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A Ready-Reference Book of Chemical and Physical Data

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PROPERTIES OF METALS AS CONDUCTORS

Metal.	Resistivity microhm-centimeters 20° C	Temp. coefficient 20° C.	Specific gravity.	Tensile strength, lbs./in.	Melting point ° C.
*Advance. See *constantan*					
Aluminum	2.824	0.0039	2.70	30,000	659
Antimony	41.7	.0036	6.6	....	630
Arsenic	33.3	.0042	5.73	....	....
Bismuth	120	.004	9.8	....	271
Brass	7	.002	8.6	70,000	900
Cadmium	7.6	.0038	8.6	....	321
*Calido. See *nichrome*					
Climax	87	.0007	8.1	150,000	1250
Cobalt	9.8	.0033	8.71	....	1480
Constantan	49	.00001	8.9	120,000	1190
Copper: annealed	1.7241	.00393	8.89	30,000	1083
hard-drawn	1.771	.00382	8.89	60,000	....
Eureka. See *constantan*					
Excello	92	.00016	8.9	95,000	1500
Gas Carbon	5000	−.0005	......	....	3500
German silver, 18% Ni	33	.0004	8.4	150,000	1100
Gold	2.44	.0034	19.3	20,000	1063
Ideal. See *constantan*					
Iron, 99.98% pure	10	.005	7.8	....	1530
Lead	22	.0039	11.4	3,000	327
Magnesium	4.6	.004	1.74	33,000	651
Manganin	44	.00001	8.4	150,000	910
Mercury	95.783	.00089	13.546	0	−38.9
Molybdenum, drawn	5.7	.004	9.0	....	2500
Monel metal	42	.0020	8.9	160,000	1300
*Nichrome	100	.0004	8.2	150,000	1500
Nickel	7.8	.006	8.9	120,000	1452
Palladium	11	.0033	12.2	39,000	1550
Phosphor bronze	7.8	.0018	8.9	25,000	750
Platinum	10	.003	21.4	50,000	1755
Silver	1.59	.0038	10.5	42,000	960
Steel, E. B. B.	10.4	.005	7.7	53,000	1510
Steel, B. B.	11.9	.004	7.7	58,000	1510
Steel, Siemens-Martin	18	.003	7.7	100,000	1510
Steel, manganese	70	.001	7.5	230,000	1260
Tantalum	15.5	.0031	16.6	....	2850
*Therlo	47	.00001	8.2	....	....
Tin	11.5	.0042	7.3	4,000	232
Tungsten, drawn	5.6	.0045	19	500,000	3400
Zinc	5.8	.0037	7.1	10,000	419

* Trade mark.

Superconductivity*

B.W. Roberts

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The following tables on superconductivity include superconductive properties of chemical elements, thin films, a selected list of compounds and alloys, and high-magnetic-field superconductors.

The historically first observed and most distinctive property of a superconductive body is the near total loss of resistance at a critical temperature (T_c) that is characteristic of each material. Figure 1(a) below illustrates schematically two types of possible transitions. The sharp vertical discontinuity in resistance is indicative of that found for a single crystal of a very pure element or one of a few well annealed alloy compositions. The broad transition, illustrated by broken lines, suggests the transition shape seen for materials that are not homogeneous and contain unusual strain distributions. Careful testing of the resistivity limits for superconductors shows that it is less than 4×10^{-23} ohm-cm, while the lowest resistivity observed in metals is of the order of 10^{-13} ohm-cm. If one compares the resistivity of a superconductive body to that of copper at room temperature, the superconductive body is at least 10^{17} times less resistive.

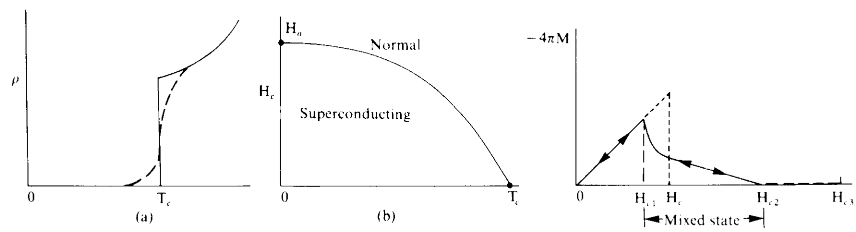

Figure 1. PHYSICAL PROPERTIES OF SUPERCONDUCTORS

(a) Resistivity versus temperature for a pure and perfect lattice (solid line). Impure and/or imperfect lattice (broken line).
(b) Magnetic-field temperature dependence for Type-I or "soft" superconductors.
(c) Schematic magnetization curve for "hard" or Type-II superconductors.

