Periodic Table of the Elements

Key

Key item	Example (iron)
atomic number	26
electronegativity	1.8
common ion charge	3+
other ion charge	2+
melting point (°C)	1535
boiling point (°C)	2750
density of solid (g/cm^3) / density of liquid (g/mL) / density of gas at SATP (g/L)	7.87
atomic radius (pm)	124
symbol of element (solids in black, liquids in blue, gases in red)	Fe
name of element	iron
electron configuration	[Ar] $4s^2 3d^6$
atomic mass (u) / atomic molar mass (g/mol)	55.85

view online

Groups: 1 IA; 2 IIA; 3 IIIB; 4 IVB; 5 VB; 6 VIB; 7 VIIB; 8, 9, 10 VI; 11 IB; 12 IIB; 13 IIIA; 14 IVA; 15 VA; 16 VIA; 17 VIIA; 18 VIIIA

Period	Group	Atomic number	Symbol	Name	Electronegativity	Ion charges	Melting point (°C)	Boiling point (°C)	Density	Atomic radius (pm)	Electron configuration	Atomic mass
1	1	1	H	hydrogen	2.1		−259	−253	0.0899	37	$1s^1$	1.01
1	18	2	He	helium	—	X	−272	−269	0.179	50	$1s^2$	4.00
2	1	3	Li	lithium	1.0		181	1342	0.534	152	[He] $2s^1$	6.94
2	2	4	Be	beryllium	1.5		1278	2970	1.85	111	[He] $2s^2$	9.01
2	13	5	B	boron	2.0	X	2300	2550	2.34	88	[He] $2s^2 2p^1$	10.81
2	14	6	C	carbon	2.5	X	3550	4827	2.26	77	[He] $2s^2 2p^2$	12.01
2	15	7	N	nitrogen	3.0		−210	−196	1.25	70	[He] $2s^2 2p^3$	14.01
2	16	8	O	oxygen	3.5		−218	−183	1.43	66	[He] $2s^2 2p^4$	16.00
2	17	9	F	fluorine	4.0		−220	−188	1.70	64	[He] $2s^2 2p^5$	19.00
2	18	10	Ne	neon	—	X	−249	−246	0.900	62	[He] $2s^2 2p^6$	20.18
3	1	11	Na	sodium	0.9		97.8	883	0.971	186	[Ne] $3s^1$	22.99
3	2	12	Mg	magnesium	1.2		649	1107	1.74	160	[Ne] $3s^2$	24.31
3	13	13	Al	aluminum	1.5		660	2467	2.70	143	[Ne] $3s^2 3p^1$	26.98
3	14	14	Si	silicon	1.8	X	1410	2355	2.33	117	[Ne] $3s^2 3p^2$	28.09
3	15	15	P	phosphorus	2.1		44.1	280	1.82	110	[Ne] $3s^2 3p^3$	30.97
3	16	16	S	sulfur	2.5		113	445	2.07	104	[Ne] $3s^2 3p^4$	32.06
3	17	17	Cl	chlorine	3.0		−101	−34.6	3.21	99	[Ne] $3s^2 3p^5$	35.45
3	18	18	Ar	argon	—	X	−189	−186	1.78	95	[Ne] $3s^2 3p^6$	39.95
4	1	19	K	potassium	0.8		63.3	760	0.862	227	[Ar] $4s^1$	39.10
4	2	20	Ca	calcium	1.0		839	1484	1.54	197	[Ar] $4s^2$	40.08
4	3	21	Sc	scandium	1.3	3+	1541	2836	2.99	161	[Ar] $4s^2 3d^1$	44.96
4	4	22	Ti	titanium	1.5	4+, 3+	1660	3287	4.54	145	[Ar] $4s^2 3d^2$	47.88
4	5	23	V	vanadium	1.6	5+, 4+	1890	3380	5.96	132	[Ar] $4s^2 3d^3$	50.94
4	6	24	Cr	chromium	1.6	3+, 2+	1857	2672	7.20	125	[Ar] $4s^1 3d^5$	52.00
