

## Solubility rules for ionic solids in water

### Soluble in water

Soluble	Exceptions	
	Insoluble	Slightly soluble
Most chlorides	AgCl, Hg <sub>2</sub> Cl <sub>2</sub>	PbCl <sub>2</sub>
Most bromides	AgBr, Hg <sub>2</sub> Br <sub>2</sub> , HgBr <sub>2</sub>	PbBr <sub>2</sub>
Most iodides	AgI, Hg <sub>2</sub> I <sub>2</sub> , HgI <sub>2</sub> , PbI <sub>2</sub>	
All nitrates	No exceptions	
Most sulfates	SrSO <sub>4</sub> , BaSO <sub>4</sub> , HgSO <sub>4</sub> , PbSO <sub>4</sub>	CaSO <sub>4</sub> , Ag <sub>2</sub> SO <sub>4</sub>

### Insoluble in water

Insoluble	Exceptions	
	Soluble	Slightly soluble
Most hydroxides	NaOH, KOH, Ba(OH) <sub>2</sub> (NH <sub>4</sub> OH does not exist)	Ca(OH) <sub>2</sub> , Sr(OH) <sub>2</sub>
Most carbonates	Na <sub>2</sub> CO <sub>3</sub> , K <sub>2</sub> CO <sub>3</sub> , (NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>	
Most phosphates	Na <sub>3</sub> PO <sub>4</sub> , K <sub>3</sub> PO <sub>4</sub> , (NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub>	
Most sulfides	Na <sub>2</sub> S, K <sub>2</sub> S, (NH <sub>4</sub> ) <sub>2</sub> S	

Soluble	=	more than 0.1 mole dissolves per litre
Slightly soluble	=	between 0.01 and 0.1 mole dissolves per litre
Insoluble	=	less than 0.01 mole dissolves per litre

### Colours of Ions in Aqueous Solution

Cation	Colour	Cation	Colour	Anion	Colour
Al <sup>3+</sup>	colourless	Hg <sub>2</sub> <sup>2+</sup>	colourless	CrO <sub>4</sub> <sup>2-</sup>	yellow
NH <sub>4</sub> <sup>+</sup>	colourless	Hg <sup>2+</sup>	colourless	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	orange
Ba <sup>2+</sup>	colourless	Ni <sup>2+</sup>	green	MnO <sub>4</sub> <sup>-</sup>	deep purple
Cd <sup>2+</sup>	colourless	K <sup>+</sup>	colourless	PO <sub>4</sub> <sup>3-</sup>	colourless
Ca <sup>2+</sup>	colourless	Ag <sup>+</sup>	colourless	S <sup>2-</sup>	colourless
Cr <sup>3+</sup>	deep green	Na <sup>+</sup>	colourless	-	-
Co <sup>2+</sup>	pink	Sr <sup>2+</sup>	colourless	[Al(OH) <sub>4</sub> ] <sup>-</sup>	colourless
Cu <sup>2+</sup>	blue	Sn <sup>2+</sup>	colourless	[Cr(OH) <sub>4</sub> ] <sup>-</sup>	deep green
Fe <sup>2+</sup>	pale green	Zn <sup>2+</sup>	colourless	[Pb(OH) <sub>4</sub> ] <sup>2-</sup>	colourless
Fe <sup>3+</sup>	brown	[Ag(NH <sub>3</sub> ) <sub>2</sub> ] <sup>+</sup>	colourless	[Zn(OH) <sub>4</sub> ] <sup>2-</sup>	colourless
Pb <sup>2+</sup>	colourless	[Cu(NH <sub>3</sub> ) <sub>4</sub> ] <sup>2+</sup>	deep blue	-	-
Mg <sup>2+</sup>	colourless	[Cd(NH <sub>3</sub> ) <sub>4</sub> ] <sup>2+</sup>	colourless	-	-
Mn <sup>2+</sup>	very pale pink	[Zn(NH <sub>3</sub> ) <sub>4</sub> ] <sup>2+</sup>	colourless	-	-



## CHEMISTRY DATA SHEET

Revised February 2000

Periodic Table

1 H 008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 *La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po	85 At	86 Rn
87 Fr	88 Ra 226.0	89 **Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt									

\* Lanthanide Series

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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\*\* Actinide Series