The temperature interval ΔT_c, over which the transition between the normal and superconductive states takes place, may be of the order of as little as 2×10^{-5} K *or* several K in width, depending on the material state. The narrow transition width was attained in 99.9999 percent pure gallium single crystals.

*Prepared for Office of Standard Reference Data, National Bureau of Standards, by Standard Reference Data Center on Superconductive Materials, Schenectady, N.Y.

Showing the Relation between Density (C. G. S.) and Baumé and Twaddell Scales for Densities above Unity

Density	Degrees Baumé	Degrees Twaddell	Density	Degrees Baumé	Degrees Twaddell	Density	Degrees Baumé	Degrees Twaddell	Denisty	Degrees Baumé	Degrees Twaddell
1.00	0.00	0	1.20	24.17	40	1.41	42.16	82	1.61	54.94	122
1.01	1.44	2	1.21	25.16	42	1.42	42.89	84	1.62	55.49	124
1.02	2.84	4	1.22	26.15	44	1.43	43.60	86	1.63	56.04	126
1.03	4.22	6	1.23	27.11	46	1.44	44.31	88	1.64	56.58	128
1.04	5.58	8	1.24	28.06	48	1.45	45.00	90	1.65	57.12	130
1.05	6.91	10	1.25	29.00	50	1.46	45.68	92	1.66	57.65	132
1.06	8.21	12	1.26	29.92	52	1.47	46.36	94	1.67	58.17	134
1.07	9.49	14	1.27	30.83	54	1.48	47.03	96	1.68	58.69	136
1.08	10.74	16	1.28	31.72	56	1.49	47.68	98	1.69	59.20	138
1.09	11.97	18	1.29	32.60	58	1.50	48.33	100	1.70	59.71	140
1.10	13.18	20	1.30	33.46	60	1.51	48.97	102	1.71	60.20	142
1.11	14.37	22	1.31	34.31	62	1.52	49.60	104	1.72	60.70	144
1.12	15.54	24	1.32	35.15	64	1.53	50.23	106	1.73	61.18	146
1.13	16.68	26	1.33	35.98	66	1.54	50.84	108	1.74	61.67	148
1.14	17.81	28	1.34	36.79	68	1.55	51.45	110	1.75	62.14	150
1.15	18.91	30	1.35	37.59	70	1.56	52.05	112	1.76	62.61	152
1.16	20.00	32	1.36	38.38	72	1.57	52.64	114	1.77	63.08	154
1.17	21.07	34	1.37	39.16	74	1.58	53.23	116	1.78	63.54	156
1.18	22.12	36	1.38	39.93	76	1.59	53.80	118	1.79	63.99	158
1.19	23.15	38	1.39	40.68	78	1.60	54.38	120	1.80	64.44	160
			1.40	41.43	80						

DENSITY OF D_2O

G. S. Kell

t, °C.	ϱ, G./Cc.	t, °C.	ϱ, G./Cc.	t, °C.	ϱ, G./Cc.	t, °C.	ϱ, G./Cc.
0	1.10469	20	1.10534	50	1.09570	80	1.07824
3.813	1.10546	25	1.10445	55	1.09325	85	1.07475
5	1.10562	30	1.10323	60	1.09060	90	1.07112
10	1.10599	35	1.10173	65	1.08777	95	1.06736
11.185	1.10600	40	1.09996	70	1.08475	100	1.06346
15	1.10587	45	1.09794	75	1.08158	101.431	1.06232

PROPERTIES LIQUID DEUTERIUM OXIDE (D_2O)

Freezing point — 301.97K (3.82°C) at 0.1013325 MPa
Boiling point — 399.57K (101.42°C) at 0.101325 MPa
Maximum density at 0.101325 MPa — 1.10534 kg/dm^3
Temperature at maximum density — 309.335K (11.185°C)
Molar mass — 0.020027478 kg/mol
Specific gas constant (Universal gas constant divided by molar mass) — 415.150 J/kgK
Critical temperature — $(643.89 + \delta)$K = $(370.74 + \delta)$°C with $-0.2 \leqq \delta \geqq + 0.2$