4	7	25	Mn	manganese	1.5	2+, 4+	1244	1962	7.20	124	[Ar] $4s^2 3d^5$	54.94
4	8	26	Fe	iron	1.8	3+, 2+	1535	2750	7.87	124	[Ar] $4s^2 3d^6$	55.85
4	9	27	Co	cobalt	1.8	2+, 3+	1495	2870	8.9	125	[Ar] $4s^2 3d^7$	58.93
4	10	28	Ni	nickel	1.8	2+, 3+	1455	2730	8.90	124	[Ar] $4s^2 3d^8$	58.69
4	11	29	Cu	copper	1.9	2+, 1+	1083	2567	8.92	128	[Ar] $4s^1 3d^{10}$	63.55
4	12	30	Zn	zinc	1.6	2+	420	907	7.14	133	[Ar] $4s^2 3d^{10}$	65.38
4	13	31	Ga	gallium	1.6	3+	29.8	2403	5.90	122	[Ar] $4s^2 3d^{10} 4p^1$	69.72
4	14	32	Ge	germanium	1.8	4+	937	2830	5.35	123	[Ar] $4s^2 3d^{10} 4p^2$	72.61
4	15	33	As	arsenic	2.0		817	613	5.73	121	[Ar] $4s^2 3d^{10} 4p^3$	74.92
4	16	34	Se	selenium	2.4		217	684	4.81	117	[Ar] $4s^2 3d^{10} 4p^4$	78.96
4	17	35	Br	bromine	2.8		−7.2	58.8	3.12	114	[Ar] $4s^2 3d^{10} 4p^5$	79.90
4	18	36	Kr	krypton	—	X	−157	−152	3.74	112	[Ar] $4s^2 3d^{10} 4p^6$	83.80
5	1	37	Rb	rubidium	0.8		38.9	686	1.53	248	[Kr] $5s^1$	85.47
5	2	38	Sr	strontium	1.0		769	1384	2.6	215	[Kr] $5s^2$	87.62
5	3	39	Y	yttrium	1.3	3+	1522	3338	4.47	181	[Kr] $5s^2 4d^1$	88.91
5	4	40	Zr	zirconium	1.4	4+	1852	4377	6.49	160	[Kr] $5s^2 4d^2$	91.22
5	5	41	Nb	niobium	1.6	5+, 3+	2468	5127	8.57	143	[Kr] $5s^1 4d^4$	92.91
5	6	42	Mo	molybdenum	1.8	6+	2610	5560	10.2	136	[Kr] $5s^1 4d^5$	95.94
5	7	43	Tc	technetium	1.9	7+	2172	4877	11.5	136	[Kr] $5s^2 4d^5$	98.91
5	8	44	Ru	ruthenium	2.2	3+, 4+	2310	3900	12.4	133	[Kr] $5s^1 4d^7$	101.07
5	9	45	Rh	rhodium	2.2	3+	1966	3727	12.4	135	[Kr] $5s^1 4d^8$	102.91
5	10	46	Pd	palladium	2.2	2+, 4+	1554	2970	12.0	138	[Kr] $4d^{10}$	106.42
5	11	47	Ag	silver	1.9	1+	962	2212	10.5	144	[Kr] $5s^1 4d^{10}$	107.87
5	12	48	Cd	cadmium	1.7	2+	321	765	8.64	149	[Kr] $5s^2 4d^{10}$	112.41
5	13	49	In	indium	1.7	3+	157	2080	7.30	163	[Kr] $5s^2 4d^{10} 5p^1$	114.82
5	14	50	Sn	tin	1.8	4+, 2+	232	2270	7.31	140	[Kr] $5s^2 4d^{10} 5p^2$	118.69
5	15	51	Sb	antimony	1.9	3+, 5+	631	1750	6.68	141	[Kr] $5s^2 4d^{10} 5p^3$	121.75
5	16	52	Te	tellurium	2.1		450	990	6.2	137	[Kr] $5s^2 4d^{10} 5p^4$	127.60
5	17	53	I	iodine	2.5		114	184	4.93	133	[Kr] $5s^2 4d^{10} 5p^5$	126.90
5	18	54	Xe	xenon	—	X	−112	−107	5.89	130	[Kr] $5s^2 4d^{10} 5p^6$	131.29
6	1	55	Cs	cesium	0.7		28.4	669	1.88	265	[Xe] $6s^1$	132.91
6	2	56	Ba	barium	0.9		725	1640	3.5	217	[Xe] $6s^2$	137.33
6	3	71	Lu	lutetium	1.2	3+	1663	3402	9.84	188	[Xe] $6s^2 4f^{14} 5d^1$	174.97
