

## 8.2 EQUILIBRIUM CONSTANTS

**TABLE 8.5** Ionic Product Constant of Water

This table gives values of  $pK_w$  on a molal scale, where  $K_w$  is the ionic activity product constant of water. Values are from W. L. Marshall and E. U. Franck, *J. Phys. Chem. Ref. Data*, **10**:295 (1981).

Temp., °C	$pK_w$	Temp., °C	$pK_w$	Temp., °C	$pK_w$
0	14.938	45	13.405	95	12.345
5	14.727	50	13.275	100	12.264
10	14.528	55	13.152	125	11.911
15	14.340	60	13.034	150	11.637
18	14.233	65	12.921	175	11.431
20	14.163	70	12.814	200	11.288
25	13.995	75	12.711	225	11.207
30	13.836	80	12.613	250	11.192
35	13.685	85	12.520	275	11.251
40	13.542	90	12.431	300	11.406

**TABLE 8.6** Solubility Product Constants

The data refer to various temperatures between 18 and 25°C, and were compiled from values cited by Bjerrum, Schwarzenbach, and Sillen, *Stability Constants of Metal Complexes*, part II, Chemical Society, London, 1958, and values taken from publications of the IUPAC Solubility Data Project: *Solubility Data Series*, International Union of Pure and Applied Chemistry, Pergamon Press, Oxford, 1979–1992; H. L. Clever, and F. J. Johnston, *J. Phys. Chem. Ref. Data*, **9**:751 (1980); Y. Marcus, *Ibid.* **9**:1307 (1980); H. L. Clever, S. A. Johnson, and M. E. Derrick, *Ibid.* **14**:631 (1985), and **21**:941 (1992).

In the table, "L" is the abbreviation of the organic ligand.

Compound	Formula	$pK_{sp}$	$K_{sp}$
Actinium hydroxide	Ac(OH) <sub>3</sub>	15	$1 \times 10^{-15}$
Aluminum arsonate	AlAsO <sub>4</sub>	15.80	$1.6 \times 10^{-16}$
cupferrate	AlL <sub>3</sub>	18.64	$2.3 \times 10^{-19}$
hydroxide	Al(OH) <sub>3</sub>	32.89	$1.3 \times 10^{-33}$
phosphate	AlPO <sub>4</sub>	20.01	$9.84 \times 10^{-21}$
8-quinolinolate	AlL <sub>3</sub>	29.00	$1.00 \times 10^{-29}$
selenide	Al <sub>2</sub> Se <sub>3</sub>	24.4	$4 \times 10^{-25}$
sulfide	Al <sub>2</sub> S <sub>3</sub>	6.7	$2 \times 10^{-7}$
Americium (III) hydroxide	Am(OH) <sub>3</sub>	19.57	$2.7 \times 10^{-20}$
(IV) hydroxide	Am(OH) <sub>4</sub>	56	$1 \times 10^{-56}$
Ammonium uranyl arsenate	NH <sub>4</sub> UO <sub>2</sub> AsO <sub>4</sub>	23.77	$1.7 \times 10^{-24}$
Arsenic (III) sulfide	As <sub>2</sub> S <sub>3</sub>	21.68	$2.1 \times 10^{-22}$

TABLE 8.6 Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
Barium			
arsenate	$Ba_3(AsO_4)_2$	50.11	$8.0 \times 10^{-51}$
bromate	$Ba(BrO_3)_2$	5.50	$2.43 \times 10^{-4}$
carbonate	$BaCO_3$	8.59	$2.58 \times 10^{-9}$
chromate	$BaCrO_4$	9.93	$1.17 \times 10^{-10}$
ferricyanide 6-hydrate	$Ba_2[Fe(CN)_6] \cdot 6H_2O$	7.49	$3.2 \times 10^{-8}$
fluoride	$BaF_2$	6.74	$1.84 \times 10^{-7}$
hexafluorosilicate	$BaSiF_6$	6	$1 \times 10^{-6}$
hydrogen phosphate	$BaHPO_4$	6.49	$3.2 \times 10^{-7}$
hydroxide 8-hydrate	$Ba(OH)_2 \cdot 8H_2O$	3.59	$2.55 \times 10^{-4}$
iodate hydrate	$Ba(IO_3)_2 \cdot H_2O$	8.40	$4.01 \times 10^{-9}$
molybdate	$BaMoO_4$	7.45	$3.54 \times 10^{-8}$
niobate	$Ba(NbO_3)_2$	16.50	$3.2 \times 10^{-17}$
nitrate	$Ba(NO_3)_2$	2.33	$4.64 \times 10^{-3}$
oxalate	$BaC_2O_4$	6.79	$1.6 \times 10^{-7}$
oxalate hydrate	$BaC_2O_4 \cdot H_2O$	7.64	$2.3 \times 10^{-8}$
permanganate	$Ba(MnO_4)_2$	9.61	$2.5 \times 10^{-10}$
perrhenate	$Ba(ReO_4)_2$	1.28	$5.2 \times 10^{-2}$
phosphate	$Ba_3(PO_4)_2$	22.47	$3.4 \times 10^{-23}$
pyrophosphate	$Ba_2P_2O_7$	10.50	$3.2 \times 10^{-11}$
8-quinolinolate	$BaL_2$	8.30	$5.0 \times 10^{-9}$
selenate	$BaSeO_4$	7.47	$3.40 \times 10^{-8}$
sulfate	$BaSO_4$	9.97	$1.08 \times 10^{-10}$
sulfite	$BaSO_3$	9.30	$5.0 \times 10^{-10}$
thiosulfate	$BaS_2O_3$	4.79	$1.6 \times 10^{-5}$
Beryllium			
carbonate 4-hydrate	$BeCO_3 \cdot 4H_2O$	3	$1 \times 10^{-3}$
hydroxide (amorphous)	$Be(OH)_2$	21.16	$6.92 \times 10^{-22}$
molybdate	$BeMoO_4$	1.49	$3.2 \times 10^{-2}$
niobate	$Be(NbO_3)_2$	15.92	$1.2 \times 10^{-16}$
Bismuth			
arsenate	$BiAsO_4$	9.35	$4.43 \times 10^{-10}$
cupferrate	$BiL_3$	27.22	$6.0 \times 10^{-28}$
hydroxide	$Bi(OH)_3$	30.4	$6.0 \times 10^{-31}$
iodide	$BiI_3$	18.11	$7.71 \times 10^{-19}$
oxide bromide	$BiOBr$	6.52	$3.0 \times 10^{-7}$
oxide chloride	$BiOCl$	30.75	$1.8 \times 10^{-31}$
oxide hydroxide	$BiO(OH)$	9.4	$4 \times 10^{-10}$
oxide nitrate	$BiO(NO_3)$	2.55	$2.82 \times 10^{-3}$
oxide nitrite	$BiO(NO_2)$	6.31	$4.9 \times 10^{-7}$
oxide thiocyanate	$BiO(SCN)$	6.80	$1.6 \times 10^{-7}$
phosphate	$BiPO_4$	22.89	$1.3 \times 10^{-23}$
sulfide	$Bi_2S_3$	97	$1 \times 10^{-97}$
Cadmium			
anthranilate	$CdL_2$	8.27	$5.4 \times 10^{-9}$
arsenate	$Cd_3(AsO_4)_2$	32.66	$2.2 \times 10^{-33}$
benzoate 2-hydrate	$CdL_2 \cdot 2H_2O$	2.7	$2 \times 10^{-3}$
borate, <i>meta</i>	$Cd(BO_2)_2$	8.64	$2.3 \times 10^{-9}$
carbonate	$CdCO_3$	12.0	$1.0 \times 10^{-12}$
cyanide	$Cd(CN)_2$	8.0	$1.0 \times 10^{-8}$
ferrocyanide	$Cd_2[Fe(CN)_6]$	16.49	$3.2 \times 10^{-17}$
fluoride	$CdF_2$	2.19	$6.44 \times 10^{-3}$

