CHAPTER
SEVEN

APPENDICES

Table 7.1 Fractional sub-divisions of an inch to decimals of an inch and to millimeters

Inches		Inches	Millimeters	Inches		Inches	Millimeters
	1/64	0.015 625	0.3969		25/64	0.390 625	9.9219
1/32		0.3125	0.7938	13/32		0.406 25	10.3188
	3/64	0.046 875	1.1906		27/64	0.421 875	10.7156
1/16		0.0625	1.5875	7/16		0.4375	11.1125
	5/64	0.078 125	1.9844		29/64	0.453 125	11.5094
3/32		0.093 75	2.3812	15/32		0.468 75	11.9062
	7/64	0.109 375	2.7781		31/64	0.484 375	12.3031
1/8		0.125	3.175	1/2		0.5	12.7
	9/64	0.140 625	3.5719		33/64	0.515 625	13.0969
5/32		0.156 25	3.9688	17/32		0.531 25	13.4938
	11/64	0.171 875	4.3656		35/64	0.546 875	13.8906
3/16		0.1875	4.7625	9/16		0.5625	14.2875
	13/64	0.203 125	5.1594		37/64	0.578 125	14.6844
7/32		0.218 75	5.5562	19/32		0.593 75	15.0812
	15/64	0.234 375	5.9531		39/64	0.609 375	15.4781
1/4		0.25	6.35	5/8		0.625	15.875
	17/64	0.265 625	6.7469		41/64	0.640 625	16.2719
9/32		0.281 25	7.1438	21/32		0.656 25	16.6688
	19/64	0.296 875	7.5406		43/64	0.671 875	17.0656
5/16		0.3125	7.9375	11/6		0.6875	17.4625
	21/64	0.328 125	8.3344		45/64	0.703 125	17.8594
11/32		0.343 75	8.7312	23/32		0.718 75	18.2562
	23/64	0.359 375	9.1281		47/64	0.734 375	18.6531
3/8		0.375	9.525	3/4		0.75	19.05

Table 7.1 Fractional sub-divisions of an inch to decimals of an inch and to millimeters *(Continued)*

Inches		Inches	Millimeters	Inches		Inches	Millimeters
	49/64	0.765 625	19.4469		57/64	0.890 625	22.6219
25/32		0.781 25	19.8438	29/32		0.906 25	23.0188
	51/64	0.796 875	20.2406		59/64	0.921 875	23.4156
13/16		0.8125	20.6375	15/16		0.9375	23.8125
	53.64	0.828 125	21.0344		61/64	0.953 125	24.2094
27/32		0.843 75	21.4312	31/32		0.968 75	24.6062
	55/64	0.859 375	21.8281		63/64	0.984 375	25.0031
7/8		0.875	22.225	1		1	25.4

Table 7.2 Inches and fractional sub-divisions of an inch to millimeters

Values rounded to 0.001 mm.

Inches		0	1	2	3	4	5
		mm	mm	mm	mm	mm	mm
—		—	25.400	50.800	76.200	101.600	127.000
	1/32	0.794	26.194	51.594	76.994	102.394	127.794
1/16		1.588	26.988	52.388	77.788	103.188	128.588
	3/32	2.381	27.781	53.181	78.581	103.981	129.381
1/8		3.175	28.575	53.975	79.375	104.775	130.175
	5/32	3.969	29.369	54.769	80.169	105.569	130.969
3/16		4.762	30.162	55.562	80.962	106.362	131.762
	7/32	5.556	30.956	56.356	81.756	107.156	132.556
1/4		6.350	31.750	57.150	82.550	107.950	133.350
	9/32	7.144	32.544	57.944	83.344	108.744	134.144
5/16		7.938	33.338	58.738	84.138	109.538	134.938
	11/32	8.731	34.131	59.531	84.931	110.331	135.731
3/8		9.525	34.925	60.325	85.725	111.125	136.525
	13/32	10.319	35.719	61.119	86.519	111.919	137.319
7/16		11.112	36.512	61.912	87.312	112.712	138.112
	15/32	11.906	37.306	62.706	88.106	113.506	138.906
1/2		12.700	38.100	63.500	88.900	114.300	139.700
	17/32	13.494	38.894	64.294	89.694	115.094	140.494
9/16		14.288	39.688	65.088	90.488	115.888	141.288
	19/32	15.081	40.481	65.881	91.281	116.681	142.081
5/8		15.875	41.275	66.675	92.075	117.475	142.875
	21/32	16.669	42.069	67.469	92.869	118.269	143.669
11/16		17.462	42.862	68.262	93.662	119.062	144.462
	23/32	18.256	43.656	69.056	94.456	119.856	145.256
3/4		19.050	44.450	69.850	95.250	120.650	146.050

Table 7.2 Inches and fractional sub-divisions of an inch to millimeters (*Continued*)
Values rounded to 0.001 mm.

Inches			0	1	2	3	4	5
			mm	mm	mm	mm	mm	mm
		25/32	19.844	45.244	70.644	96.044	121.444	146.844
	13/16		20.638	46.038	71.438	96.838	122.238	147.638
		27/32	21.431	46.831	72.231	97.631	123.031	148.431
7/8			22.225	47.625	73.025	98.425	123.825	149.225
		29/32	23.019	48.419	73.819	99.219	124.619	150.019
	15/16		23.812	49.212	74.612	100.012	125.412	150.812
		31/32	24.606	50.006	75.406	100.806	126.206	151.606

Table 7.2 Inches and fractional sub-divisions of an inch to millimeters (*Continued*)
Values rounded to 0.001 mm.

Inches			6	7	8	9	10	11
			mm	mm	mm	mm	mm	mm
	—		152.400	177.800	203.200	228.600	254.000	279.400
		1/32	153.194	178.594	203.994	229.394	254.794	280.194
	1/16		153.988	179.388	204.788	230.188	255.588	280.988
		3/32	154.781	180.181	205.581	230.981	256.381	281.781
1/8			155.575	180.975	206.375	231.775	257.175	282.575
		5/32	156.369	181.769	207.169	232.569	257.969	283.369
	3/16		157.162	182.562	207.962	233.362	258.762	284.162
		7/32	157.956	183.356	208.756	234.156	259.556	284.956
1/4			158.750	184.150	209.550	234.950	260.350	285.750
		9/32	159.544	184.944	210.344	235.744	261.144	286.544
	5/16		160.338	185.738	211.138	236.538	261.938	287.338
		11/32	161.131	186.531	211.931	237.331	262.731	288.131
3/8			161.925	187.325	212.725	238.125	263.525	288.925
		13/32	162.719	188.119	213.519	238.919	264.319	289.719
	7/16		163.512	188.912	214.312	239.712	265.112	290.512
		15/32	164.306	189.706	215.106	240.506	265.906	291.306
1/2			165.100	190.500	215.900	241.300	266.700	292.100
		17/32	165.894	191.294	216.694	242.094	267.494	292.894
	9/16		166.688	192.088	217.488	242.888	268.288	293.688
		19/32	167.481	192.881	218.281	243.681	269.081	294.481
5/8			168.275	193.675	219.075	244.475	269.875	295.275
		21/32	169.069	194.469	219.869	245.269	270.669	296.069
	11/16		169.862	195.262	220.662	246.062	271.462	296.862
		23/32	170.656	196.056	221.456	246.856	272.256	297.656
3/4			171.450	196.850	222.250	247.650	273.050	298.450

Table 7.2 Inches and fractional sub-divisions of an inch to millimeters (*Continued*)

Values rounded to 0.001 mm.

Inches		6	7	8	9	10	11
		mm	mm	mm	mm	mm	mm
	25/32	172.244	197.644	223.044	248.444	273.844	299.244
13/16		173.038	198.438	223.838	249.238	274.638	300.038
	27/32	173.831	199.231	224.631	250.031	275.431	300.831
7/8		174.625	200.025	225.425	250.825	276.225	301.625
	29/32	175.419	200.819	226.219	251.619	277.019	302.419
15/16		176.212	201.612	227.012	252.412	277.812	303.212
	31/32	177.006	202.406	227.806	253.206	278.606	304.006

12 in = 304.800 mm.

Table 7.3 Paper sizes

Class	Principal orders		Supplementary orders			
	A		C		B	
	Sing	Measures in mm	Sing	Measures in mm	Sing	Measures in mm
000	4 A 0	1682 × 2378			B 0	1000 × 1414
00	2 A 0	1189 × 1682			B 1	171 × 1000
0	A 0	841 × 1189	C 0	917 × 1297	B 2	500 × 707
1	A 1	594 × 841	C 1	648 × 917	B 3	353 × 500
2	A 2	420 × 594	C 2	458 × 648	B 4	250 × 353
3	A 3	297 × 420	C 3	324 × 458	B 5	176 × 250
4	A 4	210 × 297	C 4	229 × 324	B 6	125 × 176
5	A 5	148 × 210	C 5	162 × 229	B 7	88 × 125
6	A 6	105 × 148	C 6	114 × 162	B 8	62 × 88
7	A 7	74 × 105	C 7	81 × 114	B 9	44 × 62
8	A 8	52 × 74	C 8	57 × 81	B 10	31 × 44
9	A 9	37 × 52	C 9	40 × 57	B 11	22 × 31
10	A 10	26 × 37	C 10	28 × 40	B 12	15 × 22
11	A 11	18 × 26				
12	A 12	13 × 18				

Table 7.4 French paper sizes

Name	Measures in mm	Name	Measures in mm
pot	310 × 400	jésus	560 × 760
tellière	340 × 440	soleil	570 × 800
couronne	370 × 470	colombier litho	630 × 900
écu	400 × 520	colombier affiche	600 × 800
coquille	440 × 560	journal	650 × 940
cavalier	460 × 620	grand-aigle	750 × 1060
raisin	500 × 650	grand-monde	900 × 1200

Rudolf Hostettler, *The printer's terms*, SGM-books, St. Gallen 1949.

