Formula and data book

Chemistry v1.3

Formulas

Processing of data

Absolute uncertainty of the mean $\Delta \overline{x} = \pm \frac{\left(x_{\text{max}} - x_{\text{min}}\right)}{2}$

Percentage uncertainty (%) = $\frac{\text{absolute uncertainty}}{\text{measurement}} \times 100$

Percentage error (%) = $\left| \frac{\text{measured value} - \text{true value}}{\text{true value}} \right| \times 100$

Chemical reactions — reactants, products and energy change

 $\Delta H = H_{\text{(products)}} - H_{\text{(reactants)}}$

 $\Delta H = \Sigma (bonds broken) - \Sigma (bonds formed)$

 $Q = mc\Delta T$

Percentage yield (%) = $\frac{\text{experimental yield}}{\text{theoretical yield}} \times 100$

Aqueous solutions and acidity

Molarity = $\frac{\text{moles of solute}(n)}{\text{volume of solution}(V)}$

Chemical equilibrium systems

$$K_{c} = \frac{\left[C\right]^{c} \left[D\right]^{d}}{\left[A\right]^{a} \left[B\right]^{b}}$$
 for the reaction: $aA + bB \rightleftharpoons cC + dD$

$$K_{\mathbf{w}} = \left[\mathbf{H}^{+}\right] \left[\mathbf{OH}^{-}\right]$$

$$pH = -\log_{10} \left[H^+ \right]$$

$$pOH = -\log_{10} \lceil OH^{-} \rceil$$

$$K_{\rm w} = K_{\rm a} \times K_{\rm b}$$

$$K_{\rm a} = \frac{\left[H_3 O^+ \right] \left[A^- \right]}{\left[HA \right]}$$

$$K_{\rm b} = \frac{\left[{\rm BH}^{+} \right] \left[{\rm OH}^{-} \right]}{\left[{\rm B} \right]}$$

Physical constants and unit conversions

Physical constants and unit conversions	
Absolute zero	0 K = −273 °C
Atomic mass unit	$1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg}$
Avogadro's constant	$N_{\rm A} = 6.02 \times 10^{23} \text{ mol}^{-1}$
Ideal gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
Ionic product constant for water (at 298 K)	$K_{\rm w} = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$
Molar volume of an ideal gas (at STP)	$2.27 \times 10^{-2} \text{ m}^3 \text{ mol}^{-1} = 22.7 \text{ dm}^3 \text{ mol}^{-1}$
Specific heat capacity of water (at 298 K)	$c_{\rm w} = 4.18 \mathrm{J g^{-1} K^{-1}}$
Standard temperature and pressure (STP)	273 K and 100 kPa
Volume and capacity conversions	$1 \text{ dm}^3 = 1 \times 10^{-3} \text{ m}^3 = 1 \times 10^3 \text{ cm}^3 = 1 \text{ L}$

