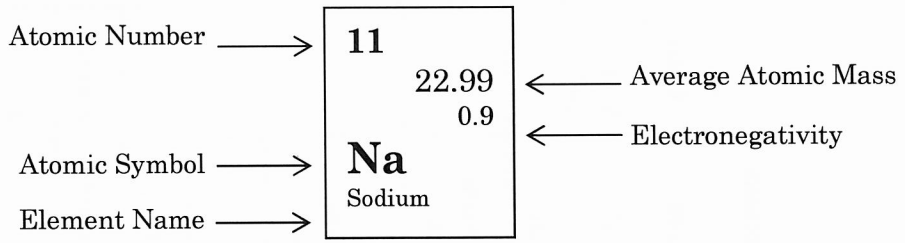
Periodic Table of Elements



( ) Indicates mass of the most stable isotope

1																	18
1.01 2.2 **H** Hydrogen	2											13	14	15	16	17	2 4.00 — **He** Helium
3 6.94 1.0 **Li** Lithium	4 9.01 1.6 **Be** Beryllium											5 10.81 2.0 **B** Boron	6 12.01 2.6 **C** Carbon	7 14.01 3.0 **N** Nitrogen	8 16.00 3.4 **O** Oxygen	9 19.00 4.0 **F** Fluorine	10 20.18 — **Ne** Neon
11 22.99 0.9 **Na** Sodium	12 24.31 1.3 **Mg** Magnesium	3	4	5	6	7	8	9	10	11	12	13 26.98 1.6 **Al** Aluminum	14 28.09 1.9 **Si** Silicon	15 30.97 2.2 **P** Phosphorus	16 32.07 2.6 **S** Sulfur	17 35.45 3.2 **Cl** Chlorine	18 39.95 — **Ar** Argon
19 39.10 0.8 **K** Potassium	20 40.08 1.0 **Ca** Calcium	21 44.96 1.4 **Sc** Scandium	22 47.87 1.5 **Ti** Titanium	23 50.94 1.6 **V** Vanadium	24 52.00 1.7 **Cr** Chromium	25 54.94 1.6 **Mn** Manganese	26 55.85 1.8 **Fe** Iron	27 58.93 1.9 **Co** Cobalt	28 58.69 1.9 **Ni** Nickel	29 63.55 1.9 **Cu** Copper	30 65.41 1.7 **Zn** Zinc	31 69.72 1.8 **Ga** Gallium	32 72.64 2.0 **Ge** Germanium	33 74.92 2.2 **As** Arsenic	34 78.96 2.6 **Se** Selenium	35 79.90 3.0 **Br** Bromine	36 83.80 — **Kr** Krypton
37 85.47 0.8 **Rb** Rubidium	38 87.62 1.0 **Sr** Strontium	39 88.91 1.2 **Y** Yttrium	40 91.22 1.3 **Zr** Zirconium	41 92.91 1.6 **Nb** Niobium	42 95.94 2.2 **Mo** Molybdenum	43 (98) 2.1 **Tc** Technetium	44 101.07 2.2 **Ru** Ruthenium	45 102.91 2.3 **Rh** Rhodium	46 106.42 2.2 **Pd** Palladium	47 107.87 1.9 **Ag** Silver	48 112.41 1.7 **Cd** Cadmium	49 114.82 1.8 **In** Indium	50 118.71 2.0 **Sn** Tin	51 121.76 2.1 **Sb** Antimony	52 127.60 2.1 **Te** Tellurium	53 126.90 2.7 **I** Iodine	54 131.29 2.6 **Xe** Xenon
55 132.91 0.8 **Cs** Cesium	56 137.33 0.9 **Ba** Barium	57-70 * 71 174.97 1.0 **Lu** Lutetium	72 178.49 1.3 **Hf** Hafnium	73 180.95 1.5 **Ta** Tantalum	74 183.84 1.7 **W** Tungsten	75 186.21 1.9 **Re** Rhenium	76 190.23 2.2 **Os** Osmium	77 192.22 2.2 **Ir** Iridium	78 195.08 2.2 **Pt** Platinum	79 196.97 2.4 **Au** Gold	80 200.59 1.9 **Hg** Mercury	81 204.38 1.8 **Tl** Thallium	82 207.20 1.8 **Pb** Lead	83 208.98 1.9 **Bi** Bismuth	84 (208.98) 2.0 **Po** Polonium	85 (209.99) 2.2 **At** Astatine	86 (222.02) — **Rn** Radon
87 (223.02) 0.7 **Fr** Francium	88 (226.03) 0.9 **Ra** Radium	89-102 ** 103 (262.11) — **Lr** Lawrencium	104 (265.12) — **Rf** Rutherfordium	105 (268.13) **Db** Dubnium	106 (271.13) — **Sg** Seaborgium	107 (270) — **Bh** Bohrium	108 (277.15) — **Hs** Hassium	109 (276.15) — **Mt** Meitnerium	110 (281.16) — **Ds** Darmstadtium	111 (280.16) — **Rg** Roentgenium	112 (285.17) — **Cn** Copernicium	113 (284.18) — **Nh** Nihomium	114 (289.19) — **Fl** Flerovium	115 (288.19) — **Mc** Moscovium	116 (293) — **Lv** Livermorium	117 (294) — **Ts** Tennessine	118 (294) — **Og** Oganesson