Table 7.5 American paper sizes

Measures		Measures	
inches	millimeters	inches	millimeters
Printing paper		Writing paper	
22 1/2 × 35	571 × 889	16 × 21	406 × 533
24 × 36	609 × 914	17 × 28	432 × 711
25 × 38	635 × 965	18 × 23	457 × 584
28 × 42	711 × 1067	18 × 46	457 × 1168
28 × 44	711 × 1118	19 × 24	482 × 609
30 1/2 × 41	775 × 1041	20 × 28	508 × 711
32 × 44	813 × 1118	21 × 32	533 × 813
33 × 44	838 × 1118	22 × 34	559 × 863
35 × 45	889 × 1143	24 × 38	609 × 965
36 × 48	914 × 1219	28 × 34	711 × 863
38 × 50	965 × 1270	34 × 44	863 × 1118
38 × 52	965 × 1320	Wrapping paper	
41 × 54	1041 × 1371	20 × 26	508 × 660
44 × 64	1118 × 1625	23 × 35	584 × 889
Cardboard		26 × 40	660 × 1016
22 1/2 × 28 1/2	571 × 724	35 × 46	889 × 1168

Rudolf Hostettler, *The printer's terms,* SGM-books, St. Gallen 1949.

Table 7.6 English paper sizes

Name	Measures	
	inches	millimeters
royal	20 × 25	508 × 635
demy	17 1/2 × 22 1/2	445 × 571
double demy	35 × 22 1/2	889 × 572
crown	15 × 20	381 × 508
double crown	30 × 20	762 × 508
foolscap	13 1/2 × 17	343 × 432
medium	18 × 23	457 × 584
imperial	22 × 30	559 × 762
	Sizes of writing paper	
post	15 1/4 × 19	387 × 482
large post	16 1/2 × 21	419 × 533
small foolscap	13 1/4 × 16 1/2	336 × 419
small demy	15 1/2 × 20	394 × 508

Rudolf Hostettler, *The printer's terms,* SGM-books, St.Gallen 1949.

Table 7.7 Radians to degrees conversions

$$1 \text{ rad} = \frac{360°}{2\pi} = \frac{180°}{\pi} = 57.295\,78° = 57°17'44.8''$$

Radian rad	Degree °	Radian rad	Degree °	Radian rad	Degree °	Radian rad	Degree °
0.0001	0.005 73	0.26	14.896 90	0.71	40.680 00	1.16	66.463 10
0.0002	0.011 46	0.27	15.469 86	0.72	41.252 96	1.17	67.036 06
0.0003	0.017 19	0.28	16.042 82	0.73	41.825 92	1.18	67.609 02
0.0004	0.022 92	0.29	16.615 78	0.74	42.398 88	1.19	68.181 98
0.0005	0.028 65	0.30	17.188 73	0.75	42.971 84	1.20	68.754 94
0.0006	0.034 38	0.31	17.761 69	0.76	43.544 79	1.21	69.327 89
0.0007	0.040 11	0.32	18.334 65	0.77	44.117 75	1.22	69.900 85
0.0008	0.045 84	0.33	18.907 61	0.78	44.690 71	1.23	70.473 81
0.0009	0.051 57	0.34	19.480 57	0.79	45.263 67	1.24	71.046 77
0.0010	0.057 30	0.35	20.053 52	0.80	45.836 62	1.25	71.619 73
0.001	0.057 30	0.36	20.626 48	0.81	46.409 58	1.26	72.192 68
0.002	0.114 59	0.37	21.199 44	0.82	46.982 54	1.27	72.765 64
0.003	0.171 89	0.38	21.772 40	0.83	47.555 50	1.28	73.338 60
0.004	0.229 18	0.39	22.345 35	0.84	48.128 46	1.29	73.911 56
0.005	0.286 48	0.40	22.918 31	0.85	48.701 41	1.30	74.484 51
0.006	0.343 77	0.41	23.491 27	0.86	49.274 37	1.31	75.057 47
0.007	0.401 07	0.42	24.064 23	0.87	49.847 33	1.32	75.630 43
0.008	0.458 37	0.43	24.637 19	0.88	50.420 29	1.33	76.203 39
0.009	0.515 66	0.44	25.210 14	0.89	50.993 24	1.34	76.776 35
0.010	0.572 96	0.45	25.783 10	0.90	51.566 20	1.35	77.349 30
0.01	0.572 96	0.46	26.356 06	0.91	52.139 16	1.36	77.922 26
0.02	1.145 92	0.47	26.929 02	0.92	52.712 12	1.37	78.495 22
0.03	1.718 87	0.48	27.501 97	0.93	53.285 08	1.38	79.068 18
0.04	2.291 83	0.49	28.074 93	0.94	53.858 03	1.39	79.641 13
0.05	2.864 79	0.50	28.647 89	0.95	54.430 99	1.40	80.214 09
0.06	3.437 75	0.51	29.220 85	0.96	55.003 95	1.41	80.787 05
0.07	4.010 70	0.52	29.793 81	0.97	55.576 91	1.42	81.360 01
0.08	4.583 66	0.53	30.366 76	0.98	56.149 86	1.43	81.932 97
0.09	5.156 62	0.54	30.939 72	0.99	56.722 82	1.44	82.505 92
0.10	5.729 58	0.55	31.512 68	1.00	57.295 78	1.45	83.078 88
0.11	6.302 54	0.56	32.085 64	1.01	57.868 74	1.46	83.651 84
0.12	6.875 49	0.57	32.658 59	1.02	58.441 70	1.47	84.224 80
0.13	7.448 45	0.58	33.231 55	1.03	59.014 65	1.48	84.797 75
0.14	8.021 41	0.59	33.804 51	1.04	59.587 61	1.49	85.370 71
0.15	8.594 37	0.60	34.377 47	1.05	60.160 57	1.50	85.943 67
0.16	9.167 32	0.61	34.950 43	1.06	60.733 53	1.51	86.516 63
0.17	9.740 28	0.62	35.523 38	1.07	61.306 48	1.52	87.089 59
0.18	10.313 24	0.63	36.096 34	1.08	61.879 44	1.53	87.662 54
0.19	10.886 20	0.64	36.669 30	1.09	62.452 40	1.54	88.235 50
0.20	11.459 16	0.65	37.242 26	1.10	63.025 36	1.55	88.808 46
0.21	12.032 11	0.66	37.815 21	1.11	63.598 32	1.56	89.381 42
0.22	12.605 07	0.67	38.388 17	1.12	64.171 27	1.57	89.954 37
0.23	13.178 03	0.68	38.961 13	1.13	64.744 23	1.58	90.527 33
0.24	13.750 99	0.69	39.534 09	1.14	65.317 19	1.59	91.100 29
0.25	14.323 95	0.70	40.107 05	1.15	65.890 15	1.60	91.673 25

Table 7.8 Degrees to radians

$1° = (2\pi/360)$ rad $= (\pi/180)$ rad $= 0.017\,453$ rad

Degree °	Radian rad	Degree °	Radian rad	Degree °	Radian rad	Degree °	Radian rad
1	0.017 45	46	0.802 85	91	1.588 25	136	2.373 63
2	0.034 91	47	0.820 30	92	1.605 70	137	2.391 10
3	0.052 36	48	0.837 76	93	1.623 16	138	2.408 55
4	0.069 81	49	0.855 21	94	1.640 61	139	2.426 01
5	0.087 27	50	0.872 66	95	1.658 06	140	2.443 46
6	0.104 72	51	0.890 12	96	1.675 52	141	2.460 91
7	0.122 17	52	0.907 57	97	1.692 97	142	2.478 37
8	0.139 63	53	0.925 02	98	1.710 42	143	2.495 82
9	0.157 08	54	0.942 48	99	1.727 88	144	2.513 27
10	0.174 53	55	0.959 53	100	1.745 33	145	2.530 73
11	0.191 99	56	0.977 38	101	1.762 78	146	2.548 18
12	0.209 44	57	0.994 84	102	1.780 24	147	2.565 63
13	0.226 89	58	1.012 29	103	1.797 69	148	2.583 09
14	0.244 35	59	1.029 74	104	1.815 14	149	2.600 54
15	0.261 80	60	1.047 20	105	1.832 60	150	2.617 99
16	0.279 25	61	1.064 65	106	1.850 05	151	2.635 45
17	0.296 71	62	1.082 10	107	1.867 50	152	2.652 90
18	0.314 16	63	1.099 56	108	1.884 96	153	2.670 35
19	0.331 61	64	1.117 01	109	1.902 41	154	2.687 81
20	0.349 07	65	1.134 46	110	1.919 86	155	2.705 26
21	0.366 52	66	1.151 92	111	1.937 32	156	2.722 71
22	0.383 97	67	1.169 37	112	1.954 77	157	2.740 17
23	0.401 43	68	1.186 82	113	1.972 22	158	2.757 62
24	0.418 88	69	1.204 28	114	1.989 68	159	2.775 07
25	0.436 33	70	1.221 73	115	2.007 13	160	2.792 53
26	0.453 79	71	1.239 18	116	2.024 58	161	2.809 98
27	0.471 24	72	1.256 64	117	2.042 04	162	2.827 43
28	0.488 69	73	1.274 09	118	2.059 49	163	2.844 89
29	0.506 15	74	1.291 54	119	2.076 94	164	2.862 34
30	0.523 60	75	1.309 00	120	2.094 40	165	2.879 79
31	0.541 05	76	1.326 45	121	2.111 85	166	2.897 25
32	0.558 51	77	1.343 90	122	2.129 30	167	2.914 70
33	0.575 96	78	1.361 36	123	2.146 75	168	2.932 15
34	0.593 41	79	1.378 81	124	2.164 21	169	2.949 61
35	0.610 87	80	1.396 26	125	2.181 66	170	2.967 06
36	0.628 32	81	1.413 72	126	2.199 11	171	2.984 51
37	0.645 77	82	1.431 17	127	2.216 57	172	3.001 97
38	0.663 23	83	1.448 62	128	2.234 02	173	3.019 42
39	0.680 68	84	1.466 08	129	2.251 47	174	3.036 87
40	0.698 13	85	1.483 53	130	2.268 93	175	3.054 33
41	0.715 58	86	1.500 98	131	2.286 38	176	3.071 78
42	0.733 04	87	1.518 44	132	2.303 83	177	3.089 23
43	0.750 49	88	1.535 89	133	2.321 29	178	3.106 69
44	0.767 94	89	1.553 34	134	2.338 74	179	3.124 14
45	0.785 40	90	1.570 80	135	2.356 19	180	3.141 59

Table 7.9 Minutes and seconds to radians

$1' = (\pi/108000)$ rad = 0.000 290 89 rad; $1'' = (\pi/648\,000)$ rad = 0.000 004 848 rad

