

# ATOMIC MASSES OF THE ELEMENTS

*Based on mass of C<sup>12</sup> at 12.00.  
Values in parentheses are the mass number of the most stable or best known isotopes for elements that do not occur naturally.*

Element	Symbol	Atomic Number	Atomic Mass	Element	Symbol	Atomic Number	Atomic Mass
Actinium	Ac	89	(227)	Mercury	Hg	80	200.6
Aluminum	Al	13	27.0	Molybdenum	Mo	42	95.9
Americium	Am	95	(243)	Neodymium	Nd	60	144.2
Antimony	Sb	51	121.8	Neon	Ne	10	20.2
Argon	Ar	18	39.9	Neptunium	Np	93	(237)
Arsenic	As	33	74.9	Nickel	Ni	28	58.7
Astatine	At	85	(210)	Niobium	Nb	41	92.9
Barium	Ba	56	137.3	Nitrogen	N	7	14.0
Berkelium	Bk	97	(247)	Nobelium	No	102	(259)
Beryllium	Be	4	9.0	Osmium	Os	76	190.2
Bismuth	Bi	83	209.0	Oxygen	O	8	16.0
Boron	B	5	10.8	Palladium	Pd	46	106.4
Bromine	Br	35	79.9	Phosphorus	P	15	31.0
Cadmium	Cd	48	112.4	Platinum	Pt	78	195.1
Calcium	Ca	20	40.1	Plutonium	Pu	94	(244)
Californium	Cf	98	(251)	Polonium	Po	84	(209)
Carbon	C	6	12.0	Potassium	K	19	39.1
Cerium	Ce	58	140.1	Praseodymium	Pr	59	140.9
Cesium	Cs	55	132.9	Promethium	Pm	61	(145)
Chlorine	Cl	17	35.5	Protactinium	Pa	91	231.0
Chromium	Cr	24	52.0	Radium	Ra	88	(226)
Chromium	Cr	24	52.0	Radium	Ra	88	(226)
Cobalt	Co	27	58.9	Radon	Rn	86	(222)
Copper	Cu	29	63.5	Rhenium	Re	75	186.2
Curium	Cm	96	(247)	Rhodium	Rh	45	102.9
Dubnium	Db	105	(262)	Rubidium	Rb	37	85.5
Dysprosium	Dy	66	162.5	Ruthenium	Ru	44	101.1
Einsteinium	Es	99	(252)	Rutherfordium	Rf	104	(261)
Erbium	Er	68	167.3	Samarium	Sm	62	150.4
Europium	Eu	63	152.0	Scandium	Sc	21	45.0
Fermium	Fm	100	(257)	Selenium	Se	34	79.0
Fluorine	F	9	19.0	Silicon	Si	14	28.1
Francium	Fr	87	(223)	Silver	Ag	47	107.9
Gadolinium	Gd	64	157.3	Sodium	Na	11	23.0
Gallium	Ga	31	69.7	Strontium	Sr	38	87.6
Germanium	Ge	32	72.6	Sulphur	S	16	32.1
Gold	Au	79	197.0	Tantalum	Ta	73	180.9
Hafnium	Hf	72	178.5	Technetium	Tc	43	(98)
Helium	He	2	4.0	Tellurium	Te	52	127.6
Holmium	Ho	67	164.9	Terbium	Tb	65	158.9
Hydrogen	H	1	1.0	Thallium	Tl	81	204.4
Indium	In	49	114.8	Thorium	Th	90	232.0
Iodine	I	53	126.9	Thulium	Tm	69	168.9
Iridium	Ir	77	192.2	Tin	Sn	50	118.7
Iron	Fe	26	55.8	Titanium	Ti	22	47.9
Krypton	Kr	36	83.8	Tungsten	W	74	183.8
Lanthanum	La	57	138.9	Uranium	U	92	238.0
Lawrencium	Lr	103	(262)	Vanadium	V	23	50.9
Lead	Pb	82	207.2	Xenon	Xe	54	131.3
Lithium	Li	3	6.9	Ytterbium	Yb	70	173.0
Lutetium	Lu	71	175.0	Yttrium	Y	39	88.9
Magnesium	Mg	12	24.3	Zinc	Zn	30	65.4
Manganese	Mn	25	54.9	Zirconium	Zr	40	91.2
Mendelevium	Md	101	(258)				

## PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 <b>H</b> Hydrogen 1.0																	2 <b>He</b> Helium 4.0
3 <b>Li</b> Lithium 6.9	4 <b>Be</b> Beryllium 9.0											5 <b>B</b> Boron 10.8	6 <b>C</b> Carbon 12.0	7 <b>N</b> Nitrogen 14.0	8 <b>O</b> Oxygen 16.0	9 <b>F</b> Fluorine 19.0	10 <b>Ne</b> Neon 20.2
11 <b>Na</b> Sodium 23.0	12 <b>Mg</b> Magnesium 24.3											13 <b>Al</b> Aluminum 27.0	14 <b>Si</b> Silicon 28.1	15 <b>P</b> Phosphorus 31.0	16 <b>S</b> Sulphur 32.1	17 <b>Cl</b> Chlorine 35.5	18 <b>Ar</b> Argon 39.9
19 <b>K</b> Potassium 39.1	20 <b>Ca</b> Calcium 40.1	21 <b>Sc</b> Scandium 45.0	22 <b>Ti</b> Titanium 47.9	23 <b>V</b> Vanadium 50.9	24 <b>Cr</b> Chromium 52.0	25 <b>Mn</b> Manganese 54.9	26 <b>Fe</b> Iron 55.8	27 <b>Co</b> Cobalt 58.9	28 <b>Ni</b> Nickel 58.7	29 <b>Cu</b> Copper 63.5	30 <b>Zn</b> Zinc 65.4	31 <b>Ga</b> Gallium 69.7	32 <b>Ge</b> Germanium 72.6	33 <b>As</b> Arsenic 74.9	34 <b>Se</b> Selenium 79.0	35 <b>Br</b> Bromine 79.9	36 <b>Kr</b> Krypton 83.8
37 <b>Rb</b> Rubidium 85.5	38 <b>Sr</b> Strontium 87.6	39 <b>Y</b> Yttrium 88.9	40 <b>Zr</b> Zirconium 91.2	41 <b>Nb</b> Niobium 92.9	42 <b>Mo</b> Molybdenum 95.9	43 <b>Tc</b> Technetium (98)	44 <b>Ru</b> Ruthenium 101.1	45 <b>Rh</b> Rhodium 102.9	46 <b>Pd</b> Palladium 106.4	47 <b>Ag</b> Silver 107.9	48 <b>Cd</b> Cadmium 112.4	49 <b>In</b> Indium 114.8	50 <b>Sn</b> Tin 118.7	51 <b>Sb</b> Antimony 121.8	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.9	54 <b>Xe</b> Xenon 131.3
55 <b>Cs</b> Cesium 132.9	56 <b>Ba</b> Barium 137.3	57 <b>La</b> Lanthanum 138.9	72 <b>Hf</b> Hafnium 178.5	73 <b>Ta</b> Tantalum 180.9	74 <b>W</b> Tungsten 183.8	75 <b>Re</b> Rhenium 186.2	76 <b>Os</b> Osmium 190.2	77 <b>Ir</b> Iridium 192.2	78 <b>Pt</b> Platinum 195.1	79 <b>Au</b> Gold 197.0	80 <b>Hg</b> Mercury 200.6	81 <b>Tl</b> Thallium 204.4	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 209.0	84 <b>Po</b> Polonium (209)	85 <b>At</b> Astatine (210)	86 <b>Rn</b> Radon (222)
87 <b>Fr</b> Francium (223)	88 <b>Ra</b> Radium (226)	89 <b>Ac</b> Actinium (227)	104 <b>Rf</b> Rutherfordium (261)	105 <b>Db</b> Dubnium (262)	106 <b>Sg</b> Seaborgium (263)	107 <b>Bh</b> Bohrium (262)	108 <b>Hs</b> Hassium (265)	109 <b>Mt</b> Meitnerium (266)									