*§ Lanthanoid Series

57 138.91 1.1 **La** Lanthanum	58 140.12 1.1 **Ce** Cerium	59 140.91 1.1 **Pr** Praseodymium	60 144.24 1.1 **Nd** Neodymium	61 (145) — **Pm** Promethium	62 150.36 1.2 **Sm** Samarium	63 151.96 — **Eu** Europium	64 157.25 1.2 **Gd** Gadolinium	65 158.93 — **Tb** Terbium	66 162.50 1.2 **Dy** Dysprosium	67 164.93 1.2 **Ho** Holmium	68 167.26 1.2 **Er** Erbium	69 168.93 1.3 **Tm** Thulium	70 173.04 — **Yb** Ytterbium

**¥ Actinoid Series

89 (227.03) 1.1 **Ac** Actinium	90 232.04 1.3 **Th** Thorium	91 231.04 1.5 **Pa** Protactinium	92 238.03 1.7 **U** Uranium	93 (237.05) 1.3 **Np** Neptunium	94 (244.06) 1.3 **Pu** Plutonium	95 (243.06) — **Am** Americium	96 (247.07) — **Cm** Curium	97 (247.07) — **Bk** Berkelium	98 (251.08) — **Cf** Californium	99 (252.08) — **Es** Einsteinium	100 (257.10) — **Fm** Fermium	101 (258.10) — **Md** Mendelevium	102 (259.10) — **No** Nobelium

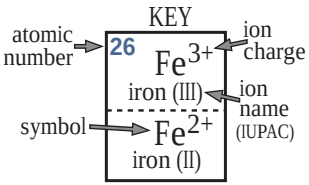
Saskatchewan Ministry of Education

PERIODIC TABLE OF IONS

TABLE OF POLYATOMIC IONS

acetate	CH_3COO^-	dihydrogen phosphate	$H_2PO_4^-$	oxalate	$C_2O_4^{2-}$
arsenate	AsO_4^{3-}	hydrogen carbonate	HCO_3^-	perchlorate	ClO_4^-
arsenite	AsO_3^{3-}	hydrogen oxalate	$HC_2O_4^-$	periodate	IO_4^-
benzoate	$C_6H_5COO^-$	hydrogen sulfate	HSO_4^-	permanganate	MnO_4^-
borate	BO_3^{3-}	hydrogen sulfide	HS^-	peroxide	O_2^{2-}
bromate	BrO_3^-	hydrogen sulfite	HSO_3^-	phosphate	PO_4^{3-}
carbonate	CO_3^{2-}	hydroxide	OH^-	pyrophosphate	$P_2O_7^{4-}$
chlorate	ClO_3^-	hypochlorite	ClO^-	sulfate	SO_4^{2-}
chloride	Cl^-	iodate	IO_3^-	sulfite	SO_3^{2-}
chlorite	ClO_2^-	monohydrogen phosphate	HPO_4^{2-}	thiocyanate	SCN^-
chromate	CrO_4^{2-}	nitrate	NO_3^-	thiosulfate	$S_2O_3^{2-}$
cyanate	CNO^-	nitrite	NO_2^-	**POSITIVE POLYATOMIC IONS**	
cyanide	CN^-	orthosilicate	SiO_4^{4-}	ammonium	NH_4^+
dichromate	$Cr_2O_7^{2-}$			hydronium	H_3O^+

KEY



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H^+ hydrogen																1 H^- hydride	2 He helium
3 Li^+ lithium	4 Be^{2+} beryllium											5 B boron	6 C carbon	7 N^{3-} nitride	8 O^{2-} oxide	9 F^- fluoride	10 Ne neon
11 Na^+ sodium	12 Mg^{2+} magnesium											13 Al^{3+} aluminum	14 Si silicon	15 P^{3-} phosphide	16 S^{2-} sulfiide	17 Cl^- chloride	18 Ar argon
19 K^+ potassium	20 Ca^{2+} calcium	21 Sc^{3+} scandium	22 Ti^{4+} titanium (IV) / Ti^{3+} titanium (III)	23 V^{3+} vanadium(III) / V^{5+} vanadium (V)	24 Cr^{3+} chromium (III) / Cr^{2+} chromium (II)	25 Mn^{2+} manganese(II) / Mn^{4+} manganese(IV)	26 Fe^{3+} iron (III) / Fe^{2+} iron (II)	27 Co^{2+} cobalt (II) / Co^{3+} cobalt (III)	28 Ni^{2+} nickel (II) / Ni^{3+} nickel (III)	29 Cu^{2+} copper (II) / Cu^+ copper (I)	30 Zn^{2+} zinc	31 Ga^{3+} gallium	32 Ge^{4+} germanium	33 As^{3-} arsenide	34 Se^{2-} selenide	35 Br^- bromide	36 Kr krypton
37 Rb^+ rubidium	38 Sr^{2+} strontium	39 Y^{3+} yttrium	40 Zr^{4+} zirconium	41 Nb^{5+} niobium (V) / Nb^{3+} niobium(III)	42 Mo^{6+} molybdenum	43 Tc^{7+} technetium	44 Ru^{3+} ruthenium(III) / Ru^{4+} ruthenium(IV)	45 Rh^{3+} rhodium	46 Pd^{2+} paladium(II) / Pd^{4+} paladium(IV)	47 Ag^+ silver	48 Cd^{2+} cadmium	49 In^{3+} indium	50 Sn^{4+} tin (IV) / Sn^{2+} tin (II)	51 Sb^{3+} antimony(III) / Sb^{5+} antimony(V)	52 Te^{2-} telluride	53 I^- iodide	54 Xe xenon
55 Cs^+ cesium	56 Ba^{2+} barium	57 La^{3+} lanthanum	72 Hf^{4+} hafnium	73 Ta^{5+} tantalum	74 W^{6+} tungsten	75 Re^{7+} rhenium	76 Os^{4+} osmium	77 Ir^{4+} iridium	78 Pt^{4+} platinum(IV) / Pt^{2+} platinum(II)	79 Au^{3+} gold (III) / Au^+ gold (I)	80 Hg^{2+} mercury (II) / Hg^+ mercury (I)	81 Tl^+ thallium (I) / Tl^{3+} thallium(III)	82 Pb^{2+} lead (II) / Pb^{4+} lead (IV)	83 Bi^{3+} bismuth(III) / Bi^{5+} bismuth(V)	84 Po^{2+} polonium(II) / Po^{4+} polonium(IV)	85 At^- astatide	86 Rn radon
87 Fr^+ francium	88 Ra^{2+} radium	89 Ac^{3+} actinium															