Minute ′	Radian rad	Minute ′	Radian rad	Second ″	Radian rad	Second ″	Radian rad
1	0.000 29	31	0.009 02	1	0.000 004 85	31	0.000 150 29
2	0.000 58	32	0.009 31	2	0.000 009 70	32	0.000 155 14
3	0.000 87	33	0.009 60	3	0.000 014 54	33	0.000 159 99
4	0.001 16	34	0.009 89	4	0.000 019 39	34	0.000 164 84
5	0.001 45	35	0.010 18	5	0.000 024 24	35	0.000 169 68
6	0.001 75	36	0.010 47	6	0.000 029 09	36	0.000 174 53
7	0.002 04	37	0.010 76	7	0.000 033 94	37	0.000 179 38
8	0.002 33	38	0.011 05	8	0.000 038 79	38	0.000 184 23
9	0.002 62	39	0.011 34	9	0.000 043 63	39	0.000 189 08
10	0.002 91	40	0.011 64	10	0.000 048 48	40	0.000 193 93
11	0.003 20	41	0.011 93	11	0.000 053 33	41	0.000 198 77
12	0.003 49	42	0.012 22	12	0.000 058 18	42	0.000 203 62
13	0.003 78	43	0.012 51	13	0.000 063 03	43	0.000 208 47
14	0.004 07	44	0.012 80	14	0.000 067 87	44	0.000 213 32
15	0.004 36	45	0.013 09	15	0.000 072 72	45	0.000 218 17
16	0.004 65	46	0.013 38	16	0.000 077 57	46	0.000 223 01
17	0.004 95	47	0.013 67	17	0.000 082 42	47	0.000 227 86
18	0.005 24	48	0.013 96	18	0.000 087 27	48	0.000 232 71
19	0.005 53	49	0.014 25	19	0.000 092 11	49	0.000 237 56
20	0.005 82	50	0.014 54	20	0.000 096 96	50	0.000 242 41
21	0.006 11	51	0.014 84	21	0.000 101 81	51	0.000 247 25
22	0.006 40	52	0.015 13	22	0.000 106 66	52	0.000 252 10
23	0.006 69	53	0.015 42	23	0.000 111 51	53	0.000 256 95
24	0.006 98	54	0.015 71	24	0.000 116 36	54	0.000 261 80
25	0.007 27	55	0.016 00	25	0.000 121 20	55	0.000 266 65
26	0.007 56	56	0.016 29	26	0.000 126 05	56	0.000 271 50
27	0.007 85	57	0.016 58	27	0.000 130 90	57	0.000 276 34
28	0.008 14	58	0.016 87	28	0.000 135 75	58	0.000 281 19
29	0.008 44	59	0.017 16	29	0.000 140 60	59	0.000 286 04
30	0.008 73	60	0.017 45	30	0.000 145 44	60	0.000 290 89

Table 7.10 Decimal angle degrees to decimal grades

1 revolution = 360° = 400^g; $1° = \dfrac{400^g}{360} = 1.111\,11^g$

Degree °	Grade g	Degree °	Grade g	Degree °	Grade g	Degree °	Grade g
0.01	0.011 111	0.08	0.088 889	0.15	0.166 667	0.22	0.244 444
0.02	0.022 222	0.09	0.100 000	0.16	0.177 778	0.23	0.255 556
0.03	0.033 333	0.10	0.111 111	0.17	0.188 889	0.24	0.266 667
0.04	0.044 444	0.11	0.122 222	0.18	0.200 000	0.25	0.277 778
0.05	0.055 556	0.12	0.133 333	0.19	0.211 111	0.26	0.288 889
0.06	0.066 667	0.13	0.144 444	0.20	0.222 222	0.27	0.300 000
0.07	0.077 778	0.14	0.155 556	0.21	0.233 333	0.28	0.311 111

Table 7.10 Decimal angle degrees to decimal grades *(Continued)*

Degree °	Grade g	Degree °	Grade g	Degree °	Grade g	Degree °	Grade g
0.29	0.322 222	0.47	0.522 222	0.65	0.722 222	0.83	0.922 222
0.30	0.333 333	0.48	0.533 333	0.66	0.733 333	0.84	0.933 333
0.31	0.344 444	0.49	0.544 444	0.67	0.744 444	0.85	0.944 444
0.32	0.355 556	0.50	0.555 556	0.68	0.755 556	0.86	0.955 556
0.33	0.366 667	0.51	0.566 667	0.69	0.766 667	0.87	0.966 667
0.34	0.377 778	0.52	0.577 778	0.70	0.777 778	0.88	0.977 778
0.35	0.388 889	0.53	0.588 889	0.71	0.788 889	0.89	0.988 889
0.36	0.400 000	0.54	0.600 000	0.72	0.800 000	0.90	1.000 000
0.37	0.411 111	0.55	0.611 111	0.73	0.811 111	0.91	1.011 111
0.38	0.422 222	0.56	0.622 222	0.74	0.822 222	0.92	1.022 222
0.39	0.433 333	0.57	0.633 333	0.75	0.833 333	0.93	1.033 333
0.40	0.444 444	0.58	0.644 444	0.76	0.844 444	0.94	1.044 444
0.41	0.455 556	0.59	0.655 556	0.77	0.855 556	0.95	1.055 556
0.42	0.466 667	0.60	0.666 667	0.78	0.866 667	0.96	1.066 667
0.43	0.477 778	0.61	0.677 778	0.79	0.877 778	0.97	1.077 778
0.44	0.488 889	0.62	0.688 889	0.80	0.888 889	0.98	1.088 889
0.45	0.500 000	0.63	0.700 000	0.81	0.900 000	0.99	1.100 000
0.46	0.511 111	0.64	0.711 111	0.82	0.911 111	1.00	1.111 111

Table 7.11 Decimal grades to decimal angle degrees

1 revolution = 400 gon = 360° $\rightarrow 1^g = \frac{360°}{400} = 0.9°$

Grade g	Degree °	Grade g	Degree °	Grade g	Degree °	Grade g	Degree °
0.01	0.009	0.21	0.189	0.41	0.369	0.61	0.549
0.02	0.018	0.22	0.198	0.42	0.378	0.62	0.558
0.03	0.027	0.23	0.207	0.43	0.387	0.63	0.567
0.04	0.036	0.24	0.216	0.44	0.396	0.64	0.576
0.05	0.045	0.25	0.225	0.45	0.405	0.65	0.585
0.06	0.054	0.26	0.234	0.46	0.414	0.66	0.594
0.07	0.063	0.27	0.243	0.47	0.423	0.67	0.603
0.08	0.072	0.28	0.252	0.48	0.432	0.68	0.612
0.09	0.081	0.29	0.261	0.49	0.441	0.69	0.621
0.10	0.090	0.30	0.270	0.50	0.450	0.70	0.630
0.11	0.099	0.31	0.279	0.51	0.459	0.71	0.639
0.12	0.108	0.32	0.288	0.52	0.468	0.72	0.648
0.13	0.117	0.33	0.297	0.53	0.477	0.73	0.657
0.14	0.126	0.34	0.306	0.54	0.486	0.74	0.666
0.15	0.135	0.35	0.315	0.55	0.495	0.75	0.675
0.16	0.144	0.36	0.324	0.56	0.504	0.76	0.684
0.17	0.153	0.37	0.333	0.57	0.513	0.77	0.693
0.18	0.162	0.38	0.342	0.58	0.522	0.78	0.702
0.19	0.171	0.39	0.351	0.59	0.531	0.79	0.711
0.20	0.180	0.40	0.360	0.60	0.540	0.80	0.720

Table 7.11 Decimal grades to decimal angle degrees *(Continued)*

Grade g	Degree °	Grade g	Degree °	Grade g	Degree °	Grade g	Degree °
0.81	0.729	0.86	0.774	0.91	0.819	0.96	0.864
0.82	0.738	0.87	0.783	0.92	0.828	0.97	0.873
0.83	0.747	0.88	0.792	0.93	0.837	0.98	0.882
0.84	0.756	0.89	0.801	0.94	0.846	0.99	0.891
0.85	0.765	0.90	0.810	0.95	0.855	1.00	0.900

Table 7.12 Grades to angle degrees and minutes

Grade g	Degree °	Minute ′	Grade g	Degree °	Minute ′	Grade g	Degree °	Minute ′	Grade g	Degree °	Minute ′
1	0	54	26	23	24	51	45	54	76	68	24
2	1	48	27	24	18	52	46	48	77	69	18
3	2	42	28	25	12	53	47	42	78	70	12
4	3	36	29	26	6	54	48	36	79	71	6
5	4	30	30	27	0	55	49	30	80	72	0
6	5	24	31	27	54	56	50	24	81	72	54
7	6	18	32	28	48	57	51	18	82	73	48
8	7	12	33	29	42	58	52	12	83	74	42
9	8	6	34	30	36	59	53	6	84	75	36
10	9	0	35	31	30	60	54	0	85	76	30
11	9	54	36	32	24	61	54	54	86	77	24
12	10	48	37	33	18	62	55	48	87	78	18
13	11	42	38	34	12	63	56	42	88	79	12
14	12	36	39	35	6	64	57	36	89	80	6
15	13	30	40	36	0	65	58	30	90	81	0
16	14	24	41	36	54	66	59	24	91	81	54
17	15	18	42	37	48	67	60	18	92	82	48
18	16	12	43	38	42	68	61	12	93	83	42
19	17	6	44	39	36	69	62	6	94	84	36
20	18	0	45	40	30	70	63	0	95	85	30
21	18	54	46	41	24	71	63	54	96	86	24
22	19	48	47	42	18	72	64	48	97	87	18
23	20	42	48	43	12	73	65	42	98	88	12
24	21	36	49	44	6	74	66	36	99	89	6
25	22	30	50	45	0	75	67	30	100	90	0

Table 7.13 Centisimal minutes and seconds to angle minutes and seconds

Centisimal minute c	Minute ′	Second ″	Centisimal minute c	Minute ′	Second ″	Centisimal second cc	Second ″	Centisimal second cc	Second ″
1	0	32.4	6	3	14.4	1	0.324	6	1.944
2	1	4.8	7	3	46.8	2	0.648	7	2.268
3	1	37.2	8	4	19.2	3	0.972	8	2.592
4	2	9.6	9	4	51.6	4	1.296	9	2.916
5	2	42.0	10	5	24.0	5	1.620	10	3.240

Table 7.13 Centisimal minutes and seconds to angle minutes and seconds (*Continued*)

