Declaration of Rachel J. Watters on Authentication of Publication

I, Rachel J. Watters, am a librarian, and the Director of Wisconsin TechSearch ("WTS"), located at 215 North Randall Avenue, Madison Wisconsin, 53706. WTS is an interlibrary loan department at the University of Wisconsin-Madison. I have worked as a librarian at the University of Wisconsin library system since 1998. I have been employed at WTS since 2002, first as a librarian and, beginning in 2011, as the Director. Through the course of my employment, I have become well informed about the operations of the University of Wisconsin library system, which follows standard library practices.

This Declaration relates to the dates of receipt and availability of the following:

CRC Handbook of Chemistry and Physics, 71st edition (1990-1991), pages 12-103 through 12-108.

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Exhibit A to this Declaration is a true and accurate copy of the title page, library date stamp, and pages 12-103 through 12-108 of *CRC Handbook of Chemistry and Physics*, 71st edition (1990-1991), from the University of Wisconsin-Madison Library collection. The date stamp on the back cover page indicates that the *CRC Handbook of*

Chemistry and Physics, 71st edition (1990-1991), was received by Memorial Library, University of Wisconsin, on July 16, 1990.

Based on the information in Exhibit A, it is clear that the volume was received by the library on or before July 16, 1990, catalogued and available to library patrons within a few days or at most 2 to 3 weeks after July 16, 1990.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: September 16, 2016

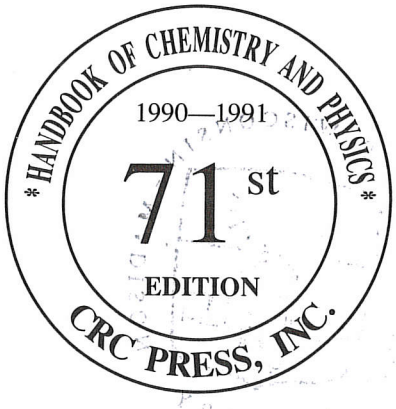
Rachel J. Watters
Director

Wisconsin TechSearch
Wendt Commons Library
215 North Randall Avenue
Madison, Wisconsin 53706

EXHIBIT A

CRC Handbook of Chemistry and Physics

A Ready-Reference Book of Chemical and Physical Data



Editor-in-Chief

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ATOMIC WEIGHTS, MELTING AND BOILING POINTS OF THE ELEMENTS (CONTINUED)

Name	Symbol	Atomic number	Atomic weight	Footnotes	Melting point (°C)	Boiling point (°C)
Radium	Ra	88	226.025	g, L	700	1140
Radon	Rn	86	(222)		–71	–61.8
Rhenium	Re	75	186.207(1)		3180	5627 (est.)
Rhodium	Rh	45	102.90550(3)		1965 ± 3	3727 ± 100
Rubidium	Rb	37	85.4678(3)	g	38.89	686
Ruthenium	Ru	44	101.07(2)	g	2310	3900
Samarium	Sm	62	150.36(3)	g	1074	1794
Scandium	Sc	21	44.955910(9)		1541	2836
Selenium	Se	34	78.96(3)		217	684.9 ± 1.0
Silicon	Si	14	28.0855(3)		1410	2355
Silver (Argentum)	Ag	47	107.8682(2)	g	961.93	2212
Sodium (Natrium)	Na	11	22.989768(6)		97.81 ± 0.03	882.9
Strontium	Sr	38	87.62(1)	g	769	1384
Sulfur	S	16	32.066(6)	r	112.8	444.674
Tantalum	Ta	73	180.9479(1)		2996	5425 ± 100
Technetium	Tc	43	(98)		2172	4877
Tellurium	Te	52	127.60(3)	g	449.5 ± 0.3	989.8 ± 3.8
Terbium	Tb	65	158.92534(3)		1356	3230
Thallium	Tl	81	204.3833(2)		303.5	1457 ± 10
Thorium	Th	90	232.0381(1)	g, L	1750	3800 (approx.)
Thullium	Tm	69	168.93421(3)		1545	1950
Tin (Stannum)	Sn	50	118.710(7)		231.9681	2270
Titanium	Ti	22	47.88(3)		1660 ± 10	3287
Tungsten (Wolfram)	W	74	183.85(3)		3410 ± 20	5660
Unnihexium	(Unh)	106	(263)			
Unnilpentium	(Unp)	105	(262)			
Unnilquadium	(Unq)	104	(261)			
Unnilseptium	(Uns)	107	(262)			
Uranium	U	92	238.0289(1)	g, m	1132 ± 0.8	3818
Vanadium	V	23	50.9415(1)		1890 ± 10	3380
Wolfram (see Tungsten)						
Xenon	Xe	54	131.29(2)	g, m	–111.9	–107.1 ± 3
Ytterbium	Yb	70	173.04(3)		819	1196
Yttrium	Y	39	88.90585(2)		1552	5338
Zinc	Zn	30	65.39(2)		419.58	907
Zirconium	Zr	40	91.224(2)	g	1852 ± 2	4377

g geological exceptional specimens are known in which the element has an isotopic composition outside the limits for normal material. The difference between the atomic weight of the element in such specimens and that given in the Table may exceed considerably the implied uncertainty.

