



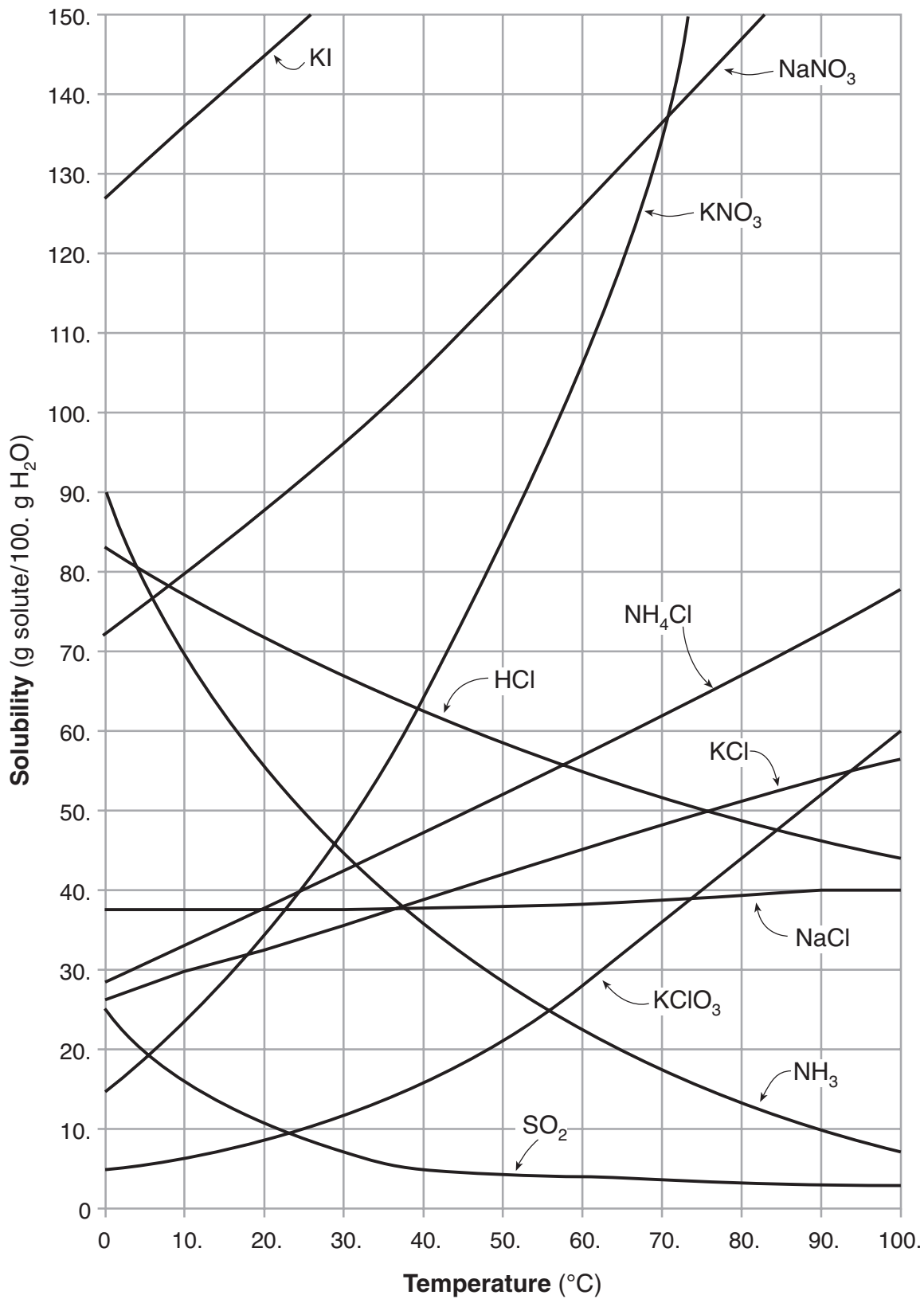
# Reference Tables for Physical Setting/CHEMISTRY