14  
**Si**  
Silicon  
28.1

- Atomic Number
- Symbol
- Name
- Atomic Mass

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58 <b>Ce</b> Cerium 140.1	59 <b>Pr</b> Praseodymium 140.9	60 <b>Nd</b> Neodymium 144.2	61 <b>Pm</b> Promethium (145)	62 <b>Sm</b> Samarium 150.4	63 <b>Eu</b> Europium 152.0	64 <b>Gd</b> Gadolinium 157.3	65 <b>Tb</b> Terbium 158.9	66 <b>Dy</b> Dysprosium 162.5	67 <b>Ho</b> Holmium 164.9	68 <b>Er</b> Erbium 167.3	69 <b>Tm</b> Thulium 168.9	70 <b>Yb</b> Ytterbium 173.0	71 <b>Lu</b> Lutetium 175.0
90 <b>Th</b> Thorium 232.0	91 <b>Pa</b> Protactinium 231.0	92 <b>U</b> Uranium 238.0	93 <b>Np</b> Neptunium (237)	94 <b>Pu</b> Plutonium (244)	95 <b>Am</b> Americium (243)	96 <b>Cm</b> Curium (247)	97 <b>Bk</b> Berkelium (247)	98 <b>Cf</b> Californium (251)	99 <b>Es</b> Einsteinium (252)	100 <b>Fm</b> Fermium (257)	101 <b>Md</b> Mendelevium (258)	102 <b>No</b> Nobelium (259)	103 <b>Lr</b> Lawrencium (262)

## NAMES, FORMULAE, AND CHARGES OF SOME COMMON IONS

\* Aqueous solutions are readily oxidized by air.

\*\* Not stable in aqueous solutions.

Positive Ions (Cations)	
Al <sup>3+</sup>	Aluminium
NH <sub>4</sub> <sup>+</sup>	Ammonium
Ba <sup>2+</sup>	Barium
Ca <sup>2+</sup>	Calcium
Cr <sup>2+</sup>	Chromium(II), chromous
Cr <sup>3+</sup>	Chromium(III), chromic
Cu <sup>+</sup>	Copper(I)*, cuprous
Cu <sup>2+</sup>	Copper(II), cupric
H <sup>+</sup>	Hydrogen
H <sub>3</sub> O <sup>+</sup>	Hydronium
Fe <sup>2+</sup>	Iron(II)*, ferrous
Fe <sup>3+</sup>	Iron(III), ferric
Pb <sup>2+</sup>	Lead(II), plumbous
Pb <sup>4+</sup>	Lead(IV), plumbic
Li <sup>+</sup>	Lithium
Mg <sup>2+</sup>	Magnesium
Mn <sup>2+</sup>	Manganese(II), manganous
Mn <sup>4+</sup>	Manganese(IV)
Hg <sub>2</sub> <sup>2+</sup>	Mercury(I)*, mercurous
Hg <sup>2+</sup>	Mercury(II), mercuric
K <sup>+</sup>	Potassium
Ag <sup>+</sup>	Silver
Na <sup>+</sup>	Sodium
Sn <sup>2+</sup>	Tin(II)*, stannous
Sn <sup>4+</sup>	Tin(IV), stannic
Zn <sup>2+</sup>	Zinc

  

Negative Ions (Anions)	
Br <sup>-</sup>	Bromide
CO <sub>3</sub> <sup>2-</sup>	Carbonate
ClO <sub>3</sub> <sup>-</sup>	Chlorate
Cl <sup>-</sup>	Chloride
ClO <sub>2</sub> <sup>-</sup>	Chlorite
CrO <sub>4</sub> <sup>2-</sup>	Chromate
CN <sup>-</sup>	Cyanide
Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	Dichromate
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	Dihydrogen phosphate
CH <sub>3</sub> COO <sup>-</sup>	Ethanoate, acetate
F <sup>-</sup>	Fluoride
HCO <sub>3</sub> <sup>-</sup>	Hydrogen carbonate, bicarbonate
HC <sub>2</sub> O <sub>4</sub> <sup>-</sup>	Hydrogen oxalate, binoxalate
HSO <sub>4</sub> <sup>-</sup>	Hydrogen sulphate, bisulphate
HSO <sub>3</sub> <sup>-</sup>	Hydrogen sulphite, bisulphite
OH <sup>-</sup>	Hydroxide
ClO <sup>-</sup>	Hypochlorite
I <sup>-</sup>	Iodide
HPO <sub>4</sub> <sup>2-</sup>	Monohydrogen phosphate
NO <sub>3</sub> <sup>-</sup>	Nitrate
NO <sub>2</sub> <sup>-</sup>	Nitrite
C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	Oxalate
O <sup>2-</sup>	Oxide**
ClO <sub>4</sub> <sup>-</sup>	Perchlorate
MnO <sub>4</sub> <sup>-</sup>	Permanganate
PO <sub>4</sub> <sup>3-</sup>	Phosphate
SO <sub>4</sub> <sup>2-</sup>	Sulphate
S <sup>2-</sup>	Sulphide
SO <sub>3</sub> <sup>2-</sup>	Sulphite
SCN <sup>-</sup>	Thiocyanate