List of elements

Name	Atomic no. Symbol	Symbol	Name	Atomic no.	Symbol	Name	Atomic no. Symbol	Symbol	Name	Atomic no. Symbol	Symbol
Hydrogen	1	Н	Gallium	31	Ga	Promethium	61	Pm	Protactinium	91	Pa
Helium	2	Не	Germanium	32	Ge	Samarium	62	Sm	Uranium	92	n
Lithium	3	Li	Arsenic	33	As	Europium	63	Eu	Neptunium	93	Np
Beryllium	4	Be	Selenium	34	Se	Gadolinium	64	Cd	Plutonium	94	Pu
Boron	5	В	Bromine	35	Br	Terbium	99	Tb	Americium	95	Am
Carbon	9	C	Krypton	36	Kr	Dysprosium	99	Dy	Curium	96	Cm
Nitrogen	7	Z	Rubidium	37	Rb	Holmium	29	Но	Berkelium	76	Bk
Oxygen	8	0	Strontium	38	Sr	Erbium	89	Er	Californium	86	Cf
Fluorine	6	Н	Yttrium	39	Y	Thulium	69	Tm	Einsteinium	66	Es
Neon	10	Ne	Zirconium	40	Zr	Ytterbium	70	Yb	Fermium	100	Fm
Sodium	11	Na	Niobium	41	Nb	Lutetium	71	Lu	Mendelevium	101	Md
Magnesium	12	Mg	Molybdenum	42	Mo	Hafnium	72	Hf	Nobelium	102	No
Aluminium	13	Al	Technetium	43	Tc	Tantalum	73	Та	Lawrencium	103	Lr
Silicon	14	Si	Ruthenium	44	Ru	Tungsten	74	M	Rutherfordium	104	Rf
Phosphorus	15	Ь	Rhodium	45	Rh	Rhenium	75	Re	Dubnium	105	Db
Sulfur	16	S	Palladium	46	Pd	Osmium	92	Os	Seaborgium	106	Sg
Chlorine	17	Cl	Silver	47	Ag	Iridium	LL	Ir	Bohrium	107	Bh
Argon	18	Ar	Cadmium	48	Cd	Platinum	78	Pt	Hassium	108	Hs
Potassium	19	K	Indium	49	In	Gold	62	Au	Meitnerium	109	Mt
Calcium	20	Ca	Tin	50	Sn	Mercury	80	Hg	Darmstadtium	110	Ds
Scandium	21	Sc	Antimony	51	Sb	Thallium	81	Tl	Roentgenium	111	Rg
Titanium	22	Ti	Tellurium	52	Te	Lead	82	Pb	Copernicium	112	Cn
Vanadium	23	Λ	Iodine	53	Ι	Bismuth	83	Bi	Nihonium	113	Nh
Chromium	24	C	Xenon	54	Xe	Polonium	84	Po	Flerovium	114	F1
Manganese	25	Mn	Cesium	55	Cs	Astatine	85	At	Moscovium	115	Mc
Iron	56	Fe	Barium	99	Ba	Radon	98	Rn	Livermorium	116	Lv
Cobalt	27	Co	Lanthanum	57	La	Francium	87	Fr	Tennessine	117	Ts
Nickel	28	ïZ	Cerium	58	Ce	Radium	88	Ra	Oganesson	118	Og
Copper	29	Cu	Praseodymium	59	Pr	Actinium	68	Ac			
Zinc	30	Zn	Neodymium	09	Nd	Thorium	06	Th			

Periodic table of the elements

18	$\frac{2}{\text{He}}$	4.00	10 N	20.18	18	Ar	39.95	36	Kr	83.80	54	Xe	131.29	98	~	(222.0)	118	or O	(294)		71	Lu	174.97	103	L	(262.1)
		17	6	19.00	17	こ	35.45	35	Br	79.90	53	_	126.90	85	At	(210.0)	117		(294)	-	70	Λþ	173.05	102	2 N	(259.1)
		16	× C	16.00	16	S	32.06	34	Se	78.97		\Box	127.60	84	P	(210.0)	116	Lv	(293)	-	69	Tm	168.93	101	Md	(258.1)
		15	Z	14.01	15	Ь	30.97	33	As	74.92	51	Sp	121.76	83	Bi	208.98	115	Mc	(288)	-	89	Εľ	167.26	100	Fm	(252.1)
		41	و ر	12.01	14	Si	28.09	32	ge	72.63	50	Sn	118.71	82	Pb	207.2		ī	(289)		29	Ho	164.93	66	ES	(252.1)
		13	2	10.81	13	Al	26.98	31	Сa	_	49		114.82	81	Ξ	204.38	113	N	(284)		99	Dy	162.50	86	Cf	(252.1)
		L			•		12	30	Zn	65.38	48	D C	112.41	08	Hg	200.59	112	Cn	(285)			$\mathbf{T}\mathbf{p}$	158.93	76	Bk	(249.1)
			*	Se			11		Cn	63.55	47	Ag	107.87	79	Au	196.97	111	K So	$(27\overline{2})$		64	<u> </u>	157.25	96	Cm	(244.1)
	mber						10	28	Z	58.69	46	Pd	106.42	78	Pt	195.08	110	Ds	(281)		63	Eu	151.96	95	Am	(241.1)
	Atomic number	Symbol	Doloting of coming one case	ialive au			6	27	ပိ	58.93	45	Rh	102.91	77	ľ		109				62	Sm	150.36	94	Pu	(239.1)
		S	î e				∞	26	Fe	55.85	44	Ru	101.07	92	SO	, ,	108		$\overline{}$		61	Pm	(146.9)	93	N N	(237.0)
	\	_ 	— ⊣ ;				7	25	Z	54.94	1	Lc	(98.91)	75	Re		107				09	Nd	144.24	92		238.0
			-):i					Ç	52.00	42	Mo	95.95	74	>	183.84	106	S	(263.1)		59	Pr	140.91	91	Pa	231.0
							2	23	>	50.94	41	S	92.91	73	La		105			-	58	Ce	140.12	06	Th	232.0
							4	22	ij	47.87	40	N	91.22	72	Ht		104	Rf	(261.1)	-	57	La	138.91	68	Ac	(227.0)
							α	21	Sc	7	39		88.91	57–71	Lantha-	spiou	89–103	Acti-	noids -		<u></u>					
		2	R	9.01	12	Mg	24.31	20	Ca	40.08	38	Sr	87.62	99	Ba	137.33	88	Ra	(226.1)							
1	H H	1.01	3	6.94	11	Na	22.99	19	\	39.10	37	Rb	85.47	55	Š	132.91	87	Fr	(223.0)							
			,														•									