90 Th 232.0	91 Pa	92 U 238.0	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
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6 ← Atomic Number  
C ← Symbol  
.:01 ← Atomic Weight

**Volumes** are given in the units of litres (L), or millilitres (mL)

**Temperatures** are given in the units of degrees Celsius (°C) or Kelvin (K). It may be assumed that 0.0°C = 273.1 K

**Energy changes** are given in the SI unit kilojoule (kJ)

**Pressures** are given in the SI unit kilopascal (kPa), in atmospheres (atm), or in millimetres of mercury (mmHg)

$$1.000 \text{ atm} = 101.3 \text{ kPa} = 760.0 \text{ mmHg}$$

**Solution concentrations** are given in the unit moles per litre (mol L<sup>-1</sup>)

$$\text{Relating commonly used symbolism, } 1 \text{ mol L}^{-1} = 1 \text{ M}$$

Universal Gas Constant, R = 8.315 J K<sup>-1</sup> mol<sup>-1</sup> or 0.08206 L atm K<sup>-1</sup> mol<sup>-1</sup>

Avogadro Constant, N = 6.022 x 10<sup>23</sup> mol<sup>-1</sup>

Magnitude of the electronic charge, q<sub>e</sub> = 1.602 x 10<sup>-19</sup> coulomb (C)

Magnitude of the charge carried by one mole of electrons = 1 faraday (F) = 9.649 x 10<sup>4</sup> C