TABLE 8.6 Solubility Product Constants (Continued)

Compound	Formula	$pK_{sp}$	$K_{sp}$
hydroxide	$Cd(OH)_2$ fresh	14.14	$7.2 \times 10^{-15}$
iodate	$Cd(IO_3)_2$	7.60	$2.5 \times 10^{-8}$
oxalate 3-water	$CdC_2O_4 \cdot 3H_2O$	7.85	$1.42 \times 10^{-8}$
phosphate	$Cd_3(PO_4)_2$	32.60	$2.53 \times 10^{-33}$
quinaldate	$CdL_2$	12.30	$5.0 \times 10^{-13}$
sulfide	$CdS$	26.10	$8.0 \times 10^{-27}$
tungstate	$CdWO_4$	5.7	$2 \times 10^{-6}$
Calcium			
acetate 3-water	$Ca(OAc)_2 \cdot 3H_2O$	2.4	$4 \times 10^{-3}$
arsenate	$Ca_3(AsO_4)_2$	18.17	$6.8 \times 10^{-19}$
benzoate 3-water	$CaL_2 \cdot 3H_2O$	2.4	$4 \times 10^{-3}$
carbonate	$CaCO_3$	8.54	$2.8 \times 10^{-9}$
carbonate (calcite)	$CaCO_3$	8.47	$3.36 \times 10^{-9}$
carbonate (aragonite)	$CaCO_3$	8.22	$6.0 \times 10^{-9}$
carbonatomagnesium	$Ca[Mg(CO_3)_2]$ dolomite	11	$1 \times 10^{-11}$
chromate	$CaCrO_4$	3.15	$7.1 \times 10^{-4}$
fluoride	$CaF_2$	8.28	$5.3 \times 10^{-9}$
hexafluorosilicate	$Ca[SiF_6]$	3.09	$8.1 \times 10^{-4}$
hydrogen phosphate	$CaHPO_4$	7.0	$1.0 \times 10^{-7}$
hydroxide	$Ca(OH)_2$	5.26	$5.5 \times 10^{-6}$
iodate 6-water	$Ca(IO_3)_2 \cdot 6H_2O$	6.15	$7.10 \times 10^{-7}$
molybdate	$CaMoO_4$	7.84	$1.46 \times 10^{-8}$
niobate	$Ca(NbO_3)_2$	17.06	$8.7 \times 10^{-18}$
oxalate hydrate	$CaC_2O_4 \cdot H_2O$	8.63	$2.32 \times 10^{-9}$
phosphate	$Ca_3(PO_4)_2$	28.68	$2.07 \times 10^{-29}$
8-quinolinolate	$CaL_2$	11.12	$7.6 \times 10^{-12}$
selenate	$CaSeO_4$	3.09	$8.1 \times 10^{-4}$
selenite	$CaSeO_3$	5.53	$8.0 \times 10^{-6}$
silicate, <i>meta</i>	$CaSiO_3$	7.60	$2.5 \times 10^{-8}$
sulfate	$CaSO_4$	4.31	$4.93 \times 10^{-5}$
sulfate dihydrate	$CaSO_4 \cdot 2H_2O$	4.50	$3.14 \times 10^{-5}$
sulfite	$CaSO_3$	7.17	$6.8 \times 10^{-8}$
sulfite 0.5-water	$CaSO_3 \cdot 0.5H_2O$	6.51	$3.1 \times 10^{-7}$
tartrate dihydrate	$CaL \cdot 2H_2O$	6.11	$7.7 \times 10^{-7}$
tungstate	$CaWO_4$	8.06	$8.7 \times 10^{-9}$
Cerium			
(III) fluoride	$CeF_3$	15.1	$8 \times 10^{-16}$
(III) hydroxide	$Ce(OH)_3$	19.80	$1.6 \times 10^{-20}$
(IV) hydroxide	$Ce(OH)_4$	47.7	$2 \times 10^{-48}$
(III) iodate	$Ce(IO_3)_3$	9.50	$3.2 \times 10^{-10}$
(IV) iodate	$Ce(IO_3)_4$	16.3	$5 \times 10^{-17}$
(III) oxalate 9-water	$Ce_2(C_2O_4)_3 \cdot 9H_2O$	25.50	$3.2 \times 10^{-26}$
(III) phosphate	$CePO_4$	23	$1 \times 10^{-23}$
(III) selenite	$Ce_2(SeO_3)_3$	24.43	$3.7 \times 10^{-25}$
(III) sulfide	$Ce_2S_3$	10.22	$6.0 \times 10^{-11}$
(III) tartrate	$Ce_2L_3$	19.0	$1.0 \times 10^{-19}$
Cesium			
bromate	$CsBrO_3$	1.7	$5 \times 10^{-2}$
chlorate	$CsClO_3$	1.4	$4 \times 10^{-2}$
cobalthexanitrite	$Cs_3[Co(NO_2)_6]$	15.24	$5.7 \times 10^{-16}$
hexachloroplatinate(IV)	$Cs_2[PtCl_6]$	7.50	$3.2 \times 10^{-8}$
hexafluoroplatinate(IV)	$Cs_2[PtF_6]$	5.62	$2.4 \times 10^{-6}$
hexafluorosilicate	$Cs_2[SiF_6]$	4.90	$1.3 \times 10^{-5}$