Critical pressure — $(21.671 + 0.27\delta \pm 0.010)$MPa
Critical density — $(356 \pm 5)kg/m^3$
Critical specific volume — $(0.00281 \pm 0.00004)m^3/kg$
Triple point temperature — (276.97 ± 0.02)K = (3.82 ± 0.02)°C
Triple point pressure — (661 ± 3)Pa
Liquid density at triple point — $(1105.5 \pm 0.2)kg/m^3$
Vapor density at triple point — $(0.00575 \pm 0.00003)kg/m^3$

VOLUME PROPERTIES OF WATER AT 1 atm*

	ρ, kg m^{-3}, Equation 1	$10^6\ \alpha$, K^{-1}, Equation 1	$10^6\ \kappa T/bar^{-1}$ Equation 2		ρ, kg m^{-3}, Equation 1	$10^6\ \alpha$, K^{-1}, Equation 1	$10^6\ \kappa T/bar^{-1}$ Equation 2
-30	983.854	-1400.0	80.79	9	999.7808	74.38	48.0560
-25	989.585	-955.9	70.94	10	999.6996	87.97	47.8086
-20	993.547	-660.6	64.25	11	999.6051	101.20	47.5726
-15	996.283	-450.3	59.44	12	999.4974	114.08	47.3474
-10	998.117	-292.4	55.83	13	999.3771	126.65	47.1327
-9	998.395	-265.3	55.22	14	999.2444	138.90	46.9280
-8	998.647	-239.5	54.64	15	999.0996	150.87	46.7331
-7	998.874	-214.8	54.08	16	998.9430	162.55	46.5475
-6	999.077	-191.2	53.56	17	998.7749	173.98	46.3708
-5	999.256	-168.6	53.06	18	998.5956	185.15	46.2029
-4	999.414	-146.9	52.58	19	998.4052	196.08	46.0433
-3	999.550	-126.0	52.12	20	998.2041	206.78	45.8918
-2	999.666	-106.0	51.69	21	997.9925	217.26	45.7482
-1	999.762	-86.7	51.28	22	997.7705	227.54	45.6122
0	999.8395	-68.05	50.8850	23	997.5385	237.62	45.4835
1	999.8985	-50.09	50.5091	24	997.2965	247.50	45.3619
2	999.9399	-32.74	50.1505	25	997.0449	257.21	45.2472
3	999.9642	-15.97	49.8081	26	996.7837	266.73	45.1392
4	999.9720	0.27	49.4812	27	996.5132	276.10	45.0378
5	999.9638	16.00	49.1692	28	996.2335	285.30	44.9427
6	999.9402	31.24	48.8712	29	995.9448	294.34	44.8537
7	999.9015	46.04	48.5868	30	995.6473	303.24	44.7707
8	999.8482	60.41	48.3152	31	995.3410	312.00	44.6935

VOLUME PROPERTIES OF WATER AT 1 atm* (continued)

	ρ, kg m^{-3}, Equation 1	$10^6\ \alpha$, K^{-1}, Equation 1	$10^6\ \kappa T$/bar^{-1} Equation 2
32	995.0262	320.63	44.6221
33	994.7030	329.12	44.5561
34	994.3715	337.48	44.4956
35	994.0319	345.73	44.4404
36	993.6842	353.86	44.3903
37	993.3287	361.88	44.3452
38	992.9653	369.79	44.3051
39	992.5943	377.59	44.2697
40	992.2158	385.30	44.2391
41	991.8298	392.91	44.2131
42	991.4364	400.43	44.1917
43	991.0358	407.85	44.1747
44	990.6280	415.19	44.1620
45	990.2132	422.45	44.1536
46	989.7914	429.63	44.1494
47	989.3628	436.73	44.1494
48	988.9273	443.75	44.1533
49	988.4851	450.71	44.1613
50	988.0363	457.59	44.1732
51	987.5809	464.40	44.189
52	987.1190	471.15	44.209
53	986.6508	477.84	44.232
54	986.1761	484.47	44.259
55	985.6952	491.04	44.290
56	985.2081	497.55	44.324
57	984.7149	504.01	44.362
58	984.2156	510.41	44.403
59	983.7102	516.76	44.448
60	983.1989	523.07	44.496
61	982.6817	529.32	44.548
62	982.1586	535.53	44.603
63	981.6297	541.70	44.662
64	981.0951	547.82	44.723
65	980.5548	553.90	44.788
66	980.0089	559.94	44.857
67	979.4573	565.95	44.928
68	978.9003	571.91	45.003
69	978.3377	577.84	45.081
70	977.7696	583.74	45.162
71	977.1962	589.60	45.246
72	976.6173	595.43	45.333
73	976.0332	601.23	45.424
74	975.4437	607.00	45.517
75	974.8990	612.75	45.614
76	974.2490	618.46	45.714
77	973.6439	624.15	45.817
78	973.0336	629.82	45.922
79	972.4183	635.46	46.031
80	971.7978	641.08	46.143
81	971.1723	646.67	46.258
82	970.5417	652.25	46.376
83	969.9062	657.81	46.497
84	969.2657	663.34	46.621
85	968.6203	668.86	46.748
86	967.9700	674.37	46.878
87	967.3148	679.85	47.011
88	966.6547	685.33	47.148
89	965.9898	690.78	47.287

