
Cl_2(g)	223.1	O_2(g)	205.1
Co(s)	30.0	P_4(s)	164.4
Cr(s)	23.8	S_8(s, rhombic)	254.4
Cu(s)	33.2	Xe(g)	170.1
F_2(g)	202.8	Zn(s)	41.6

Thermodynamic Data

	$\Delta_f H°$(298 K) /(kJ/mol)	$\Delta_f G°$(298 K) /(kJ/mol)	$S°$(298 K) /(J/(mol K))
AgCl(s)	-127.1	-109.8	96.2
AgI(s)	-61.8	-66.2	115.5
Al_2O_3(s)	-1676.3	-1581.9	50.9
Br(g)	111.9	82.4	175.0
Br_2(aq)	-3.1	4.1	130.2
Br_2(g)	30.9	3.1	245.5
C(g)	716.7	671.3	158.0
C(s,diamond)	1.9	2.9	2.4
CO(g)	-110.5	-137.2	197.7
CO_2(g)	-393.5	-394.4	213.7
$COCl_2$(g)	-218.8	-204.6	283.5
CCl_4(l)	-135.4	-65.2	216.4
CH_3CHO(g)	-166.2	-128.9	250.3
CH_3OH(g)	-200.7	-162.0	239.8
CH_3OH(l)	-238.7	-166.3	126.8
CH_4(g)	-74.8	-50.7	186.3
C_2H_2(g)	226.7	209.2	200.9
C_2H_4(g)	52.3	68.2	219.6
C_2H_5OH(g)	-235.1	-168.5	282.7
C_2H_5OH(l)	-277.7	-174.8	160.7
C_2H_6(g)	-84.7	-32.8	229.6
C_6H_{12}(l)	-156.4	26.9	204.4
$C_6H_{12}O_6$(s)	-1275.1	-911.1	212.2
C_6H_6(l)	49.0	124.5	173.4
Cl(g)	121.7	105.7	165.2
Cl_2(aq)	-23.1	7.1	121.2
F(g)	79.0	61.9	158.8
Fe_2O_3(s)	-824.2	-742.2	87.4
H(g)	218.0	203.2	114.7
H_2O(g)	-241.8	-228.6	188.8
H_2O(l)	-285.8	-237.1	69.9
H_2S(g)	-20.6	-33.6	205.8
H_2SO_4(aq)	-909.3	-744.5	20.1
HBr(g)	-36.4	-53.5	198.7
HCl(aq)	-167.2	-131.2	56.5
HCl(g)	-92.3	-95.3	186.9
HF(g)	-271.1	-273.2	173.8
HI(g)	26.5	1.7	206.6
HNO_3(aq)	-207.4	-111.3	146.4
I(g)	106.8	70.3	180.8
I_2(aq)	23.4	16.3	137.1
ICl(g)	17.8	-5.5	247.6
MgO(s)	-601.7	-569.4	26.9
N(g)	472.7	455.5	153.3
N_2H_4(g)	95.4	159.4	238.5
N_2H_4(l)	50.6	149.3	121.2
N_2O(g)	82.1	104.2	219.9
N_2O_4(g)	9.2	97.9	304.3
Na(g)	107.3	76.8	153.7
NH_3(aq)	-80.3	-26.5	111.3
NH_3(g)	-46.1	-16.5	192.5
NO(g)	90.3	86.6	210.8
NO_2(g)	33.2	51.3	240.1
NOBr(g)	82.2	82.4	273.7
NOCl(g)	51.7	66.1	261.7
O(g)	249.2	231.7	161.1
O_3(g)	142.7	163.2	238.9
P(g)	314.6	278.3	163.2
PbI_2(s)	-175.5	-173.6	174.9
PCl_3(g)	-287.0	-267.8	311.8
PCl_5(g)	-374.9	-305.0	364.6
PH_3(g)	5.4	13.4	210.2
S(g)	278.8	238.3	167.8
SF_6(g)	-1209.0	-1105.0	291.8
SO_2(g)	-296.8	-300.2	248.2
SO_3(g)	-395.7	-371.1	256.8
XeF_2(g)	-108.1	-48.2	254.3
XeF_4(s)	-251.1	-121.2	146.3

Average Gaseous Bond Energies

$\Delta_{bond}H°$ /(kJ/mol)