Volume of 1.000 mol of an ideal gas at 0.0°C and 101.3 kPa is 22.41 L

and at 25.0°C and 101.3 kPa is 24.47 L

S.T.P. is 0.0°C and 101.3 kPa

Standard Reduction Potentials at 25°C

Half-reaction	E° (volts)
F <sub>2</sub> (g) + 2 e <sup>-</sup> ⇌ 2 F <sup>-</sup> (aq)	+ 2.87
H <sub>2</sub> O <sub>2</sub> (aq) + 2 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ 2 H <sub>2</sub> O(l)	+ 1.78
PbO <sub>2</sub> (s) + SO <sub>4</sub> <sup>2-</sup> (aq) + 4 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ PbSO <sub>4</sub> (s) + 2 H <sub>2</sub> O(l)	+ 1.69
2 HClO(aq) + 2 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ Cl <sub>2</sub> (g) + 2 H <sub>2</sub> O(l)	+ 1.61
MnO <sub>4</sub> <sup>-</sup> (aq) + 8 H <sup>+</sup> (aq) + 5 e <sup>-</sup> ⇌ Mn <sup>2+</sup> (aq) + 4 H <sub>2</sub> O(l)	+ 1.51
Au <sup>3+</sup> (aq) + 3 e <sup>-</sup> ⇌ Au(s)	+ 1.50
HClO(aq) + H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ Cl <sup>-</sup> (aq) + H <sub>2</sub> O(l)	+ 1.48
PbO <sub>2</sub> (s) + 4 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ Pb <sup>2+</sup> (aq) + 2 H <sub>2</sub> O(l)	+ 1.46
Cl <sub>2</sub> (g) + 2 e <sup>-</sup> ⇌ 2 Cl <sup>-</sup> (aq)	+ 1.36
Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> (aq) + 14 H <sup>+</sup> (aq) + 6 e <sup>-</sup> ⇌ 2 Cr <sup>3+</sup> (aq) + 7 H <sub>2</sub> O(l)	+ 1.23
O <sub>2</sub> (g) + 4 H <sup>+</sup> (aq) + 4 e <sup>-</sup> ⇌ 2 H <sub>2</sub> O(l)	+ 1.23
MnO <sub>2</sub> (s) + 4 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ Mn <sup>2+</sup> (aq) + 2 H <sub>2</sub> O(l)	+ 1.22
Br <sub>2</sub> (l) + 2 e <sup>-</sup> ⇌ 2 Br <sup>-</sup> (aq)	+ 1.07
NO <sub>3</sub> <sup>-</sup> (aq) + 4 H <sup>+</sup> (aq) + 3 e <sup>-</sup> ⇌ NO(g) + 2 H <sub>2</sub> O(l)	+ 0.96
2 Hg <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Hg <sub>2</sub> <sup>2+</sup> (aq)	+ 0.91
Hg <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Hg(l)	+ 0.85
O <sub>2</sub> (g) + 4 H <sup>+</sup> (aq)[1.00 x 10 <sup>-7</sup> mol L <sup>-1</sup> ] + 4 e <sup>-</sup> ⇌ 2 H <sub>2</sub> O(l)	+ 0.82
NO <sub>3</sub> <sup>-</sup> (aq) + 2 H <sup>+</sup> (aq) + e <sup>-</sup> ⇌ NO <sub>2</sub> (g) + H <sub>2</sub> O(l)	+ 0.80
Ag <sup>+</sup> (aq) + e <sup>-</sup> ⇌ Ag(s)	+ 0.80
Hg <sub>2</sub> <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ 2 Hg(l)	+ 0.80
Fe <sup>3+</sup> (aq) + e <sup>-</sup> ⇌ Fe <sup>2+</sup> (aq)	+ 0.77
O <sub>2</sub> (g) + 2 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ H <sub>2</sub> O <sub>2</sub> (aq)	+ 0.68
MnO <sub>4</sub> <sup>-</sup> (aq) + 2 H <sub>2</sub> O(l) + 3 e <sup>-</sup> ⇌ MnO <sub>2</sub> (s) + 4 OH <sup>-</sup> (aq)	+ 0.59
I <sub>2</sub> (s) + 2 e <sup>-</sup> ⇌ 2 I <sup>-</sup> (aq)	+ 0.54
Cu <sup>+</sup> (aq) + e <sup>-</sup> ⇌ Cu(s)	+ 0.52
O <sub>2</sub> (g) + 2 H <sub>2</sub> O(l) + 4 e <sup>-</sup> ⇌ 4 OH <sup>-</sup> (aq)	+ 0.40
Cu <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Cu(s)	+ 0.34
Cu <sup>2+</sup> (aq) + e <sup>-</sup> ⇌ Cu <sup>+</sup> (aq)	+ 0.16
Sn <sup>4+</sup> (aq) + 2 e <sup>-</sup> ⇌ Sn <sup>2+</sup> (aq)	+ 0.15
S(s) + 2 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ H <sub>2</sub> S(aq)	+ 0.14
2 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ H <sub>2</sub> (g)	0 exactly
Pb <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Pb(s)	- 0.13
Sn <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Sn(s)	- 0.14
Ni <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Ni(s)	- 0.26
Co <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Co(s)	- 0.28
PbSO <sub>4</sub> (s) + 2 e <sup>-</sup> ⇌ Pb(s) + SO <sub>4</sub> <sup>2-</sup> (aq)	- 0.36
Cd <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Cd(s)	- 0.40
2 H <sub>2</sub> O(l) + 2 e <sup>-</sup> ⇌ H <sub>2</sub> (g) + 2 OH <sup>-</sup> (aq)[1.00 x 10 <sup>-7</sup> mol L <sup>-1</sup> ]	- 0.41
2 CO <sub>2</sub> (g) + 2 H <sup>+</sup> (aq) + 2 e <sup>-</sup> ⇌ HOCCOOH(aq)	- 0.43
Fe <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Fe(s)	- 0.44
Au(CN) <sub>2</sub> <sup>-</sup> (aq) + e <sup>-</sup> ⇌ Au(s) + 2 CN <sup>-</sup> (aq)	- 0.60
Cr <sup>3+</sup> (aq) + 3 e <sup>-</sup> ⇌ Cr(s)	- 0.73
Zn <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Zn(s)	- 0.76
2 H <sub>2</sub> O(l) + 2 e <sup>-</sup> ⇌ H <sub>2</sub> (g) + 2 OH <sup>-</sup> (aq)	- 0.83
Mn <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Mn(s)	- 1.18
Al <sup>3+</sup> (aq) + 3 e <sup>-</sup> ⇌ Al(s)	- 1.66
Mg <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Mg(s)	- 2.37
Na <sup>+</sup> (aq) + e <sup>-</sup> ⇌ Na(s)	- 2.71
Ca <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Ca(s)	- 2.76
Sr <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Sr(s)	- 2.89
Ba <sup>2+</sup> (aq) + 2 e <sup>-</sup> ⇌ Ba(s)	- 2.91
K <sup>+</sup> (aq) + e <sup>-</sup> ⇌ K(s)	- 2.93