TABLE 8.6 Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
perchlorate	CsClO <sub>4</sub>	2.40	$3.95 \times 10^{-3}$
periodate	CsIO <sub>4</sub>	5.29	$5.16 \times 10^{-6}$
permanganate	CsMnO <sub>4</sub>	4.08	$8.2 \times 10^{-5}$
perrhanate	CsReO <sub>4</sub>	3.40	$4.0 \times 10^{-4}$
tetrafluoroborate	Cs[BF <sub>4</sub> ]	4.7	$5 \times 10^{-5}$
Chromium(II)			
hydroxide	Cr(OH) <sub>2</sub>	15.7	$2 \times 10^{-16}$
Chromium(III)			
arsenate	CrAsO <sub>4</sub>	20.11	$7.7 \times 10^{-21}$
fluoride	CrF <sub>3</sub>	10.18	$6.6 \times 10^{-11}$
hydroxide	Cr(OH) <sub>3</sub>	30.20	$6.3 \times 10^{-31}$
phosphate 4-water	CrPO <sub>4</sub> ·4H <sub>2</sub> O green	22.62	$2.4 \times 10^{-23}$
	violet	17.00	$1.0 \times 10^{-17}$
Cobalt			
anthranilate	CoL <sub>2</sub>	9.68	$2.1 \times 10^{-10}$
arsenate	Co <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	28.17	$6.80 \times 10^{-29}$
carbonate	CoCO <sub>3</sub>	12.84	$1.4 \times 10^{-13}$
ferrocyanide	Co <sub>2</sub> [Fe(CN) <sub>6</sub> ]	14.74	$1.8 \times 10^{-15}$
hydrogen phosphate	CoHPO <sub>4</sub>	6.7	$2 \times 10^{-7}$
(II) hydroxide	Co(OH) <sub>2</sub> fresh	14.23	$5.92 \times 10^{-15}$
(III) hydroxide	Co(OH) <sub>3</sub>	43.80	$1.6 \times 10^{-44}$
iodate	Co(IO <sub>3</sub> ) <sub>2</sub>	4.0	$1.0 \times 10^{-4}$
phosphate	Co <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	34.69	$2.05 \times 10^{-35}$
selenite	CoSeO <sub>3</sub>	6.80	$1.6 \times 10^{-7}$
quinaldate	CoL <sub>2</sub>	10.80	$1.6 \times 10^{-11}$
8-quinolinolate	CoL <sub>2</sub>	24.80	$1.6 \times 10^{-25}$
sulfide	$\alpha$ -CoS	20.40	$4.0 \times 10^{-21}$
	$\beta$ -CoS	24.70	$2.0 \times 10^{-25}$
Copper(I)			
azide	CuN <sub>3</sub>	8.31	$4.9 \times 10^{-9}$
bromide	CuBr	8.20	$6.27 \times 10^{-9}$
chloride	CuCl	6.76	$1.72 \times 10^{-7}$
cyanide	CuCN	19.46	$3.47 \times 10^{-20}$
hydroxide	CuOH	14	$1 \times 10^{-14}$
iodide	CuI	11.90	$1.27 \times 10^{-12}$
sulfide	Cu <sub>2</sub> S	47.60	$2.5 \times 10^{-48}$
tetraphenylborate	CuL	8.0	$1.0 \times 10^{-8}$
thiocyanate	CuSCN	12.75	$1.77 \times 10^{-13}$
Copper(II)			
anthranilate	CuL <sub>2</sub>	13.22	$6.0 \times 10^{-14}$
arsenate	Cu <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	35.10	$7.95 \times 10^{-36}$
azide	Cu(N <sub>3</sub> ) <sub>2</sub>	9.20	$6.3 \times 10^{-10}$
carbonate	CuCO <sub>3</sub>	9.86	$1.4 \times 10^{-10}$
chromate	CuCrO <sub>4</sub>	5.44	$3.6 \times 10^{-6}$
dithiooxamide	CuL	15.12	$7.67 \times 10^{-16}$
ferrocyanide	Cu <sub>2</sub> [Fe(CN) <sub>6</sub> ]	15.89	$1.3 \times 10^{-16}$
hydroxide	Cu(OH) <sub>2</sub>	19.66	$2.2 \times 10^{-20}$
iodate	Cu(IO <sub>3</sub> ) <sub>2</sub>	7.16	$6.94 \times 10^{-8}$
oxalate	CuC <sub>2</sub> O <sub>4</sub>	9.35	$4.43 \times 10^{-10}$
phosphate	Cu <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	36.85	$1.40 \times 10^{-37}$
pyrophosphate	Cu <sub>3</sub> P <sub>2</sub> O <sub>7</sub>	15.08	$8.3 \times 10^{-16}$
quinaldate	CuL <sub>2</sub>	16.80	$1.6 \times 10^{-17}$
8-quinolinolate	CuL <sub>2</sub>	29.70	$2.0 \times 10^{-30}$

**TABLE 8.6** Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
selenite	$CuSeO_3$	7.68	$2.1 \times 10^{-8}$
sulfide	$CuS$	35.20	$6.3 \times 10^{-36}$
Dysprosium			
chromate 10-water	$Dy_2(CrO_4)_3 \cdot 10H_2O$	8	$1 \times 10^{-8}$
hydroxide	$Dy(OH)_3$	21.85	$1.4 \times 10^{-22}$
Erbium			
hydroxide	$Er(OH)_3$	23.39	$4.1 \times 10^{-24}$
Europium			
hydroxide	$Eu(OH)_3$	23.03	$9.38 \times 10^{-24}$
Gadolinium			
hydrogen carbonate	$Gd(HCO_3)_3$	1.7	$2 \times 10^{-2}$
hydroxide	$Gd(OH)_3$	22.74	$1.8 \times 10^{-23}$
Gallium			
ferrocyanide	$Ga_4[Fe(CN)_6]_3$	33.82	$1.5 \times 10^{-34}$
hydroxide	$Ga(OH)_3$	35.14	$7.28 \times 10^{-36}$
8-quinolinolate	$GaL_3$	40.80	$1.6 \times 10^{-41}$
Germanium			
oxide	$GeO_2$	57.0	$1.0 \times 10^{-57}$
Gold(I)			
chloride	$AuCl$	12.70	$2.0 \times 10^{-13}$
iodide	$AuI$	22.80	$1.6 \times 10^{-23}$
Gold(III)			
chloride	$AuCl_3$	24.50	$3.2 \times 10^{-25}$
hydroxide	$Au(OH)_3$	45.26	$5.5 \times 10^{-46}$
iodide	$AuI_3$	46	$1 \times 10^{-46}$
oxalate	$Au_2(C_2O_4)_3$	10	$1 \times 10^{-10}$
Hafnium			
hydroxide	$Hf(OH)_3$	25.40	$4.0 \times 10^{-26}$
Holmium			
hydroxide	$Ho(OH)_3$	22.3	$5.0 \times 10^{-23}$
Indium			
ferrocyanide	$In_4[Fe(CN)_6]_3$	43.72	$1.9 \times 10^{-44}$
hydroxide	$In(OH)_3$	33.2	$6.3 \times 10^{-34}$
quinolinolate	$InL_3$	31.34	$4.6 \times 10^{-32}$
selenite	$In_2(SeO_3)_3$	32.60	$4.0 \times 10^{-33}$
sulfide	$In_2S_3$	73.24	$5.7 \times 10^{-74}$
Iron(II)			
carbonate	$FeCO_3$	10.50	$3.13 \times 10^{-11}$
fluoride	$FeF_2$	5.63	$2.36 \times 10^{-6}$
hydroxide	$Fe(OH)_2$	16.31	$4.87 \times 10^{-17}$
oxalate dihydrate	$FeC_2O_4 \cdot 2H_2O$	6.50	$3.2 \times 10^{-7}$
sulfide	$FeS$	17.20	$6.3 \times 10^{-18}$
Iron(III)			
arsenate	$FeAsO_4$	20.24	$5.7 \times 10^{-21}$
ferrocyanide	$Fe_4[Fe(CN)_6]_3$	40.52	$3.3 \times 10^{-41}$
hydroxide	$Fe(OH)_3$	38.55	$2.79 \times 10^{-39}$
phosphate dihydrate	$FePO_4 \cdot 2H_2O$	15.00	$9.91 \times 10^{-16}$
quinaldate	$FeL_3$	16.89	$1.3 \times 10^{-17}$
selenite	$Fe_2(SeO_3)_3$	30.70	$2.0 \times 10^{-31}$
Lanthanum			
bromate 9-water	$La(BrO_3)_3 \cdot 9H_2O$	2.50	$3.2 \times 10^{-3}$
fluoride	$LaF_3$	16.2	$7 \times 10^{-17}$