H–H	436	C–C	348	N–N	250
H–C	414	C–N	305	N–O	208
H–N	389	C–O	359	N–F	277
H–O	464	C–S	272	N–Cl	200
H–S	368	C–F	486	F–F	159
H–F	565	C–Cl	339	Cl–Cl	243
H–Cl	431	C–Br	286	Br–Br	193
H–Br	366	S–F	284	I–I	151
H–I	297	S–Cl	255	S–S	274
C=C	611	N=N	440	C≡C	837
C=N	615	N=O	590	C≡N	891
C=O	745	O=O	498	C≡O	1072
C=O (CO_2)	799	P=O	460	N≡N	945

Water Vapor

Temp. /°C	Press. /mmHg
0.0	4.6
10.0	9.2
15.0	12.8
18.0	15.5
20.0	17.5
21.0	18.7
22.0	19.8
23.0	21.1
24.0	22.4
25.0	23.8
28.0	28.3
30.0	31.8
40.0	55.3
50.0	92.5
60.0	149.4
70.0	233.7
80.0	355.1
90.0	525.8
100.0	760.0

Densities

(at 298 K; /(g/cm^3))

H_2O(g)	0.0006
H_2O(l)	1.00
H_2O(s)	0.917
C(s, diamond)	3.26
CH_3CH_2OH(l)	0.789
CH_2Cl_2(l)	1.325
NaCl(s)	2.16
glass	2.7
Al(s)	2.70
$BaSO_4$(s)	4.50
AgCl(s)	5.56
Fe(s)	7.87
brass	8.4
Cu(s)	8.94
Ag(s)	10.5
Pb(s)	11.3
Hg(l)	13.53
Au(s)	19.3
Ir(s)	22.5

Concentrated Acids and Bases

	density /(g/cm^3)	% by mass	conc. /(mol/L)
HNO_3	1.41	69.0	15.4
H_2SO_4	1.83	94.0	17.6
$HClO_4$	1.67	70.0	11.6
HCl	1.19	38.0	12.4
HBr	1.52	48.0	9.0
HI	1.70	57.0	4.5
HF	1.14	45.0	25.7
CH_3COOH	1.05	99.5	17.4
H_3PO_4	1.69	85.0	14.7
NaOH	1.53	50.0	19.1
NH_3	0.90	28.0	14.8

Miscellaneous

$$x = \frac{-b \pm \sqrt{b^2 - 4\,a\,c}}{2\,a}$$

$$\mathrm{u} = 1.66054 \cdot 10^{-27}\ \mathrm{kg}$$

$$N_A = 6.022142 \cdot 10^{23}\ \mathrm{mol}^{-1}$$

$$q_{e^-} = 1.60218 \cdot 10^{-19}\ \mathrm{C}$$

$$F = 96\,485\ \mathrm{C}\left(\mathrm{mol\ e^-}\right)^{-1}$$

$$R = 8.314472\ \mathrm{J\ mol^{-1}\ K^{-1}}$$

$$= 8.314472\ \mathrm{L\ kPa\ mol^{-1}\ K^{-1}}$$

$$= 0.08314472\ \mathrm{L\ bar\ mol^{-1}\ K^{-1}}$$

$$= 0.08206\ \mathrm{L\ atm\ mol^{-1}\ K^{-1}}$$

$$h = 6.626069 \cdot 10^{-34}\ \mathrm{J\ s}$$

$$c = 2.99792458 \cdot 10^{8}\ \mathrm{m\ s^{-1}}$$

$$K_w(298\ \mathrm{K}) = 1.00 \cdot 10^{-14}$$

$$0\ °\mathrm{C} = 273.15\ \mathrm{K}$$

$$C_P\left(\mathrm{H_2O(l)}\right) = 4.19\ \mathrm{J\ g^{-1}\ K^{-1}}$$

$$1\ \mathrm{atm} = 101.325\ \mathrm{kPa} = 760\ \mathrm{mmHg}$$

$$1\ \mathrm{bar} = 100.000\ \mathrm{kPa} = 750\ \mathrm{mmHg}$$

Standard Reduction Potentials (298 K)