58 Ce^{3+} cerium	59 Pr^{3+} praseodymium	60 Nd^{3+} neodymium	61 Pm^{3+} promethium	62 Sm^{3+} samarium(III) / Sm^{2+} samarium(II)	63 Eu^{3+} europium (III) / Eu^{2+} europium (II)	64 Gd^{3+} gadolinium	65 Tb^{3+} terbium	66 Dy^{3+} dysprosium	67 Ho^{3+} holmium	68 Er^{3+} erbium	69 Tm^{3+} thulium	70 Yb^{3+} ytterbium(III) / Yb^{3+} ytterbium(II)	71 Lu^{3+} lutetium
90 Th^{4+} thorium	91 Pa^{5+} protactinium(V) / Pa^{4+} protactinium(IV)	92 U^{6+} uranium (VI) / U^{4+} uranium (IV)	93 Np^{5+} neptunium	94 Pu^{4+} plutonium(IV) / Pu^{6+} plutonium(VI)	95 Am^{3+} americium(III) / Am^{4+} americium(IV)	96 Cm^{3+} curium	97 Bk^{3+} berkelium(III) / Bk^{4+} berkelium(IV)	98 Cf^{3+} californium	99 Es^{3+} einsteinium	100 Fm^{3+} fermium	101 Md^{2+} mendelevium (II) / Md^{3+} mendelevium (III)	102 No^{2+} nobelium(II) / No^{3+} nobelium(III)	103 Lr^{3+} lawrencium

List of Common Multivalent Ions

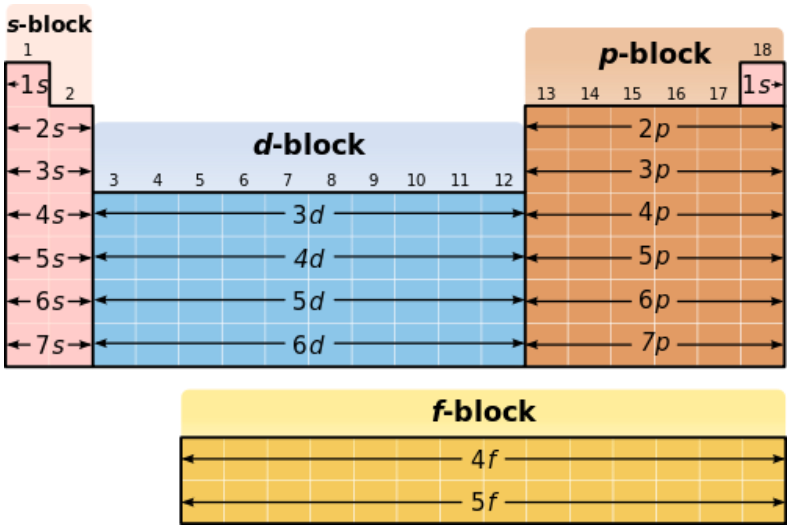
The following elements form **multivalent ions**, and therefore require a Roman numeral charge when writing the name of the compound. Rare and synthetic elements are not included in this list.

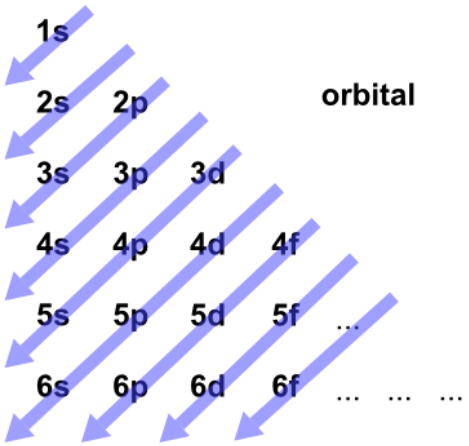
Element	Sym.	Possible Charges	Element	Sym.	Possible Charges
Titanium	Ti	+2, +3, +4	Tin	Sn	+2, +4
Vanadium	V	+2, +3, +4, +5	Rhenium	Re	+4, +6, +7
Chromium	Cr	+2, +3, +6	Osmium	Os	+3, +4
Manganese	Mn	+2, +3, +4, +7	Iridium	Ir	+3, +4
Iron	Fe	+2, +3	Platinum	Pt	+2, +4
Cobalt	Co	+2, +3	Gold	Au	+1, +3
Nickel	Ni	+2, +3	Mercury	Hg	+1, +2
Copper	Cu	+1, +2	Thallium	Tl	+1, +3
Niobium	Nb	+2, +5	Lead	Pb	+2, +4
Molybdenum	Mo	+3, +6	Bismuth	Bi	+3, +5
Palladium	Pd	+2, +4	Polonium	Po	+2, +4