## 2011 Edition

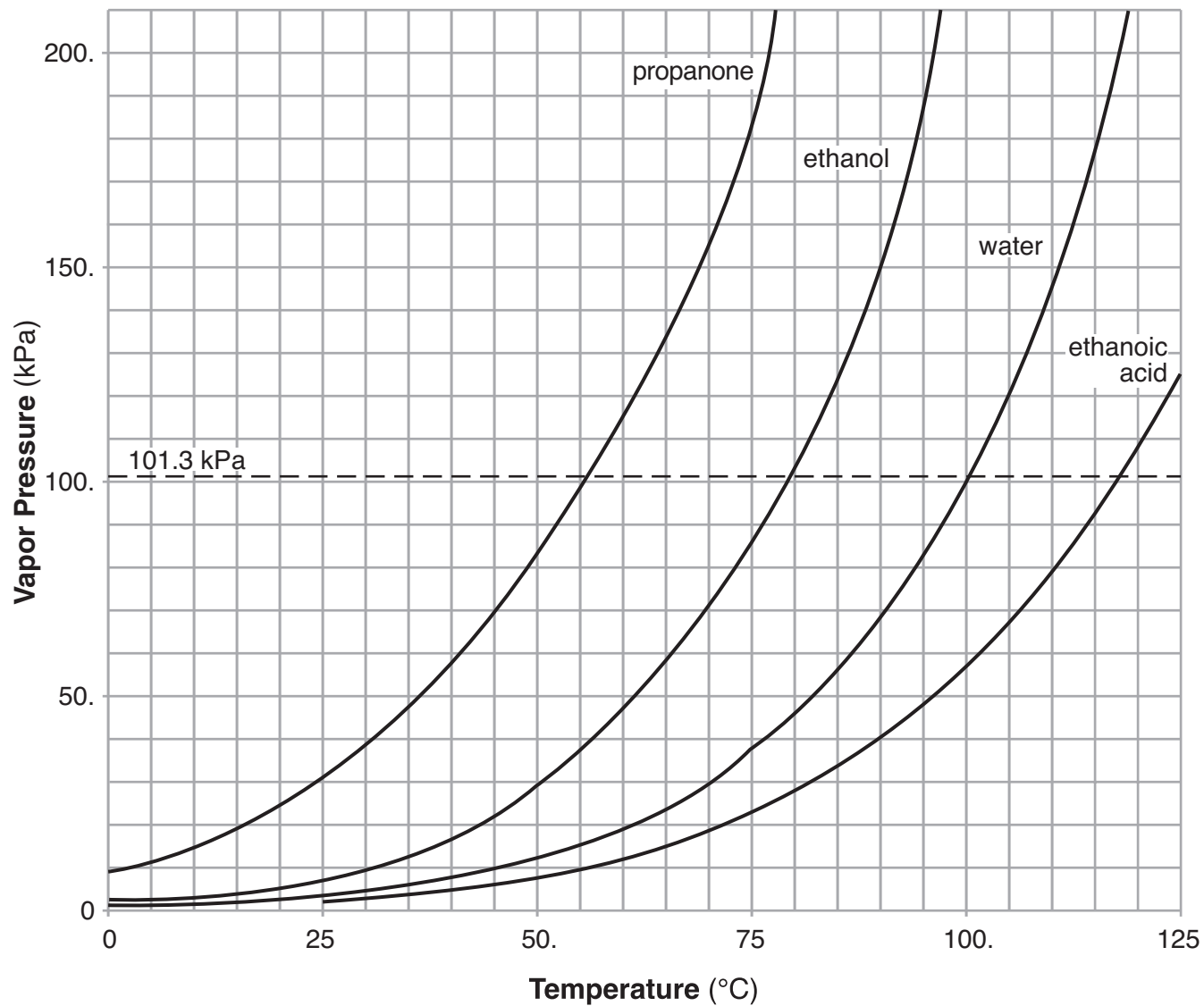
**Table B**  
**Physical Constants for Water**

Heat of Fusion	334 J/g
Heat of Vaporization	2260 J/g
Specific Heat Capacity of $\text{H}_2\text{O}(\ell)$	4.18 J/g•K

**Table G**  
**Solubility Curves at Standard Pressure**



**Table H**  
**Vapor Pressure of Four Liquids**



**Table I**  
**Heats of Reaction at 101.3 kPa and 298 K**

Reaction	$\Delta H$ (kJ)*
$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$	-890.4
$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \longrightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\ell)$	-2219.2
$2\text{C}_8\text{H}_{18}(\ell) + 25\text{O}_2(\text{g}) \longrightarrow 16\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\ell)$	-10943
$2\text{CH}_3\text{OH}(\ell) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\ell)$	-1452
$\text{C}_2\text{H}_5\text{OH}(\ell) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\ell)$	-1367
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \longrightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\ell)$	-2804
$2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g})$	-566.0
$\text{C}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g})$	-393.5
$4\text{Al}(\text{s}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{Al}_2\text{O}_3(\text{s})$	-3351
$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{NO}(\text{g})$	+182.6
$\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow 2\text{NO}_2(\text{g})$	+66.4
$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{g})$	-483.6
$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\ell)$	-571.6
$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow 2\text{NH}_3(\text{g})$	-91.8
$2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_6(\text{g})$	-84.0
$2\text{C}(\text{s}) + 2\text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_4(\text{g})$	+52.4
$2\text{C}(\text{s}) + \text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_2(\text{g})$	+227.4
$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$	+53.0
$\text{KNO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	+34.89
$\text{NaOH}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$	-44.51
$\text{NH}_4\text{Cl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+14.78
$\text{NH}_4\text{NO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	+25.69
$\text{NaCl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+3.88
$\text{LiBr}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Li}^+(\text{aq}) + \text{Br}^-(\text{aq})$	-48.83
$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \longrightarrow \text{H}_2\text{O}(\ell)$	-55.8