Reaction	$E°_{red}$ /V	Reaction	$E°_{red}$ /V
$F_2(g) + 2e^- \rightarrow 2F^-$	2.866	$2H^+ + 2e^- \rightarrow H_2(g)$	0.000
$Au^+ + e^- \rightarrow Au(s)$	1.830	$Fe^{3+} + 3e^- \rightarrow Fe(s)$	-0.037
$Co^{3+} + e^- \rightarrow Co^{2+}$	1.820	$Pb^{2+} + 2e^- \rightarrow Pb(s)$	-0.125
$Mn^{3+} + e^- \rightarrow Mn^{2+}$	1.511	$Sn^{2+} + 2e^- \rightarrow Sn(s)$	-0.138
$Au^{3+} + 3e^- \rightarrow Au(s)$	1.520	$In^+ + e^- \rightarrow In(s)$	-0.140
$Ce^{4+} + e^- \rightarrow Ce^{3+}$	1.461	$V^{3+} + e^- \rightarrow V^{2+}$	-0.255
$Au^{3+} + 2e^- \rightarrow Au^+$	1.360	$Ni^{2+} + 2e^- \rightarrow Ni(s)$	-0.257
$Cl_2(g) + 2e^- \rightarrow 2Cl^-$	1.358	$Co^{2+} + 2e^- \rightarrow Co(s)$	-0.277
$Tl^{3+} + 2e^- \rightarrow Tl^+$	1.252	$Tl^+ + e^- \rightarrow Tl(s)$	-0.336
$Ir^{3+} + 3e^- \rightarrow Ir(s)$	1.156	$In^{3+} + 3e^- \rightarrow In(s)$	-0.338
$Br_2(l) + 2e^- \rightarrow 2Br^-$	1.065	$In^{2+} + e^- \rightarrow In^+$	-0.400
$Pd^{2+} + 2e^- \rightarrow Pd(s)$	0.951	$Cd^{2+} + 2e^- \rightarrow Cd(s)$	-0.403
$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$	0.920	$Cr^{3+} + e^- \rightarrow Cr^{2+}$	-0.424
$Hg^{2+} + 2e^- \rightarrow Hg(l)$	0.851	$In^{3+} + 2e^- \rightarrow In^+$	-0.443
$Ag^+ + e^- \rightarrow Ag(s)$	0.800	$Fe^{2+} + 2e^- \rightarrow Fe(s)$	-0.440
$Hg_2^{2+} + 2e^- \rightarrow 2Hg(l)$	0.789	$In^{3+} + e^- \rightarrow In^{2+}$	-0.490
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	0.771	$Cr^{3+} + 3e^- \rightarrow Cr(s)$	-0.744
$Rh^{3+} + 3e^- \rightarrow Rh(s)$	0.758	$Zn^{2+} + 2e^- \rightarrow Zn(s)$	-0.762
$Rh^+ + e^- \rightarrow Rh(s)$	0.600	$Se + 2e^- \rightarrow Se^{2-}$	-0.924
$I_2(s) + 2e^- \rightarrow 2I^-$	0.536	$V^{2+} + 2e^- \rightarrow V(s)$	-1.175
$I_3^- + 2e^- \rightarrow 3I^-$	0.536	$Mn^{2+} + 2e^- \rightarrow Mn(s)$	-1.185
$Cu^+ + e^- \rightarrow Cu(s)$	0.521	$Al^{3+} + 3e^- \rightarrow Al(s)$	-1.676
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	0.342	$Be^{2+} + 2e^- \rightarrow Be(s)$	-1.847
$Ge^{2+} + 2e^- \rightarrow Ge(s)$	0.240	$Mg^{2+} + 2e^- \rightarrow Mg(s)$	-2.356
$Cu^{2+} + e^- \rightarrow Cu^+$	0.159	$Na^+ + e^- \rightarrow Na(s)$	-2.714
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	0.154	$Ca^{2+} + 2e^- \rightarrow Ca(s)$	-2.840
$Ge^{4+} + 4e^- \rightarrow Ge(s)$	0.124	$Ba^{2+} + 2e^- \rightarrow Ba(s)$	-2.923
$Ge^{4+} + 2e^- \rightarrow Ge^{2+}$	0.001	$K^+ + e^- \rightarrow K(s)$	-2.924
$2H^+ + 2e^- \rightarrow H_2(g)$	0.000	$Li^+ + e^- \rightarrow Li(s)$	-3.040

Standard Reduction Potentials (298 K)