	ρ, kg m^{-3},	$10^6\ \alpha$, K^{-1},	$10^6\ \kappa T$/bar^{-1}	
	Equation 1	Equation 1	Equation 2	Equation 3
90	965.3201	696.23	47.429	47.428
91	964.6457	701.66	47.574	47.574
92	963.9664	707.08	47.722	47.722
93	963.2825	712.49	47.874	47.873
94	962.5938	717.89	48.028	48.028
95	961.9004	723.28	48.185	48.185
96	961.2023	728.67	48.346	48.346
97	960.4996	734.04	48.509	48.510
98	959.7923	739.41	48.676	48.677
99	959.0803	744.78	48.846	48.847
100	958.3637	750.14	49.019	49.020
101	957.642	755.5		49.20
102	956.917	760.8		49.38
103	956.186	766.2		49.56
104	955.451	771.5		49.74
105	954.712	776.9		49.93
106	953.968	782.2		50.13
107	953.220	787.6		50.32
108	952.467	792.9		50.52
109	951.709	798.3		50.72
110	950.947	803.6		50.93
115	947.070	830.4		52.01
120	943.083	857.4		53.17
125	938.984	884.7		54.43
130	934.775	912.3		55.79
135	930.456	940.3		57.24
140	926.026	968.9		58.80
145	921.484	998.0		60.47
150	916.829	1027.8		62.25

Equations:

$$\rho/\text{kg m}^{-3} = (999.83952 + 16.945176\,t - 7.9870401 \times 10^{-3}\,t^2 - 46.170461 \times 10^{-6}\,t^3 + 105.56302 \times 10^{-9}\,t^4 - 280.54253 \times 10^{-12}\,t^5)/(1 + 16.879850 \times 10^{-3}\,t) \quad (1)$$

$$10^6\,\kappa_T/\text{bar}^{-1} = (50.88496 + 0.6163813\,t + 1.459187 \times 10^{-3}\,t^2 + 20.08438 \times 10^{-6}\,t^3 - 58.47727 \times 10^{-9}\,t^4 + 410.4110 \times 10^{-12}\,t^5)/(1 + 19.67348 \times 10^{-3}\,t) \quad (2)$$

$$10^6\,\kappa_T/\text{bar}^{-1} = (50.884917 + 0.62590623\,t + 1.3848668 \times 10^{-3}\,t^2 + 21.603427 \times 10^{-6}\,t^3 - 72.087667 \times 10^{-9}\,t^4 + 465.45054 \times 10^{-12}\,t^5)/(1 + 19.859983 \times 10^{-3}\,t) \quad (3)$$

$$\kappa_S = (\partial \ln \rho/\partial P)_S = \frac{1}{\rho U^2} \quad (4)$$

*Density ρ, thermal expansivity $\alpha = -(\partial \ln \rho/\partial T)_p$, and isothermal compressibility $\kappa T = (\partial \ln \rho/\partial p)T$. For purposes of this table, ordinary water is that with a maximum density of 999.972 kg m^{-3}. Equation 4 for the compressibility should be used for temperatures $0 < t < 100$°C, and Equation 3 for $100 < t < 150$°C. The liquid is metastable below 0°C and above 100°C. Values below 0°C were obtained by extrapolation, and no claim is made for their accuracy.

