



## Selected Solubility Products and Formation Constants at 25<sup>o</sup>C

### Solubility Rules

Although all compounds have a characteristic solubility in water at a given temperature, some families of compounds are more soluble than others and it is useful to know certain general rules of solubility. We call any substance the solubility of which is less than 0.01 mol/L insoluble. If its solubility is greater than 0.1 mol/L, we call it soluble. If its solubility is between 0.01 and 0.1 mol/L, we say that it is slightly soluble. The following solubility rules can be used to determine solubilities in water, with the disclaimer that they don't always hold, nor do they include every ion which is in common use, but they are good to have nearby when needed:

1. All sodium, potassium, and ammonium salts are soluble.
2. All nitrates, acetates and perchlorates are soluble.
3. All silver, lead and mercury(I) salts are insoluble.
4. All chlorides, bromides and iodides are soluble.
5. All carbonates, sulfides, oxides and hydroxides are insoluble.
6. All sulfates are soluble except strontium sulfate and barium sulfate.

That having been said, here is a table of solubility product constants.

<u>Compound</u>	<u>Formula</u>	<u>K<sub>sp</sub></u>
aluminum hydroxide	Al(OH) <sub>3</sub>	4.6 x 10 <sup>-33</sup>
aluminum phosphate	AlPO <sub>4</sub>	6.3 x 10 <sup>-19</sup>
barium carbonate	BaCO <sub>3</sub>	5.1 x 10 <sup>-9</sup>
barium chromate	BaCrO <sub>4</sub>	2.2 x 10 <sup>-10</sup>
barium fluoride	BaF <sub>2</sub>	1.0 x 10 <sup>-6</sup>
barium hydroxide	Ba(OH) <sub>2</sub>	5 x 10 <sup>-3</sup>
barium iodate	Ba(IO <sub>3</sub> ) <sub>2</sub>	1.5 x 10 <sup>-9</sup>
barium oxalate	BaC <sub>2</sub> O <sub>4</sub>	2.3 x 10 <sup>-8</sup>
barium sulfate	BaSO <sub>4</sub>	1.1 x 10 <sup>-10</sup>
barium sulfite	BaSO <sub>3</sub>	8 x 10 <sup>-7</sup>
barium thiosulfate	BaS <sub>2</sub> O <sub>3</sub>	1.6 10 <sup>-5</sup>
bismuthyl chloride	BiOCl	1.8 x 10 <sup>-31</sup>
bismuthyl hydroxide	BiOOH	4 x 10 <sup>-10</sup>
bismuth(III) sulfide	Bi <sub>2</sub> S <sub>3</sub>	1 x 10 <sup>-97</sup>
cadmium carbonate	CdCO <sub>3</sub>	5.2 x 10 <sup>-12</sup>
cadmium hydroxide	Cd(OH) <sub>2</sub>	2.5 x 10 <sup>-14</sup>
cadmium iodate	Cd(IO <sub>3</sub> ) <sub>2</sub>	2.3 x 10 <sup>-8</sup>
cadmium sulfide	CdS	8.0 x 10 <sup>-27</sup>
calcium carbonate	CaCO <sub>3</sub>	3.8 x 10 <sup>-9</sup>