Reaction (state: aqueous unless specified)	$E°_{red}$ /V
$F_2(g) + 2H^+ + 2e^- \rightarrow 2HF(g)$	3.013
$S_2O_8^{2-} + 2H^+ + 2e^- \rightarrow 2HSO_4^-$	2.123
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	2.010
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O(l)$	1.763
$PbO_2(s) + SO_4^{2-} + 4H^+ + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$	1.690
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O(l)$	1.507
$ClO_4^- + 8H^+ + 8e^- \rightarrow Cl^- + 4H_2O(l)$	1.370
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O(l)$	1.330
$MnO_2(s) + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O(l)$	1.230
$O_2(g) + 4H^+ + 4e^- \rightarrow 2H_2O(l)$	1.229
$2IO_3^- + 12H^+ + 10e^- \rightarrow I_2 + 6H_2O(l)$	1.195
$N_2O_4(g) + 4H^+ + 4e^- \rightarrow NO(g) + 2H_2O(l)$	1.035
$AuCl_4^- + 3e^- \rightarrow Au(s) + 4Cl^-$	1.002
$AuBr_2^- + e^- \rightarrow Au(s) + 2Br^-$	0.959
$NO_3^- + 4H^+ + 3e^- \rightarrow NO(g) + 2H_2O(l)$	0.957
$AuBr_4^- + 3e^- \rightarrow Au(s) + 4Br^-$	0.854
$O_2(g) + 2H^+ + 2e^- \rightarrow H_2O_2(aq)$	0.695
$S_2O_6^{2-} + 4H^+ + 2e^- \rightarrow 2H_2SO_3(aq)$	0.600
$MnO_4^- + 2H_2O(l) + 3e^- \rightarrow MnO_2(s) + 4OH^-$	0.595
$Ag_2C_2O_4(s) + 2e^- \rightarrow 2Ag(s) + C_2O_4^{2-}$	0.478
$Ag_2CO_3(s) + 2e^- \rightarrow 2Ag(s) + CO_3^{2-}$	0.468
$Ag_2CrO_4(s) + 2e^- \rightarrow 2Ag(s) + CrO_4^{2-}$	0.446
$2H_2O(l) + O_2(g) + 4e^- \rightarrow 4OH^-$	0.401
$[Fe(CN)_6]^{3-} + e^- \rightarrow [Fe(CN)_6]^{4-}$	0.361
$AgIO_3(s) + e^- \rightarrow Ag(s) + IO_3^-$	0.354
$Hg_2Cl_2(s) + 2e^- \rightarrow 2Hg(l) + 2Cl^-$	0.268
$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-$	0.222
$Co(OH)_3(s) + e^- \rightarrow Co(OH)_2(s) + OH^-$	0.171
$S(s) + 2H^+ + 2e^- \rightarrow H_2S(g)$	0.144
$Hg_2Br_2(s) + 2e^- \rightarrow 2Hg(l) + 2Br^-$	0.139
$S_4O_6^{2-} + 2H^+ + 2e^- \rightarrow 2HS_2O_3^-$	0.090
$AgSCN(s) + e^- \rightarrow Ag(s) + SCN^-$	0.090
$AgBr(s) + e^- \rightarrow Ag(s) + Br^-$	0.071
$CuI_2^- + 2e^- \rightarrow Cu(s) + 2I^-$	0.000
$AgCN(s) + e^- \rightarrow Ag(s) + CN^-$	-0.017
$Ag(CN)_2^- + e^- \rightarrow Ag(s) + 2CN^-$	-0.310
$PbF_2(s) + 2e^- \rightarrow Pb(s) + 2F^-$	-0.344
$PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}$	-0.356
$PbI_2(s) + 2e^- \rightarrow Pb(s) + 2I^-$	-0.365
$2CO_2(g) + 2H^+ + 2e^- \rightarrow H_2C_2O_4(aq)$	-0.490
$Cd(C_2O_4)(s) + 2e^- \rightarrow Cd(s) + C_2O_4^{2-}$	-0.522
$Fe(OH)_3(s) + e^- \rightarrow Fe(OH)_2(s) + OH^-$	-0.560
$Co(OH)_2(s) + 2e^- \rightarrow Co(s) + 2OH^-$	-0.730
$Cd(OH)_2(s) + 2e^- \rightarrow Cd(s) + 2OH^-$	-0.824
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-$	-0.828
$Zn(OH)_2(s) + 2e^- \rightarrow Zn(s) + 2OH^-$	-1.246
$Al(OH)_4^- + 3e^- \rightarrow Al(s) + 4OH^-$	-2.310
$Zr(O)(OH)_2(s) + H_2O(l) + 4e^- \rightarrow Zr(s) + 4OH^-$	-2.363
$Mg(OH)_2(s) + 2e^- \rightarrow Mg(s) + 2OH^-$	-2.687
$Sr(OH)_2(s) + 2e^- \rightarrow Sr(s) + 2OH^-$	-2.878
$Ca(OH)_2(s) + 2e^- \rightarrow Ca(s) + 2OH^-$	-3.020