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Viscosities of Sucrose Solutions at Various Temperatures: Tables of Recalculated Values

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Viscosities of Sucrose Solutions at Various Temperatures: Tables of Recalculated Values[1]

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The tables of viscosities of sucrose solutions appearing in NBS Circular 440 were calculated, assuming the value of the viscosity of water at 20° C to be 1.0050 centipoises. Subsequently, a redetermination of the absolute viscosity of water at 20° C established the value 1.0020 centipoises. In addition, more precise values have been obtained for the calibration constants of the viscometers used in the original measurements of sucrose solutions upon which the tables were largely based. Incorporating these more precise values, the above tables have been recalculated.

At the Eleventh Session of the International Commission for Uniform Methods of Sugar Analysis at Paris, 1954, the report on Subject 19 presented by the Referee, A. Van Hook [1],[2] called attention to the determination of the viscosity of water at 20° C at the National Bureau of Standards [2]. This value 0.01002 poise has been adopted by the National Bureau of Standards, the American Society for Testing Materials, the National Physical Laboratory in England, and the Physikalische-Technische Bundesanstalt in Germany. The Referee's report also pointed out the desirability of a standard set of viscosity values of sucrose solutions.

A discussion of the subject of viscosity of sucrose solutions is given in chapter XXI of reference [3]. In the chapter, reference is made to the work of Bingham and Jackson [4] and to Landt's comprehensive review [5] of all data published up to 1936 and his comparison of this with the experimental values on solutions containing 60 to 84 percent of sucrose.

The lack of agreement disclosed by this review [5], together with indirect evidence that some of the interpolated values given by Bingham and Jackson [4] were in error by several percent, led to a further investigation at NBS by J. F. Swindells, R. F. Jackson, and C. S. Cragoe [3, p. 357]. The values obtained in this study were used as the major basis for the calculation of tables 130, 131, and 132, pages 671 to 673 in Circular 440 [3]. Viscosity measurements were made over the range 0° to 35° C on solutions containing 30, 40, 50, 60, 65, 70, and 75 percent of sucrose by weight in vacuum. These solutions were initially prepared with a precision of better than 0.001 percent in the concentration, using sucrose of the highest purity. Changes in the initial concentration during the filling of the viscometers were minimized by special precautions described in chapter XXI [3]. Three instruments similar to the one described by Bingham and Jackson [4] were employed with capillaries of different diameters. The instrument with the smallest capillary was calibrated with water at 20° C, assuming the value 1.0050 centipoises. The calibrations of the other instruments were carried out with several liquids of higher viscosity in a step-by-step process. Drainage errors were eliminated by always flowing the liquids into a dry bulb. A separate sample was used for each viscosity determination. At least two measurements, usually agreeing to 0.1 percent or better, were made at each

[1] Supersedes tables 130, 131, 132, and 133 of National Bureau of Standards Circular 440, Polarimetry, saccharimetry, and the sugars (1942).

[2] Figures in brackets indicate the literature references on page 3.

temperature, which was adjusted to the desired integral temperature (indicated by a platinum resistance thermometer) and usually maintained constant to less than 0.01° C. The very precise measurements by Jones and Stauffer [9] of the viscosity of 20-percent-sucrose solutions at 25° C were used as the primary basis for the fixation of the viscosity values for 20-percent solutions. The values above 35° C were based largely on the results of Bingham and Jackson [4], Landt [5], and Bennett and Nees [6].

In all of the above data, the value of the viscosity of water at 20° C (0.01005 poise) accepted at that time (1942) was used. The acceptance of this value was deemed feasible because at that time the value 0.01005 was generally employed. However, during the period 1938 to 1941, an investigation of the viscosity of water at 20° C and other temperatures was in progress at NBS by Coe and Godfrey, who reported the tentative value 0.010020 poise at 20° C in a letter to the editor of the Journal of Applied Physics [7]. It was recognized, however, that with the completion of so small a part of the contemplated series of measurements of water, the statement of this tentative value at that time was justified only by the necessity of indefinitely suspending the work. The work was resumed in 1947 by J. F. Swindells, who completed the experimental program and reduced all the data. The final result of the completed determination was found to be 0.010019 $\pm$0.000003 poise. The magnitude of the uncertainty in this value is such that the simpler value of 0.010020 poise at 20° C has been adopted.