calcium chromate	CaCrO <sub>4</sub>	7.1 x 10 <sup>-4</sup>
calcium fluoride	CaF <sub>2</sub>	5.3 x 10 <sup>-9</sup>
calcium hydroxide	Ca(OH) <sub>2</sub>	5.5 x 10 <sup>-6</sup>
calcium iodate	Ca(IO <sub>3</sub> ) <sub>2</sub>	7.1 x 10 <sup>-7</sup>
calcium oxalate hydrate	CaC <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O	1.96 x 10 <sup>-8</sup>
calcium hydrogen phosphate	CaHPO <sub>4</sub>	1 x 10 <sup>-7</sup>
calcium phosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	1 x 10 <sup>-26</sup>
calcium sulfate	CaSO <sub>4</sub>	9.1 x 10 <sup>-6</sup>
calcium sulfite	CaSO <sub>3</sub>	6.8 x 10 <sup>-8</sup>
chromium(II) hydroxide	Cr(OH) <sub>2</sub>	2 x 10 <sup>-16</sup>
chromium(III) hydroxide	Cr(OH) <sub>3</sub>	6.3 x 10 <sup>-31</sup>
cobalt(II) carbonate	CoCO <sub>3</sub>	1.4 x 10 <sup>-13</sup>
cobalt(III) hydroxide	Co(OH) <sub>3</sub>	1.6 x 10 <sup>-44</sup>
cobalt(II) sulfide	CoS	4.0 x 10 <sup>-21</sup>
copper(I) chloride	CuCl	1.2 x 10 <sup>-6</sup>
copper(I) cyanide	CuCN	3.2 x 10 <sup>-20</sup>
copper(I) iodide	CuI	1.1 x 10 <sup>-12</sup>
copper(I) sulfide	Cu <sub>2</sub> S	2.5 x 10 <sup>-48</sup>
copper(II) arsenate	Cu <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	7.6 x 10 <sup>-36</sup>
copper(II) carbonate	CuCO <sub>3</sub>	1.4 x 10 <sup>-10</sup>
copper(II) chromate	CuCrO <sub>4</sub>	3.6 x 10 <sup>-6</sup>
copper(II) ferrocyanide	Cu <sub>2</sub> [Fe(CN) <sub>6</sub> ]	1.3 x 10 <sup>-16</sup>
copper(II) hydroxide	Cu(OH) <sub>2</sub>	2.2 x 10 <sup>-20</sup>
copper(II) sulfide	CuS	6 x 10 <sup>-37</sup>
copper(II) thiocyanate	Cu(SCN) <sub>2</sub>	4.0 x 10 <sup>-14</sup>
fluorapatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> F	1.0 x 10 <sup>-60</sup>
hydroxyapatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> OH	1.0 x 10 <sup>-36</sup>
iron(II) carbonate	FeCO <sub>3</sub>	3.2 x 10 <sup>-11</sup>
iron(II) hydroxide	Fe(OH) <sub>2</sub>	8.0 x 10 <sup>-16</sup>
iron(II) sulfide	FeS	6 x 10 <sup>-19</sup>
iron(III) arsenate	FeAsO <sub>4</sub>	5.7 x 10 <sup>-21</sup>

iron(III) ferrocyanide	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$	$3.3 \times 10^{-41}$
iron(III) hydroxide	$\text{Fe}(\text{OH})_3$	$4 \times 10^{-38}$
iron(III) phosphate	$\text{FePO}_4$	$1.3 \times 10^{-22}$
lead(II) arsenate	$\text{Pb}_3(\text{AsO}_4)_2$	$4.0 \times 10^{-36}$
lead(II) azide	$\text{Pb}(\text{N}_3)_2$	$2.5 \times 10^{-9}$
lead(II) bromate	$\text{Pb}(\text{BrO}_3)_2$	$7.9 \times 10^{-6}$
lead(II) bromide	$\text{PbBr}_2$	$4.0 \times 10^{-5}$
lead(II) carbonate	$\text{PbCO}_3$	$7.4 \times 10^{-14}$
lead(II) chloride	$\text{PbCl}_2$	$1.6 \times 10^{-5}$
lead(II) chromate	$\text{PbCrO}_4$	$2.8 \times 10^{-13}$
lead(II) fluoride	$\text{PbF}_2$	$2.7 \times 10^{-8}$
lead(II) hydroxide	$\text{Pb}(\text{OH})_2$	$1.2 \times 10^{-5}$
lead(II) iodate	$\text{Pb}(\text{IO}_3)_2$	$2.6 \times 10^{-13}$
lead(II) iodide	$\text{PbI}_2$	$7.1 \times 10^{-9}$
lead(II) sulfate	$\text{PbSO}_4$	$1.6 \times 10^{-8}$
lead(II) sulfide	$\text{PbS}$	$3 \times 10^{-29}$
lithium carbonate	$\text{Li}_2\text{CO}_3$	$2.5 \times 10^{-2}$
lithium fluoride	$\text{LiF}$	$3.8 \times 10^{-3}$
lithium phosphate	$\text{Li}_3\text{PO}_4$	$3.2 \times 10^{-9}$
magnesium ammonium phosphate	$\text{MgNH}_4\text{PO}_4$	$2.5 \times 10^{-13}$
magnesium arsenate	$\text{Mg}_3(\text{AsO}_4)_2$	$2.1 \times 10^{-20}$
magnesium carbonate	$\text{MgCO}_3$	$3.5 \times 10^{-8}$
magnesium fluoride	$\text{MgF}_2$	$3.7 \times 10^{-8}$
magnesium hydroxide	$\text{Mg}(\text{OH})_2$	$1.8 \times 10^{-11}$
magnesium oxalate	$\text{MgC}_2\text{O}_4$	$7 \times 10^{-7}$
magnesium phosphate	$\text{Mg}_3(\text{PO}_4)_2$	$1 \times 10^{-25}$
manganese(II) carbonate	$\text{MnCO}_3$	$1.8 \times 10^{-11}$
manganese(II) hydroxide	$\text{Mn}(\text{OH})_2$	$1.9 \times 10^{-9}$
manganese(II) sulfide	$\text{MnS}$	$2.5 \times 10^{-13}$
mercury(I) bromide	$\text{Hg}_2\text{Br}_2$	$5.6 \times 10^{-23}$
mercury(I) chloride	$\text{Hg}_2\text{Cl}_2$	$5.0 \times 10^{-13}$