Centisimal minute c	Minute ′	Second ″	Centisimal minute c	Minute ′	Second ″	Centisimal second ∝	Second ″	Centisimal second ∝	Second ″
11	5	56.4	56	30	14.4	11	3.564	56	18.144
12	6	28.8	57	30	46.8	12	3.888	57	18.468
13	7	1.2	58	31	19.2	13	4.212	58	18.792
14	7	33.6	59	31	51.6	14	4.536	59	19.116
15	8	6.0	60	32	24.0	15	4.860	60	19.440
16	8	38.4	61	32	56.4	16	5.184	61	19.764
17	9	10.8	62	33	28.8	17	5.508	62	20.088
18	9	43.2	63	34	1.2	18	5.832	63	20.412
19	10	15.6	64	34	33.6	19	6.156	64	20.736
20	10	48.0	65	35	6.0	20	6.480	65	21.060
21	11	20.4	66	35	38.4	21	6.804	66	21.384
22	11	52.8	67	36	10.8	22	7.128	67	21.708
23	12	25.2	68	36	43.2	23	7.452	68	22.032
24	12	57.6	69	37	15.6	24	7.776	69	22.356
25	13	30.0	70	37	48.0	25	8.100	70	22.680
26	14	24.0	71	38	20.4	26	8.424	71	23.004
27	14	34.8	72	38	52.8	27	8.748	72	23.328
28	15	7.2	73	39	25.2	28	9.072	73	23.652
29	15	39.6	74	39	57.6	29	9.396	74	23.976
30	16	1.2	75	40	30.0	30	9.720	75	24.300
31	16	44.4	76	41	2.4	31	10.044	76	24.624
32	17	16.8	77	41	34.8	32	10.368	77	24.948
33	17	49.2	78	42	7.2	33	10.692	78	25.272
34	18	21.6	79	42	39.6	34	11.016	79	25.596
35	18	54.0	80	43	12.0	35	11.340	80	25.920
36	19	26.4	81	43	44.4	36	11.664	81	26.244
37	19	58.8	82	44	16.8	37	11.988	82	26.568
38	20	31.2	83	44	49.2	38	12.312	83	26.892
39	21	3.6	84	45	21.6	39	12.636	84	27.216
40	21	36.0	85	45	54.0	40	12.960	85	27.540
41	22	8.4	86	46	26.4	41	13.284	86	27.864
42	22	40.8	87	46	58.8	42	13.608	87	28.188
43	23	13.2	88	47	31.2	43	13.932	88	28.512
44	23	45.6	89	48	3.6	44	14.256	89	28.836
45	24	18.0	90	48	36.0	45	14.580	90	29.160
46	24	50.4	91	49	8.4	46	14.904	91	29.484
47	25	22.8	92	49	40.8	47	15.228	92	29.808
48	25	55.2	93	50	13.2	48	15.552	93	30.132
49	26	27.6	94	50	45.6	49	15.876	94	30.456
50	27	0.0	95	51	18.0	50	16.200	95	30.780
51	27	32.4	96	51	50.4	51	16.524	96	31.104
52	28	4.8	97	52	22.8	52	16.848	97	31.428
53	28	37.2	98	52	55.2	53	17.172	98	31.752
54	29	9.6	99	53	27.6	54	17.496	99	32.076
55	29	42.0	100	54	0.0	55	17.820	100	32.400

Table 7.14 Decimal angle degrees to angle minutes and seconds

Degree °	Minute ′	Second ″	Degree °	Minute ′	Second ″	Degree °	Minute ′	Second ″
0.0001	0	0.36	0.21	12	36	0.61	36	36
0.0002	0	0.72	0.22	13	12	0.62	37	12
0.0003	0	1.08	0.23	13	48	0.63	37	48
0.0004	0	1.44	0.24	14	24	0.64	38	24
0.0005	0	1.80	0.25	15	0	0.65	39	0
0.0006	0	2.16	0.26	15	36	0.66	39	36
0.0007	0	2.52	0.27	16	12	0.67	40	12
0.0008	0	2.88	0.28	16	48	0.68	40	48
0.0009	0	3.24	0.29	17	24	0.69	41	24
0.0010	0	3.60	0.30	18	0	0.70	42	0
0.001	0	3.6	0.31	18	36	0.71	42	36
0.002	0	7.2	0.32	19	12	0.72	43	12
0.003	0	10.8	0.33	19	48	0.73	43	48
0.004	0	14.4	0.34	20	24	0.74	44	24
0.005	0	18.0	0.35	21	0	0.75	45	0
0.006	0	21.6	0.36	21	36	0.76	45	36
0.007	0	25.2	0.37	22	12	0.77	46	12
0.008	0	28.8	0.38	22	48	0.78	46	48
0.009	0	32.4	0.39	23	24	0.79	47	24
0.010	0	36	0.40	24	0	0.80	48	0
0.01	0	36	0.41	24	36	0.81	48	36
0.02	1	12	0.42	25	12	0.82	49	12
0.03	1	48	0.43	25	48	0.83	49	48
0.04	2	24	0.44	26	24	0.84	50	24
0.05	3	0	0.45	27	0	0.85	51	0
0.06	3	36	0.46	27	36	0.86	51	36
0.07	4	12	0.47	28	12	0.87	52	12
0.08	4	48	0.48	28	48	0.88	52	48
0.09	5	24	0.49	29	24	0.89	53	24
0.10	6	0	0.50	30	0	0.90	54	0
0.11	6	36	0.51	30	36	0.91	54	36
0.12	7	12	0.52	31	12	0.92	55	12
0.13	7	48	0.53	31	48	0.93	55	48
0.14	8	24	0.54	32	24	0.94	56	24
0.15	9	0	0.55	33	0	0.95	57	0
0.16	9	36	0.56	33	36	0.96	57	36
0.17	10	12	0.57	34	12	0.97	58	12
0.18	10	48	0.58	34	48	0.98	58	48
0.19	11	24	0.59	35	24	0.99	59	24
0.20	12	0	0.60	36	0	1.00	60	0

Table 7.15 Angle minutes and seconds to decimal degrees

Minute ′	Degree °	Minute ′	Degree °	Socond ″	Degree °	Socond ″	Degree °
1	0.016 667	31	0.516 667	1	0.000 278	31	0.008 611
2	0.033 333	32	0.533 333	2	0.000 556	32	0.008 889
3	0.050 000	33	0.550 000	3	0.000 833	33	0.009 167
4	0.066 667	34	0.566 667	4	0.001 111	34	0.009 444
5	0.083 333	35	0.583 333	5	0.001 389	35	0.009 722
6	0.100 000	36	0.600 000	6	0.001 667	36	0.010 000
7	0.116 667	37	0.616 667	7	0.001 994	37	0.010 278
8	0.133 333	38	0.633 333	8	0.002 222	38	0.010 556
9	0.150 000	39	0.650 000	9	0.002 500	39	0.010 833
10	0.166 667	40	0.666 667	10	0.002 778	40	0.011 111
11	0.183 333	41	0.683 333	11	0.003 056	41	0.011 389
12	0.200 000	42	0.700 000	12	0.003 333	42	0.011 667
13	0.216 667	43	0.716 667	13	0.003 611	43	0.011 994
14	0.233 333	44	0.733 333	14	0.003 889	44	0.012 222
15	0.250 000	45	0.750 000	15	0.004 167	45	0.012 500
16	0.266 667	46	0.766 667	16	0.004 444	46	0.012 778
17	0.283 333	47	0.783 333	17	0.004 722	47	0.013 056
18	0.300 000	48	0.800 000	18	0.005 000	48	0.013 333
19	0.316 667	49	0.816 667	19	0.005 278	49	0.013 611
20	0.333 333	50	0.833 333	20	0.005 556	50	0.013 889
21	0.350 000	51	0.850 000	21	0.005 833	51	0.014 167
22	0.366 667	52	0.866 667	22	0.006 111	52	0.014 444
23	0.383 333	53	0.883 333	23	0.006 389	53	0.014 722
24	0.400 000	54	0.900 000	24	0.006 667	54	0.015 000
25	0.416 667	55	0.916 667	25	0.006 944	55	0.015 278
26	0.433 333	56	0.933 333	26	0.007 222	56	0.015 556
27	0.450 000	57	0.950 000	27	0.007 500	57	0.015 833
28	0.466 667	58	0.966 667	28	0.007 778	58	0.016 111
29	0.483 333	59	0.983 333	29	0.008 056	59	0.016 389
30	0.500 000	60	1.000 000	30	0.008 333	60	0.016 667

The Beaufort Scale of Wind Forces (Symbol: Bf)

A group of numerical values ranging from 0 to 17 with the corresponding range of wind velocities is called the Beaufort Scale. Only Beaufort numbers 0–12 are used in navigation, while Beaufort numbers 13–17 are used for high altitudes. The approximate connection between the wind force in Beaufort numbers (Bf) and the corresponding wind velocity (v) is expressed in meters per second (m/s) by the equation:

$$v = 0.836\sqrt{\mathrm{Bf}^{\,3}}$$

The scale is also linked to the appropriate size of waves on the sea. It is used in meteorology and navigation.

It was named after the British admiral Sir Francis Beaufort (1774–1857).

Table 7.16. The Beaufort scale of wind forces on land

Bf	Name	Wind effects on land	Speed intervals for various wind forces		
			m/s	km/h	knots
0	Calm	Smoke rises vertically; flags and leaves are immobile.	<0.4	<1	<1
1	Light air	People do not feel it as yet; direction of wind shown by smoke but not by wind vanes.	0.4 ... 1.5	1 ... 5	1 ... 3
2	Light breeze	Leaves rustle, ordinary vanes are moved by wind.	1.6 ... 3.3	6 ... 11	4 ... 6
3	Gentle breeze	Leaves and small twigs are in constant motion, wind extends light flags.	3.4 ... 5.4	12 ... 19	7 ... 10
4	Moderate breeze	Raises dust, dry leaves and papers; small flags are extended; smaller branches are moved.	5.5 ... 7.9	20 ... 28	11 ... 16
5	Fresh breeze	Large branches and small trees in leaf begin to sway.	8.0 ... 10.7	29 ... 38	17 ... 21
6	Strong breeze	Large branches in motion, telegraph wires whistle, umbrellas are used with difficulty.	10.8 ... 13.8	39 ... 49	22 ... 27
7	Near gale	Whole trees are in motion, pedestrians experience an inconvenience in walking against wind.	13.9 ... 17.1	50 ... 61	28 ... 33
8	Gale	Breaks twigs off trees, generally impedes progress.	17.2 ... 20.7	62 ... 74	34 ... 40
9	Strong gale	Slight structural damage occurs, chimney pots and roofing-tiles are removed.	20.8 ... 24.4	75 ... 88	41 ... 47
10	Whole gale	Trees are uprooted, considerable structural damage occurs.	24.5 ... 28.4	89 ... 102	48 ... 55
11	Storm	Very rarely experienced, accompanied by widespread damage.	28.5 ... 32.6	103 ... 117	56 ... 63
12	Hurricane	Devastation.	32.7 ... 36.9	118 ... 133	64 ... 71
13			37.0 ... 41.4	134 ... 149	72 ... 80
14			41.5 ... 46.1	150 ... 166	81 ... 89
15			46.2 ... 50.9	167 ... 183	90 ... 99
16			51.0 ... 56.0	184 ... 201	100 ... 108
17			56.1 ... 61.2	202 ... 220	109 ... 118

$$1\ \text{knot} = \frac{1\ \text{nautical mile}}{\text{hour}} = \frac{1\ \text{n mile}}{\text{h}} = 1.852\ \text{km/h} = 1852\ \text{m/h}$$

$$1\ \text{foot} = 0.3048\ \text{meters (exactly)}$$

The Engler Degree (°E), the Saybolt Second (″S), the Redwood Second (″R) and the Centistock (cSt)

The following units of measurement for kinematic viscosity (especially of oils) are still in frequent use: the "Engler degree" (°E) in Central Europe, the "Saybolt second" (″S) in America and the "Redwood second" (″R) in Great Britain.