During this latter period, 1947 to 1952, a critical study was in progress, which was related to the precise measurement of viscosity and included a detailed investigation of the constants of the identical viscometers used in the work of Swindells, Jackson, and Cragoe, which was the major basis for tables 130, 131, 132 of NBS Circ. 440 [8].

The recalculation of tables 130, 131, and 132 has been made by using the more precise values for viscometer constants and the new value for the viscosity of water at 20° C (i. e., 0.010020 poise). Data of other investigators, which were considered in arriving at the tabulated values in table 133, were adjusted to the new basis by application of the factor, 0.997015, which represents the ratio of the new to the old value for the viscosity of water at 20° C.

It is recommended that the revised tables for the viscosities of sucrose solutions at various temperatures, presented in this Supplement, be substituted for the original tables in Circular 440.

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[2] J. F. Swindells, J. R. Coe, Jr., and T. B. Godfrey, J. Research NBS **48,** 1 (1952) RP2279.

[3] Polarimetry, saccharimetry, and the sugars, NBS Circ. 440, p. 350 (1942). (Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price $4.25).

[4] E. C. Bingham and R. F. Jackson, Bul. BS **14,** 59 (1917) S298.

[5] E. Landt, Z. Wirtscharftsgruppe Zuckerind. **85,** 395 (1935); **86,** 8 (1936); Zucker **6,** 558 (1953); **7,** 214 (1954).

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[7] J. R. Coe and T. B. Godfrey, J. Appl. Phys. **15,** 625 (1944).

[8] J. F. Swindells, R. C. Hardy, and R. L. Cottington, J. Research NBS **52,** 105 (1954) RP2479

[9] G. Jones and R. E. Stauffer, J. Am. Chem. Soc. **59,** 1630 (1937).

ADDITIONAL REFERENCE

H. Breitung, Z. Zuckerind., Berlin, **6,** 185, 254 (1956).

TABLE 130 (revised 1957). *Viscosity, in Centipoises, of Sucrose Solutions*

For use in the calibration of viscometers, especially for the measurements of solutions of sugars and sugar products. These values are based upon measurements made at the National Bureau of Standards on solutions containing 30, 40, 50, 60, 65, and 70 percent of sucrose by weight in vacuum, using the value 1.0020 centipoises for water at 20° C and are estimated to be accurate to about 0.1 percent