6	4	72	Hf	hafnium	1.3	4+	2227	4602	13.3	156	[Xe] $6s^2 4f^{14} 5d^2$	178.49
6	5	73	Ta	tantalum	1.5	5+	2996	5425	16.6	143	[Xe] $6s^2 4f^{14} 5d^3$	180.95
6	6	74	W	tungsten	1.7	6+	3410	5660	19.4	137	[Xe] $6s^2 4f^{14} 5d^4$	183.85
6	7	75	Re	rhenium	1.9	7+	3180	5627	21.0	137	[Xe] $6s^2 4f^{14} 5d^5$	186.21
6	8	76	Os	osmium	2.2	4+	2700	5300	22.5	134	[Xe] $6s^2 4f^{14} 5d^6$	190.2
6	9	77	Ir	iridium	2.2	4+	2410	4130	22.4	136	[Xe] $6s^2 4f^{14} 5d^7$	192.22
6	10	78	Pt	platinum	2.2	4+, 2+	1772	3827	21.5	138	[Xe] $6s^1 4f^{14} 5d^9$	195.08
6	11	79	Au	gold	2.4	3+, 1+	1064	2808	19.3	144	[Xe] $6s^1 4f^{14} 5d^{10}$	196.97
6	12	80	Hg	mercury	1.9	2+, 1+	−39.0	357	13.5	160	[Xe] $6s^2 4f^{14} 5d^{10}$	200.59
6	13	81	Tl	thallium	1.8	1+, 3+	304	1457	11.85	170	[Xe] $6s^2 4f^{14} 5d^{10} 6p^1$	204.38
6	14	82	Pb	lead	1.8	2+, 4+	328	1740	11.3	175	[Xe] $6s^2 4f^{14} 5d^{10} 6p^2$	207.20
6	15	83	Bi	bismuth	1.9	3+, 5+	271	1560	9.80	155	[Xe] $6s^2 4f^{14} 5d^{10} 6p^3$	209.98
6	16	84	Po	polonium	2.0	2+, 4+	254	962	9.40	167	[Xe] $6s^2 4f^{14} 5d^{10} 6p^4$	(209)
6	17	85	At	astatine	2.2		302	337	—	142	[Xe] $6s^2 4f^{14} 5d^{10} 6p^5$	(210)
6	18	86	Rn	radon	—	X	−71	−61.8	9.73	140	[Xe] $6s^2 4f^{14} 5d^{10} 6p^6$	(222)
7	1	87	Fr	francium	0.7		27	677	—	—	[Rn] $7s^1$	(223)
7	2	88	Ra	radium	0.9		700	1140	5	215	[Rn] $7s^2$	226.03
7	3	103	Lr	lawrencium	—	3+	1627	—	—	—	[Rn] $7s^2 5f^{14} 6d^1$	(260)
7	4	104	Rf	rutherfordium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^2$	(261)
7	5	105	Db	dubnium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^3$	(262)
7	6	106	Sg	seaborgium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^4$	(266)
7	7	107	Bh	borium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^5$	(264)
7	8	108	Hs	hassium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^6$	(269)
7	9	109	Mt	meitnerium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^7$	(278)
7	10	110	Ds	darmstadtium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^8$	(281)
7	11	111	Rg	roentgenium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^9$	(282)
7	12	112	Cn	copernicium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10}$	(285)
7	13	113	Nh	nihonium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10} 7p^1$	(286)
7	14	114	Fl	flerovium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10} 7p^2$	(289)