The Engler degree (symbol: °E) is a unit of measurement for kinematic viscosity. It

is measured using the Engler viscosimeter by means of measuring the time t required by a liquid of volume $V = 200\ cm^3$, and the time t_0 required by the same volume of distilled water (H_2O), to flow through the viscosimeter at a temperature of 20°C. The ratio t/t_0 is called the Engler viscosity $N = t/t_0$.

When the ratio $t/t_0 = 1$, i.e. when $t = t_0$, we say that the liquid has a viscosity of one Engler degree °E.

Distilled water at 20°C therefore has an Engler viscosity $N = 1$°E. It is named after the German chemist Engler (1842–1925).

The Saybolt universal second (symbol: "S) is an American unit of measurement for kinematic viscosity. It is determined by means of the Saybolt viscosimeter by measuring the time required for liquid (oil) with a volume of 60 cm^3 to flow through the viscosimeter at the temperature during measurement.

The Redwood second I (symbol: "R I) is an English unit of measurement for kinematic viscosity. It is determined by measuring the time required for a volume of 50 cm^3 of a liquid (oil) to flow through the Redwood viscosimeter.

The Redwood second II = 0.1 "R I, i.e. "R I ≈ 10 "R II.

The unit "R II is used for measuring the viscosity of heavy oils.

Table 7.17 Relationship between the Engler degree (°E), the Redwood second ("R), the Saybolt second ("S) and the centistokes (cSt)

°E	"R	"S at 99°C	cSt	°E	"R	"S at 99°C	cSt
1.0	–	–	1.0	11.0	341	391	84
1.1	–	33.7	1.82	11.5	357	409	88
1.2	–	36.3	2.82	12.0	369	423	91
1.3	34.8	38.8	3.92	12.5	384	441	96
1.4	37.7	42.5	5.08	13.0	401	460	99
1.5	40.8	46.6	6.25	13.5	418	474	103
1.6	44.1	49.9	7.41	14.0	427	491	106
1.8	50.7	57.6	9.66	14.5	446	512	110
2.0	57.8	66.4	11.8	15.0	465	535	114
2.5	74.5	86.0	16.8	15.5	472	540	117
3.0	88.8	103.1	21.1	16.0	487	560	121
3.5	103.6	121	25.4	16.5	507	584	126
4.0	121.1	140.2	29.5	17.0	527	604	130
4.5	137	158	33.4	17.5	543	615	133
5.0	153	176	37.4	18.0	546	646	136
5.5	169	194	41.3	18.5	568	653	140
6.0	184	212	45.1	19.0	587	674	144
6.5	199	229	49	19.5	595	688	148
7.0	215	246	53	20.0	605	695	151
7.5	231	265	57	20.5	630	725	156
8.0	246	283	61	21.0	648	744	160
8.5	260	300	64	21.5	664	758	164
9.0	276	318	68	22.0	673	788	167
9.5	292	335	72	22.5	692	794	171
10.0	308	354	76	23.0	709	814	175
10.5	325	372	80	23.5	728	830	179

Table 7.17 Relationship between the Engler degree (°E), the Redwood second (″R), the Saybolt second (″S) and the centistokes (cSt) *(Continued)*

°E	″R	″S at 99°C	cSt	°E	″R	″S at 99°C	cSt
24.0	739	850	183	75	2225	2630	560
24.5	753	871	186	80	2435	2800	603
25.0	769	884	190	85	2630	3040	650
30	920	1060	228	90	2800	3200	670
35	1075	1236	266	100	3050	3500	760
40	1225	1410	304	110	3350	3900	840
45	1380	1595	345	120	3700	4200	902
50	1539	1768	380	130	4000	4600	998
55	1700	1952	420	150	4700	5200	1160
60	1860	2135	458	170	5200	6000	1300
65	2021	2325	499	200	6100	7000	1500
70	2220	2500	520				

Table 7.18 The Relationship between the centistokes (cSt), the Engler degree (°E), the Redwood second (″R) and the Saybolt second (″S)

cSt	°E	″R	″S	cSt	°E	″R	″S
1.0	1.00	28.5		11.8	2.00	57.5	65.2
1.5	1.06	30.5		12.2	2.04	59	66.6
2.0	1.12	31	32.6	12.6	2.08	60	68.1
2.5	1.17	32	34.4	13.0	2.12	61	69.6
3.0	1.22	33	36.0	13.5	2.17	63	71.5
3.5	1.26	34.5	37.6	14.0	2.22	64.5	73.4
4.0	1.30	35.5	39.1	14.5	2.27	66	75.3
4.5	1.35	37	40.7	15.0	2.32	68	77.2
5.0	1.40	38	42.3	15.5	2.38	70	79.2
5.5	1.44	39.5	43.9	16.0	2.43	71.5	81.1
6.0	1.48	41	45.5	16.5	2.5	73	83.1
6.5	1.52	42	47.1	17.0	2.55	75	85.1
7.0	1.56	43.5	48.7	17.5	2.6	77	87.1
7.5	1.60	45	50.3	18.0	2.65	78.5	89.2
8.0	1.65	46	52.0	18.5	2.7	80	91.2
8.5	1.70	47.5	53.7	19.0	2.75	82	93.3
9.0	1.75	49	55.4	19.5	2.8	84	95.4
9.5	1.79	50.5	57.1	20.0	2.9	86	97.5
10.0	1.83	52	58.8	20.5	2.95	88	99.6
10.2	1.85	52.5	59.5	21.0	3.0	90	101.7
10.4	1.87	53	60.2	21.5	3.05	92	103.9
10.6	1.89	53.5	60.9	22.0	3.1	93	106.0
10.8	1.91	54.5	61.6	22.5	3.15	95	108.2
11.0	1.93	55	62.3	23.0	3.2	97	110.3
11.4	1.97	56	63.7	23.5	3.3	99	112.4

Table 7.18 Relationship between the centistokes (cSt), the Engler degree (°E), the Redwood second (″R) and the Saybolt second (″S) *(Continued)*

cSt	°E	″R	″S	cSt	°E	″R	″S
24.0	3.35	101	114.6	40	5.35	164	185.7
24.5	3.4	103	116.8	41	5.45	168	190.2
25	3.45	105	118.9	42	5.6	172	194.7
26	3.6	109	123.3	43	5.75	177	199.2
27	3.7	113	127.7	44	5.85	181	203.8
28	3.85	117	132.1	45	6.0	185	208.4
29	3.95	121	136.5	46	6.1	189	213.0
30	4.1	125	140.9	47	6.25	193	217.6
31	4.2	129	145.3	48	6.45	197	222.2
32	4.35	133	149.7	49	6.5	201	226.8
33	4.45	136	154.2	50	6.65	205	231.4
34	4.6	140	158.7	52	6.9	213	240.6
35	4.7	144	163.2	54	7.1	221	249.9
36	4.85	148	167.7	56	7.4	229	259.0
37	4.95	152	172.2	58	7.65	237	268.2
38	5.1	156	176.7	60	7.9	245	277.4
39	5.2	160	181.2	70			323.4

Table 7.19 Relationship between the units of measurement for kinematic viscosity that can be used for high levels of viscosity

Unit	Symbol	°E	cSt	″R I	″S
1 Engler degree	°E	1	0.132	0.0326	0.0285
1 centistokes	cSt	7.58	1	0.247	0.216
1 Redwood second	″RI	30.7	4.05	1	0.877
1 Saybolt second	″S	35.11	4.62	1.14	1

The Baumé Scale (°Bé)

The degree Baumé (symbol: °Bé) is a unit of the Baumé hydrometer scale, which indicates the density of liquids, acids and solutions, and in which 0° is the point to which the hydrometer sinks in water (H_2O) and 10° the point to which it sinks in a 10% solution of sodium chloride in water. The interval from 0 to 10 is divided into 10 equal parts and, in that way, the unit of the hydrometer scale, 1°Bé is obtained.

It is named after the French chemist Antoineu Baumé (1728–1804).

An example: sulfuric acid used for automobile batteries has a density of 32°Bé.

Table 7.20 Comparison of the values of the areometric Baumé scale and the values of liquid density in kg/dm³ at temperature 15°C

	°Bé	0	1	2	3	4	5	6	7	8	9
for	0	1.0000	1.0070	1.0141	1.0212	1.0285	1.0359	1.0434	1.0510	1.0587	1.0665
ρ >1 kg/dm³	10	1.0744	1.0825	1.0907	1.0990	1.1074	1.1160	1.1247	1.1335	1.1425	1.1516

Table 7.20 Comparison of the values of the areometric Baumé scale and the values of liquid density in kg/dm³ at temperature 15°C

	°Bé	0	1	2	3	4	5	6	7	8	9
for $\rho > 1$ kg/dm³	20	1.1609	1.1703	1.1799	1.1896	1.1995	1.2095	1.2197	1.2301	1.2407	1.2515
	30	1.2624	1.2736	1.2849	1.2964	1.3082	1.3202	1.3324	1.3448	1.3574	1.3703
	40	1.3834	1.3968	1.4105	1.4244	1.4386	1.4531	1.4679	1.4829	1.4983	1.5141
	50	1.5301	1.5465	1.5633	1.5804	1.5979	1.6158	1.6341	1.6528	1.6719	1.6915
	60	1.7116	1.7321	1.7532	1.7747	1.7968	1.8195	1.8427	1.8665	1.8910	1.9161
	70	1.9419	—	—	—	—	—	—	—	—	—

Example: areometric density 32°Be (for $\rho > 1$ kg/dm³) corresponds to density $\rho = 1.2849$ kg/dm³.