m modified isotopic compositions may be found in commercially available material because it has been subjected to an undisclosed or inadvertent isotopic separation. Substantial deviations in atomic weight of the element from that given in the Table can occur.

r range in isotopic composition of normal terristrial material prevents a more precise atomic weight being given; the tabulated A_r (E) value should be applicable to any normal material.

t Triple point; (graphite-liquid-gas), 3627 ± 50°C at a pressure of 10.1 MPa and (graphite-diamond-liquid), 3830 to 3930°C at a pressure of 12 to 13 GPa.

L Longest half-life isotope mass is chosen for the tabulated Ar (E) value.

EXHIBIT A

SPECIFIC HEAT AND ENTHALPY OF SOME SOLIDS AT LOW TEMPERATURES

R. J. Corruccini and J. J. Gniewek

For a more extensive listing of data one is referred to N.B.S. Monograph 21 (1960)

Joules/g × 453.6 = joules/lb × 0.239 = cal/g × 0.4299 = Btu/lb

Metals

	Aluminum		Beryllium		Bismuth		Cadmium	
T	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.00010[a]	—	—	—	—	—	—	—
1	0.000051	0.000025	0.000025	0.000013	0.00000598	0.00000158	0.000008	0.000003
2	0.000108	0.000105	0.000051	0.000051	0.0000461	0.0000233	0.000033	0.000022
3	0.000176	0.000246	0.000079	0.000116	0.000170	0.000123	0.000090	0.000082
4	0.000261	0.000463	0.000109	0.000209	0.000493	0.000432	0.00021	0.00022
6	0.00050	0.00121	0.000180	0.000496	0.00214	0.00288	0.00130	0.0015
8	0.00088	0.0026	0.000271	0.000944	0.00547	0.0102	0.0043	0.0070
10	0.0014	0.0049	0.000389	0.00160	0.0104	0.0259	0.0080	0.109
15	0.0040	0.018	0.000842	0.00457	0.0238	0.111	0.025	0.102
20	0.0089	0.048	0.00161	0.0105	0.0363	0.262	0.046	0.28
25	0.0175	0.112	0.00279	0.0212	0.0477	0.472	0.066	0.56
30	0.0315	0.232	0.00450	0.0392	0.0572	0.734	0.086	0.94
35	0.0515	0.436	—	—	—	—	—	—
40	0.0775	0.755	0.00996	0.109	0.0727	1.38	0.117	1.96
50	0.142	1.85	0.0192	0.253	0.0846	2.17	0.141	3.26
60	0.214	3.64	0.0341	0.523	0.0935	3.06	0.159	4.76
70	0.287	6.15	0.0562	0.971	0.100	4.03	0.172	6.43
80	0.357	9.37	0.0906	1.69	0.105	5.05	0.182	8.20
90	0.422	13.25	0.139	2.82	0.108	6.12	0.190	10.1
100	0.481	17.76	0.199	4.51	0.111	7.21	0.196	12.0

	Chromium		Copper		Germanium[b]		Gold	
T	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$g^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.0000285	0.0000142	0.000012	0.000006	0.000000528	0.000000132	0.000006	0.000002
2	0.000058	0.0000573	0.000028	0.000025	0.00000423	0.00000211	0.000025	0.000016
3	0.000089	0.000131	0.000053	0.000064	0.0000144	0.0000107	0.000070	0.000061
4	0.00014	0.000237	0.000091	0.00013	0.0000344	0.0000343	0.00016	0.00017
6	0.000206	0.000567	0.00023	0.00044	0.000125	0.000179	0.00050	0.00078
6	0.000206	0.000567	0.00023	0.00044	0.000125	0.000179	0.00050	0.00078
8	0.000312	0.00107	0.00047	0.00112	0.000335	0.000612	0.0012	0.0024
10	0.000451	0.00182	0.00086	0.0024	0.000813	0.00169	0.0022	0.0056
15	0.00102	0.00528	0.0027	0.0107	0.00445	0.0136	0.0074	0.028
20	0.00210	0.0128	0.0077	0.034	0.0125	0.0540	0.0159	0.086
25	0.00392	0.0274	0.016	0.090	0.0240	0.145	0.0263	0.191
30	0.00683	0.0532	0.027	0.195	0.0366	0.296	0.0371	0.349
40	0.0171	0.163	0.060	0.61	0.0617	0.786	0.0572	0.821
50	0.0358	0.421	0.099	1.40	0.0858	1.52	0.0726	1.47
60	0.0621	0.904	0.137	2.58	0.108	2.50	0.0842	2.25
70	0.093	1.68	0.173	4.13	0.131	3.70	0.0928	3.14
80	0.127	2.77	0.205	6.02	0.153	5.12	0.0992	4.10
90	0.161	4.21	0.232	8.22	0.173	6.74	0.1043	5.12
100	0.193	5.98	0.254	10.6	0.191	8.55	0.1083	6.18