Substance: Name	Substance: Formula	In contact with	Temperature °C	Surface tension dynes/cm
Phenylhydrazine	$C_6H_8N_2$	--vapor	20	46.1
Phosphorus tribromide	PBr_3	--air	24	45.8
Phosphorus trichloride	PCl_3	--vapor	20	29.1
Phosphorus triiodide	PI_3	--vapor	75.3	56.5
Propionic acid	$C_3H_6O_2$	--vapor	20	26.7
n-Propyl acetate	$C_5H_{10}O_2$	--air or vapor	20	24.3
n-Propyl alcohol	C_3H_8O	--vapor	20	23.78
n-Propylamine	C_3H_9N	--air	20	22.4
n-Propyl bromide	C_3H_7Br	--vapor	71	19.65
n-Propyl chloride	C_3H_7Cl	--air	47	18.2
n-Propyl formate	$C_4H_8O_2$	--vapor	20	24.5
Pyridine	C_8H_5N	--air	20	38.0
Quinoline	C_9H_7N	--air	20	45.0
Ricinoleic acid	$C_{18}H_{34}O_3$	--air	16	35.81
Selenium	Se	--air	217	92.4
Styrene	C_8H_8	--air	19	32.14
Sulfuric acid (98.5%)	H_2SO_4	--air or vapor	20	55.1
Tetrabromoethane 1,1,2,2-	$C_2H_2Br_4$	--air	20	49.67
Tetrachloroethane 1,1,2,2-	$C_2H_2Cl_4$	--air	22.5	36.03
Tetrachloroethylene	C_2Cl_4	--vapor	20	31.74
Toluene	C_7H_8	--vapor	10	27.7
	C_7H_8	--vapor	20	28.5
	C_7H_8	--vapor	30	27.4
m-Toluidine	C_7H_9N	--vapor	20	36.9
o-Toluidine	C_7H_9N	--air or vapor	20	40.0
p-Toluidine	C_7H_9N	--air	50	34.6
Trichloroacetic acid	$C_2HCl_3O_2$	--nitrogen	80.2	27.8
Trichloroethane 1,1,2-	$C_2H_3Cl_3$	--air	114	22.0
Triethyl phosphate	$C_6H_{15}O_4P$	--air	15.5	30.61
Trimethylamine	C_3H_9N	--nitrogen	−4	17.3
Triphenylcarbinol	$C_{19}H_{16}O$	--vapor	165.8	30.38
Vinyl acetate	$C_4H_6O_2$	--vapor	20	23.95
	$C_4H_6O_2$	--vapor	25	23.16
	$C_4H_6O_2$	--vapor	30	22.54
Water	H_2O	--air	18	73.05
m-Xylene	C_8H_{10}	--vapor	20	28.9
o-Xylene	C_8H_{10}	--air	20	30.10
p-Xylene	C_8H_{10}	--vapor	20	28.37

VISCOSITY

Viscosity. — All fluids possess a definite resistance to change of form and many solids show a gradual yielding to forces tending to change their form. This property, a sort of internal friction, is called viscosity; it is expressed in dyne-seconds per cm² or poises. Dimensions, —$[m\, l^{-1}\, t^{-1}]$. If the tangential force per unit area, exerted by a layer of fluid upon one adjacent is one dyne for a space rate of variation of the tangential velocity of unity, the viscosity is one poise.

Kinematic viscosity is the ratio of viscosity to density. The c.g.s. unit of kinematic viscosity is the **stoke.**

Flow of liquids through a tube; where l is the length of the tube, r its radius, p the difference of pressure at the ends, η the coefficient of viscosity, the volume escaping per second,

$$v = \frac{\pi p r^4}{8 l \eta} \text{ (Poiseuille).}$$

The volume will be given in cm³ per second if l and r are in cm, p in dynes per cm² and η in poises or dyne-seconds per cm².

VISCOSITY OF WATER BELOW 0°C

White-Twining 1914

Temperature	Viscosity centipoises	Temperature	Viscosity centipoises
0°C	1.798	−7.23	2.341
−2.10	1.930	−8.48	2.458
−4.70	2.121	−9.30	2.549
−6.20	2.250		

ABSOLUTE VISCOSITY OF WATER AT 20°C

Swindells, J. R. Coe, Jr., and T. B. Godfrey, Journal of Research, National Bureau of Standards **48**, 1, 1952.
The value found for the viscosity of water at 20°C was 0.010019 ± 0.000003 poise.
The value **0.01002** poise is to be used as the absolute value of the viscosity of water for calibration purposes.