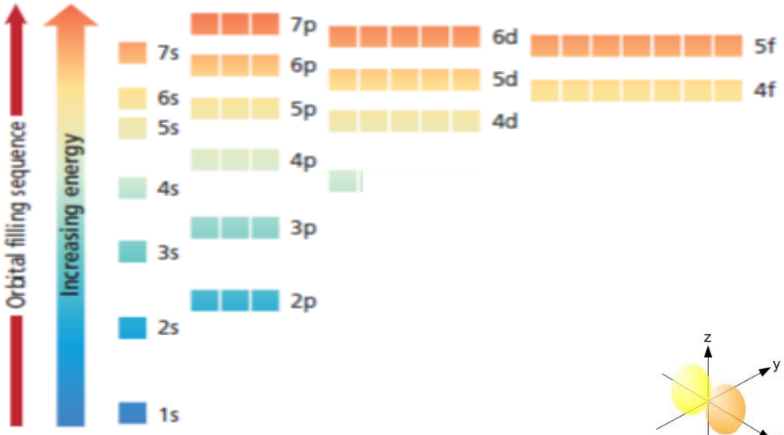
Steps to Determine Charge from the Chemical Formula

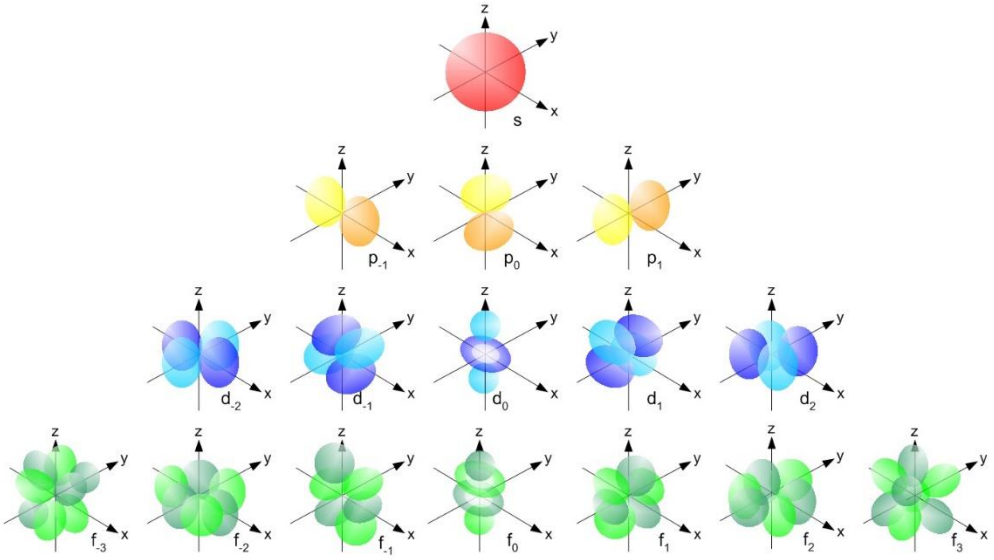
1. Find total negative charge on all anions.
2. Divide value by number of cations to give charge on one multivalent cation.