## SOLUBILITY OF COMMON COMPOUNDS IN WATER

*The term soluble here means > 0.1 mol/L at 25°C.*

Negative Ions (Anions)	Positive Ions (Cations)	Solubility of Compounds
All	Alkali ions: Li <sup>+</sup> , Na <sup>+</sup> , K <sup>+</sup> , Rb <sup>+</sup> , Cs <sup>+</sup> , Fr <sup>+</sup>	Soluble
All	Hydrogen ion: H <sup>+</sup>	Soluble
All	Ammonium ion: NH <sub>4</sub> <sup>+</sup>	Soluble
Nitrate, NO <sub>3</sub> <sup>-</sup>	All	Soluble
Chloride, Cl <sup>-</sup> or Bromide, Br <sup>-</sup> or Iodide, I <sup>-</sup>	All others	Soluble
Sulphate, SO <sub>4</sub> <sup>2-</sup>	Ag <sup>+</sup> , Pb <sup>2+</sup> , Cu <sup>+</sup>	Low Solubility
Sulphide, S <sup>2-</sup>	All others	Soluble
Hydroxide, OH <sup>-</sup>	Ag <sup>+</sup> , Ca <sup>2+</sup> , Sr <sup>2+</sup> , Ba <sup>2+</sup> , Pb <sup>2+</sup>	Low Solubility
Phosphate, PO <sub>4</sub> <sup>3-</sup> or Carbonate, CO <sub>3</sub> <sup>2-</sup> or Sulphite, SO <sub>3</sub> <sup>2-</sup>	Alkali ions, H <sup>+</sup> , NH <sub>4</sub> <sup>+</sup> , Be <sup>2+</sup> , Mg <sup>2+</sup> , Ca <sup>2+</sup> , Sr <sup>2+</sup> , Ba <sup>2+</sup>	Soluble
All others	Alkali ions, H <sup>+</sup> , NH <sub>4</sub> <sup>+</sup> , Sr <sup>2+</sup>	Low Solubility
All others	Alkali ions, H <sup>+</sup> , NH <sub>4</sub> <sup>+</sup>	Soluble
All others	All others	Low Solubility