VISCOSITY CONVERSION TABLE

Poise = c.g.s. unit of absolute viscosity = $\frac{g}{s \times cm}$

Stoke = c.g.s. unit of kinematic viscosity = $\frac{g}{s \times cm \times \text{density } (t°F)}$

Centipoise = 0.01 poise
Centistoke = 0.01 stoke
Centipoises = Centistokes × density (at given temperature)

To convert poises to $\frac{lb}{s \times ft}$ or $\frac{lb}{h \times ft}$ multiply by 0.0672 or 242 respectively.

Centistokes	Saybolt Seconds at 100°F	Saybolt Seconds at 130°F	Saybolt Seconds at 210°F	Redwood Seconds at 70°F	Redwood Seconds at 140°F	Redwood Seconds at 200°F	Engler Degrees at all temps.
2.0	32.6	32.7	32.8	30.2	31.0	31.2	1.14
3.0	36.0	36.1	36.3	32.7	33.5	33.7	1.22
4.0	39.1	39.2	39.4	35.3	36.0	36.3	1.31
5.0	42.3	42.4	42.6	37.9	38.5	38.9	1.40
6.0	45.5	45.6	45.8	40.5	41.0	41.5	1.48
7.0	48.7	48.8	49.0	43.2	43.7	44.2	1.56
8.0	52.0	52.1	52.4	46.0	46.4	46.9	1.65
9.0	55.4	55.5	55.8	48.9	49.1	49.7	1.75
10.0	58.8	58.9	59.2	51.7	52.0	52.6	1.84
11.0	62.3	62.4	62.7	54.8	55.0	55.6	1.93
12.0	65.9	66.0	66.4	57.9	58.1	58.8	2.02
14.0	73.4	73.5	73.9	64.4	64.6	65.3	2.22
16.0	81.1	81.3	81.7	71.0	71.4	72.2	2.43
18.0	89.2	89.4	89.8	77.9	78.5	79.4	2.64
20.0	97.5	97.7	98.2	85.0	85.8	86.9	2.87
22.0	106.0	106.2	106.7	92.4	93.3	94.5	3.10
24.0	114.6	114.8	115.4	99.9	100.9	102.2	3.34
26.0	123.3	123.5	124.2	107.5	108.6	110.0	3.58
28.0	132.1	132.4	133.0	115.3	116.5	118.0	3.82
30.0	140.9	141.2	141.9	123.1	124.4	126.0	4.07
32.0	149.7	150.0	150.8	131.0	132.3	134.1	4.32
34.0	158.7	159.0	159.8	138.9	140.2	142.2	4.57
36.0	167.7	168.0	168.9	146.9	148.2	150.3	4.83
38.0	176.7	177.0	177.9	155.0	156.2	158.3	5.08
40.0	185.7	186.0	187.0	163.0	164.3	166.7	5.34
42.0	194.7	195.1	196.1	171.0	172.3	175.0	5.59
44.0	203.8	204.2	205.2	179.1	180.4	183.3	5.85
46.0	213.0	213.4	214.5	187.1	188.5	191.7	6.11
48.0	222.2	222.6	223.8	195.2	196.6	200.0	6.37
50.0	231.4	231.8	233.0	203.3	204.7	208.3	6.63
60.0	277.4	277.9	279.3	243.5	245.3	250.0	7.90
70.0	323.4	324.0	325.7	283.9	286.0	291.7	9.21
80.0	369.6	370.3	372.2	323.9	326.6	333.4	10.53
90.0	415.8	416.6	418.7	364.4	367.4	375.0	11.84
*100.0	462.0	462.9	465.2	404.9	408.2	416.7	13.16

* At higher values use the same ratio as above for 100 centistokes; e.g., 110 centistokes = 110 × 4.620 Saybolt seconds at 100°F.
To obtain the Saybolt Universal viscosity equivalent to a kinematic viscosity determined at t °F, multiply the equivalent Saybolt Universal viscosity at 100°F by $1 + (t-100)0.000064$; e.g., 10 centistokes at 210°F are equivalent to 58.8 × 1.0070, or 59.2 Saybolt Universal seconds at 210°F.