Groups are numbered according to IUPAC convention 1-18.

*Values in brackets are for the isotope with the longest half-life.

Atomic and ionic radii of selected elements

18	He 37	10 Ne 62	$\mathbf{Ar} \\ 101$	36 Kr	0110	54 Xe	136	
	17		CI 100 100 81 (1–)	35 Br	(-1) 96	53 I	136 220 (1–)	
	16	8 0 64 (40 (2-)	S 104 104 184 (2–)	34 Se 118	198 (2–) 196 (1–)	$\frac{52}{\text{Te}}$	$\frac{137}{221(2-)}$	
	15	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Si P S CI 114 109 104 100 40 (4+) 38 (5+) 184 (2-) 181 (1-)	33 As		$\frac{51}{\mathbf{S}\mathbf{b}}$	140 137 136 76 (3+) 221 (2-) 220 (1-	
	41	C C 75 16 (4+)	Si 114 114 40 (4+)	32 Ge	53 (4+) 272 (4-)	50 Sn		
	13	5 B 84 27 (3+)	13 AI 124 53 (3+)	31 Ga	62 (3+)		8(
			12	30 Zn	74 (2+)	48 Cd	$\begin{array}{c c} 13\widetilde{6} & 140 \\ 115 & (1+) & 95 & (2+) \end{array}$	
		-12 m)	_ =	Cu Cu	77 (1+) 73 (2+)	\mathbf{Ag}		
	umber	Atomic radius (10 ⁻¹² m) Charge of ion Ionic radius (10 ⁻¹² m)	, 01	N	59	46 Pd	130 86 (2+)	
	Atomic number Symbol	Atomic radius Charge of ion Ionic radius (6		74 (2+) 61 (3+)	45 Rh	134 67 (3+)	
			∞	26 Fe	78/	44 Ru	136 62 (4+)	
	3	130 ←	_	25 Mn	$\infty \circ$	43 Tc	138 65 (4+)	
		76	9	Cr	62 (3+) 44 (6+)	42 Mo	148 65 (4+)	
			V	V	54	Nb 41	156 64 (5+)	
			4	22 Ti	Z ŦŢ		164 72 (4+)	
			m	Sc Ti	75 (3+)	39 Y	176 90 (3+)	
	7	Be 99 45 (2+)	Na Mg 160 (1+) 72 (2+)	\mathbf{Ca}	1/4 00 (2+	38 Sr	215 190 176 52 (1+) 118 (2+) 90 (3+)	56 Ba 206 135 (2+)
П	\mathbf{H} 32 208 (1–)	3 Li 130 76 (1+)	Na 160 160 102 (1+)	19 K	138 (1+)	37 Rb	215 152 (1+)	CS B 238 20 167 (1+) 135

Groups are numbered according to IUPAC convention 1-18.