Table 7.20 Comparison of the values of the areometric Baumé scale and the values of liquid density in kg/dm³ at temperature 15°C *(Continued)*

	°Bé	0	1	2	3	4	5	6	7	8	9
for $\rho < 1$ kg/dm³	10	1.0000	0.9931	0.9863	0.9796	0.9730	0.9665	0.9601	0.9537	0.9475	0.9413
	20	0.9352	0.9292	0.9232	0.9174	0.9116	0.9058	0.9002	0.8946	0.8891	0.8837
	30	0.8783	0.8730	0.8677	0.8625	0.8574	0.8523	0.8473	0.8424	0.8375	0.8327
	40	0.8279	0.8232	0.8185	0.8139	0.8093	0.8048	0.8004	0.7959	0.7916	0.7873
	50	0.7830	0.7788	0.7746	0.7704	0.7664	0.7623	0.7583	0.7543	0.7504	0.7465
	60	0.7427	0.7389	0.7351	0.7314	0.7277	0.7241	0.7204	0.7169	0.7133	0.7098
	70	0.7063	0.7029	0.6995	0.6961	0.6928	0.6895	0.6862	0.6829	0.6797	0.6765
	80	0.6734	0.6703	0.6672	0.6641	0.6610	0.6580	0.6550	0.6521	0.6492	0.6463
	90	0.6434	—	—	—	—	—	—	—	—	—

Example: areometric density 50°Be (for $\rho < 1$ kg/dm³) corresponds to actual density $\rho = 0.783$ kg/dm³.

Table 7.21 Relationship of areometric densities of various scales to actual density ρ

	Name of scale	Temperature	Relationship to actual density ρ	
		°C	for $\rho > 1$ kg/dm³	for $\rho < 1$ kg/dm³
1	2	3	4	5
1	Balling	17.5	$\rho = \frac{200\ \text{kg/dm}^3}{200 - N}$	$\rho = \frac{200\ \text{kg/dm}^3}{200 + N}$
2	Baumé (rational)	15	$\rho = \frac{144.32\ \text{kg/dm}^3}{144.32 - N}$	$\rho = \frac{144.32\ \text{kg/dm}^3}{144.32 + N}$
3	Baumé (old)	17.5	$\rho = \frac{146.78\ \text{kg/dm}^3}{146.78 - N}$	$\rho = \frac{146.78\ \text{kg/dm}^3}{146.78 + N}$
4	Baumé (American)	15	$\rho = \frac{145\ \text{kg/dm}^3}{145 - N}$	$\rho = \frac{140\ \text{kg/dm}^3}{130 + N}$
5	Baumé (Dutch)	12.5	$\rho = \frac{144\ \text{kg/dm}^3}{144 - N}$	$\rho = \frac{144\ \text{kg/dm}^3}{144 + N}$
6	Beck	12.5	$\rho = \frac{170\ \text{kg/dm}^3}{170 - N}$	$\rho = \frac{170\ \text{kg/dm}^3}{170 + N}$

Table 7.21 Relationship of areometric densities of various scales to actual density ρ *(Continued)*

	Name of scale	Temperature °C	Relationship to actual density ρ for $\rho > 1\ kg/dm^3$	Relationship to actual density ρ for $\rho < 1 kg/dm^3$
1	2	3	4	5
7	Brix	15.625	$\rho = \frac{400\ kg/dm^3}{400 - N}$	$\rho = \frac{400\ kg/dm^3}{400 + N}$
8	Cartier	12.5	$\rho = \frac{136.8\ kg/dm^3}{126.1 - N}$	$\rho = \frac{136.8\ kg/dm^3}{126.1 + N}$
9	Stoppan	15.625	$\rho = \frac{166\ kg/dm^3}{166 - N}$	$\rho = \frac{166\ kg/dm^3}{166 + N}$
10	Twaddel (English)	15.56	$\rho = \left(1 + \frac{N}{200}\right)\frac{kg}{dm^3}$	—
11	American Petroleum Institute	15.56	—	$\rho = \frac{141.5\ kg/dm^3}{131.5 + N}$

$N = l/L$, l and L represent the depth to which the areometer is submerged.

Table 7.22 Decibels (dB) to nepers (Np)

db	0	1	2	3	4	5	6	7	8	9
0	—	0.1151	0.2302	0.3453	0.4604	0.5755	0.6906	0.8057	0.9208	1.0359
10	1.151	1.2661	1.3812	1.4963	1.6114	1.7265	1.8416	1.9567	2.0718	2.1869
20	2.302	2.4171	2.5322	2.6473	2.7624	2.8775	2.9226	3.1077	3.2228	3.3379
30	3.453	3.5681	3.6832	3.7983	3.9134	4.0285	4.1436	4.2587	4.3738	4.4889
40	4.604	4.7191	4.8342	4.9493	5.0644	5.1795	5.2946	5.4097	5.5248	5.6399
50	5.755	5.8701	5.9852	6.1003	6.2154	6.3305	6.4456	6.5607	6.6758	6.7909
60	6.906	7.0211	7.1362	7.2513	7.3664	7.4815	7.5966	7.7117	7.8268	7.9419
70	8.057	8.1721	8.2872	8.4023	8.5174	8.6325	8.7476	8.8627	8.9778	9.0929
80	9.208	9.3231	9.4382	9.5533	9.6684	9.7835	9.8986	10.0137	10.1288	10.2439
90	10.359	10.4741	10.5892	10.7043	10.8194	10.9345	11.0496	11.1647	11.2798	11.3949
100	11.510	11.6251	11.7402	11.8553	11.9704	12.0855	12.2006	12.3157	12.4308	12.5459
110	12.661	12.7761	12.8912	13.0063	13.1214	13.2365	13.3516	13.4667	13.5818	13.6969
120	13.812	13.9271	14.0422	14.1573	14.2724	14.3875	14.5026	14.6177	14.7328	14.8479

Example: 67 dB = 60 dB + 7 dB = 6.9060 Np + 0.8057 Np = 7.7117 Np.

Table 7.23 Nepers (Np) to decibels (dB)

dB	0	1	2	3	4	5	6	7	8	9
0	—	8.686	17.372	26.058	34.744	43.430	52.116	60.802	69.488	78.174
10	86.86	95.546	104.232	112.918	121.604	130.290	138.976	147.662	156.348	165.034
20	173.72	182.406	191.092	199.778	208.464	217.150	225.836	234.522	243.208	251.894
30	260.58	269.266	277.952	286.638	295.324	304.010	312.696	321.382	330.068	338.754
40	347.44	356.126	364.812	373.498	382.184	390.870	399.556	408.242	416.928	425.614

Table 7.23 Nepers (Np) to decibels (dB) *(Continued)*

dB	0	1	2	3	4	5	6	7	8	9
50	434.30	442.986	451.672	460.358	469.044	477.730	486.416	495.102	503.788	512.474
60	521.16	529.846	538.532	547.218	555.904	564.590	573.276	581.962	590.648	599.334
70	608.02	616.706	625.392	634.078	642.764	651.450	660.136	668.822	677.508	686.194
80	694.88	703.566	712.252	720.938	729.624	738.310	746.996	755.682	764.368	773.054
90	781.74	790.426	799.112	807.798	816.484	825.170	833.856	842.542	851.228	859.914
100	868.59	877.28	885.96	894.65	903.33	912.02	920.71	929.39	938.08	946.76
110	955.45	964.13	972.82	981.51	990.19	998.88	1007.56	1016.25	1024.94	1033.62
120	1042.31	1050.99	1059.68	1068.37	1077.05	1085.74	1094.42	1103.11	1111.79	1120.48

Example: 12 Np = 10 Np + 2 Np = 86.86 dB + 17.372 dB = 104.23 dB.

Table 7.24 Some characteristic temperature points

State	Temperature				
	K	°C	°Ré	°F	°R
absolute zero	0	−273.15	−218.52	−459.67	0
freezing point of pure water (H_2O)	273.15	0	0	+32	491.67
triple point of pure water (H_2O)	273.16	+0.01	+0.008	+32.0183	491.688
boiling point of pure water (H_2O)	373.15	+100	+80	+212	671.67

Table 7.25 Numerical equations that link various temperature scales

	K	°C	°Ré
	1	2	3
1	$\{T\}_K = \{t\}_{°C} + 273.15$	$\{t\}_{°C} = \{T\}_K - 273.15$	$\{t_R\}_{°Ré} = \frac{4}{5}[\{T\}_K - 273.15]$
2	$\{T\}_K = \frac{5}{4}\{t_R\}_{°Ré} + 273.15$	$\{t\}_{°C} = \frac{5}{4}\{t_R\}_{°Ré}$	$\{t_R\}_{°Ré} = \frac{4}{5}\{t\}_{°C}$
3	$\{T\}_K = \frac{5}{9}[\{t_F\}_{°F} + 459.67]$	$\{t\}_{°C} = \frac{5}{9}[\{t_F\}_{°F} - 32]$	$\{T_R\}_{°Ré} = \frac{4}{9}[\{t_F\}_{°F} - 32]$
4	$\{T\}_K = \frac{5}{9}\{t_R\}_{°R}$	$\{t\}_{°C} = \frac{5}{9}[\{T_R\}_{°R} - 491.67]$	$\{t_R\}_{°Ré} = \frac{4}{9}\{T_R\}_{°R} - 491.67$

Table 7.25 Numerical equation that link various temperature scales *(Continued)*

	°F	°R
	4	5
1	$\{t_F\}_{°F} = \frac{9}{5}\{T\}_K - 459.67$	$\{t_R\}_{°R} = \frac{9}{5}\{t\}_K$
2	$\{t_F\}_{°F} = \frac{9}{5}\{t\}_{°C} + 32$	$\{T_R\}_{°R} = \frac{9}{5}\{t\}_{°C} + 491.67$
3	$\{t_F\}_{°F} = \frac{9}{4}\{t_R\}_{°Ré} + 32$	$\{T_R\}_{°R} = \frac{9}{4}\{t_R\}_{°Ré} + 491.67$
4	$\{t_F\}_{°F} = \{T_R\}_{°R} - 459.67$	$\{T_R\}_{°R} = \{t\}_{°F} + 459.67$

The numerical equations link the numerical values $\{T\}_K$, $\{t\}_{°C}$, $\{t_R\}_{°Ré}$, $\{t_F\}_{°F}$ and $\{T_R\}_{°R}$ of the quantities T, t, t_R, t_F and T_R expressed in units K, °C, °Ré, °F and °R, i.e. $\{T\}_K = \frac{T}{K}$, $\{t\}_{°C} = \frac{1}{°C}$, $\{t_R\}_{°Ré} = \frac{t_R}{°Ré}$, $\{t_F\}_{°F} = \frac{t_F}{°F}$ and $\{T_R\}_{°R} = \frac{T_R}{°R}$, where T is the Kelvin temperature, t the Celsius temperature, t_R the Reaumur temperature, t_F the Fahrenheit temperature and T_R the Rankin temperature, while K is the unit of temperature Kelvin, °C Celsius degree, °Ré Réaumur degree, °F Fahrenheit degree and °R Rankin degree.