	Indium		α-Iron[c]		γ-Iron[d]		Lead	
T	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.000029	0.000011	0.000090	0.000045	—	—	0.000026	0.000010
1	0.000019[a]	0.000006[a]	—	—	—	—	0.000012[a]	0.000003[a]
2	0.000138	0.000085	0.000183	0.000181	—	—	0.00012	0.00007
2	0.000141[a]	0.000073[a]	—	—	—	—	0.00009[a]	0.00005[a]
								0.00028
3	0.000410	0.000341	0.000279	0.000412	—	—	0.00033	0.00023[a]
3	0.000464[a]	0.000357[a]	—	—	—	—	0.00031[a]	
3.40[e]	0.000584	0.000537	—	—	—	—	—	—
3.40	0.000669[a]	0.000581[a]	—	—	—	—	—	—
4	0.00095	0.00099	0.000382	0.000742	—	—	0.0007	0.0008
4	—	—	—	—	—	—	0.0007[a]	0.0007[a]
5	—	—	—	—	—	—	0.0015	0.0018
5	—	—	—	—	—	—	0.0015[a]	0.0018[a]
6	0.00359	0.00520	0.000615	0.00173	—	—	0.0029	0.0039
6	—	—	—	—	—	—	0.0030[a]	0.0040[a]
7	—	—	—	—	—	—	0.0048	0.008

SPECIFIC HEAT AND ENTHALPY OF SOME SOLIDS AT LOW TEMPERATURES (continued)

T	Chromium		Copper		Germanium[b]		Gold	
	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$g^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
7	—	—	—	—	—	—	0.0050[a]	0.008[a]
8	0.00855	0.0170	0.00090	0.003233	—	—	0.0073	0.014
10	0.0155	0.0408	0.00124	0.00537	—	—	0.0137	0.034
15	0.036	0.170	0.00249	0.0145	—	—	0.0335	0.150
20	0.0608	0.413	0.0045	0.0316	0.007	0	0.0531	0.368
25	0.0857	0.778	0.0075	0.061	—	—	0.0681	0.672
30	0.108	1.265	0.0124	0.110	0.016	0.11	0.0796	1.042
40	0.141	2.52	0.029	0.31	0.041	0.39	0.0944	1.920
50	0.162	4.04	0.055	0.73	0.090	1.0^2	0.103	2.91
60	0.176	5.73	0.087	1.43	0.13^7	2.1^6	0.108	3.97
70	0.186	7.53	0.121	2.46	0.18^0	3.7^5	0.112	5.07
80	0.193	9.42	0.154	3.84	0.21^8	5.74^4	0.114	6.20
90	0.198	11.38	0.186	5.55	0.25^5	8.1^1	0.116	7.35
100	0.203	13.39	0.216	7.56	0.28^8	10^8	0.118	853

T	Molybdenum		Nickel		Palladium	
	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jgum[1]	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.0000229	0.0000105	0.000120	0.000060	0.000099	0.0000493
2	0.0000472	0.0000445	0.000242	0.000241	0.000203	0.000200
2	—	—	—	—	—	—
3	0.0000745	0.000105	0.000369	0.000546	0000318	0.000459
3	—	—	—	—	—	—
4	0.000106	0.000194	0.000503	0.00098	0.000447	0.000840
4	—	—	—	—	—	—
5	—	—	—	—	—	—
5	—	—	—	—	—	—
6	0.000191	0.000484	0.00082	0.00228	0.000891	0.00231
6	—	—	—	—	—	—
7	—	—	—	—	—	—
7	—	—	—	—	—	—
8	0.000317	0.000981	0.00119	0.00428	0.00141	0.00460
8	—	—	—	—	—	—
9	—	—	—	—	—	—
9	—	—	—	—	—	—
10	0.000498	0.00178	0.00162	0.0071	0.00210	0.00807
15	0.00131	0.00610	0.0031	0.0185	0.00471	0.0245
20	0.00287	0.0161	0.0058	0.041	0.00922	0.0586
25	0.00577	0.0374	0.0101	0.079	0.0160	0.120
30	0.00960	0.0729	0.0167	0.145	0.0258	0.223
40	0.0236	0.232	0.0381	0.413	0.0507	0.600
50	0.0410	0.554	0.0682	0.937	0.0777	1.24
60	0.0619	1.07	0.103	1.79	0.101	2.14
70	0.0838	1.80	0.139	3.00	0.122	3.26
80	0.104	2.74	0.173	4.56	0.139	4.56
90	0.123	3.88	0.204	6.45	0.154	6.03
100	0.139	5.20	0.232	8.63	0.167	7.63