Electronegativities and first ionisation energies of selected elements

18	He He	2379				1527						2.6			
		17	9 F	4.0	17 Cl	3.2	35	Br	3.0 1146	53	_	2.7			
		16	8	3.4	S 16	2.6	34	Se	2.6 947	52	Te	2.1 876			
		15	Z	3.0	15 P	2.2	33	As	2.2 953	51	Sp	2.1 840			
		14	9 9	2.6 1093	14 Si	1.9	32	Ge	2.0 768	50	Sn	2.0			
		13	5 B	2.0	13 Al	1.6	31	Сa	1.8	49	In	1.8			
						12	30	Zn	1.7	48	Cq	1.7 874			
				-1)		11	29	Cn	1.9 752			1.9			
	ımber		gativity	First ionisation enthalpies $(kJ \text{ mol}^{-1})$					1.9			2.2			
	- Atomic number	Symbol	Electronegativity	First ionisation enthalpies (kJ n		6			1.9						
	\bigvee_{A}	į.		_ -		∞				1		2.2			
			2.2	<u>81</u>					1.6 724						
						9	24	Cr	1.7	42	Mo	2.2 691			
									1.6						
									1.5						
		,							1.4						
			4 Be												
-	H H	2.2	$\frac{3}{\text{Li}}$	1.0	\mathbf{Na}	0.9	19	Y	0.8	37	Rb	0.8	55	3 0	382

Groups are numbered according to IUPAC convention 1-18.

Solubility of selected compounds at 298 K

	bromide	carbonate	chloride	hydroxide	iodide	nitrate	oxide	phosphate	sulfate
aluminium	s		S	i	S	s	i	i	S
ammonium	s	s	S	s	S	s		S	S
barium	s	i	S	S	S	S	s	i	i
calcium	s	i	S	р	S	S	p	i	р
cobalt(II)	s	i	S	i	S	S	i	i	S
copper(II)	s		S	i	i	S	i	i	S
iron(II)	s	i	S	i	S	s	i	i	S
iron(III)	s		S	i	S	S	i	i	S
lead(II)	р	i	S	i	i	s	i	i	i
lithium	s	S	S	S	S	S	S		S
magnesium	s	i	S	i	S	S	i	p	S
manganese(II)	s	i	S	i	S	S	i	p	S
potassium	S	S	S	S	S	S	S	S	S
silver	i	i	i	i	i	S	i	i	p
sodium	S	S	S	S	S	S	S	S	S
zinc	S	i	S	i	S	S	i	i	S

Key

Abbreviation	Explanation
S	soluble in water (solubility greater than 10 g L^{-1})
p	partially soluble in water (solubility between 1 and 10 g L^{-1})
i	insoluble in water (solubility less than 1 g L ⁻¹)
	no data

Average bond enthalpies at 298 K

Single bonds

				Δ	H (kJ mol	-1)			
	Н	С	N	0	F	S	Cl	Br	I
Н	436								
C	414	346							
N	391	286	158						
0	463	358	214	144					
F	567	492	278	191	159				
S	364	289			327	266			
Cl	431	324	192	206	255	271	242		
Br	366	285		201	249	218	219	193	
I	298	228		201	280		211	178	151

Multiple bonds

Bond	ΔH (kJ mol ⁻¹)
C=C	614
C≡C	839
C=N	615
C≡N	890
C=O	804
N=N	470
N≡N	945
O=O	498

Reactivity series of metals

Element	Reactivity
K	most reactive
Na	^
Li	
Ba	
Sr	
Ca	
Mg	
Al	
C*	
Mn	
Zn	
Cr	
Fe	
Cd	
Со	
Ni	
Sn	
Pb	
H ₂ *	
Sb	
Bi	
Cu	
Hg	
Ag	
Au	
Pt	least reactive

^{*}Carbon (C) and hydrogen gas (H_2) added for comparison.