Example: Calculation of the value of the Fahrenheit temperature which corresponds to the state: t = 50°C, i.e. the numerical value of: $\{t\}_{°C} = \frac{t}{°C} = 50$. According to expression 2 in column 4 we obtain the Fahrenheit temperature $\{t_F\}_{°F} = \frac{9}{5}\{t\}_{°C} + 32 = \frac{9}{5}\cdot 50 + 32 = 9\cdot 10 + 32 = 122$. This means that $\{t_F\}_{°F} = \frac{t_F}{°F} = 122$, from which follows that t_F = 122°F.

Note: In Tables 7.24 and 7.25 the degree Réaumur is represented by the symbol °Ré in order to differentiate it from the symbol °R, which represents the degree Rankin.

Table 7.26 Degrees Celsius to degrees Fahrenheit

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
−20	−4.0	6	42.8	32	89.6	58	136.4	84	183.2
−19	−2.2	7	44.6	33	91.4	59	138.2	85	185.0
−18	−0.4	8	46.4	34	93.2	60	140.0	86	186.8
−17	+1.4	9	48.2	35	95.0	61	141.8	87	188.6
−16	3.2	10	50.0	36	96.8	62	143.6	88	190.4
−15	5.0	11	51.8	37	98.6	63	145.4	89	192.2
−14	6.8	12	53.6	38	100.4	64	147.2	90	194.0
−13	8.6	13	55.4	39	102.2	65	149.0	91	195.8
−12	10.4	14	57.2	40	104.0	66	150.8	92	197.6
−11	12.2	15	59.0	41	105.8	67	152.6	93	199.4
−10	14.0	16	60.8	42	107.6	68	154.4	94	201.2
−9	15.8	17	62.6	43	109.4	69	156.2	95	203.0
−8	17.6	18	64.4	44	111.2	70	158.0	96	204.8
−7	19.4	19	66.2	45	113.0	71	159.8	97	206.6
−6	21.2	20	68.0	46	114.8	72	161.6	98	208.4
−5	23.0	21	69.8	47	116.6	73	163.4	99	210.2
−4	24.8	22	71.6	48	118.4	74	165.2	100	212.0
−3	26.6	23	73.4	49	120.2	75	167.0	101	213.8
−2	28.4	24	75.2	50	122.0	76	168.8	102	215.6
−1	30.2	25	77.0	51	123.8	77	170.6	103	217.4
±0	32.0	26	78.8	52	125.6	78	172.4	104	219.2
1	33.8	27	80.6	53	127.4	79	174.2	105	221.0
2	35.6	28	82.4	54	129.2	80	176.0	106	222.8
3	37.4	29	84.2	55	131.0	81	177.8	107	224.6
4	39.2	30	86.0	56	132.8	82	179.6	108	226.4
5	41.0	31	87.8	57	134.6	83	181.4	109	228.2

Table 7.26 Degrees Celsius to degrees Fahrenheit *(Continued)*

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
110	230.0	144	291.2	178	352.4	320	608	1300	2372
111	231.8	145	293.0	179	354.2	330	626	1350	2462
112	233.6	146	294.8	180	356.0	340	644	1400	2552
113	235.4	147	296.6	181	357.8	350	662	1450	2642
114	237.2	148	298.4	182	359.6	360	680	1500	2732
115	239.0	149	300.2	183	361.4	370	698	1550	2822
116	240.8	150	302.0	184	363.2	380	716	1600	2912
117	242.6	151	303.8	185	365.0	390	734	1650	3002
118	244.4	152	305.6	186	366.8	400	752	1700	3092
119	246.2	153	307.4	187	368.6	410	770	1750	3182
120	248.0	154	309.2	188	370.4	420	788	1800	3272
121	249.8	155	311.0	189	372.2	430	806	1850	3362
122	251.6	156	312.8	190	374.0	440	824	1900	3452
123	253.4	157	314.6	191	375.8	450	842	1950	3542
124	255.2	158	316.4	192	377.6	460	860	2000	3632
125	257.0	159	318.2	193	379.4	470	878	2050	3722
126	258.8	160	320.0	194	381.2	480	896	2100	3812
127	260.6	161	312.8	195	383.0	490	914	2150	3902
128	262.4	162	323.6	196	384.8	500	932	2200	3992
129	264.2	163	325.4	197	386.6	550	1022	2250	4082
130	266.0	164	327.2	198	388.4	600	1112	2300	4172
131	267.8	165	329.0	199	390.2	650	1202	2350	4262
132	269.6	166	330.8	200	392	700	1292	2400	4352
133	271.4	167	332.6	210	410	750	1382	2450	4442
134	273.2	168	334.4	220	428	800	1472	2500	4532
135	275.0	169	336.2	230	446	850	1562	2550	4622
136	276.8	170	338.0	240	464	900	1652	2600	4712
137	278.6	171	339.8	250	482	950	1742	2650	4802
138	280.4	172	341.6	260	500	1000	1832	2700	4892
139	282.2	173	343.4	270	518	1050	1922	2750	4982
140	284.0	174	345.2	280	536	1100	2012	2800	5072
141	285.8	175	347.0	290	554	1150	2102	2850	5162
142	287.6	176	348.8	300	572	1200	2192	2900	5252
143	289.4	177	350.6	310	590	1250	2282	2950	5342

Example: −15°C = 5°F; 450°C = 842°F.

Interpolation factor

°C	1	2	3	4	5	6	7	8	9	10	20	30
°F	1.8	3.6	5.4	7.2	9	10.8	12.6	14.4	16.2	18	36	54

°C	40	50	60	70	80	90	100
°F	72	90	108	126	144	162	180

Table 7.27 Degrees Fahrenheit to degrees Celsius

°F	°C	°F	°C	°F	°C	°F	°C
−459.67	−273.15	23	−5.00	65	18.33	170	76.67
−400	−240.00	24	−4.44	66	18.89	180	82.22
−350	−212.22	25	−3.89	67	19.44	190	87.78
−328	−200.00	26	−3.30	68	20.00	200	93.33
−300	−184.44	27	−2.78	69	20.56	210	98.89
−250	−156.67	28	−2.22	70	21.11	220	104.44
−200	−128.89	29	−1.67	71	21.67	230	110.00
−150	−101.11	30	−1.11	72	22.22	240	115.56
−148	−100.00	31	−0.56	73	22.78	250	121.11
−100	−73.33	32	±0	74	23.33	260	126.67
−90	−67.78	33	0.56	75	23.89	270	132.22
−80	−62.22	34	1.11	76	24.44	280	137.78
−70	−56.67	35	1.67	77	25.00	290	143.33
−60	−51.11	36	2.22	78	25.56	300	148.89
−50	−45.56	37	2.78	79	26.11	310	154.44
−40	−40.00	38	3.33	80	26.67	320	160.00
−30	−34.44	39	3.89	81	27.22	330	165.56
−20	−28.89	40	4.44	82	27.78	340	171.11
−10	−23.33	41	5.00	83	28.33	350	176.67
±0	−17.78	42	5.56	84	28.89	360	182.22
1	−17.22	43	6.11	85	29.44	370	187.78
2	−16.67	44	6.67	86	30.00	380	193.33
3	−16.11	45	7.22	87	30.56	390	198.89
4	−15.56	46	7.78	88	31.11	400	204.44
5	−15.00	47	8.33	89	31.67	410	210.00
6	−14.44	48	8.89	90	32.22	420	215.56
7	−13.89	49	9.44	91	32.78	430	221.11
8	−13.33	50	10.00	92	33.33	440	226.67
9	−12.78	51	10.56	93	33.89	450	232.22
10	−12.22	52	11.11	94	34.44	460	237.78
11	−11.67	53	11.67	95	35.00	470	243.33
12	−11.11	54	12.22	96	35.56	480	248.89
13	−10.56	55	12.78	97	36.11	490	254.44
14	−10.00	56	13.33	98	36.67	500	260.00
15	−9.44	57	13.89	99	37.22	510	265.50
16	−8.89	58	14.44	100	37.78	520	271.11
17	−8.33	59	15.00	110	43.33	530	276.67
18	−7.78	60	15.56	120	48.89	540	282.22
19	−7.22	61	16.11	130	54.44	550	287.78
20	−6.67	62	16.67	140	60.00	560	293.33
21	−6.11	63	17.22	150	65.56	570	298.89
22	−5.56	64	17.78	160	71.11	580	304.44

Table 7.27 Degrees Fahrenheit to degrees Celsius *(Continued)*

°F	°C	°F	°C	°F	°C	°F	°C
590	310.00	800	426.67	1100	593.33	3200	1760.0
600	315.56	810	432.22	1200	648.89	3300	1815.6
610	321.11	820	437.78	1300	704.44	3400	1871.1
620	326.67	830	443.33	1400	760.00	3500	1926.7
630	332.22	840	448.89	1500	815.56	3600	1982.2
640	337.78	850	454.44	1600	871.11	3700	2037.8
650	343.33	860	460.00	1700	926.67	3800	2093.3
660	348.89	870	465.56	1800	982.22	3900	2148.9
670	354.44	880	471.11	1900	1037.8	4000	2204.4
680	360.00	890	476.67	2000	1093.3	4100	2260.0
690	365.56	900	482.22	2100	1148.9	4200	2315.6
700	371.11	910	487.78	2200	1204.4	4300	2371.1
710	376.67	920	493.33	2300	1260.0	4400	2426.7
720	382.22	930	498.89	2400	1315.6	4500	2482.2
730	387.78	940	504.44	2500	1371.1	4600	2537.8
740	393.33	950	510.00	2600	1426.7	4700	2593.3
750	398.89	960	515.56	2700	1482.2	4800	2648.9
760	404.44	970	521.11	2800	1537.8	4900	2704.4
770	410.00	980	526.67	2900	1593.3	5000	2760.0
780	415.56	990	532.22	3000	1648.9		
790	421.11	1000	537.78	3100	1704.4		

Interpolation factor

°F	1	2	3	4	5	6	7	8	9	10	20
°C	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.56	11.11

°F	30	40	50	60	70	80	90	100
°C	16.67	22.22	27.78	33.33	38.39	44.44	50.00	55.56

Example: –459.67°F = –273.15°C; 60°F = 15.56°C.