Electron Configuration



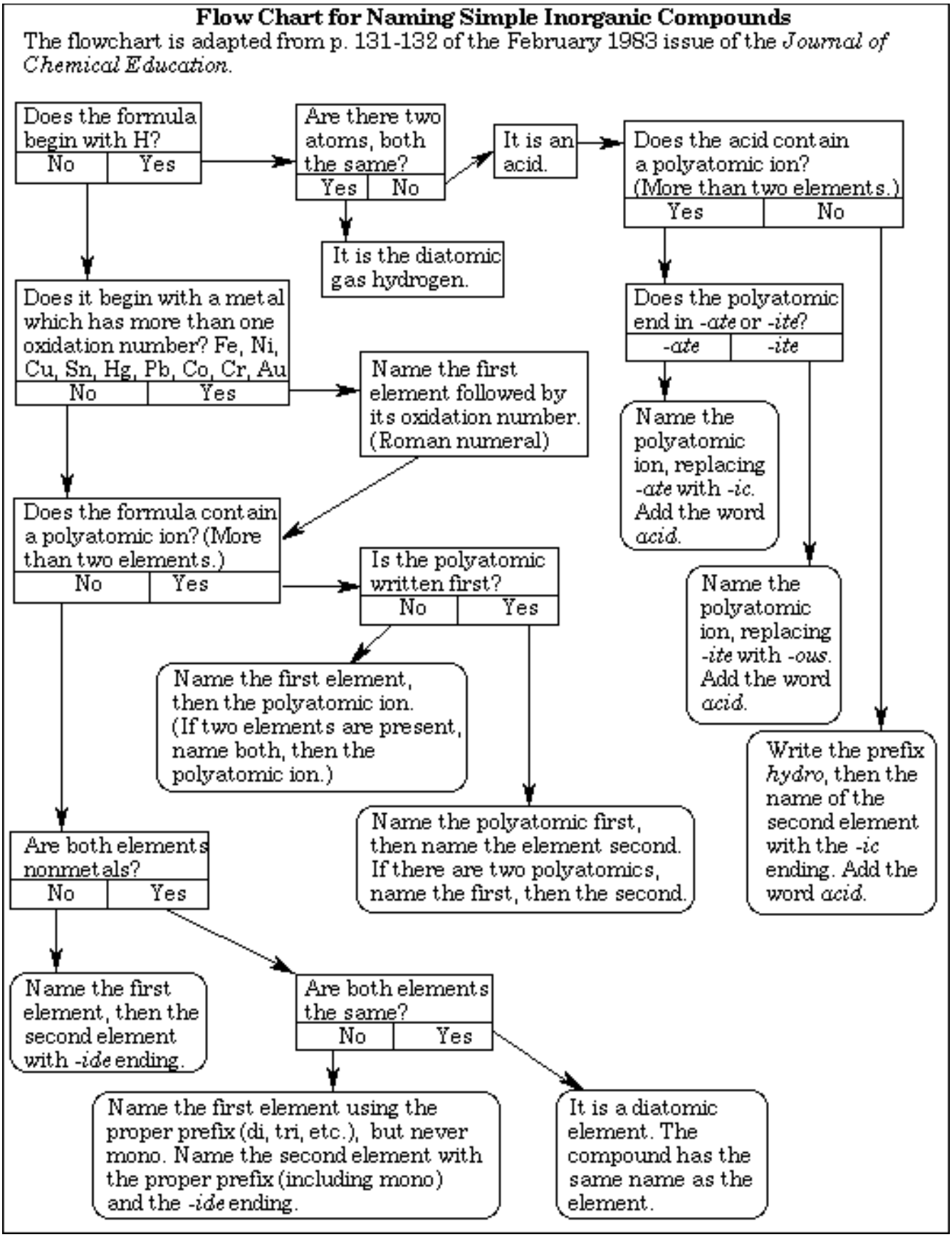




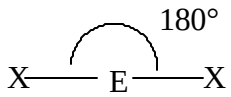
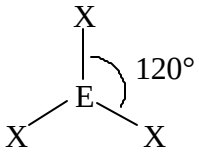
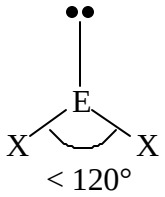
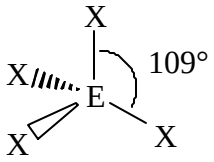
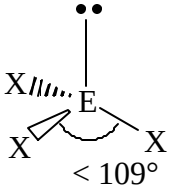
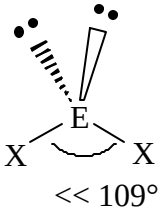
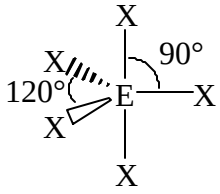
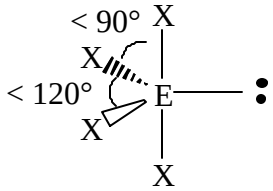
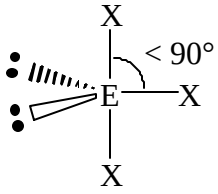
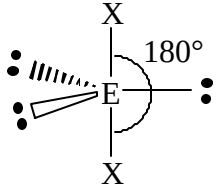
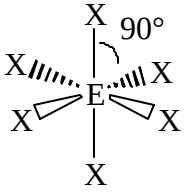
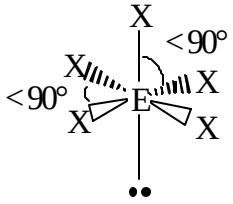
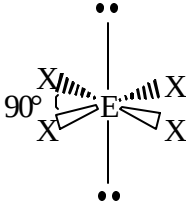
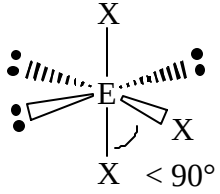
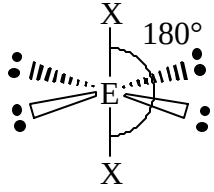


Flow Chart for Naming Simple Inorganic Compounds

The flowchart is adapted from p. 131-132 of the February 1983 issue of the *Journal of Chemical Education*.



VSEPR Geometries

Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 **Linear**				
3	 **Trigonal Planar**	 **Bent or Angular**			
4	 **Tetrahedral**	 **Trigonal Pyramid**	 **Bent or Angular**		
5	 **Trigonal Bipyramid**	 **Sawhorse or Seesaw**	 **T-shape**	 **Linear**	
6	 **Octahedral**	 **Square Pyramid**	 **Square Planar**	 **T-shape**	 **Linear**

Solubility of Common Compounds in Water

Rule	Negative Ions	Positive Ions	Solubility
1	essentially all	Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+	soluble
2	essentially all	H^+	soluble
3	essentially all	NH_4^+	soluble
4	Chlorate, ClO_3^- nitrate, NO_3^- perchlorate, ClO_4^-	essentially all	soluble
5	acetate, CH_3COO^-	Ag^+	low solubility
		all others	soluble
6	fluoride, F^-	Mg^{2+}, Ca^{2+}, Ba^{2+}, Pb^{2+}	low solubility
		all others	soluble
7	bromide, Br^- chloride, Cl^- iodide, I^-	Ag^+, Pb^{2+}, Hg_2^{2+}, Cu^+, Tl^+	low solubility
		all others	soluble
8	sulfate, SO_4^{2-}	Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}, Pb^{2+}, Ag^+, Hg_2^{2+}	low solubility
		all others	soluble
9	sulfide, S^{2-}	Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+, H^+, NH_4^+, Be^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}	soluble
		all others	low solubility
10	hydroxide, OH^-	Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+, H^+, NH_4^+, Sr^{2+}, Ba^{2+}, Ra^{2+}, Tl^+	soluble
		all others	low solubility
11	carbonate, CO_3^{2-} phosphate, PO_4^{3-} sulfite, SO_3^{2-}	Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+, H^+, NH_4^+	soluble
		all others	low solubility

*considered soluble if they give ion concentrations above 0.1 mol/L at room temperature