TABLE 8.6 Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
hydroxide	$\text{La}(\text{OH})_3$	18.70	$2.0 \times 10^{-19}$
iodate	$\text{La}(\text{IO}_3)_3$	11.12	$7.50 \times 10^{-12}$
molybdate	$\text{La}_2(\text{MoO}_4)_3$	20.4	$4 \times 10^{-21}$
oxalate 9-water	$\text{La}_2(\text{C}_2\text{O}_4)_3$	26.60	$2.5 \times 10^{-27}$
phosphate	$\text{LaPO}_4$	22.43	$3.7 \times 10^{-23}$
sulfide	$\text{La}_2\text{S}_3$	12.70	$2.0 \times 10^{-13}$
tungstate trihydrate	$\text{La}_2(\text{WO}_4)_3 \cdot 3\text{H}_2\text{O}$	3.90	$1.3 \times 10^{-4}$
Lead			
acetate	$\text{Pb}(\text{OAc})_2$	2.75	$1.8 \times 10^{-3}$
anthranilate	$\text{PbL}_2$	9.81	$1.6 \times 10^{-10}$
arsenate	$\text{Pb}_3(\text{AsO}_4)_3$	35.39	$4.0 \times 10^{-36}$
azide	$\text{Pb}(\text{N}_3)_2$	8.59	$2.5 \times 10^{-9}$
borate, <i>meta</i>	$\text{Pb}(\text{BO}_2)_3$	10.78	$1.6 \times 10^{-11}$
bromate	$\text{Pb}(\text{BrO}_3)_2$	1.70	$2.0 \times 10^{-2}$
bromide	$\text{PbBr}_2$	6.82	$6.60 \times 10^{-6}$
carbonate	$\text{PbCO}_3$	13.13	$7.4 \times 10^{-14}$
chloride	$\text{PbCl}_2$	4.77	$1.70 \times 10^{-5}$
chloride fluoride	$\text{PbClF}$	8.62	$2.4 \times 10^{-9}$
chlorite	$\text{Pb}(\text{ClO}_2)_2$	8.4	$4 \times 10^{-9}$
chromate	$\text{PbCrO}_4$	12.55	$2.8 \times 10^{-13}$
ferrocyanide	$\text{Pb}_2[\text{Fe}(\text{CN})_6]$	14.46	$3.5 \times 10^{-15}$
fluoride	$\text{PbF}_2$	7.48	$3.3 \times 10^{-8}$
fluoride iodide	$\text{PbFI}$	8.07	$8.5 \times 10^{-9}$
hydrogen phosphate	$\text{PbHPO}_4$	9.90	$1.3 \times 10^{-10}$
hydrogen phosphite	$\text{PbHPO}_3$	6.24	$5.8 \times 10^{-7}$
hydroxide	$\text{Pb}(\text{OH})_2$	14.84	$1.43 \times 10^{-15}$
hydroxide bromide	$\text{PbOHBr}$	14.70	$2.0 \times 10^{-15}$
hydroxide chloride	$\text{PbOHCl}$	13.7	$2 \times 10^{-14}$
hydroxide nitrate	$\text{PbOHNO}_3$	3.55	$2.8 \times 10^{-4}$
iodate	$\text{Pb}(\text{IO}_3)_2$	12.43	$3.69 \times 10^{-13}$
iodide	$\text{PbI}_2$	8.01	$9.8 \times 10^{-9}$
molybdate	$\text{PbMoO}_4$	13.00	$1.0 \times 10^{-13}$
niobate	$\text{Pb}(\text{NbO}_3)_2$	16.62	$2.4 \times 10^{-17}$
oxalate	$\text{PbC}_2\text{O}_4$	9.32	$4.8 \times 10^{-10}$
phosphate	$\text{Pb}_3(\text{PO}_4)_2$	42.10	$8.0 \times 10^{-43}$
quinaldate	$\text{PbL}_2$	10.60	$2.5 \times 10^{-11}$
selenate	$\text{PbSeO}_4$	6.84	$1.37 \times 10^{-7}$
selenite	$\text{PbSeO}_3$	11.50	$3.2 \times 10^{-12}$
sulfate	$\text{PbSO}_4$	7.60	$2.53 \times 10^{-8}$
sulfide	$\text{PbS}$	27.10	$8.0 \times 10^{-28}$
thiocyanate	$\text{Pb}(\text{SCN})_2$	4.70	$2.0 \times 10^{-5}$
thiosulfate	$\text{PbS}_2\text{O}_3$	6.40	$4.0 \times 10^{-7}$
tungstate	$\text{PbWO}_4$	6.35	$4.5 \times 10^{-7}$
Lead(IV)			
hydroxide	$\text{Pb}(\text{OH})_4$	65.50	$3.2 \times 10^{-66}$
Lithium			
carbonate	$\text{Li}_2\text{CO}_3$	1.60	$2.5 \times 10^{-2}$
fluoride	$\text{LiF}$	2.74	$1.84 \times 10^{-3}$
phosphate	$\text{Li}_3\text{PO}_4$	10.63	$2.37 \times 10^{-11}$
uranylarsenate	$\text{LiUO}_2\text{AsO}_4$	18.82	$1.5 \times 10^{-19}$
Lutetium			
hydroxide	$\text{Lu}(\text{OH})_3$	23.72	$1.9 \times 10^{-24}$