SOLUBILITY PRODUCT CONSTANTS AT 25°C

Name	Formula	$K_{sp}$
Barium carbonate	BaCO <sub>3</sub>	$2.6 \times 10^{-9}$
Barium chromate	BaCrO <sub>4</sub>	$1.2 \times 10^{-10}$
Barium sulphate	BaSO <sub>4</sub>	$1.1 \times 10^{-10}$
Calcium carbonate	CaCO <sub>3</sub>	$5.0 \times 10^{-9}$
Calcium oxalate	CaC <sub>2</sub> O <sub>4</sub>	$2.3 \times 10^{-9}$
Calcium sulphate	CaSO <sub>4</sub>	$7.1 \times 10^{-5}$
Copper(I) iodide	CuI	$1.3 \times 10^{-12}$
Copper(II) iodate	Cu(IO <sub>3</sub> ) <sub>2</sub>	$6.9 \times 10^{-8}$
Copper(II) sulphide	CuS	$6.0 \times 10^{-37}$
Iron(II) hydroxide	Fe(OH) <sub>2</sub>	$4.9 \times 10^{-17}$
Iron(II) sulphide	FeS	$6.0 \times 10^{-19}$
Iron(III) hydroxide	Fe(OH) <sub>3</sub>	$2.6 \times 10^{-39}$
Lead(II) bromide	PbBr <sub>2</sub>	$6.6 \times 10^{-6}$
Lead(II) chloride	PbCl <sub>2</sub>	$1.2 \times 10^{-5}$
Lead(II) iodate	Pb(IO <sub>3</sub> ) <sub>2</sub>	$3.7 \times 10^{-13}$
Lead(II) iodide	PbI <sub>2</sub>	$8.5 \times 10^{-9}$
Lead(II) sulphate	PbSO <sub>4</sub>	$1.8 \times 10^{-8}$
Magnesium carbonate	MgCO <sub>3</sub>	$6.8 \times 10^{-6}$
Magnesium hydroxide	Mg(OH) <sub>2</sub>	$5.6 \times 10^{-12}$
Silver bromate	AgBrO <sub>3</sub>	$5.3 \times 10^{-5}$
Silver bromide	AgBr	$5.4 \times 10^{-13}$
Silver carbonate	Ag <sub>2</sub> CO <sub>3</sub>	$8.5 \times 10^{-12}$
Silver chloride	AgCl	$1.8 \times 10^{-10}$
Silver chromate	Ag <sub>2</sub> CrO <sub>4</sub>	$1.1 \times 10^{-12}$
Silver iodate	AgIO <sub>3</sub>	$3.2 \times 10^{-8}$
Silver iodide	AgI	$8.5 \times 10^{-17}$
Strontium carbonate	SrCO <sub>3</sub>	$5.6 \times 10^{-10}$
Strontium fluoride	SrF <sub>2</sub>	$4.3 \times 10^{-9}$
Strontium sulphate	SrSO <sub>4</sub>	$3.4 \times 10^{-7}$
Zinc sulphide	ZnS	$2.0 \times 10^{-25}$

RELATIVE STRENGTHS OF BRÖNSTED-LOWRY ACIDS AND BASES

in aqueous solution at room temperature.