Solubility Product Constant (K_{sp}) Values at 25 °C

Salt	K_{sp}	Salt	K_{sp}	Salt	K_{sp}	Salt	K_{sp}
Bromides		**Carbonates**		**Oxalates**		**Sulfides**	
$PbBr_2$	6.6×10^{-6}	$MgCO_3$	6.8×10^{-6}	MgC_2O_4	4.8×10^{-6}	CoS	2.0×10^{-25}
CuBr	6.3×10^{-9}	$NiCO_3$	1.3×10^{-7}	FeC_2O_4	2×10^{-7}	CuS	6.3×10^{-36}
AgBr	5.4×10^{-13}	$CaCO_3$	5.0×10^{-9}	NiC_2O_4	1×10^{-7}	FeS	6.3×10^{-18}
Hg_2Br_2	6.4×10^{-23}	$SrCO_3$	5.6×10^{-10}	SrC_2O_4	5×10^{-8}	HgS	1.6×10^{-52}
Chlorides		$MnCO_3$	2.2×10^{-11}	CuC_2O_4	3×10^{-8}	PbS	8.0×10^{-28}
$PbCl_2$	1.2×10^{-5}	$CuCO_3$	2.5×10^{-10}	BaC_2O_4	1.6×10^{-7}	CdS	8×10^{-27}
CuCl	1.7×10^{-7}	$CoCO_3$	1.0×10^{-10}	CdC_2O_4	1.4×10^{-8}	MnS	2.5×10^{-10}
AgCl	1.8×10^{-10}	$FeCO_3$	2.1×10^{-11}	ZnC_2O_4	1.4×10^{-9}	NiS	3×10^{-19}
Hg_2Cl_2	1.4×10^{-18}	$ZnCO_3$	1.2×10^{-10}	CaC_2O_4	2.3×10^{-9}	AgS	6×10^{-50}
Fluorides		Ag_2CO_3	8.1×10^{-12}	$Ag_2C_2O_4$	3.5×10^{-11}	ZnS	1.1×10^{-21}
BaF_2	1.8×10^{-7}	$CdCO_3$	6.2×10^{-12}	PbC_2O_4	4.8×10^{-12}	**Hydroxides**	
MgF_2	7.4×10^{-11}	$PbCO_3$	7.4×10^{-14}	$Hg_2C_2O_4$	1.8×10^{-13}	$Ba(OH)_2$	5.0×10^{-3}
SrF_2	2.5×10^{-9}	**Chromates**		MnC_2O_4	1×10^{-15}	$Sr(OH)_2$	6.4×10^{-3}
CaF_2	1.5×10^{-10}	$CaCrO_4$	7.1×10^{-4}	**Phosphates**		$Ca(OH)_2$	4.7×10^{-6}
Iodides		$SrCrO_4$	2.2×10^{-5}	Ag_3PO_4	8.9×10^{-17}	$Mg(OH)_2$	5.6×10^{-12}
PbI_2	8.5×10^{-9}	Hg_2CrO_4	2.0×10^{-9}	$AlPO_4$	9.8×10^{-21}	$Mn(OH)_2$	2.1×10^{-13}
CuI	1.1×10^{-12}	$BaCrO_4$	1.2×10^{-10}	$Mn_3(PO_4)_2$	1×10^{-22}	$Cd(OH)_2$	5.3×10^{-15}
AgI	8.5×10^{-17}	Ag_2CrO_4	2.0×10^{-12}	$Ba_3(PO_4)_2$	3×10^{-23}	$Pb(OH)_2$	1.2×10^{-15}
Hg_2I_2	4.5×10^{-29}	$PbCrO_4$	2.8×10^{-13}	$BiPO_4$	1.3×10^{-23}	$Fe(OH)_2$	4.9×10^{-17}
Sulfates		**Acetates**		$Sr_3(PO_4)_2$	4×10^{-28}	$Ni(OH)_2$	5.5×10^{-16}
$CaSO_4$	7.1×10^{-5}	$AgCH_3COO$	4.4×10^{-3}	$Pb_3(PO_4)_2$	7.9×10^{-43}	$Co(OH)_2$	1.1×10^{-15}
Hg_2SO_4	6.8×10^{-7}	$Hg_2(CH_3COO)_2$	4×10^{-10}	$Ca_3(PO_4)_2$	1×10^{-26}	$Zn(OH)_2$	4.1×10^{-17}
Ag_2SO_4	1.2×10^{-5}	**Arsenates**				$Cu(OH)_2$	1.6×10^{-19}
$SrSO_4$	3.5×10^{-7}	$Pb_3(AsO_4)_2$	4×10^{-36}			$Hg(OH)_2$	3.1×10^{-26}
$PbSO_4$	1.8×10^{-8}	$Mg_3(AsO_4)_2$	2×10^{-20}			$Sn(OH)_2$	5.4×10^{-27}
$BaSO_4$	1.1×10^{-10}					$Cr(OH)_3$	6.7×10^{-31}
						$Fe(OH)_3$	2.6×10^{-39}
						$Al(OH)_3$	1.9×10^{-33}

EQUILIBRIUM CONSTANTS

Acid-Ionization Constants, K_a, at 25°C.

Substance	Formula	K_a
Acetic acid	$HC_2H_3O_2$	1.7×10^{-5}
Benzoic acid	$HC_7H_5O_2$	6.3×10^{-5}
Boric acid	H_3BO_3	5.9×10^{-10}
Carbonic acid	H_2CO_3	4.3×10^{-7}
	HCO_3^-	4.8×10^{-11}
Chlorous acid	$HClO_2$	1.1×10^{-2}
Cyanic acid	HOCN	3.5×10^{-4}
Formic acid	$HCHO_2$	1.7×10^{-4}
Hydrocyanic acid	HCN	4.9×10^{-10}
Hydrofluoric acid	HF	6.8×10^{-4}
Hydrogen sulfate ion	HSO_4^-	1.1×10^{-2}
Hydrosulfuric acid	H_2S	8.9×10^{-8}
	HS^-	1.2×10^{-13}
Hypobromous acid	HBrO	2.1×10^{-9}
Hypochlorous acid	HClO	3.5×10^{-8}
Nitrous acid	HNO_2	4.5×10^{-4}
Oxalic acid	$H_2C_2O_4$	5.6×10^{-2}
	$HC_2O_4^-$	5.1×10^{-5}
Phosphoric acid	H_3PO_4	6.9×10^{-3}
	$H_2PO_4^-$	6.2×10^{-8}
	HPO_4^{2-}	4.8×10^{-13}
Phosphorous acid	H_3PO_3	1.6×10^{-2}
	$H_2PO_3^-$	7×10^{-7}
Propionic acid	$HC_3H_5O_2$	1.3×10^{-5}
Pyruvic acid	$HC_3H_3O_3$	1.4×10^{-4}
Sulfuric acid	H_2SO_4	strong
	HSO_4^-	1.3×10^{-2}
Sulfurous acid	H_2SO_3	1.3×10^{-2}
	HSO_3^-	6.3×10^{-8}

Base Ionization Constants, K_b, at 25°C.