TABLE 8.6 Solubility Product Constants (Continued)

Compound	Formula	$pK_{sp}$	$K_{sp}$
<b>Magnesium</b>			
ammonium phosphate	$MgNH_4PO_4$	12.60	$2.5 \times 10^{-13}$
arsenate	$Mg_3(AsO_4)_2$	19.68	$2.1 \times 10^{-20}$
carbonate	$MgCO_3$	5.17	$6.82 \times 10^{-6}$
carbonate trihydrate	$MgCO_3 \cdot 3H_2O$	5.62	$2.38 \times 10^{-6}$
fluoride	$MgF_2$	10.29	$5.16 \times 10^{-11}$
hydroxide	$Mg(OH)_2$	11.25	$5.61 \times 10^{-12}$
iodate 4-water	$Mg(IO_3)_2 \cdot 4H_2O$	2.50	$3.2 \times 10^{-3}$
niobate	$Mg(NbO_3)_2$	16.64	$2.3 \times 10^{-17}$
oxalate dihydrate	$MgC_2O_4 \cdot 2H_2O$	5.32	$4.83 \times 10^{-6}$
phosphate	$Mg_3(PO_4)_2$	23.98	$1.04 \times 10^{-24}$
8-quinolinolate	$MgL_2$	15.40	$4.0 \times 10^{-16}$
selenite	$MgSeO_3$	4.89	$1.3 \times 10^{-5}$
sulfite	$MgSO_3$	2.50	$3.2 \times 10^{-3}$
<b>Manganese</b>			
anthranilate	$MnL_2$	6.75	$1.8 \times 10^{-3}$
arsenate	$Mn_3(AsO_4)_2$	28.72	$1.9 \times 10^{-29}$
carbonate	$MnCO_3$	10.63	$2.34 \times 10^{-11}$
ferrocyanide	$Mn_2[Fe(CN)_6]$	12.10	$8.0 \times 10^{-13}$
iodate	$Mn(IO_3)_2$	6.36	$4.37 \times 10^{-7}$
hydroxide	$Mn(OH)_2$	12.72	$1.9 \times 10^{-13}$
oxalate dihydrate	$MnC_2O_4 \cdot 2H_2O$	6.77	$1.70 \times 10^{-7}$
8-quinolinolate	$MnL_2$	21.70	$2.0 \times 10^{-22}$
selenite	$MnSeO_3$	6.90	$1.3 \times 10^{-7}$
sulfide	MnS amorphous	9.60	$2.5 \times 10^{-10}$
	MnS crystalline	12.60	$2.5 \times 10^{-13}$
<b>Mercury(I)</b>			
azide	$Hg_2(N_3)_2$	9.15	$7.1 \times 10^{-10}$
bromide	$Hg_2Br_2$	22.19	$6.40 \times 10^{-23}$
carbonate	$Hg_2CO_3$	16.44	$3.6 \times 10^{-17}$
chloride	$Hg_2Cl_2$	17.84	$1.43 \times 10^{-18}$
cyanide	$Hg_2(CN)_2$	39.3	$5 \times 10^{-40}$
chromate	$Hg_2CrO_4$	8.70	$2.0 \times 10^{-9}$
ferricyanide	$(Hg_2)_3[Fe(CN)_6]_2$	20.07	$8.5 \times 10^{-21}$
fluoride	$Hg_2F_2$	5.51	$3.10 \times 10^{-6}$
hydrogen phosphate	$Hg_2HPO_4$	12.40	$4.0 \times 10^{-13}$
hydroxide	$Hg_2(OH)_2$	23.70	$2.0 \times 10^{-24}$
iodate	$Hg_2(IO_3)_2$	13.71	$2.0 \times 10^{-14}$
iodide	$Hg_2I_2$	28.72	$5.2 \times 10^{-29}$
oxalate	$Hg_2C_2O_4$	12.76	$1.75 \times 10^{-13}$
quinaldate	$Hg_2L_2$	17.90	$1.3 \times 10^{-18}$
selenite	$Hg_2SeO_3$	14.20	$8.4 \times 10^{-15}$
sulfate	$Hg_2SO_4$	6.19	$6.5 \times 10^{-7}$
sulfite	$Hg_2SO_3$	27.0	$1.0 \times 10^{-27}$
sulfide	$Hg_2S$	47.0	$1.0 \times 10^{-47}$
thiocyanate	$Hg_2(SCN)_2$	19.49	$3.2 \times 10^{-20}$
tungstate	$Hg_2WO_4$	16.96	$1.1 \times 10^{-17}$
<b>Mercury(II)</b>			
bromide	$HgBr_2$	19.21	$6.2 \times 10^{-20}$
hydroxide	$Hg(OH)_2$	25.52	$3.2 \times 10^{-26}$
iodate	$Hg(IO_3)_2$	12.49	$3.2 \times 10^{-13}$
iodide	$HgI_2$	28.54	$2.9 \times 10^{-29}$
1,10-phenanthroline	$HgL_2$	24.70	$2.0 \times 10^{-25}$