Name of Acid	Acid	Base	$K_a$
Perechloric	HClO <sub>4</sub>	$\rightarrow$ H <sup>+</sup> + ClO <sub>4</sub> <sup>-</sup>	very large
Hydroiodic	HI	$\rightarrow$ H <sup>+</sup> + I <sup>-</sup>	very large
Hydrobromic	HBr	$\rightarrow$ H <sup>+</sup> + Br <sup>-</sup>	very large
Hydrochloric	HCl	$\rightarrow$ H <sup>+</sup> + Cl <sup>-</sup>	very large
Nitric	HNO <sub>3</sub>	$\rightarrow$ H <sup>+</sup> + NO <sub>3</sub> <sup>-</sup>	very large
Sulphuric	H <sub>2</sub> SO <sub>4</sub>	$\rightarrow$ H <sup>+</sup> + HSO <sub>4</sub> <sup>-</sup>	very large
Hydronium ion	H <sub>3</sub> O <sup>+</sup>	$\rightleftharpoons$ H <sup>+</sup> + H <sub>2</sub> O	1.0
Iodic	HIO <sub>3</sub>	$\rightleftharpoons$ H <sup>+</sup> + IO <sub>3</sub> <sup>-</sup>	$1.7 \times 10^{-1}$
Oxalic	H <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	$\rightleftharpoons$ H <sup>+</sup> + HC <sub>2</sub> O <sub>4</sub> <sup>-</sup>	$5.9 \times 10^{-2}$
Sulphurous (SO <sub>2</sub> + H <sub>2</sub> O)	H <sub>2</sub> SO <sub>3</sub>	$\rightleftharpoons$ H <sup>+</sup> + HSO <sub>3</sub> <sup>-</sup>	$1.5 \times 10^{-2}$
Hydrogen sulphate ion	HSO <sub>4</sub> <sup>-</sup>	$\rightleftharpoons$ H <sup>+</sup> + SO <sub>4</sub> <sup>2-</sup>	$1.2 \times 10^{-2}$
Phosphoric	H <sub>3</sub> PO <sub>4</sub>	$\rightleftharpoons$ H <sup>+</sup> + H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	$7.5 \times 10^{-3}$
Hexaquoiron ion, iron(III) ion	Fe(H <sub>2</sub> O) <sub>6</sub> <sup>3+</sup>	$\rightleftharpoons$ H <sup>+</sup> + Fe(H <sub>2</sub> O) <sub>5</sub> (OH) <sup>2+</sup>	$6.0 \times 10^{-3}$
Citric	H <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>	$\rightleftharpoons$ H <sup>+</sup> + H <sub>2</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> <sup>-</sup>	$7.1 \times 10^{-4}$
Nitrous	HNO <sub>2</sub>	$\rightleftharpoons$ H <sup>+</sup> + NO <sub>2</sub> <sup>-</sup>	$4.6 \times 10^{-4}$
Hydrofluoric	HF	$\rightleftharpoons$ H <sup>+</sup> + F <sup>-</sup>	$3.5 \times 10^{-4}$
Methanoic, formic	HCOOH	$\rightleftharpoons$ H <sup>+</sup> + HCOO <sup>-</sup>	$1.8 \times 10^{-4}$
Hexaquochromium ion, chromium(III) ion	Cr(H <sub>2</sub> O) <sub>6</sub> <sup>3+</sup>	$\rightleftharpoons$ H <sup>+</sup> + Cr(H <sub>2</sub> O) <sub>5</sub> (OH) <sup>2+</sup>	$1.5 \times 10^{-4}$
Benzoic	C <sub>6</sub> H <sub>5</sub> COOH	$\rightleftharpoons$ H <sup>+</sup> + C <sub>6</sub> H <sub>5</sub> COO <sup>-</sup>	$6.5 \times 10^{-5}$
Hydrogen oxalate ion	HC <sub>2</sub> O <sub>4</sub> <sup>-</sup>	$\rightleftharpoons$ H <sup>+</sup> + C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	$6.4 \times 10^{-5}$