\*The  $\Delta H$  values are based on molar quantities represented in the equations.

**Table J**  
**Activity Series\*\***

Most Active	Metals	Nonmetals	Most Active
↓	Li	F <sub>2</sub>	↓
	Rb	Cl <sub>2</sub>	
	K	Br <sub>2</sub>	
	Cs	I <sub>2</sub>	
	Ba		
	Sr		
	Ca		
	Na		
	Mg		
	Al		
	Ti		
	Mn		
	Zn		
	Cr		
	Fe		
	Co		
	Ni		
	Sn		
	Pb		
	H <sub>2</sub>		
Cu			
Ag			
Au		Least Active	
Least Active			

**Table N**  
**Selected Radioisotopes**

Nuclide	Half-Life	Decay Mode
$^{198}\text{Au}$	2.695 d	$\beta^-$
$^{14}\text{C}$	5715 y	$\beta^-$
$^{37}\text{Ca}$	182 ms	$\beta^+$
$^{60}\text{Co}$	5.271 y	$\beta^-$
$^{137}\text{Cs}$	30.2 y	$\beta^-$
$^{53}\text{Fe}$	8.51 min	$\beta^+$
$^{220}\text{Fr}$	27.4 s	$\alpha$
$^3\text{H}$	12.31 y	$\beta^-$
$^{131}\text{I}$	8.021 d	$\beta^-$
$^{37}\text{K}$	1.23 s	$\beta^+$
$^{42}\text{K}$	12.36 h	$\beta^-$
$^{85}\text{Kr}$	10.73 y	$\beta^-$
$^{16}\text{N}$	7.13 s	$\beta^-$
$^{19}\text{Ne}$	17.22 s	$\beta^+$
$^{32}\text{P}$	14.28 d	$\beta^-$
$^{239}\text{Pu}$	$2.410 \times 10^4$ y	$\alpha$
$^{226}\text{Ra}$	1599 y	$\alpha$
$^{222}\text{Rn}$	3.823 d	$\alpha$
$^{90}\text{Sr}$	29.1 y	$\beta^-$
$^{99}\text{Tc}$	$2.13 \times 10^5$ y	$\beta^-$
$^{232}\text{Th}$	$1.40 \times 10^{10}$ y	$\alpha$
$^{233}\text{U}$	$1.592 \times 10^5$ y	$\alpha$
$^{235}\text{U}$	$7.04 \times 10^8$ y	$\alpha$
$^{238}\text{U}$	$4.47 \times 10^9$ y	$\alpha$

Source: *CRC Handbook of Chemistry and Physics*, 91<sup>st</sup> ed., 2010–2011, CRC Press

**Table M**  
**Common Acid–Base Indicators**

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.1–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8–9	colorless to pink
litmus	4.5–8.3	red to blue
bromcresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

Source: *The Merck Index*, 14<sup>th</sup> ed., 2006, Merck Publishing Group

1 H 1.0079																2 He 4.0026	
3 Li 6.941	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.989	12 Mg 24.305											13 Al 26.981	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.88	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 59.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.905	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 * La 138.90	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 # Ac 227.03	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Uun (269)	111 Uuu (272)	112 Uub (277)						

* Lanthanides	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
# Actinides	90 Th 232.03	91 Pa 231.03	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (257)	102 No (255)	103 Lr (256)