Substance	Formula	K_b
Ammonia	NH_3	1.8×10^{-5}
Aniline	$C_6H_5NH_2$	4.2×10^{-10}
Dimethylamine	$(CH_3)_2NH$	5.1×10^{-4}
Ethylamine	$C_2H_5NH_2$	4.7×10^{-4}
Hydrazine	N_2H_4	1.7×10^{-6}
Hydroxylamine	NH_2OH	1.1×10^{-8}
Methylamine	CH_3NH_2	4.4×10^{-4}
Pyridine	C_5H_5N	1.4×10^{-9}
Urea	NH_2CONH_2	1.5×10^{-14}

Rules for Assigning Oxidation Numbers

Oxidation numbers are real or hypothetical charges on atoms, assigned by the following rules:

1. Atoms in elements are assigned 0.

2. All simple monatomic ions have oxidation numbers equal to their charges. (e.g., all Group IA ions are +1; all group IIA ions are +2; all the following ions have oxidation numbers given by their charges - Fe^{2+}, Al^{3+}, S^{2-}, N^{3-})

3. Fluorine is always -1 in its compounds.

4. Halogens are usually -1, except when a central atom or when combined with a more electronegative element (e.g., assign I as -1 in NI_3, but +3 in ICl_3).

5. Oxygen is -2 in most of its compounds, except in cases like peroxides (H_2O_2, Na_2O_2) where it is -1.

6. Hydrogen is usually +1, except in hydrides with electropositive elements, particularly with metal cations, where it is -1 (e.g., NaH, CaH_2, BH_4^-).

7. The sum of all oxidation numbers for a neutral compound is zero; the sum is the charge on the species for a complex ion.

Standard Reduction Potentials (at 25°C, 101.325 kPa, 1M)

Half-Reaction	E° (Volts)
$Li^+ + e^- \rightarrow Li$	-3.040
$K^+ + e^- \rightarrow K$	-2.942
$Rb^+ + e^- \rightarrow Rb$	-2.942
$Cs^+ + e^- \rightarrow Cs$	-2.923
$Ba^{2+} + 2e^- \rightarrow Ba$	-2.92
$Sr^{2+} + 2e^- \rightarrow Sr$	-2.89
$Ca^{2+} + 2e^- \rightarrow Ca$	-2.84
$Na^+ + e^- \rightarrow Na$	-2.713
$La^{3+} + 3e^- \rightarrow La$	-2.37
$Mg^{2+} + 2e^- \rightarrow Mg$	-2.356
$Ce^{3+} + 3e^- \rightarrow Ce$	-2.34
$Nd^{3+} + 3e^- \rightarrow Nd$	-2.32
$H_2 + 2e^- \rightarrow 2H^-$	-2.25
$Sc^{3+} + 3e^- \rightarrow Sc$	-2.03
$Be^{2+} + 2e^- \rightarrow Be$	-1.97
$Al^{3+} + 3e^- \rightarrow Al$	-1.676
$U^{3+} + 3e^- \rightarrow U$	-1.66
$Ti^{2+} + 2e^- \rightarrow Ti$	-1.63
$Hf^{4+} + 4e^- \rightarrow Hf$	-1.56
$No^{3+} + 3e^- \rightarrow No$	-1.2
$Mn^{2+} + 2e^- \rightarrow Mn$	-1.18
$Cr^{2+} + 2e^- \rightarrow Cr$	-0.90
$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$	-0.828
$Zn^{2+} + 2e^- \rightarrow Zn$	-0.7626
$Cr^{3+} + 3e^- \rightarrow Cr$	-0.74
$Ga^{3+} + 3e^- \rightarrow Ga$	-0.529
$U^{4+} + e^- \rightarrow U^{3+}$	-0.52
$2CO_2 + 2H^+ + 2e^- \rightarrow H_2C_2O_4$	-0.475
$S + 2e^- \rightarrow S^{2-}$	-0.447
$Fe^{2+} + 2e^- \rightarrow Fe$	-0.44
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	-0.424
$2H_2O + 2e^- \rightarrow H_2 + 2OH^-(10^{-7}M)$	-0.414
$Cd^{2+} + 2e^- \rightarrow Cd$	-0.4025
$Ti^{3+} + e^- \rightarrow Ti^{2+}$	-0.37
$PbI_2 + 2e^- \rightarrow Pb + 2I^-$	-0.365
$PbSO_4 + 2e^- \rightarrow Pb + SO_4$	-0.3505
$In^{3+} + 3e^- \rightarrow In$	-0.3382
$Tl^+ + e^- \rightarrow Tl$	-0.3363
$Co^{2+} + 2e^- \rightarrow Co$	-0.277
$H_3PO_4 + 2H^+ + 2e^- \rightarrow H_3PO_3 + H_2O$	-0.276
$Ni^{2+} + 2e^- \rightarrow Ni$	-0.257
$Sn^{2+} + 2e^- \rightarrow Sn$	-0.136
$Pb^{2+} + 2e^- \rightarrow Pb$	-0.1251
$Hg_2I_2 + 2e^- \rightarrow 2Hg + 2I^-$	-0.0405
$Fe^{3+} + 3e^- \rightarrow Fe$	-0.04
$2H^+ + 2e^- \rightarrow H_2$	0.0000
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	0.154