7	15	115	Mc	moscovium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10} 7p^3$	(290)
7	16	116	Lv	livermorium			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10} 7p^4$	(293)
7	17	117	Ts	tennessine			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10} 7p^5$	(294)
7	18	118	Og	oganesson			—	—	—	—	[Rn] $7s^2 5f^{14} 6d^{10} 7p^6$	(294)
6		57	La	lanthanum	1.1	3+, 2+	918	3464	6.15	195	[Xe] $6s^2 5d^1$	138.90
6		58	Ce	cerium	1.1	3+	798	3443	6.69	185	[Xe] $6s^2 4f^1 5d^1$	140.12
6		59	Pr	praseodymium	1.1	3+	931	3520	6.64	185	[Xe] $6s^2 4f^3$	140.91
6		60	Nd	neodymium	1.2	3+	1021	3074	7.01	185	[Xe] $6s^2 4f^4$	144.24
6		61	Pm	promethium	—	3+	1042	3000	7.26	185	[Xe] $6s^2 4f^5$	(145)
6		62	Sm	samarium	1.2	3+, 2+	1074	1794	7.52	185	[Xe] $6s^2 4f^6$	150.36
6		63	Eu	europium	—	3+, 2+	822	1527	5.24	185	[Xe] $6s^2 4f^7$	151.96
6		64	Gd	gadolinium	1.1	3+	1313	3273	7.90	180	[Xe] $6s^2 4f^7 5d^1$	157.25
6		65	Tb	terbium	1.2	3+	1356	3230	8.23	175	[Xe] $6s^2 4f^9$	158.92
6		66	Dy	dysprosium	—	3+	1412	2567	8.55	175	[Xe] $6s^2 4f^{10}$	162.50
6		67	Ho	holmium	1.2	3+	1474	2700	8.80	175	[Xe] $6s^2 4f^{11}$	164.93
6		68	Er	erbium	1.2	3+	1529	2868	9.07	175	[Xe] $6s^2 4f^{12}$	167.26
6		69	Tm	thulium	1.2	3+	1545	1950	9.32	175	[Xe] $6s^2 4f^{13}$	168.93
6		70	Yb	ytterbium	1.1	3+, 2+	819	1196	6.97	175	[Xe] $6s^2 4f^{14}$	173.04
7		89	Ac	actinium	1.1	3+, 2+	1050	3200	10.1	195	[Rn] $7s^2 6d^1$	227.03
7		90	Th	thorium	1.3	4+	1750	4790	11.7	180	[Rn] $7s^2 6d^2$	232.04
7		91	Pa	protactinium	1.5	5+, 4+	1600	—	15.4	180	[Rn] $7s^2 5f^2 6d^1$	231.04
7		92	U	uranium	1.7	6+, 4+	1132	3818	19.1	175	[Rn] $7s^2 5f^3 6d^1$	238.03
7		93	Np	neptunium	1.3	5+	630	3902	20.5	175	[Rn] $7s^2 5f^4 6d^1$	(237)
7		94	Pu	plutonium	1.3	4+, 6+	641	3232	19.8	175	[Rn] $7s^2 5f^6$	(244)
7		95	Am	americium	1.3	3+, 4+	994	2607	13.7	175	[Rn] $7s^2 5f^7$	(243)
7		96	Cm	curium	—	3+	1340	3110	13.5	—	[Rn] $7s^2 5f^7 6d^1$	(247)
7		97	Bk	berkelium	—	3+, 4+	986	—	14	—	[Rn] $7s^2 5f^9$	(247)
7		98	Cf	californium	—	3+	900	—	—	—	[Rn] $7s^2 5f^{10}$	(251)
7		99	Es	einsteinium	—	3+	860	—	—	—	[Rn] $7s^2 5f^{11}$	(252)
7		100	Fm	fermium	—	3+	1527	—	—	—	[Rn] $7s^2 5f^{12}$	(257)
7		101	Md	mendelevium	—	2+, 3+	1021	3074	—	—	[Rn] $7s^2 5f^{13}$	(258)
7		102	No	nobelium	—	2+, 3+	863	—	—	—	[Rn] $7s^2 5f^{14}$	(259)