**Table S**  
**Properties of Selected Elements**

Atomic Number	Symbol	Name	First Ionization Energy (kJ/mol)	Electro-negativity	Melting Point (K)	Boiling* Point (K)	Density** (g/cm <sup>3</sup> )	Atomic Radius (pm)
1	H		1312	2.2	14	20.	0.000082	32
2	He		2372	—	—	4	0.000164	37
3	Li		520.	1.0	454	1615	0.534	130.
4	Be		900.	1.6	1560.	2744	1.85	99
5	B		801	2.0	2348	4273	2.34	84
6	C		1086	2.6	—	—	—	75
7	N		1402	3.0	63	77	0.001145	71
8	O		1314	3.4	54	90.	0.001308	64
9	F		1681	4.0	53	85	0.001553	60.
10	Ne		2081	—	24	27	0.000825	62
11	Na		496	0.9	371	1156	0.97	160.
12	Mg		738	1.3	923	1363	1.74	140.
13	Al		578	1.6	933	2792	2.70	124
14	Si		787	1.9	1687	3538	2.3296	114
15	P			2.2	317	554	1.823	109
16	S			2.6	388	718	2.00	104
17	Cl		1251	3.2	172	239	0.002898	100.
18	Ar		1521	—	84	87	0.001633	101
19	K		419	0.8	337	1032	0.89	200.
20	Ca			1.0	1115	1757	1.54	174
21	Sc		633	1.4	1814	3109	2.99	159
22	Ti		659	1.5	1941	3560.	4.506	148
23	V		651	1.6	2183	3680.	6.0	144
24	Cr		653	1.7	2180.	2944	7.15	130.
25	Mn		717	1.6	1519	2334	7.3	129
26	Fe		762	1.8	1811	3134	7.87	124
27	Co		760.	1.9	1768	3200.	8.86	118
28	Ni		737	1.9	1728	3186	8.90	117
29	Cu		745	1.9	1358	2835	8.96	122
30	Zn		906	1.7	693	1180.	7.134	120.
31	Ga		579	1.8	303	2477	5.91	123
32	Ge		762	2.0	1211	3106	5.3234	120.
33	As		944	2.2	1090.	—	5.75	120.
34	Se		941	2.6	494	958	4.809	118
35	Br		1140.	3.0	266	332	3.1028	117
36	Kr		1351	—	116	120.	0.003425	116
37	Rb		403	0.8	312	961	1.53	215
38	Sr		549	1.0	1050.	1655	2.64	190.
39	Y		600.	1.2	1795	3618	4.47	176
40	Zr		640.	1.3	2128	4682	6.52	164

Atomic Number	Symbol	Name	First Ionization Energy (kJ/mol)	Electro-negativity	Melting Point (K)	Boiling Point (K)	Density** (g/cm <sup>3</sup> )	Atomic Radius (pm)
41	Nb		652	1.6	2750.	5017	8.57	156
42	Mo		684	2.2	2896	4912	10.2	146
43	Tc		702	2.1	2430.	4538	11	138
44	Ru		710.	2.2	2606	4423	12.1	136
45	Rh		720.	2.3	2237	3968	12.4	134
46	Pd		804	2.2	1828	3236	12.0	130.
47	Ag		731	1.9	1235	2435	10.5	136
48	Cd		868	1.7	594	1040.	8.69	140.
49	In		558	1.8	430.	2345	7.31	142
50	Sn		709	2.0	505	2875	7.287	140.
51	Sb		831	2.1	904	1860.	6.68	140.
52	Te		869	2.1	723	1261	6.232	137
53	I		1008	2.7	387	457	4.933	136
54	Xe		1170.	2.6	161	165	0.005366	136
55	Cs		376	0.8	302	944	1.873	238
56	Ba		503	0.9	1000.	2170.	3.62	206
57	La		538	1.1	1193	3737	6.15	194
<b>Elements 58–71 have been omitted.</b>								
72	Hf		659	1.3	2506	4876	13.3	164
73	Ta		728	1.5	3290.	5731	16.4	158
74	W		759	1.7	3695	5828	19.3	150.
75	Re		756	1.9	3458	5869	20.8	141
76	Os		814	2.2	3306	5285	22.587	136
77	Ir		865	2.2	2719	4701	22.562	132
78	Pt		864	2.2	2041	4098	21.5	130.
79	Au		890.	2.4	1337	3129	19.3	130.
80	Hg		1007	1.9	234	630.	13.5336	132
81	Tl		589	1.8	577	1746	11.8	144
82	Pb		716	1.8	600.	2022	11.3	145
83	Bi		703	1.9	544	1837	9.79	150.
84	Po		812	2.0	527	1235	9.20	142
85	At		—	2.2	575	—	—	148
86	Rn		1037	—	202	211	0.009074	146
87	Fr		393	0.7	300.	—	—	242
88	Ra		509	0.9	969	—	5	211
89	Ac		499	1.1	1323	3471	10.	201
<b>Elements 90 and above have been omitted.</b>								

\* boiling point at standard pressure

\*\* density of solids and liquids at room temperature and density of gases at 298 K and 101.3 kPa

— no data available

Source: *CRC Handbook for Chemistry and Physics*, 91<sup>st</sup> ed., 2010–2011, CRC Press