Ethanoic, acetic	CH <sub>3</sub> COOH	$\rightleftharpoons$ H <sup>+</sup> + CH <sub>3</sub> COO <sup>-</sup>	$1.8 \times 10^{-5}$
Dihydrogen citrate ion	H <sub>2</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> <sup>-</sup>	$\rightleftharpoons$ H <sup>+</sup> + HC <sub>6</sub> H <sub>5</sub> O <sub>7</sub> <sup>2-</sup>	$1.7 \times 10^{-5}$
Hexaquoaluminum ion, aluminum ion	Al(H <sub>2</sub> O) <sub>6</sub> <sup>3+</sup>	$\rightleftharpoons$ H <sup>+</sup> + Al(H <sub>2</sub> O) <sub>5</sub> (OH) <sup>2+</sup>	$1.4 \times 10^{-5}$
Carbonic (CO <sub>2</sub> + H <sub>2</sub> O)	H <sub>2</sub> CO <sub>3</sub>	$\rightleftharpoons$ H <sup>+</sup> + HCO <sub>3</sub> <sup>-</sup>	$4.3 \times 10^{-7}$
Monohydrogen citrate ion	HC <sub>6</sub> H <sub>5</sub> O <sub>7</sub> <sup>2-</sup>	$\rightleftharpoons$ H <sup>+</sup> + C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> <sup>3-</sup>	$4.1 \times 10^{-7}$
Hydrogen sulphite ion	HSO <sub>3</sub> <sup>-</sup>	$\rightleftharpoons$ H <sup>+</sup> + SO <sub>3</sub> <sup>2-</sup>	$1.0 \times 10^{-7}$
Hydrogen sulphide	H <sub>2</sub> S	$\rightleftharpoons$ H <sup>+</sup> + HS <sup>-</sup>	$9.1 \times 10^{-8}$
Dihydrogen phosphate ion	H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	$\rightleftharpoons$ H <sup>+</sup> + HPO <sub>4</sub> <sup>2-</sup>	$6.2 \times 10^{-8}$
Boric	H <sub>3</sub> BO <sub>3</sub>	$\rightleftharpoons$ H <sup>+</sup> + H <sub>2</sub> BO <sub>3</sub> <sup>-</sup>	$7.3 \times 10^{-10}$
Ammonium ion	NH <sub>4</sub> <sup>+</sup>	$\rightleftharpoons$ H <sup>+</sup> + NH <sub>3</sub>	$5.6 \times 10^{-10}$
Hydrocyanic	HCN	$\rightleftharpoons$ H <sup>+</sup> + CN <sup>-</sup>	$4.9 \times 10^{-10}$
Phenol	C <sub>6</sub> H <sub>5</sub> OH	$\rightleftharpoons$ H <sup>+</sup> + C <sub>6</sub> H <sub>5</sub> O <sup>-</sup>	$1.3 \times 10^{-10}$
Hydrogen carbonate ion	HCO <sub>3</sub> <sup>-</sup>	$\rightleftharpoons$ H <sup>+</sup> + CO <sub>3</sub> <sup>2-</sup>	$5.6 \times 10^{-11}$
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	$\rightleftharpoons$ H <sup>+</sup> + HO <sub>2</sub> <sup>-</sup>	$2.4 \times 10^{-12}$
Monohydrogen phosphate ion	HPO <sub>4</sub> <sup>2-</sup>	$\rightleftharpoons$ H <sup>+</sup> + PO <sub>4</sub> <sup>3-</sup>	$2.2 \times 10^{-13}$
Water	H <sub>2</sub> O	$\rightleftharpoons$ H <sup>+</sup> + OH <sup>-</sup>	$1.0 \times 10^{-14}$
Hydroxide ion	OH <sup>-</sup>	$\leftarrow$ H <sup>+</sup> + O <sup>2-</sup>	very small
Ammonia	NH <sub>3</sub>	$\leftarrow$ H <sup>+</sup> + NH <sub>2</sub> <sup>-</sup>	very small