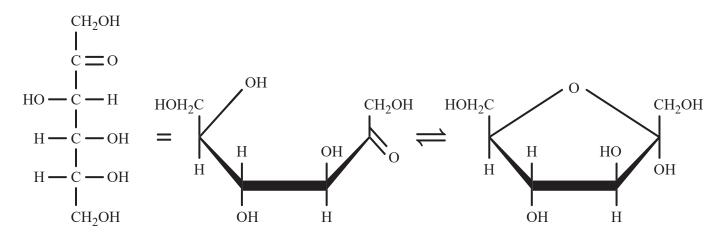
Standard electrode potentials at 298 K

Oxidised species Reduced species	<i>E</i> ° (V)
$\operatorname{Li}^{+}(\operatorname{aq}) + \operatorname{e}^{-} \rightleftharpoons \operatorname{Li}(\operatorname{s})$	-3.04
$K^+(aq) + e^- \rightleftharpoons K(s)$	-2.94
$Ba^{2+}(aq) + 2e^- \rightleftharpoons Ba(s)$	-2.91
$\operatorname{Ca}^{2+}(\operatorname{aq}) + 2\operatorname{e}^{-} \rightleftharpoons \operatorname{Ca}(\operatorname{s})$	-2.87
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	-2.71
$Mg^{2+}(aq) + 2e^{-} \rightleftharpoons Mg(s)$	-2.36
$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	-1.68
$Mn^{2+}(aq) + 2e^- \rightleftharpoons Mn(s)$	-1.18
$2H_2O(1) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	-0.83
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	-0.76
$Fe^{2+}(aq) + 2e^{-} \rightleftharpoons Fe(s)$	-0.44
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	-0.24
$\operatorname{Sn}^{2+}(\operatorname{aq}) + 2\operatorname{e}^- \rightleftharpoons \operatorname{Sn}(\operatorname{s})$	-0.14
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	-0.13
$2H^{+}(aq) + 2e^{-} \rightleftharpoons H_{2}(g)$	0.00
$Cu^{2+}(aq) + e^{-} \rightleftharpoons Cu^{+}(aq)$	+0.16
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons SO_2(aq) + 2H_2O(1)$	+0.16
$Cu^{2+}(aq) + 2e^{-} \rightleftharpoons Cu(s)$	+0.34
$O_2(g) + 2H_2O(1) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{+}(aq) + e^{-} \rightleftharpoons Cu(s)$	+0.52
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$Fe^{3+}(aq) + e^{-} \rightleftharpoons Fe^{2+}(aq)$	+0.77
$Ag^{+}(aq) + e^{-} \rightleftharpoons Ag(s)$	+0.80
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.08
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(1)$	+1.23
$\operatorname{Cl}_2(g) + 2e^- \rightleftharpoons 2\operatorname{Cl}^-(aq)$	+1.36
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(1)$	+1.36
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(1)$	+1.51
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+2.89

Glucose and fructose: straight chain and α -ring forms

Straight chain D-glucose

α-D-glucose



Straight chain D-fructose

 α -D-fructose

Common amino acids

Common name (symbol)	Structural formula	pH of isoelectric point
Alanine (Ala)	Н О II Н ₂ N-С-С-ОН СН ₃	6.1
Asparagine (Asn)	$\begin{array}{c} H & O \\ I & II \\ H_2N-C-C-C-OH \\ I \\ CH_2 \\ C=O \\ I \\ NH_2 \end{array}$	5.4
Cysteine (Cys)	$\begin{array}{ccc} & H & O \\ I & II \\ H_2N-C-C-OH \\ I & \\ CH_2 & \\ I & \\ SH & \\ \end{array}$	5.1
Glutamine (Gln)	$\begin{array}{c} H & O \\ I & II \\ H_2N-C-C-C-OH \\ I \\ CH_2 \\ I \\ CH_2 \\ I \\ C=O \\ I \\ NH_2 \end{array}$	5.7
Histidine (His)	H O I II H ₂ N-C-C-OH CH ₂ NH	7.6

Common name (symbol)	Structural formula	pH of isoelectric point
Arginine (Arg)	H O II H ₂ N-C-C-OH CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ NH C=NH NH ₂	10.7
Aspartic acid (Asp)	H O I II H2N-C-C-OH CH2 C=O I OH	3.0
Glutamic acid (Glu)	H O I II H2N-C-C-OH I CH2 CH2 I C=O I OH	3.2
Glycine (Gly)	H O I II H ₂ N-C-C-OH I H	6.1
Isoleucine (Ile)	H O I II H2N-C-C-OH I CHCH3 I CH2 I CH3	6.0