VISCOSITY CONVERSION

Kinematic

To convert from	To	Multiply by
cm^2/s (stokes)	Centistokes	10^2
	ft^2/h	3.875
	ft^2/s	1.076×10^{-3}
	in^2/s	1.550×10^{-1}
	m^2/h	3.600×10^{-1}
$cm^2/s \times 10^2$ (centistokes)	cm^2/s (stokes)	1×10^{-2}
	ft^2/h	3.875×10^{-2}
	ft^2/s	1.076×10^{-5}
	in^2/s	1.550×10^{-3}
	m^2/h	3.600×10^{-3}
ft^2/s	cm^2/s (stokes)	2.581×10^{-1}
	$cm/s \times 10^2$ (centistokes)	2.581×10
	ft^2/s	2.778×10^{-4}
	in^2/s	4.000×10^{-2}
	m^2/h	9.290×10^{-2}

To convert from	To	Multiply by
ft^2/s	cm^2/s (stokes)	9.29×10^2
	$cm^2/s \times 10^2$ (centistokes)	9.29×10^4
	ft^2/h	3.60×10^3
	in^2/h	1.44×10^2
	m^2/h	3.345×10^2
$in.^2/s$	cm^2/s (stokes)	6.452
	$cm^2/s \times 10^2$ (centistokes)	6.452×10^2
	ft^2/h	2.50×10
	ft^2/s	6.944×10^{-3}
	m^2/h	2.323
m^2/h	cm^2/s (stokes)	2.778
	$cm^2/s \times 10^2$ (centistokes)	2.778×10^2
	ft^2/h	1.076×10
	ft^2/s	2.990×10^{-3}
	in^2/s	4.306×10^{-1}

Absolute

Absolute viscosity = kinematic viscosity × density; lb = mass pounds; lb_f = force pounds

To convert from	To	Multiply by
g/(cm)(s) [poise]	$g/(cm)(s)(10^2)$ [centipoise]	10^2
	kg/(m)(h)	3.6×10^2
	lb/(ft)(s)	6.72×10^{-2}
	lb/(ft)(h)	2.419×10^2
	lb/(in)(s)	5.6×10^{-3}
	$(g_f)(s)/cm^2$	1.02×10^{-3}
	$(lb_f)(s)/in^2$ [Reyn]	1.45×10^{-5}
	$(lb_f)(s)/ft^2$	2.089×10^{-3}

To convert from	To	Multiply by
$g/(cm)(s)(10^2)$ [centipoise]	g/(cm)(s) [poise]	10^{-2}
	kg/(m)(h)	3.6
	lb/(ft)(s)	6.72×10^{-4}
	lb/(ft)(h)	2.419
	lb/(in)(s)	5.60×10^{-5}
	$(lb_f)(s)/cm^2$	1.02×10^{-5}
	$(lb_f)(s)/in^2$ [Reyn]	1.45×10^{-7}

VISCOSITY CONVERSION (continued)

To convert from	To	Multiply by
g/(cm)(s)(10^2) [centipoise]	$(lb_f)(s)/ft^2$	2.089×10^{-5}
kg/(m)(h)	g/(cm)(s)	2.778×10^{-3}
	g/(cm)(s)(10^2) [centipoise]	2.778×10^{-1}
	lb/(ft)(s)	1.867×10^{-4}
	lb/(ft)(h)	6.720×10^{-1}
	lb/(in)(s)	1.555×10^{-5}
	$(lb_f)(s)/in^2$ [Reyn]	4.029×10^{-8}
	$(lb_f)(s)/ft^2$	5.801×10^{-6}
lb/(in)(s)	$(lb_f)(s)/ft^2$	3.73×10^{-1}
$(g_f)(s)/cm^2$	g/(cm)(s)	9.807×10^{2}
	g/(cm)(s)(10^2) [centipoise]	9.807×10^{4}
	kg/(m)(h)	3.530×10^{5}
	lb/(ft)(s)	6.590×10
	lb/(ft)(h)	2.372×10^{5}
	lb/(in)(s)	5.492
	$(lb_f)(s)/in^2$ [Reyn]	1.422×10^{-2}
	$(lb_f)(s)/ft^2$	2.048
$(lb_f)(s)/in^2$ [Reyn]	g/(cm)(s) [poise]	6.895×10^{4}
	g/(cm)(s)(10^2) [centipoise]	6.895×10^{6}
	kg/(m)(h)	2.482×10^{7}
	lb/(ft)(s)	4.633×10^{3}
	lb/(ft)(h)	1.668×10^{7}
	lb/(in)(s)	3.861×10^{2}
	$(g_f)(s)/cm^2$	7.031×10
	$(lb_f)(s)/ft^2$	1.440×10^{2}
$(lb_f)(s)/ft^2$	g/(cm)(s) [poise]	4.788×10^{2}
	g/(cm)(s)(10^2) [centipoise]	4.788×10^{4}
	kg/(m)(h)	1.724×10^{5}
	lb/(ft)(s)	3.217×10
	lb/(ft)(h)	1.158×10^{5}
	lb/(in)(s)	2.681
	$(g_f)(s)/cm^2$	4.882×10^{-1}
	$(lb_f)(s)/in^2$ [Reyn]	6.944×10^{-3}
lb/(ft)(s)	g/(cm)(s) [poise]	1.488×10^{1}
	g/(cm)(s)(10^2) [centipoise]	1.488×10^{2}
	kg/(m)(h)	5.357×10^{3}
	lb/(ft)(h)	3.60×10^{2}
	lb/(in)(s)	8.333×10^{-2}
	$(g_f)(s)/cm^3$	1.518×10^{-2}
	$(lb_f)(s)/in^2$ [Reyn]	2.158×10^{-4}
	$(lb_f)(s)/ft^2$	3.108×10^{-2}
lb/(ft)(h)	g/(cm)(s) [poise]	4.134×10^{-3}
	g/(cm)(s)(10^2) [centipoise]	4.134×10^{-1}
	kg/(m)(h)	1.488
	lb/(ft)(s)	2.778×10^{-4}
	lb/(in)(s)	2.315×10^{-5}
	$(g_f)(s)/cm^2$	4.215×10^{-6}
	$(lb_f)(s)/in^2$ [Reyn]	5.996×10^{-8}
	$(lb_f)(s)/ft^2$	8.634×10^{-6}
lb/(in)(s)	g/(cm)(s) [poise]	1.786×10^{2}
	g/(cm)(s)(10^2) [centipoise]	1.786×10^{4}
	kg/(m)(h)	6.429×10^{4}
	lb/(ft)(s)	1.2×10
	lb/(ft)(h)	4.32×10^{4}
	$(g_f)(s)/cm^2$	1.821×10^{-1}
	$(lb_f)(s)/in^2$ [Reyn]	2.590×10^{-3}