Reference

Common Polyatomic Ions

Ion	Name	Ion	Name
$C_2H_3O_2^-$	acetate	CO_3^{2-}	carbonate
ClO_3^-	chlorate*	CrO_4^{2-}	chromate
ClO_2^-	chlorite *	$Cr_2O_7^{2-}$	dichromate
CN^-	cyanide	HPO_4^{2-}	hydrogen phosphate
$H_2PO_4^-$	dihydrogen phosphate	$C_2O_4^{2-}$	oxalate
HCO_3^-	hydrogen carbonate (bicarbonate)	O_2^{2-}	peroxide
HSO_4^-	hydrogen sulfate (bisulfate)	SiO_3^{2-}	silicate
HS^-	hydrogen sulfide (bisulfide)	SO_4^{2-}	sulfate
HSO_3^-	hydrogen sulfite (bisulfite)	SO_3^{2-}	sulfite
ClO^-, OCl^-	hypochlorite *	$S_2O_3^{2-}$	thiosulfate
OH^-	hydroxide	BO_3^{3-}	borate
NO_2^-	nitrite	PO_4^{3-}	phosphate
NO_3^-	nitrate	$P_3O_{10}^{5-}$	tripolyphosphate
ClO_4^-	perchlorate*	NH_4^+	ammonium
MnO_4^-	permanganate	H_3O^+	hydronium
SCN^-	thiocyanate	Hg_2^{2+}	mercury(I)

*There are also corresponding ions containing Br and I instead of Cl.

Ion Colours

Ion	Solution colour
Groups 1, 2, 17	colourless
$Cr^{2+}_{(aq)}$	blue
$Cr^{3+}_{(aq)}$	green
$Co^{2+}_{(aq)}$	pink
$Cu^{+}_{(aq)}$	green
$Cu^{2+}_{(aq)}$	blue
$Fe^{2+}_{(aq)}$	pale green
$Fe^{3+}_{(aq)}$	yellow-brown
$Mn^{2+}_{(aq)}$	pale pink
$Ni^{2+}_{(aq)}$	green
$CrO_{4(aq)}^{2-}$	yellow
$Cr_2O_{7(aq)}^{2-}$	orange
$MnO_{4(aq)}^{-}$	purple

Ion	Flame
Li^+	bright red
Na^+	yellow
K^+	violet
Ca^{2+}	yellow-red
Sr^{2+}	bright red
Ba^{2+}	yellow-green
Cu^{2+}	blue (halides) green (others)
Pb^{2+}	light blue-grey
Zn^{2+}	whitish green

Defined (Exact) Quantities

1 mL*	=	1 cm^{3*}
1 kL†	=	1 $m^{3†}$
1000 kg	=	1 t
1 Mg	=	1 t
1 atm	=	101.325 kPa
0°C	=	273.15 K
STP	=	0°C and 101.325 kPa
SATP	=	25°C and 100 kPa

*† assume that these are equivalent

MEASURED (UNCERTAIN) QUANTITIES

N_A	=	6.02×10^{23}/mol
R	=	8.31 kPa • L/(mol • K)
F	=	9.65×10^4 C/mol
K_w	=	1.0×10^{-14} $(mol/L)^2$
$H_{fusion\ H_2O}$	=	+6.03 kJ/mol
$H_{vap\ H_2O}$	=	+40.8 kJ/mol
c	=	3.00×10^8 m/s
V_{STP}	=	22.4 L/mol
V_{SATP}	=	24.8 L/mol
d_{H_2O}	=	1.00 g/mL

SI PREFIXES

Prefix	Symbol	Factor
giga	G	10^9
mega	M	10^6
kilo	k	10^3
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