TABLE 8.6 Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
quinaldate	HgL <sub>2</sub>	16.80	$1.6 \times 10^{-17}$
selenite	HgSeO <sub>3</sub>	13.82	$1.5 \times 10^{-14}$
sulfide	HgS red	52.4	$4 \times 10^{-53}$
	HgS black	51.80	$1.6 \times 10^{-52}$
Neodymium			
carbonate	Nd <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub>	32.97	$1.08 \times 10^{-33}$
hydroxide	Nd(OH) <sub>3</sub>	21.49	$3.2 \times 10^{-22}$
Neptunyl(VI)			
hydroxide	NpO <sub>2</sub> (OH) <sub>2</sub>	21.60	$2.5 \times 10^{-22}$
Nickel			
ammine perrhenate	[Ni(NH <sub>3</sub> ) <sub>6</sub> ][ReO <sub>4</sub> ] <sub>2</sub>	3.29	$5.1 \times 10^{-4}$
anthranilate	NiL <sub>2</sub>	9.09	$8.1 \times 10^{-10}$
arsenate	Ni <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	25.51	$3.1 \times 10^{-26}$
carbonate	NiCO <sub>3</sub>	6.85	$1.42 \times 10^{-7}$
ferrocyanide	Ni <sub>2</sub> [Fe(CN) <sub>6</sub> ]	14.89	$1.3 \times 10^{-15}$
hydrazine sulfate	[Ni(N <sub>2</sub> H <sub>4</sub> ) <sub>3</sub> ]SO <sub>4</sub>	13.15	$7.1 \times 10^{-15}$
hydroxide	Ni(OH) <sub>2</sub> fresh	15.26	$5.48 \times 10^{-16}$
iodate	Ni(IO <sub>3</sub> ) <sub>2</sub>	4.33	$4.71 \times 10^{-5}$
oxalate	NiC <sub>2</sub> O <sub>4</sub>	9.4	$4 \times 10^{-10}$
phosphate	Ni <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	31.32	$4.74 \times 10^{-32}$
pyrophosphate	Ni <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	12.77	$1.7 \times 10^{-13}$
quinaldate	NiL <sub>2</sub>	10.1	$8 \times 10^{-11}$
8-quinolinolate	NiL <sub>2</sub>	26.1	$8 \times 10^{-27}$
selenite	NiSeO <sub>3</sub>	5.0	$1.0 \times 10^{-5}$
α-sulfide	α-NiS	18.50	$3.2 \times 10^{-19}$
β-sulfide	β-NiS	24.0	$1.0 \times 10^{-24}$
γ-sulfide	γ-NiS	25.70	$2.0 \times 10^{-26}$
Palladium			
(II) hydroxide	Pd(OH) <sub>2</sub>	31.0	$1.0 \times 10^{-31}$
(IV) hydroxide	Pd(OH) <sub>4</sub>	70.20	$6.3 \times 10^{-71}$
quinaldate	PdL <sub>2</sub>	12.90	$1.3 \times 10^{-13}$
thiocyanate	Pd(SCN) <sub>2</sub>	22.36	$4.39 \times 10^{-23}$
Platinum			
(IV) bromide	PtBr <sub>4</sub>	40.50	$3.2 \times 10^{-41}$
(II) hydroxide	Pt(OH) <sub>2</sub>	35	$1 \times 10^{-35}$
Plutonium			
(III) fluoride	PuF <sub>3</sub>	15.60	$2.5 \times 10^{-16}$
(IV) fluoride	PuF <sub>4</sub>	19.20	$6.3 \times 10^{-20}$
(IV) hydrogen phosphate	Pu(HPO <sub>4</sub> ) <sub>2</sub> · xH <sub>2</sub> O	27.7	$2 \times 10^{-28}$
(III) hydroxide	Pu(OH) <sub>3</sub>	19.70	$2.0 \times 10^{-20}$
(IV) hydroxide	Pu(OH) <sub>4</sub>	55	$1 \times 10^{-55}$
(IV) iodate	Pu(IO <sub>3</sub> ) <sub>4</sub>	12.3	$5 \times 10^{-13}$
(VI) carbonate	PuO <sub>2</sub> CO <sub>3</sub>	12.77	$1.7 \times 10^{-13}$
(V) hydroxide	PuO <sub>2</sub> (OH)	9.3	$5 \times 10^{-10}$
(VI) hydroxide	PuO <sub>2</sub> (OH) <sub>2</sub>	24.7	$2 \times 10^{-25}$
Polonium			
sulfide	PoS	28.26	$5.6 \times 10^{-29}$
Potassium			
hexabromoplatinate	K <sub>2</sub> [PtBr <sub>6</sub> ]	4.20	$6.3 \times 10^{-5}$
hexachloropalladate	K <sub>2</sub> [PdCl <sub>6</sub> ]	5.22	$6.0 \times 10^{-6}$
hexachloroplatinate	K <sub>2</sub> [PtCl <sub>6</sub> ]	5.13	$7.48 \times 10^{-6}$
hexafluoroplatinate	K <sub>2</sub> [PtF <sub>6</sub> ]	4.54	$2.9 \times 10^{-5}$



TABLE 8.6 Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
hexafluorosilicate	$K_2[SiF_6]$	6.06	$8.7 \times 10^{-7}$
hexafluorozirconate	$K_2[ZrF_6]$	3.3	$5 \times 10^{-4}$
iodate	$KIO_4$	3.43	$3.74 \times 10^{-4}$
perchlorate	$KClO_4$	1.98	$1.05 \times 10^{-2}$
sodium cobaltinitrite hydrate	$K_2Na[Co(NO_2)_6] \cdot H_2O$	10.66	$2.2 \times 10^{-11}$
tetraphenylborate	$K[B(C_6H_5)_4]$	7.66	$2.2 \times 10^{-8}$
uranyl arsenate	$K[UO_2AsO_4]$	22.60	$2.5 \times 10^{-23}$
uranyl carbonate	$K_4[UO_2(CO_3)_3]$	4.20	$6.3 \times 10^{-5}$
Praseodymium hydroxide	$Pr(OH)_3$	23.45	$3.39 \times 10^{-24}$
Promethium hydroxide	$Pm(OH)_3$	21	$1 \times 10^{-21}$
Radium iodate	$Ra(IO_3)_2$	8.94	$1.16 \times 10^{-9}$
sulfate	$RaSO_4$	10.44	$3.66 \times 10^{-11}$
Rhodium hydroxide	$Rh(OH)_3$	23	$1 \times 10^{-23}$
Rubidium cobaltinitrite	$Rb_3[Co(NO_2)_6]$	14.83	$1.5 \times 10^{-15}$
hexachloroplatinate	$Rb_2[PtCl_6]$	7.20	$6.3 \times 10^{-8}$
hexafluoroplatinate	$Rb_2[PtF_6]$	6.12	$7.7 \times 10^{-7}$
hexafluorosilicate	$Rb_2[SiF_6]$	6.30	$5.0 \times 10^{-7}$
perchlorate	$RbClO_4$	2.52	$3.0 \times 10^{-3}$
periodate	$RbIO_4$	3.26	$5.5 \times 10^{-4}$
Ruthenium hydroxide	$Ru(OH)_3$	36	$1 \times 10^{-36}$
Samarium hydroxide	$Sm(OH)_3$	22.08	$8.3 \times 10^{-23}$
Scandium fluoride	$ScF_3$	23.24	$5.81 \times 10^{-24}$
hydroxide	$Sc(OH)_3$	30.65	$2.22 \times 10^{-31}$
Silver acetate	$AgOAc$	2.71	$1.94 \times 10^{-3}$
arsenate	$Ag_3AsO_4$	21.99	$1.03 \times 10^{-22}$
azide	$AgN_3$	8.54	$2.8 \times 10^{-9}$
bromate	$AgBrO_3$	4.27	$5.38 \times 10^{-5}$
bromide	$AgBr$	12.27	$5.35 \times 10^{-13}$
carbonate	$Ag_2CO_3$	11.07	$8.46 \times 10^{-12}$
chloride	$AgCl$	9.75	$1.77 \times 10^{-10}$
chlorite	$AgClO_2$	3.70	$2.0 \times 10^{-4}$
chromate	$Ag_2CrO_4$	11.95	$1.12 \times 10^{-12}$
cobaltinitrite	$Ag_3[Co(NO_2)_6]$	20.07	$8.5 \times 10^{-21}$
cyanamide	$Ag_2CN_2$	10.14	$7.2 \times 10^{-11}$
cyanate	$AgOCN$	6.64	$2.3 \times 10^{-7}$
cyanide	$AgCN$	16.22	$5.97 \times 10^{-17}$
dichromate	$Ag_2Cr_2O_7$	6.70	$2.0 \times 10^{-7}$
dicyanamide	$AgN(CN)_2$	8.85	$1.4 \times 10^{-9}$
ferrocyanide	$Ag_4[Fe(CN)_6]$	40.81	$1.6 \times 10^{-41}$
hydroxide	$AgOH$	7.71	$2.0 \times 10^{-8}$
hyponitrite	$Ag_2N_2O_2$	18.89	$1.3 \times 10^{-19}$
iodate	$AgIO_3$	7.50	$3.17 \times 10^{-8}$