T	Platinum		Rhodium		Silicon[1]		Silver	
	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.000035	0.0000175	0.000048	0.000024	0.000000263	0.0000000658	0.0000072	0.0000032
2	0.000074	0.000071	0.000097	0.000096	0.00000210	0.00000105	0.0000239	0.0000176
3	0.000122	0.000168	0.000147	0.000218	0.00000709	0.00000532	0.0000595	0.0000574
4	0.000186	0.000320	0.000201	0.000392	0.0000168	0.0000168	0.000124	0.000146
6	0.00037	0.00085	0.00032	0.00091	0.0000596	0.0000853	0.00039	0.00062
8	0.00067	0.00188	0.00047	0.00170	0.000140	0.000279	0.00091	0.00187
10	0.00112	0.00365	0.00065	0.00281	0.000275	0.000679	0.0018	0.00452
15	0.0033	0.0135	0.00135	0.00765	0.00109	0.00374	0.0064	0.0233
20	0.0074	0.0395	0.00271	0.0174	0.00337	0.0138	0.0155	0.076
25	0.0137	0.092	0.00561	0.0373	0.00849	0.0423	0.0287	0.185
30	0.0212	0.182	0.0106	0.0071	0.0171	0.105	0.0442	0.368
40	0.038	0.048	0.266	0.256	0.0440	0.400	0.078	0.979
50	0.055	0.95	0.0489	0.633	0.0785	1.00	0.108	1.91
60	0.068	1.56	0.9724	1.238	0.115	1.97	0.133	3.12
70	0.079	2.29	0.094	2.07	0.152	3.31	0.151	4.54
80	0.088	3.12	0.114	3.11	0.188	5.01	0.166	6.13
90	0.094	4.02	0.132	4.34	0.224	7.06	0.177	7.85
100	0.100	5.01	0.147	5.74	0.259	9.47	0.187	9.67

SPECIFIC HEAT AND ENTHALPY OF SOME SOLIDS AT LOW TEMPERATURES (continued)

T	Sodium[m]		Tantalum		Tin (white)		Titanium	
	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.000081	0.000035	0.000032	0.000016	0.0000170	0.0000079	0.000071	0.000035
1	—	—	0.0000063[a]	0.0000021[a]	0.0000041[a]	0.0000009[a]	—	—
2	0.000289	0.000204	0.000068	0.000065	0.000047	0.0000383	0.000146	0.000143
2	—	—	0.000054[a]	0.000026[a]	0.000048[a]	0.0000228[a]	—	—
3	0.00076	0.00070	0.000112	0.000155	0.000109	0.000113	0.000226	0.000329
3	—	—	0.000178[a]	0.000138[a]	0.000151[a]	0.000116[a]	—	—
3.72[n]	—	—	—	—	0.000198	0.000221	—	—
3.72	—	—	—	—	0.000285[a]	0.000270[a]	—	—
4	0.00160	0.00184	0.000171	0.000295	0.000245	0.000283	0.000317	0.000599
4	—	—	0.000352[a]	0.000400[a]	—	—	—	—
4.39[o]	—	—	0.000201	0.000368	—	—	—	—
4.39	—	—	0.000433[a]	0.000553[a]	—	—	—	—
5	0.00298	0.00408	—	—	0.00054	0.00065	—	—
6	0.0051	0.0081	0.000333	0.000776	0.00127	0.00151	0.00054	0.00145
8	0.0122	0.0247	0.000648	0.00173	0.0042	0.0068	0.00084	0.00281
10	0.0238	0.0602	0.00117	0.00352	0.0081	0.0190	0.00126	0.00489
12	0.0397	0.123	—	—	—	—	—	—
14	0.063	0.225	—	—	—	—	—	—
15	—	—	0.00360	0.0145	0.226	0.093	0.0033	0.0156
16	0.093	0.380	—	—	—	—	—	—
18	0.124	0.597	—	—	—	—	—	—
20	0.155	0.875	0.00823	0.0432	0.040	0.251	0.0070	0.040
25	0.259	1.90	0.0153	0.102	0.058	0.498	0.0134	0.090
30	0.364	3.45	0.0240	0.202	0.076	0.834	0.0245	0.182
40	0.544	8.03	0.0430	0.540	0.106	1.75	0.0571	0.581
50	0.695	14.2	0.0604	1.06	0.130	2.93	0.0992	1.358
60	0.793	21.7	0.0754	1.74	0.148	4.33	0.1467	2.592
70	0.86	30.0	00.189	4.27	0.162	5.88	0.189	4.27
80	0.91	38.9	0.0976	3.49	0.173	7.55	0.230	6.37
90	0.95	48.2	0.105	4.50	0.182	9.33	0.267	8.86
100	0.98	57.9	0.111	5.58	0.189	11.18	0.300	11.69