mercury(I) chromate	Hg <sub>2</sub> CrO <sub>4</sub>	2.0 x 10 <sup>-9</sup>
mercury(I) cyanide	Hg <sub>2</sub> (CN) <sub>2</sub>	5 x 10 <sup>-40</sup>
mercury(I) iodide	HgI <sub>2</sub>	4.5 x 10 <sup>-29</sup>
mercury(I) sulfate	Hg <sub>2</sub> SO <sub>4</sub>	7.4 x 10 <sup>-7</sup>
mercury(I) sulfide	Hg <sub>2</sub> S	1.0 x 10 <sup>-47</sup>
mercury(I) thiocyanate	Hg <sub>2</sub> (SCN) <sub>2</sub>	3.0 x 10 <sup>-20</sup>
mercury(II) sulfide	HgS	1.6 x 10 <sup>-52</sup>
mercury(II) thiocyanate	Hg(SCN) <sub>2</sub>	2.8 x 10 <sup>-20</sup>
nickel(II) carbonate	NiCO <sub>3</sub>	6.6 x 10 <sup>-9</sup>
nickel(II) hydroxide	Ni(OH) <sub>2</sub>	2.0 x 10 <sup>-15</sup>
nickel(II) sulfide	NiS	3 x 10 <sup>-19</sup>
scandium fluoride	ScF <sub>3</sub>	4.2 x 10 <sup>-18</sup>
scandium hydroxide	Sc(OH) <sub>3</sub>	4.2 x 10 <sup>-18</sup>
silver arsenate	Ag <sub>3</sub> AsO <sub>4</sub>	1.0 x 10 <sup>-22</sup>
silver acetate	AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	2.0 x 10 <sup>-3</sup>
silver azide	AgN <sub>3</sub>	2.0 x 10 <sup>-8</sup>
silver benzoate	AgC <sub>7</sub> H <sub>5</sub> O <sub>2</sub>	2.5 x 10 <sup>-5</sup>
silver bromate	AgBrO <sub>3</sub>	5.5 x 10 <sup>-5</sup>
silver bromide	AgBr	5.3 x 10 <sup>-13</sup>
silver carbonate	Ag <sub>2</sub> CO <sub>3</sub>	8.1 x 10 <sup>-12</sup>
silver chloride	AgCl	1.8 x 10 <sup>-10</sup>
silver chromate	Ag <sub>2</sub> CrO <sub>4</sub>	1.1 x 10 <sup>-12</sup>
silver cyanide	AgCN	1.2 x 10 <sup>-16</sup>
silver iodate	AgIO <sub>3</sub>	3.0 x 10 <sup>-8</sup>
silver iodide	AgI	8.3 x 10 <sup>-17</sup>
silver nitrite	AgNO <sub>2</sub>	6.0 x 10 <sup>-4</sup>
silver oxalate	Ag <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	3.6 x 10 <sup>-11</sup>
silver sulfate	Ag <sub>2</sub> SO <sub>4</sub>	1.4 x 10 <sup>-5</sup>
silver sulfide	Ag <sub>2</sub> S	6 x 10 <sup>-51</sup>
silver sulfite	AgSO <sub>3</sub>	1.5 x 10 <sup>-14</sup>
silver thiocyanate	AgSCN	1.0 x 10 <sup>-12</sup>