Continues on the next page

Common name (symbol)	Structural formula	pH of isoelectric point
Leucine (Leu)	H O I II H ₂ N-C-C-OH CH ₂ CHCH ₃ CH ₃	6.0
Methionine (Met)	H O I II H ₂ N-C-C-OH CH ₂ CH ₂ S CH ₃	5.7
Proline (Pro)	O II C-OH HN	6.3
Threonine (Thr)	H O I II H ₂ N-C-C-OH I CHOH I CH ₃	5.6
Tyrosine (Tyr)	H O I II H ₂ N-C-C-OH CH ₂ OH	5.7

Common name (symbol)	Structural formula	pH of isoelectric point
Lysine (Lys)	H O I II H ₂ N-C-C-OH CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ NH ₂	9.7
Phenylalanine (Phe)	$\begin{array}{c} H & O \\ I & II \\ H_2N-C-C-OH \\ I \\ CH_2 \\ \end{array}$	5.7
Serine (Ser)	$\begin{array}{cccc} & H & O \\ I & II \\ H_2N-C-C-OH \\ I & \\ CH_2 & I \\ OH & \end{array}$	5.7
Tryptophan (Trp)	$\begin{array}{c} H & O \\ I & II \\ H_2N-C-C-OH \\ CH_2 \\ HN-C \end{array}$	5.9
Valine (Val)	$\begin{array}{c} H & O \\ I & II \\ H_2N-C-C-OH \\ I \\ CHCH_3 \\ I \\ CH_3 \end{array}$	6.0

Acid-base indicators

Name	pK _a	pH range of colour change	Colour change (acidic to basic)
Methyl orange	3.7	3.1–4.4	red to yellow
Bromophenol blue	4.2	3.0–4.6	yellow to blue
Bromocresol green	4.7	3.8–5.4	yellow to blue
Methyl red	5.1	4.4–6.2	pink to yellow
Bromothymol blue	7.0	6.0–7.6	yellow to blue
Phenol red	7.9	6.8–8.4	yellow to red
Phenolphthalein	9.6	8.3–10.0	colourless to pink

Infrared data

Characteristic range of infrared absorption due to stretching in organic molecules.

Bond	Organic molecules	Wavenumber (cm ⁻¹)
C-I	iodoalkanes	490–620
C-Br	bromoalkanes	500–600
C-Cl	chloroalkanes	600–800
C-F	fluoroalkanes	1000–1400
С-О	alcohol, ester	1050–1410
C=C	alkenes	1620–1680
C=O	aldehydes, carboxylic acid, ester, ketones	1700–1750
C≡C	alkynes	2100–2260
О-Н	carboxylic acids (hydrogen-bonded)	2500–3000
С-Н	alkanes, alkenes, alkynes, aldehydes, amides	2720–3100
О-Н	alcohol (hydrogen-bonded)	3200–3600
N-H	amines	3300–3500

Formulas and charges for common polyatomic ions

Anions			
acetate (ethanoate)	CH ₃ COO ⁻ or C ₂ H ₃ O ₂ ⁻		
carbonate	CO ₃ ²⁻		
chlorate	ClO ₃		
chlorite	ClO ₂		
chromate	CrO ₄ ²⁻		
citrate	C ₆ H ₅ O ₇ ³⁻		
cyanide	CN ⁻		
dichromate	Cr ₂ O ₇ ²⁻		
dihydrogen phosphate	H ₂ PO ₄		
hypochlorite	CIO ⁻		
hydrogen carbonate	HCO ₃		
hydrogen sulfate	HSO ₄		
hydrogen phosphate	HPO ₄ ²⁻		
hydroxide	OH ⁻		
nitrate	NO ₃		
nitrite	NO ₂		
perchlorate	ClO ₄		
permanganate	MnO ₄		
peroxide	O ₂ ²⁻		
phosphate	PO ₄ ³⁻		
sulfate	SO ₄ ²⁻		
sulfite	SO ₃ ²⁻		
thiosulfate	$S_2O_3^{2-}$		

Cations		
ammonium	NH ₄ ⁺	
hydronium	H ₃ O ⁺	

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