T	Tungsten		Zinc	
	C_p	$H - H_o$	C_p	$H - H_o$
°K	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}	$jg^{-1}\ deg^{-1}\ K$	jg^{-1}
1	0.0000074	0.0000037	0.000011	0.000005
2	0.0000158	0.0000152	0.000028	0.000023
3	0.0000262	0.0000360	0.000058	0.000065
4	0.0000393	0.0000685	0.00011	0.00014
6	0.0000783	0.000182	0.00029	0.00053
8	0.000141	0.000396	0.00096	0.0016
10	0.000234	0.000765	0.0025	0.0050
15	0.000725	0.00297	0.011	0.034
20	0.00189	0.00927	0.026	0.125
25	0.00421	0.0237	0.049	0.31
30	0.00783	0.0534	0.076	0.62
40	0.0184	0.181	0.125	1.62
50	0.0332	0.436	0.171	3.11
60	0.0483	0.843	0.208	5.01
70	0.0605	1.39	0.236	7.23
80	0.0715	2.05	0.258	9.70
90	0.0810	2.81	0.277	12.38
100	0.0888	3.66	0.293	15.24

[a] Superconducting.

[b] In germanium the electronic specific heat is markedly dependent on impurities. The values given are for pure germanium (negligible electronic specific heat).

[c] α-Iron is the form that is thermodynamically stable at low temperatures. It has the body-centered cubic lartice which is the basis of the ferritic steels.

[d] γ-Iron is stable between 910 and 1400°C. It has the face-centered cubic structure which is the basis of the austenitic steels.Since pure γ-iron is not stable at low temperatures the above values were calculated by application of the Kopp-Neumann rule to experimental data on two austenitic Fe-Mn alloys and are of uncertain accuracy.

[e] Superconducting transition temperature.

[i] Superconducting transition temperature of mercury.

[j] Melting temperature of mercury.

[l] In silicon the electronic specific heat, γT, is markedly dependent on impurities. Values of the coefficient, γa, from zero to $2.4 \times 10^{-6}\ jg^{-1}\ deg^{-2}\ K$ have been reported. The values in the above table are for pure silicon ($\gamma = 0$).

[m] It has been shown (Barrett 1956, Hull & Rosenberg 1959) that sodium partially transforms at low temperatures from the normal body-centered cubic structure to close-packed hexagonal. The transformation is of the martensitic type and is promoted by cold-working at the low temperatures. Inasmuch as none of the calorimetric measurements on sodium were accompanied by crystallographic analysis, the tabulated data below 100°K are to some degree ambiguous.

[n] Superconducting transition temperature of tin.

[o] Superconducting transition temperature of tantalum.

CONSTANTS OF DEBYE-SOMMERFELD EQUATION

EXHIBIT A

$C_v = \gamma T + \alpha T^3$; $\alpha = 12\pi^4 R/5\theta^3$; $O \leq T \leq Tmax$; Tmax = maximum temperature to which the equation can be used with the limiting value of θ.