strontium carbonate	SrCO <sub>3</sub>	1.1 x 10 <sup>-10</sup>
strontium chromate	SrCrO <sub>4</sub>	2.2 x 10 <sup>-5</sup>
strontium fluoride	SrF <sub>2</sub>	2.5 x 10 <sup>-9</sup>
strontium oxalate	SrC <sub>2</sub> O <sub>4</sub>	4 x 10 <sup>-7</sup>
strontium sulfate	SrSO <sub>4</sub>	3.2 x 10 <sup>-7</sup>
strontium sulfite	SrSO <sub>3</sub>	4 x 10 <sup>-8</sup>
thallium(I) bromate	TlBrO <sub>3</sub>	1.7 x 10 <sup>-4</sup>
thallium(I) bromide	TlBr	3.4 x 10 <sup>-6</sup>
thallium(I) chloride	TlCl	1.7 x 10 <sup>-4</sup>
thallium(I) chromate	Tl <sub>2</sub> CrO <sub>4</sub>	9.8 x 10 <sup>-15</sup>
thallium(I) iodate	TlIO <sub>3</sub>	3.1 x 10 <sup>-6</sup>
thallium(I) iodide	TlI	6.5 x 10 <sup>-8</sup>
thallium(I) sulfide	Tl <sub>2</sub> S	6 x 10 <sup>-22</sup>
thallium(I) thiocyanate	TlSCN	1.6 x 10 <sup>-4</sup>
thallium(III) hydroxide	Tl(OH) <sub>3</sub>	6.3 x 10 <sup>-46</sup>
tin(II) hydroxide	Sn(OH) <sub>2</sub>	1.4 x 10 <sup>-28</sup>
tin(II) sulfide	SnS	1 x 10 <sup>-26</sup>
zinc carbonate	ZnCO <sub>3</sub>	1.4 x 10 <sup>-11</sup>
zinc cyanide	Zn(CN) <sub>2</sub>	3 x 10 <sup>-16</sup>
zinc hydroxide	Zn(OH) <sub>2</sub>	1.2 x 10 <sup>-17</sup>
zinc iodate	Zn(IO <sub>3</sub> ) <sub>2</sub>	3.9 x 10 <sup>-6</sup>
zinc oxalate	ZnC <sub>2</sub> O <sub>4</sub>	2.7 x 10 <sup>-8</sup>
zinc phosphate	Zn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	9.0 x 10 <sup>-33</sup>
zinc sulfide	ZnS	2 x 10 <sup>-25</sup>
<b>Formation Constants of Selected Complex Ions, at 25<sup>o</sup>C</b>		
	<b>Formula</b>	<b>K<sub>f</sub></b>
	Ag(CN) <sub>2</sub> <sup>-</sup>	5.6 x 10 <sup>18</sup>
	Ag(NH <sub>3</sub> ) <sub>2</sub> <sup>+</sup>	1.7 x 10 <sup>7</sup>
	Ag(S <sub>2</sub> O <sub>3</sub> ) <sub>2</sub> <sup>3-</sup>	2.9 x 10 <sup>13</sup>
	Co(SCN) <sup>+</sup>	100

$\text{Cu}(\text{CN})_2^-$	$1.0 \times 10^{16}$
$\text{Cu}(\text{NH}_3)_4^{2+}$	$1.0 \times 10^{13}$
$\text{Fe}(\text{SCN})^{2+}$	900
$\text{HgI}_4^{2-}$	$4.2 \times 10^{27}$
$\text{Zn}(\text{NH}_3)_4^{2+}$	$2.9 \times 10^9$
$\text{Zn}(\text{OH})_4^{2-}$	$4.6 \times 10^{17}$