TABLE 8.6 Solubility Product Constants (Continued)

Compound	Formula	$pK_{sp}$	$K_{sp}$
iodide	AgI	16.07	$8.52 \times 10^{-17}$
molybdate	$Ag_2MoO_4$	11.55	$2.8 \times 10^{-12}$
nitrite	AgNO <sub>2</sub>	3.22	$6.0 \times 10^{-4}$
oxalate	$Ag_2C_2O_4$	11.27	$5.40 \times 10^{-12}$
phosphate	$Ag_3PO_4$	16.05	$8.89 \times 10^{-17}$
quinaldate	AgL	16.89	$1.3 \times 10^{-17}$
perrhenate	AgReO <sub>4</sub>	4.10	$8.0 \times 10^{-5}$
selenate	$Ag_2SeO_4$	7.25	$5.7 \times 10^{-8}$
selenite	$Ag_2SeO_3$	15.00	$1.0 \times 10^{-15}$
selenocyanate	AgSeCN	15.40	$4.0 \times 10^{-16}$
sulfate	$Ag_2SO_4$	4.92	$1.20 \times 10^{-5}$
sulfite	$Ag_2SO_3$	13.82	$1.50 \times 10^{-14}$
sulfide	$Ag_2S$	49.20	$6.3 \times 10^{-50}$
thiocyanate	AgSCN	11.99	$1.03 \times 10^{-12}$
vanadate	AgVO <sub>3</sub>	6.3	$5 \times 10^{-7}$
tungstate	$Ag_2WO_4$	11.26	$5.5 \times 10^{-12}$
Sodium			
ammonium cobaltinitrite	$Na(NH_4)_2[Co(NO_2)_6]$	10.66	$2.2 \times 10^{-11}$
antimonate	$Na[Sb(OH)_6]$	7.4	$4 \times 10^{-8}$
hexafluoroaluminate	$Na_2[AlF_6]$	9.39	$4.0 \times 10^{-10}$
uranyl arsenate	$NaUO_2AsO_4$	21.87	$1.3 \times 10^{-22}$
Strontium			
arsenate	$Sr_3(AsO_4)_2$	18.37	$4.29 \times 10^{-19}$
carbonate	SrCO <sub>3</sub>	9.25	$5.60 \times 10^{-10}$
chromate	SrCrO <sub>4</sub>	4.65	$2.2 \times 10^{-5}$
fluoride	SrF <sub>2</sub>	8.36	$4.33 \times 10^{-9}$
iodate	$Sr(IO_3)_2$	6.94	$1.14 \times 10^{-7}$
iodate hydrate	$Sr(IO_3)_2 \cdot H_2O$	6.42	$3.77 \times 10^{-7}$
molybdate	SrMoO <sub>4</sub>	6.7	$2 \times 10^{-7}$
niobate	$Sr(NbO_3)_2$	17.38	$4.2 \times 10^{-18}$
oxalate hydrate	$SrC_2O_4 \cdot H_2O$	6.80	$1.6 \times 10^{-7}$
phosphate	$Sr_3(PO_4)_2$	27.39	$4.0 \times 10^{-28}$
8-quinolinolate	SrL <sub>2</sub>	9.3	$5 \times 10^{-10}$
selenate	SrSeO <sub>4</sub>	3.09	$8.1 \times 10^{-4}$
selenite	SrSeO <sub>3</sub>	5.74	$1.8 \times 10^{-6}$
sulfate	SrSO <sub>4</sub>	6.46	$3.44 \times 10^{-7}$
sulfite	SrSO <sub>3</sub>	7.4	$4 \times 10^{-8}$
tungstate	SrWO <sub>4</sub>	9.77	$1.7 \times 10^{-10}$
Terbium			
hydroxide	Tb(OH) <sub>3</sub>	21.70	$2.0 \times 10^{-22}$
Tellurium			
hydroxide	Te(OH) <sub>4</sub>	53.52	$3.0 \times 10^{-54}$
Thallium(I)			
azide	TlN <sub>3</sub>	3.66	$2.2 \times 10^{-4}$
bromate	TlBrO <sub>3</sub>	4.96	$1.10 \times 10^{-5}$
bromide	TlBr	5.43	$3.71 \times 10^{-6}$
chloride	TlCl	3.73	$1.86 \times 10^{-4}$
chromate	Tl <sub>2</sub> CrO <sub>4</sub>	12.06	$8.67 \times 10^{-13}$
ferrocyanide dihydrate	$Tl_4[Fe(CN)_6] \cdot 2H_2O$	9.3	$5 \times 10^{-10}$
hexachloroplatinate	$Tl_2[PtCl_6]$	11.40	$4.0 \times 10^{-12}$
iodate	TlIO <sub>3</sub>	5.51	$3.12 \times 10^{-6}$
iodide	TlI	7.26	$5.54 \times 10^{-8}$