Note: When converting Celsius temperature to Fahrenheit temperature, and vice versa, the first value (in given examples 1000°C and 1000°F) must be read off from the tables in order to take into account the difference in the temperature scales, while the other values are determined by interpolation, as can be seen in the examples.

Example 7.26.1

Expression of the temperature of the melting point of copper (Cu) t = 1083°C in degrees Fahrenheit (°F).

According to Table 7.26: 1000°C = 1832°F, and by using interpolation:

80°C = 144°F and 3°C = 5.4°F

1083°C = 1000°C + 80°C + 3°C = 1832°F + 144°F = 5.4°F = 1981.4°F

Or by using the numerical equation in Table 7.25 line 2, column 4, we obtain the numerical value for the unit °F:

$$\{t_F\}_{°F} = \frac{9}{5}\{t\}_{°C} + 32 = \frac{9}{5}\cdot 1083 + 32 = 1949.4 + 32 = 1981.4$$

Since the numerical value is defined by the general expression: $\{t_F\} = \frac{t_F}{[t_F]}$, it follows that the temperature of the melting point of copper (Cu) in degrees Fahrenheit (°F) is:

$$t_F = \{t_F\}[t_F] = 1981.4°F$$

Example 7.27.1

Expression of the temperature of the melting point of copper (Cu) t_F = 1982°F in degrees Celsius (°C).

According to Table 7.27: 1000°F = 537.78°C, and by using interpolation:

900°F = 500°C, 80°F = 44.44°C and 2°F = 1.11°C

1982°F = 1000°F + 900°F + 80°F + 2°F =

= 537.78°C + 500°C +44.44°C + 1.11°C = 1083.33°C

Or by calculating by using the numerical equation in Table 7.25, line 3, column 2 we obtain the numerical value for the unit °C:

$$\{t\}_{°C} = \frac{5}{9}[\{t_F\}_{°F} - 32] = \frac{5}{9}[1982 - 32] = \frac{5}{9} \cdot 1950 = 1083.33.$$

Since the numerical value is defined by the general expression $\{t\} = \frac{t}{[t]}$, it follows that the temperature of the melting point of copper (Cu) in degrees Celsius (°C) is:

$$t = \{t\}[t] = 1083.33°C$$

It is obvious that in both Examples (7.26.1 and 7.27.1) we are dealing with the same state expressed in different units.

Table 7.28 Standard atomic weights of the elements

Element		Atomic number, proton number	Relative atomic mass (atomic weight)	Electron distribution by shells (K to Q)						
Name	Symbol	Z	A_r	K	L	M	N	O	P	Q
hydrogen	H	1	1.0079	1						
helium	He	2	4.002 60	2						
lithium	Li	3	6.941	2	1					
beryllium	Be	4	9.012 18	2	2					
boron	B	5	10.81	2	3					
carbon	C	6	12.011	2	4					
nitrogen	N	7	14.0067	2	5					
oxygen	O	8	15.9994	2	6					
fluorine	F	9	18.998 40	2	7					
neon	Ne	10	20.179	2	8					
sodium	Na	11	22.986 77	2	8	1				
magnesium	Mg	12	24.305	2	8	2				
aluminum	Al	13	26.981 54	2	8	3				
silicon	Si	14	28.086	2	8	4				
phosphorus	P	15	30.973 76	2	8	5				
sulfur	S	16	32.06	2	8	6				
chlorine	Cl	17	35.453	2	8	7				
argon	Ar	18	39.948	2	8	8				

Table 7.28 Standard atomic weights of the elements *(Continued)*

Element		Atomic number, proton number	Relative atomic mass (atomic weight)	Electron distribution by shells (K to Q)						
Name	Symbol	Z	A_r	K	L	M	N	O	P	Q
potassium	K	19	39.098	2	8	8	1			
calcium	Ca	20	40.08	2	8	8	2			
scandium	Sc	21	44.9559	2	8	9	2			
titanium	Ti	22	47.90	2	8	10	2			
vanadium	V	23	50.9414	2	8	11	2			
chromium	Cr	24	51.996	2	8	13	1			
manganese	Mn	25	54.9380	2	8	13	2			
iron	Fe	26	55.847	2	8	14	2			
cobalt	Co	27	58.9332	2	8	15	2			
nickel	Ni	28	58.71	2	8	16	2			
copper	Cu	29	63.546	2	8	18	1			
zinc	Zn	30	65.38	2	8	18	2			
gallium	Ga	31	69.72	2	8	18	3			
germanium	Ge	32	72.59	2	8	18	4			
arsenic	As	33	74.9216	2	8	18	5			
selenium	Se	34	78.96	2	8	18	6			
bromine	Br	35	79.904	2	8	18	7			
krypton	Kr	36	83.80	2	8	18	8			
rubidium	Rb	37	85.4678	2	8	18	8	1		
strontium	Sr	38	87.62	2	8	18	8	2		
yttrium	Y	39	88.9059	2	8	18	9	2		
zirconium	Zr	40	91.22	2	8	18	10	2		
niobium	Nb	41	92.9064	2	8	18	12	1		
molybdenum	Mo	42	95.94	2	8	18	13	1		
technetium	Tc	43	98.9062	2	8	18	14	1		
ruthenium	Ru	44	101.07	2	8	18	15	1		
rhodium	Rh	45	102.9055	2	8	18	16	1		
palladium	Pd	46	106.4	2	8	18	18	0		
silver	Ag	47	107.868	2	8	18	18	1		
cadmium	Cd	48	112.40	2	8	18	18	2		
indium	In	49	114.82	2	8	18	18	3		
tin	Sn	50	118.69	2	8	18	18	4		
antimony	Sb	51	121.75	2	8	18	18	5		
tellurium	Te	52	127.60	2	8	18	18	6		
iodine	I (J)	53	126.9045	2	8	18	18	7		
xenon	Xe	54	131.30	2	8	18	18	8		
cesium	Cs	55	132.9054	2	8	18	18	8	1	
barium	Ba	56	137.34	2	8	18	18	8	2	
lanthanum	La	57	138.9055	2	8	18	18	9	2	
cerium	Ce	58	140.12	2	8	18	19	9	2	
praseodymium	Pr	59	140.9077	2	8	18	21	8	2	
neodymium	Nd	60	144.24	2	8	18	22	8	2	
promethium	Pm	61	145.0	2	8	18	23	8	2	

Table 7.28 Standard atomic weights of the elements *(Continued)*

Element		Atomic number, proton number	Relative atomic mass (atomic weight)	Electron distribution by shells (K to Q)						
Name	Symbol	Z	A_r	K	L	M	N	O	P	Q
samarium	Sm	62	150.45	2	8	18	24	8	2	
europium	Eu	63	151.96	2	8	18	25	8	2	
gadolinium	Gd	64	157.25	2	8	18	25	9	2	
terbium	Tb	65	158.9254	2	8	18	27	8	2	
dysprosium	Dy	66	162.50	2	8	18	28	8	2	
holmium	Ho	67	164.9304	2	8	18	29	8	2	
erbium	Er	68	167.26	2	8	18	30	8	2	
thulium	Tm	69	168.9342	2	8	18	31	8	2	
ytterbium	Yb	70	173.04	2	8	18	32	8	2	
lutetium	Lu	71	174.97	2	8	18	32	9	2	
hafnium	Hf	72	178.49	2	8	18	32	10	2	
tantalum	Ta	73	180.9479	2	8	18	32	11	2	
tungsten	W	74	183.85	2	8	18	32	12	2	
rhenium	Re	75	186.2	2	8	18	32	13	2	
osmium	Os	76	190.2	2	8	18	32	14	2	
iridium	Ir	77	192.22	2	8	18	32	15	2	
platinum	Pt	78	195.09	2	8	18	32	17	1	
gold	Au	79	196.9665	2	8	18	32	18	1	
mercury	Hg	80	200.59	2	8	18	32	18	2	
thallium	Tl	81	204.37	2	8	18	32	18	3	
lead	Pb	82	207.2	2	8	18	32	18	4	
bismuth	Bi	83	208.9804	2	8	18	32	18	5	
polonium	Po	84	209.0	2	8	18	32	18	6	
astatine	At	85	210.0	2	8	18	32	18	7	
radon	Rn	86	222.0	2	8	18	32	18	8	
francium	Fr	87	223.0	2	8	18	32	18	8	1
radium	Ra	88	226.0254	2	8	18	32	18	8	2
actinium	Ac	89	227.0	2	8	18	32	18	9	2
thorium	Th	90	232.038	2	8	18	32	18	10	2
protactinium	Pa	91	231.0359	2	8	18	32	20	9	2
uranium	U	92	238.029	2	8	18	32	21	9	2
neptunium	Np	93	237.0482	2	8	18	32	22	9	2
plutonium	Pu	94	244	2	8	18	32	24	8	2
americium	Am	95	243	2	8	18	32	25	8	2
curium	Cm	96	247	2	8	18	32	25	9	2
berkelium	Bk	97	247	2	8	18	32	26	9	2
californium	Cf	98	251	2	8	18	32	28	8	2
einsteinium	Es	99	254	2	8	18	32	29	8	2
fermium	Fm	100	257	2	8	18	32	30	8	2
mendelevium	Md	101	258	2	8	18	32	31	8	2
nobelium	No	102	255	2	8	18	32	32	8	2
lawrencium	Lr (Lw)	103	256	2	8	18	32	32	9	2
unnilquadium	Ku	104	261	2	8	18	32	32	10	2
unnilpentium		105		2	8	18	32	32	11	2