# STANDARD REDUCTION POTENTIALS OF HALF-CELLS

*Ionic concentrations are at 1M in water at 25°C.*

Oxidizing Agents	Reducing Agents	E° (Volts)
$F_{2(g)} + 2e^- \rightleftharpoons 2F^-$		+2.87
$S_2O_8^{2-} + 2e^- \rightleftharpoons 2SO_4^{2-}$		+2.01
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$		+1.78
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$		+1.51
$Au^{3+} + 3e^- \rightleftharpoons Au_{(s)}$		+1.50
$BrO_3^- + 6H^+ + 5e^- \rightleftharpoons \frac{1}{2}Br_{2(l)} + 3H_2O$		+1.48
$ClO_4^- + 8H^+ + 8e^- \rightleftharpoons Cl^- + 4H_2O$		+1.39
$Cl_{2(g)} + 2e^- \rightleftharpoons 2Cl^-$		+1.36
$C_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2CO_3^{2-} + 7H_2O$		+1.23
$\frac{1}{2}O_{2(g)} + 2H^+ + 2e^- \rightleftharpoons H_2O$		+1.23
$MnO_{2(s)} + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$		+1.22
$IO_3^- + 6H^+ + 5e^- \rightleftharpoons \frac{1}{2}I_{2(l)} + 3H_2O$		+1.20
$Br_{2(l)} + 2e^- \rightleftharpoons 2Br^-$		+1.09
$AuCl_4^- + 3e^- \rightleftharpoons Au_{(s)} + 4Cl^-$		+1.00
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO_{(g)} + 2H_2O$		+0.96
$Hg_2^{2+} + 2e^- \rightleftharpoons 2Hg_{(l)}$		+0.85
$\frac{1}{2}O_{2(g)} + 2H^+(10^{-7}M) + 2e^- \rightleftharpoons H_2O$		+0.82
$2NO_3^- + 4H^+ + 2e^- \rightleftharpoons N_2O_{(g)} + 2H_2O$		+0.80
$Ag^+ + e^- \rightleftharpoons Ag_{(s)}$		+0.80
$\frac{1}{2}Hg_2^{2+} + e^- \rightleftharpoons Hg_{(l)}$		+0.80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$		+0.77
$O_{2(g)} + 2H^+ + 2e^- \rightleftharpoons H_2O_2$		+0.70
$MnO_4^- + 2H_2O + 3e^- \rightleftharpoons MnO_{2(s)} + 4OH^-$		+0.60
$I_2_{(s)} + 2e^- \rightleftharpoons 2I^-$		+0.54
$Cu^+ + e^- \rightleftharpoons Cu_{(s)}$		+0.52
$H_2SO_3 + 4H^+ + 4e^- \rightleftharpoons S_{(s)} + 3H_2O$		+0.45
$Cu^{2+} + 2e^- \rightleftharpoons Cu_{(s)}$		+0.34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons H_2SO_3 + H_2O$		+0.17
$Cu^+ + e^- \rightleftharpoons Cu_{(s)}$		+0.15
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$		+0.15
$S_{(s)} + 2H^+ + 2e^- \rightleftharpoons H_2S_{(g)}$		+0.14
$2H^+ + 2e^- \rightleftharpoons H_{2(g)}$		+0.00
$Pb^{2+} + 2e^- \rightleftharpoons Pb_{(s)}$		-0.13
$Sn^{2+} + 2e^- \rightleftharpoons Sn_{(s)}$		-0.14
$Ni^{2+} + 2e^- \rightleftharpoons Ni_{(s)}$		-0.26
$H_3PO_4 + 2H^+ + 2e^- \rightleftharpoons H_3PO_3 + H_2O$		-0.28
$Co^{3+} + 2e^- \rightleftharpoons Co_{(s)}$		-0.28
$Se_{(s)} + 2H^+ + 2e^- \rightleftharpoons H_2Se$		-0.40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$		-0.41
$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-(10^{-7}M)$		-0.41
$Fe^{2+} + 2e^- \rightleftharpoons Fe_{(s)}$		-0.45
$Ag_2S_{(s)} + 2e^- \rightleftharpoons 2Ag_{(s)} + S^{2-}$		-0.69
$Cr^{3+} + 3e^- \rightleftharpoons Cr_{(s)}$		-0.74
$Zn^{2+} + 2e^- \rightleftharpoons Zn_{(s)}$		-0.76
$Te_{(s)} + 2H^+ + 2e^- \rightleftharpoons H_2Te$		-0.79
$2H_2O + 2e^- \rightleftharpoons H_2_{(g)} + 2OH^-$		-0.83
$Mn^{2+} + 2e^- \rightleftharpoons Mn_{(s)}$		-1.19
$Al^{3+} + 3e^- \rightleftharpoons Al_{(s)}$		-1.66
$Mg^{2+} + 2e^- \rightleftharpoons Mg_{(s)}$		-2.37
$Na^+ + e^- \rightleftharpoons Na_{(s)}$		-2.71
$Ca^{2+} + 2e^- \rightleftharpoons Ca_{(s)}$		-2.87
$Sr^{2+} + 2e^- \rightleftharpoons Sr_{(s)}$		-2.89
$Ba^{2+} + 2e^- \rightleftharpoons Ba_{(s)}$		-2.91
$K^+ + e^- \rightleftharpoons K_{(s)}$		-2.93
$Rb^+ + e^- \rightleftharpoons Rb_{(s)}$		-2.98
$Cs^+ + e^- \rightleftharpoons Cs_{(s)}$		-3.03
$Li^+ + e^- \rightleftharpoons Li_{(s)}$		-3.04

← WEAK STRENGTH OF REDUCING AGENT STRONG →

← STRONG STRENGTH OF OXIDIZING AGENT WEAK →

## ACID-BASE INDICATORS

Indicator	pH Range in Which Colour Change Occurs	Colour Change as pH Increases
Methyl violet	0.0 – 1.6	yellow to blue
Thymol blue	1.2 – 2.8	red to yellow
Orange IV	1.4 – 2.8	red to yellow
Methyl orange	3.2 – 4.4	red to yellow
Bromocresol green	3.8 – 5.4	yellow to blue
Methyl red	4.8 – 6.0	red to yellow
Chlorophenol red	5.2 – 6.8	yellow to red
Bromthymol blue	6.0 – 7.6	yellow to blue
Phenol red	6.6 – 8.0	yellow to red
Neutral red	6.8 – 8.0	red to amber
Thymol blue	8.0 – 9.6	yellow to blue
Phenolphthalein	8.2 – 10.0	colourless to pink
Thymolphthalein	9.4 – 10.6	colourless to blue
Alizarin yellow	10.1 – 12.0	yellow to red
Indigo carmine	11.4 – 13.0	blue to yellow