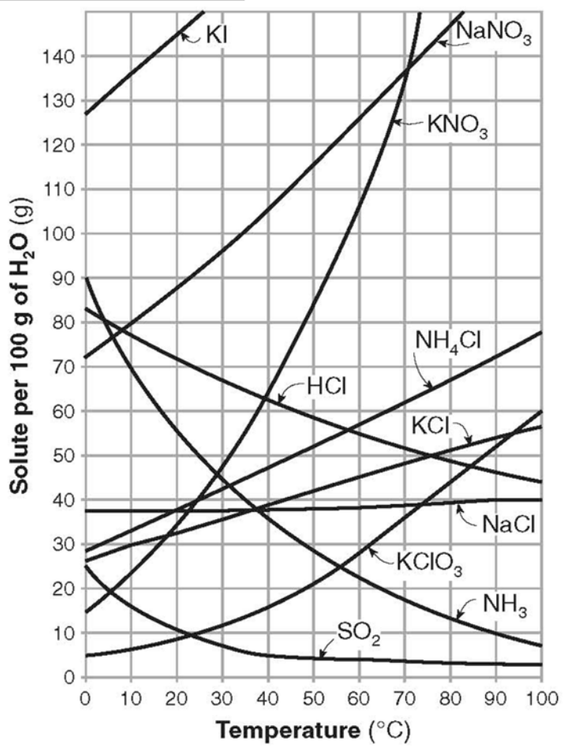
Common Acid–Base Indicators

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.2–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8.2–10	colorless to pink
litmus	5.5–8.2	red to blue
bromcresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

Solubility of Ionic Compounds at SATP

		Anions						
		Cl^-, Br^-, I^-	S^{2-}	OH^-	SO_4^{2-}	CO_3^{2-}, PO_4^{3-}, SO_3^{2-}	$C_2H_3O_2^-$	NO_3^-
Cations	High solubility (aq) ≥0.1 mol/L (at SATP)	most	Group 1, NH_4^+ Group 2	Group 1, NH_4^+ Sr^{2+}, Ba^{2+}, Tl^+	most	Group 1, NH_4^+	most	all
		All Group 1 compounds, including acids, and all ammonium compounds are assumed to have high solubility in water.						
	Low Solubility (s) <0.1 mol/L (at SATP)	Ag^+, Pb^{2+}, Tl^+, Hg_2^{2+} (Hg^+), Cu^+	most	most	Ag^+, Pb^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Ra^{2+}	most	Ag^+	none

Solubility Curves



SPECIFIC HEAT CAPACITIES OF PURE SUBSTANCES

Substance	Specific Heat Capacity* (J/(g • °C))	Substance	Specific Heat Capacity* (J/(g • °C))
aluminum	0.900	nickel	0.444
calcium	0.653	potassium	0.753
copper	0.385	silver	0.237
gold	0.129	sodium	1.226
hydrogen	14.267	sulfur	0.732
iron	0.444	tin	0.213
lead	0.159	zinc	0.388
lithium	3.556	ice, $H_2O_{(s)}$	2.01
magnesium	1.017	water, $H_2O_{(l)}$	4.19
mercury	0.138	steam, $H_2O_{(g)}$	2.01

*Elements at SATP state.

Concentrated Reagents*

Reagent	Formula	Molar mass (g/mol)	Concentration (mol/L)	Concentration (mass %)
acetic acid	$HC_2H_3O_{2(aq)}$	60.05	17.45	99.8
carbonic acid	$H_2CO_{3(aq)}$	62.03	0.039	0.17
formic acid	$HCOOH_{(aq)}$	46.03	23.6	90.5
hydrobromic acid	$HBr_{(aq)}$	80.91	8.84	48.0
hydrochloric acid	$HCl_{(aq)}$	36.46	12.1	37.2
hydrofluoric acid	$HF_{(aq)}$	20.01	28.9	49.0
nitric acid	$HNO_{3(aq)}$	63.02	15.9	70.4
perchloric acid	$HClO_{4(aq)}$	100.46	11.7	70.5
phosphoric acid	$H_3PO_{4(aq)}$	98.00	14.8	85.5
sulfurous acid	$H_2SO_{3(aq)}$	82.08	0.73	6.0
sulfuric acid	$H_2SO_{4(aq)}$	98.08	18.0	96.0
ammonia	$NH_{3(aq)}$	17.04	14.8	28.0
potassium hydroxide	$KOH_{(aq)}$	56.11	11.7	45.0
sodium hydroxide	$NaOH_{(aq)}$	40.00	19.4	50.5

*Typical concentrations of commercial concentrated reagents