Half-Reaction	E°Volts
$SO_4^{2-} + 4H^+ + 2e^- \rightarrow H_2SO_3 + H_2O$	0.158
$Cu^{2+} + e^- \rightarrow Cu^+$	0.159
$HAsO_2 + 3H^+ + 3e^- \rightarrow As + 2H_2O$	0.248
$UO_2^{2+} + 4H^+ + 2e^- \rightarrow U^{4+} + 2H_2O$	0.27
$Bi^{3+} + 3e^- \rightarrow Bi$	0.3172
$Cu^{2+} + 2e^- \rightarrow Cu$	0.340
$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	0.401
$Cu^+ + e^- \rightarrow Cu$	0.520
$I_2 + 2e^- \rightarrow 2I^-$	0.5355
$H_3AsO_4 + 2H^+ + 2e^- \rightarrow HAsO_2 + 2H_2O$	0.560
$O_2 + 2H^+ + 2e^- \rightarrow H_2O_2$	0.695
$Rh^{3+} + 3e^- \rightarrow Rh$	0.7
$Tl^{3+} + 3e^- \rightarrow Tl$	0.72
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	0.771
$NO_3^- + 2H^+ + e^- \rightarrow NO_2 + H_2O$	0.775
$Hg_2^{2+} + 2e^- \rightarrow Hg$	0.7960
$Ag^+ + e^- \rightarrow Ag$	0.7991
$O_2 + 4H^+(10^{-7}M) + 4e^- \rightarrow 2H_2O$	0.815
$AmO_2^+ + 4H^+ + e^- \rightarrow Am^{4+} + 2H_2O$	0.82
$NO_3^- + 2H^+ + 2e^- \rightarrow NO_2^- + H_2O$	0.835
$OsO_4 + 8H^+ 8e^- \rightarrow Os + 4H_2O$	0.84
$Hg^{2+} + 2e^- \rightarrow Hg$	0.8535
$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$	0.9110
$Pd^{2+} + 2e^- \rightarrow Pd$	0.915
$NO_3^- + 4H^+ + 3e^- \rightarrow NO(g) + 2H_2O$	0.957
$Br_2 + 2e^- \rightarrow 2Br^-$	1.0652
$SeO_4^{2-} + 4H^+ + 2e^- \rightarrow H_2SeO_3 + H_2O$	1.151
$Ir^{3+} + 3e^- \rightarrow Ir$	1.156
$Pt^{2+} + 2e^- \rightarrow Pt$	1.188
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	1.229
$Tl^{3+} + 2e^- \rightarrow Tl^+$	1.25
$Pd^{4+} + 2e^- \rightarrow Pd^{2+}$	1.263
$Cl_2 + 2e^- \rightarrow 2Cl^-$	1.35828
$Au^{3+} + 2e^- \rightarrow Au^+$	1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	1.36
$MnO_4^- + 8H^+ 5e^- \rightarrow Mn^{2+} + 4H_2O$	1.51
$Au^{3+} + 3e^- \rightarrow Au$	1.52
$H_5IO_6 + H^+ + 2e^- \rightarrow IO_3^- + 3H_2O$	1.603
$2HBrO + 2H^+ + 2e^- \rightarrow Br_2 + 2H_2O$	1.604
$PbO_2 + SO_4^{2-} + 4H^+ + 2e^- \rightarrow PbSO_4 + 2H_2O$	1.698
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$	1.763
$Au^+ + e^- \rightarrow Au$	1.83
$Co^{3+} + e^- \rightarrow Co^{2+}$	1.92
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	1.96
$O_3 + 2H^+ + 2e^- \rightarrow O_2 + H_2O$	2.075
$F_2 + 2e^- \rightarrow 2F^-$	2.87
$F_2 + 2H^+ + 2e^- \rightarrow 2HF$	3.053

Formula Sheet – Chemistry

$[\ ]$ = mol/L or M

$$\text{Molarity (M)} = \frac{\text{amount of solute (moles)}}{\text{volume of solution (litres)}}$$

$$C_1V_1 = C_2V_2 \quad \text{or} \quad M_1V_1 = M_2V_2$$

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} \quad \text{or} \quad n = \frac{m}{\text{molar mass}}$$

$$M_aV_a = M_bV_b \quad \text{or} \quad C_aV_a = C_bV_b$$

$$pH = -\log\left[H_3O^+\right] \quad \text{or} \quad pH = -\log\left[H^+\right]$$

$$\left[H^+\right]\left[OH^-\right] = 1\times10^{-14} \quad \text{or} \quad \left[H_3O^+\right]\left[OH^-\right] = 1\times10^{-14}$$

$$pH + pOH = 14$$

SI Prefixes

Value	Prefix	Organic Prefix
1	mono	meth
2	di	eth
3	tri	prop
4	tetra	but
5	penta	pent
6	hexa	hex
7	hepta	hept
8	octa	oct
9	nona	non
10	deca	dec

Notation

Symbol	Term	Unit
E°	standard electric potential	V or J/C
K_c	equilibrium constant	___
K_a	acid ionization constant	___
K_b	base ionization constant	___
M	molar mass	g/mol
m	mass	g
n	amount of substance	mol
P	pressure	kPa
V	volume	L
C	concentration	mol/L