Substance	$10^6\gamma$	γ	$10^6\alpha$	θ^o	T^{max}
Metals	$jg^{-1}\ deg^{-2}\ K$	$mjg\text{-}atom^{-1}\ deg^{-2}\ K$	$jg^{-1}\ deg^{-4}\ K$	deg K	deg K
Aluminum	50.4	1.36	0.93	425	4
Beryllium	25	0.226	0.138	1160	20
Bismuth	0.32	0.067	5.66	118	2
Cadmium	5.6	0.63	2.69	186	3
Chromium	28.3	1.47	0.165	610	4
Copper	10.81	0.687	0.746	344.5	10
Germanium	[a]	[a]	0.528	370	2
Gold	3.75	0.74	2.19	165	15
Indium	15.8	1.81	13.1	109	2
α-Iron	90	5.0	0.349	464	10
Lead	15.1	3.1	10.6	96	4
Magnesium	54	1.32	1.19	406	4
α-Manganese	251	13.8	0.328	476	12
Molybdenum	23	2.18	0.238	440	4
Nickel	120	7.0	0.39	440	4
Niobium	85	7.9	0.64	320	1
Palladium	98	10.5	0.89	274	4
Platinum	34.1	6.7	0.72	240	3
Rhodium	48	4.9	0.173	478	4
Silicon	[a]	[a]	0.263	640	4
Silver	5.65	0.610	1.58	225	4
Sodium[a]	60	1.37	21.4	158	4
Tantalum	31.5	5.7	0.69	250	4
Tin (white)	14.7	1.75	2.21	195	2
Titanium	71	3.4	0.54	420	10
Tungsten	7	1.3	0.16	405	4
Zinc	9.6	0.63	1.10	300	4
Alloys					
Constantan[a]	113	6.9	0.56	384	15
Monel[a]	108	6.5	0.62	374	20
Other inorganic substances					
Diamond	—	—	0.0152	2200	50
Ice	—	—	15.2	192	10
Pyrex	—	—	3.14	—	5
Organic substances					
Glyptal	—	—	27	—	4
Lucite	—	—	35	—	4
Polystyrene	—	—	63	—	4

[a] Superconducting.

EXHIBIT A

THERMAL PROPERTIES OF PURE METALS

From Handbook of Tables for Applied Engineering Science by R. E. Bolz and G. L. Tuve, The Chemical Rubber Co., 1970

	At Atmospheric Pressure						Liquid Metal			
		At 100°K		At 25°C (77°F)				Vapor pressure		
Metal	Latent heat of fusion, cal/g	Thermal conductivity, watts cm°C	Specific heat, cal/g°C	Specific heat, cal/g°C	Coeff. of linear expansion, ($\times 10^{-6}$) $(°C)^{-1}$	Thermal conductivity, watts/cm°C*	Specific heat (liquid) at 2000°K cal/g°C	10^{-3} atm	10^{-6} atm	10^{-9} atm
								Boiling point temperatures, °K		
Aluminum	95	3.00	0.115	0.215	25	2.37	0.26	1,782	1,333	1,063
Antimony	38.5	—	0.040	0.050	9	0.185	0.062	1,007	741	612
Beryllium	324	—	0.049	0.436	12	2.18	0.78	1,793	1,347	1,085
Bismuth	12.4	—	0.026	0.030	13	0.084	0.036	1,155	851	677
Cadmium	13.2	1.03	0.047	0.055	30	0.93	0.063	655	486	388
Chromium	79	1.58	0.046	0.110	6	0.91	0.224	1,992	1,530	1,247
Cobalt	66	—	0.057	0.10	12	0.69	0.164	2,167	1,652	1,345
Copper	49	4.83	0.061	0.092	16.6	3.98	0.118	1,862	1,391	1,120
Gold	15	3.45	0.026	0.031	14.2	3.15	0.0355	2,023	1,510	1,211
Iridium	33	—	0.022	0.031	6	1.47	0.0434	3,253	2,515	2,062
Iron	65	1.32	0.052	0.108	12	0.803	0.197	2,093	1,594	1,297
Lead	5.5	0.396	0.028	0.031	29	0.346	0.033	1,230	889	698
Magnesium	88.0	1.69	0.016	0.243	25	1.59	0.32	857	638	509
Manganese	64	—	0.064	0.114	22	—	0.20	1,495	1,131	913
Mercury	2.7	—	0.029	0.033	—	0.0839	—	393	287	227
Molybdenum	69	1.79	0.033	0.060	5	1.4	0.089	3,344	2,558	2,079
Nickel	71	1.58	0.055	0.106	13	0.899	0.175	2,156	1,646	1,343
Niobium (Columbium)	68	0.552	0.045	0.064	7	0.52	0.083	3,523	2,721	2,232
Osmium	34	—	—	0.031	5	0.61	0.039	—	—	—
Platinum	24	0.79	0.024	0.032	9	0.73	0.043	2,817	2,155	1,757
Plutonium	3	—	0.019	0.032	54	0.08	0.041	2,200	1,596	1,252
Potassium	14.5	—	0.150	0.180	83	0.99	—	606	430	335
Rhodium	50	—	—	0.058	8	1.50	0.092	—	—	—
Selenium	16	—	—	0.077	37	0.005	—	—	—	—
Silicon	430	—	0.062	0.17	3	0.835	0.217	2,340	1,749	1,427
Silver	26.5	4.50	0.045	0.057	19	4.27	0.068	1,582	1,179	952
Sodium	27	—	0.234	0.293	70	1.34	—	701	504	394
Tantalum	41	0.592	0.026	0.034	6.5	0.54	0.040	3,959	3,052	2,495
Thorium	17	—	0.024	0.03	12	0.41	0.047	3,251	2,407	1,919
Tin	14.1	0.85	0.039	0.054	20	0.64	0.058	1,857	1,366	1,080
Titanium	100	0.312	0.072	0.125	8.5	0.2	0.188	2,405	1,827	1,484
Tungsten	46	2.35	0.021	0.032	4.5	1.78	0.040	4,139	3,228	2,656
Uranium	12	—	0.022	0.028	13.4	0.25	0.048	2,861	2,128	1,699
Vanadium	98	—	0.061	0.116	8	0.60	0.207	2,525	1,948	1,591
Zinc	27	1.32	0.063	0.093	35	1.15	—	752	559	449