**TABLE 8.6** Solubility Product Constants (*Continued*)

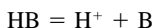
Compound	Formula	$pK_{sp}$	$K_{sp}$
oxalate	$Tl_2C_2O_4$	3.7	$2 \times 10^{-4}$
selenate	$Tl_2SeO_4$	4.00	$1.0 \times 10^{-4}$
selenite	$Tl_2SeO_3$	38.7	$2 \times 10^{-39}$
sulfide	$Tl_2S$	20.30	$5.0 \times 10^{-21}$
thiocyanate	TISCN	3.80	$1.57 \times 10^{-4}$
Thallium(III)			
hydroxide	$Tl(OH)_3$	43.77	$1.68 \times 10^{-44}$
8-quinolinolate	$TlL_3$	32.40	$4.0 \times 10^{-33}$
Thorium			
hydrogen phosphate	$Th(HPO_4)_2$	20	$1 \times 10^{-20}$
hydroxide	$Th(OH)_4$	44.40	$4.0 \times 10^{-45}$
iodate	$Th(IO_3)_4$	14.60	$2.5 \times 10^{-15}$
oxalate	$Th(C_2O_4)_2$	22	$1 \times 10^{-22}$
phosphate	$Th_3(PO_4)_4$	78.60	$2.5 \times 10^{-79}$
Thulium			
hydroxide	$Tm(OH)_3$	23.48	$3.3 \times 10^{-24}$
Tin			
(II) hydroxide	$Sn(OH)_2$	27.26	$5.45 \times 10^{-28}$
(IV) hydroxide	$Sn(OH)_4$	56	$1 \times 10^{-56}$
(II) sulfide	$SnS$	25.00	$1.0 \times 10^{-25}$
Titanium			
(III) hydroxide	$Ti(OH)_3$	40	$1 \times 10^{-40}$
(IV) oxide hydroxide	$TiO(OH)_2$	29	$1 \times 10^{-29}$
Uranium(IV)			
fluoride 2.5-water	$UF_4 \cdot 2.5H_2O$	21.24	$5.7 \times 10^{-22}$
Uranyl(VI)(2+)			
carbonate	$UO_2CO_3$	11.73	$1.8 \times 10^{-12}$
ferrocyanide	$UO_2[Fe(CN)_6]$	13.15	$7.1 \times 10^{-14}$
hydrogen arsenate	$UO_2HAsO_4$	10.50	$3.2 \times 10^{-11}$
hydrogen phosphate	$UO_2HPO_4$	10.67	$2.1 \times 10^{-11}$
hydroxide	$UO_2(OH)_2$	21.95	$1.1 \times 10^{-22}$
iodate hydrate	$UO_2(IO_3)_2 \cdot H_2O$	7.50	$3.2 \times 10^{-8}$
oxalate trihydrate	$UO_2C_2O_4 \cdot 3H_2O$	3.7	$2 \times 10^{-4}$
phosphate	$(UO_2)_3(PO_4)_2$	46.7	$2 \times 10^{-47}$
sulfite	$UO_2SO_3$	8.58	$2.6 \times 10^{-9}$
thiocyanate	$(UO_2)(SCN)_2$	3.4	$4 \times 10^{-4}$
Vanadium			
(IV) hydroxide	$VO(OH)_2$	22.13	$5.9 \times 10^{-23}$
(III) phosphate	$(VO_2)_3PO_4$	24.1	$8 \times 10^{-25}$
Ytterbium			
hydroxide	$Yb(OH)_3$	23.60	$2.5 \times 10^{-24}$
Yttrium			
carbonate	$Y_2(CO_3)_3$	2.99	$1.03 \times 10^{-3}$
fluoride	$YF_3$	20.06	$8.62 \times 10^{-21}$
hydroxide	$Y(OH)_3$	22.00	$1.00 \times 10^{-22}$
iodate	$Y(IO_3)_3$	9.95	$1.12 \times 10^{-10}$
oxalate	$Y_2(C_2O_4)_3$	28.28	$5.3 \times 10^{-29}$
Zinc			
anthranilate	$ZnL_2$	9.23	$5.9 \times 10^{-10}$
arsenate	$Zn_3(AsO_4)_2$	27.55	$2.8 \times 10^{-28}$
borate hydrate	$Zn(BO_2)_2 \cdot H_2O$	10.18	$6.6 \times 10^{-11}$
carbonate	$ZnCO_3$	9.94	$1.46 \times 10^{-10}$
ferrocyanide	$Zn_2[Fe(CN)_6]$	15.40	$4.0 \times 10^{-15}$

**TABLE 8.6** Solubility Product Constants (*Continued*)

Compound	Formula	$pK_{sp}$	$K_{sp}$
fluoride	$ZnF_2$	1.52	$3.04 \times 10^{-2}$
hydroxide	$Zn(OH)_2$	16.5	$3 \times 10^{-17}$
iodate dihydrate	$Zn(IO_3)_2 \cdot 2H_2O$	5.37	$4.1 \times 10^{-6}$
oxalate dihydrate	$ZnC_2O_4 \cdot 2H_2O$	8.86	$1.38 \times 10^{-9}$
phosphate	$Zn_3(PO_4)_2$	32.04	$9.0 \times 10^{-33}$
quinaldate	$ZnL_2$	13.80	$1.6 \times 10^{-14}$
8-quinolinolate	$ZnL_2$	24.30	$5.0 \times 10^{-25}$
selenide	$ZnSe$	25.44	$3.6 \times 10^{-26}$
selenite hydrate	$ZnSeO_3 \cdot H_2O$	6.80	$1.57 \times 10^{-7}$
sulfide	$\alpha$ -ZnS	23.80	$1.6 \times 10^{-24}$
	$\beta$ -ZnS	21.60	$2.5 \times 10^{-22}$
Zirconium			
oxide hydroxide	$ZrO(OH)_2$	48.20	$6.3 \times 10^{-49}$
phosphate	$Zr_3(PO_4)_4$	132	$1 \times 10^{-132}$

### 8.2.1 Proton-Transfer Reactions

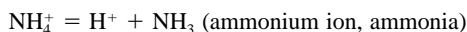
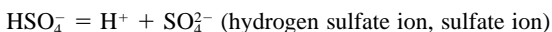
The  $pK_a$  values listed in Tables 8.7 and 8.8 are the negative (decadic) logarithms of the acidic dissociation constant, i.e.,  $-\log_{10} K_a = pK_a$ . For the general proton-transfer reaction



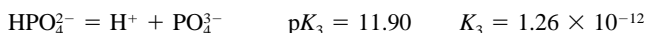
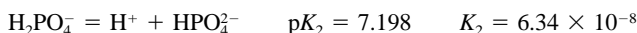
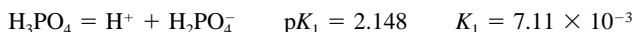
the acidic dissociation constant is formulated as follows:

$$K_a = \frac{[H^+][B]}{[HB]}$$

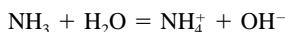
The most common charge types for the acid HB and its conjugate base B are



Acids which have more than one acidic hydrogen ionize in steps, as shown for phosphoric acid:



If the basic dissociation constant  $K_b$  for the equilibrium such as



is required,  $pK_b$  may be calculated from the relationship

$$pK_b = pK_w - pK_a$$