THE VISCOSITY OF WATER 0°C TO 100°C

°C	η(cp)	°C	η(cp)	°C	η(cp)	°C	η(cp)
0	1.787	26	0.8705	52	0.5290	78	0.3638
1	1.728	27	.8513	53	.5204	79	.3592
2	1.671	28	.8327	54	.5121	80	.3547
3	1.618	29	.8148	55	.5040	81	.3503
4	1.567	30	.7975	56	.4961	82	.3460
5	1.519	31	.7808	57	.4884	83	.3418
6	1.472	32	.7647	58	.4809	84	.3377
7	1.428	33	.7491	59	.4736	85	.3337
8	1.386	34	.7340	60	.4665	86	.3297
9	1.346	35	.7194	61	.4596	87	.3259
10	1.307	36	.7052	62	.4528	88	.3221
11	1.271	37	.6915	63	.4462	89	.3184
12	1.235	38	.6783	64	.4398	90	.3147
13	1.202	39	.6654	65	.4335	91	.3111
14	1.169	40	.6529	66	.4273	92	.3076
15	1.139	41	.6408	67	.4213	93	.3042
16	1.109	42	.6291	68	.4155	94	.3008
17	1.081	43	.6178	69	.4098	95	.2975
18	1.053	44	.6067	70	.4042	96	.2942
19	1.027	45	.5960	71	.3987	97	.2911
20	1.002	46	.5856	72	.3934	98	.2879
21	0.9779	47	.5755	73	.3882	99	.2848
22	.9548	48	.5656	74	.3831	100	.2818
23	.9325	49	.5561	75	.3781		
24	.9111	50	.5468	76	.3732		
25	.8904	51	.5378	77	.3684		

The above table was calculated from the following empirical relationships derived from measurements in viscometers calibrated with water at 20°C (and one atmosphere), modified to agree with the currently accepted value for the viscosity at 20° of 1.002 cp:

$$0° \text{ to } 20°\text{C}: \log_{10} \eta_T = \frac{1301}{998.333 + 8.1855(T-20) + 0.00585(T-20)^2} - 1.30233$$

(R. C. Hardy and R. L. Cottington, J.Res.NBS *42*, 573 (1949).)

$$20° \text{ to } 100°\text{C}: \log_{10} \frac{\eta_T}{\eta_{20}} = \frac{1.3272(20-T) - 0.001053(T-20)^2}{T + 105}$$

(J. F. Swindells, NBS, unpublished results.)