* (watts/cm°C) × 860.421 = Cal(gm)$hr^{-1}cm^{-1}°C^{-1}$
(watts/cm°C) × 57.818 = Btu $hr^{-1}ft^{-1}°F$.

THERMAL CONDUCTIVITY OF DIELECTRIC CRYSTALS

Name	Remarks	Conductivity $mW \cdot cm^{-1} \cdot K$ 83 K	273 K	Name	Remarks	Conductivity $mW \cdot cm^{-1} \cdot K$ 83 K	273 K
Marble	Small crystals, 99.9% $CaCO_3$	42	33	90% KBr, 10% KCl	Do	50	29
Do	99.99% $CaCO_3$	54	38	75% KBr, 25% KCl	Do	29	21
Do	Large crystals	50	33	50% KBr, 50% KCl	Do	25	25
Calcite	Main crystal axis perpendicular to rod axis	180	46	25% KBr, 75% KCl	Pressed at 8000 atm	46	33
				10% KBr, 90% KCl	Do	80	50
Do	Main crystal axis parallel to rod axis	293	54	50% KCl, 50% NaCl	Do	188	71
				KNO_2	Do	17	21
Sylvite	Natural crystal	159	75	Mercuric chloride	Do	17	13
KCl	Pressed at 8000 atm	314	88	NH_4Cl	Do	109	25
KCl	From a melt	402	92	NH_2Br	Do	67	25
NaCl	Do	343	92	$Ba(NO_3)_2$	Do	33	13
NaCl	Pressed at 8000 atm	251	71	Copper sulfate		29	21
Rock salt	Do	180	63	Magnesium sulfate		25	25
Sylvite	Do	343	84	$K_4Fe(CN_6)$		17	17
KCl	Pressed at 1250 atm	243	75	Chrom alum		13	21
KCl	Pressed at 2500 atm	368	92	Potassium alum		13	21
KCl	Pressed at 8900 atm	402	96	Potassium bichromate	Main crystal axis perpendicular to rod axis	17	21
KBr	Pressed at 8000 atm	92	38				
NaBr	Do	50	25	Do	Main crystal axis parallel to rod axis	17	17
KI	Do	121	29				
KF	Do	234	71	Topaz	Mineral		234
NaF	Do	519	105	Zincblende	Do	63	264
RbI	Do	59	33	Beryll	Do	88	84
RbCl	Do	29	21	Tourmaline	Do	38	46

THERMAL CONDUCTIVITY OF CERTAIN METALS

EXHIBIT A

From NSRDS-NBS 8
R. W. Powell, C. Y. Ho, and P. E. Liley

The thermal conductivity, k, is given in the units $W \cdot cm \cdot cm^{-2} \cdot K^{-1}$.
To convert to $cal \cdot cm \cdot cm^{-2} \cdot h^{-1} \cdot K^{-1}$ multiply the values listed in the tables by 860.421.
To convert to $Btu \cdot ft \cdot ft^{-2} \cdot h^{-1} \cdot °F^{-1}$ multiply the values listed in the tables by 57.818.
ρ_0 is the residual electrical resistivity and the value of ρ at 4.2°K is used approximately as ρ_0.

T,K	Aluminum 99.996+% ρ_0 = 0.00315 μohm cm	Copper 99.999+% ρ_0 = 0.000851 μohm cm	Gold 99.999+% ρ_0 = 0.0055 μohm cm	Iron 99.998+% ρ_0 = 0.0327 μohm cm	Manganin	Platinum 99.999% ρ_0 = 0.0106 μohm cm	Silver 99.999+% ρ_0 = 0.00062 μohm cm	Tungsten 99.99+% ρ_0 = 0.0017 μohm cm
0	0	0	0	0	0	0	0	0
1	7.8	28.7	4.4	0.75	0.0007	2.31	39.4	14.4
2	15.5	57.3	8.9	1.49	0.0018	4.60	78.3	28.7
3	23.2	85.5	13.1	2.24	0.0031	6.79	115	42.6
4	30.8	113	17.1	2.97	0.0046	8.8	147	55.6
5	38.1	138	20.7	3.71	0.0062	10.5	172	67.1
6	45.1	159	23.7	4.42	0.0078	11.8	187	76.2
7	51.5	177	26.0	5.13	0.0095	12.6	193	82.4
8	57.3	189	27.5	5.80	0.0111	12.9	190	85.3
9	62.2	195	28.2	6.45	0.0128	12.8	181	85.1
10	66.1	196	28.2	7.05	0.0145	12.3	168	82.4
11	69.0	193	27.7	7.62	0.0162	11.7	154	77.9
12	70.8	185	26.7	8.13	0.0180	10.9	139	72.4
13	71.5	176	25.5	8.58	0.0197	10.1	124	66.4
14	71.3	166	24.1	8.97	0.0215	9.3	109	60.4
15	70.2	156	22.6	9.30	0.0232	8.4	96	54.8
16	68.4	145	20.9	9.56	0.0250	7.6	85	49.3
18	63.5	124	17.7	9.88	0.0285	6.1	66	40.0
20	56.5	105	15.0	9.97	0.0322	4.9	51	32.6
25	40.0	68	10.2	9.36	0.0410	3.15	29.5	20.4
30	28.5	43	7.6	8.14	0.0497	2.28	19.3	13.1
35	21.0	29	6.1	6.81	0.0583	1.80	13.7	8.9
40	16.0	20.5	5.2	5.55	0.067	1.51	10.5	6.5
45	12.5	15.3	4.6	4.50	0.075	1.32	8.4	5.07
50	10.0	12.2	4.2	3.72	0.082	1.18	7.0	4.17
60	6.7	8.5	3.8	2.65	0.097	1.01	5.5	3.18
70	5.0	6.7	3.58	2.04	0.110	0.90	4.97	2.76
80	4.0	5.7	3.52	1.68	0.120	0.84	4.71	2.56
90	3.4	5.14	3.48	1.46	0.127	0.81	4.60	2.44
100	3.0	4.83	3.45	1.32	0.133	0.79	4.50	2.35
150	2.47	4.28	3.35	1.04	0.156	0.762	4.32	2.10
200	2.37	4.13	3.27	0.94	0.172	0.748	4.30	1.97
250	2.35	4.04	3.20	0.865	0.193	0.737	4.28	1.86
273	2.36	4.01	3.18	0.835	0.206	0.734	4.28	1.82
300	2.37	3.98	3.15	0.803	0.222	0.730	4.27	1.78
350	2.40	3.94	3.13	0.744	0.250	0.726	4.24	1.70
400	2.40	3.92	3.12	0.694	(0.279)	0.722	4.20	1.62
500	2.37	3.88	3.09	0.613	(0.338)	0.719	4.13	1.49
600	2.32	3.83	3.04	0.547	(0.397)	0.720	4.05	1.39
700	2.26	3.77	2.98	0.487		0.723	3.97	1.33
800	2.20	3.71	2.92	0.433		0.729	3.89	1.28
900	2.13	3.64	2.85	0.380		0.737	3.82	1.24
1000	[0.93]**	3.57	(2.78)	0.326		0.748	(3.74)	1.21
1100	[0.96]	3.50	(2.71)	0.297		0.760	(3.66)	1.18
1200	[0.99]	3.42	(2.62)	0.282		0.775	(3.58)	1.15
1300	[1.02]	(3.34)†	(2.51)	0.299		0.791		1.13
1400				0.309		0.807		1.11
1500				0.318		0.824		1.09
1600				(0.327)		0.842		1.07
						0.860		1.05
						0.877		1.03
						(0.895)		1.02
						(0.913)		1.00
								0.98
								0.96
								0.94
								0.925
								0.915
								0.905
								0.900
								(0.895)

* In the table the third significant figure is given only for the purpose of comparison and for smoothness and is not indicative of the degree of accuracy.
** Values in square brackets are for liquid state.
† Values in parentheses are extrapolated.
‡ Estimated.