Sucrose by weight in vacuum	°C										
	15	16	17	18	19	20	21	22	23	24	25
%											
20	2.254	2.186	2.122	2.060	2.002	1.945	1.890	1.839	1.789	1.741	1.695
1	2.357	2.286	2.218	2.153	2.091	2.031	1.974	1.920	1.867	1.817	1.769
2	2.469	2.393	2.322	2.253	2.187	2.124	2.064	2.006	1.951	1.897	1.846
3	2.589	2.509	2.433	2.360	2.290	2.224	2.160	2.099	2.040	1.985	1.931
4	2.719	2.633	2.553	2.475	2.402	2.331	2.264	2.199	2.137	2.078	2.021
5	2.859	2.768	2.683	2.601	2.522	2.447	2.376	2.307	2.241	2.178	2.118
6	3.010	2.915	2.823	2.736	2.652	2.573	2.496	2.424	2.354	2.287	2.223
7	3.175	3.072	2.975	2.881	2.793	2.708	2.627	2.550	2.475	2.404	2.336
8	3.352	3.243	3.139	3.040	2.945	2.855	2.768	2.686	2.606	2.531	2.459
9	3.546	3.430	3.318	3.212	3.111	3.015	2.922	2.834	2.750	2.668	2.592
30	3.757	3.632	3.513	3.400	3.290	3.187	3.089	2.995	2.904	2.818	2.735
1	3.988	3.854	3.726	3.603	3.487	3.376	3.270	3.169	3.072	2.980	2.892
2	4.239	4.095	3.957	3.826	3.700	3.581	3.467	3.359	3.255	3.156	3.062
3	4.515	4.359	4.211	4.069	3.934	3.806	3.684	3.567	3.455	3.348	3.246
4	4.818	4.650	4.489	4.336	4.191	4.052	3.920	3.793	3.673	3.559	3.448
5	5.154	4.971	4.797	4.631	4.473	4.323	4.180	4.043	3.913	3.789	3.670
6	5.524	5.325	5.135	4.956	4.785	4.621	4.466	4.318	4.177	4.043	3.914
7	5.933	5.716	5.511	5.314	5.127	4.950	4.782	4.621	4.468	4.321	4.182
8	6.389	6.152	5.926	5.712	5.508	5.315	5.130	4.955	4.788	4.629	4.476
9	6.895	6.634	6.388	6.152	5.930	5.718	5.517	5.325	5.142	4.968	4.803
40	7.463	7.176	6.904	6.646	6.401	6.167	5.947	5.736	5.536	5.345	5.164
1	8.102	7.785	7.483	7.198	6.928	6.671	6.426	6.195	5.974	5.765	5.565
2	8.821	8.468	8.133	7.818	7.518	7.234	6.965	6.708	6.465	6.234	6.014
3	9.630	9.238	8.866	8.514	8.181	7.867	7.567	7.284	7.015	6.759	6.515
4	10.55	10.11	9.694	9.300	8.929	8.579	8.246	7.931	7.631	7.347	7.077
5	11.59	11.09	10.63	10.19	9.775	9.383	9.010	8.660	8.336	8.011	7.710
6	12.77	12.21	11.69	11.20	10.73	10.30	9.877	9.484	9.112	8.758	8.423
7	14.12	13.49	12.91	12.36	11.83	11.33	10.86	10.42	10.00	9.606	9.231
8	15.67	14.96	14.30	13.66	13.08	12.51	11.98	11.49	11.01	10.57	10.15
9	17.47	16.65	15.89	15.17	14.51	13.87	13.28	12.71	12.17	11.68	11.20
50	19.53	18.61	17.74	16.92	16.15	15.43	14.75	14.11	13.50	12.94	12.40
1	21.94	20.88	19.89	18.94	18.07	17.24	16.46	15.73	15.04	14.40	13.78
2	24.76	23.53	22.38	21.31	20.29	19.34	18.45	17.60	16.82	16.07	15.37
3	28.08	26.65	25.32	24.07	22.89	21.79	20.76	19.80	18.88	18.03	17.23
4	32.00	30.33	28.77	27.31	25.95	24.68	23.47	22.36	21.30	20.32	19.39
5	36.65	34.69	32.87	31.16	29.57	28.07	26.68	25.38	24.15	23.00	21.93
6	42.23	39.92	37.76	35.75	33.87	32.12	30.49	28.96	27.53	26.18	24.92
7	48.96	46.21	43.64	41.25	39.03	36.95	35.03	33.22	31.53	29.96	28.48
8	57.12	53.83	50.75	47.90	45.25	42.78	40.49	38.34	36.34	34.47	32.73
9	67.12	63.13	59.43	56.00	52.81	49.84	47.09	44.53	42.13	39.91	37.83
60	79.49	74.62	70.10	65.93	62.07	58.49	55.16	52.08	49.20	46.52	40.03
1	94.91	88.91	83.38	78.27	73.54	69.16	65.10	61.35	57.86	54.61	51.60
2	114.3	106.8	99.66	93.65	87.82	82.42	77.45	72.83	68.57	64.60	60.92
3	138.9	129.6	120.9	113.1	105.8	99.08	92.90	87.19	81.92	77.02	72.49
4	170.4	158.6	147.6	137.7	128.6	120.1	112.4	105.2	98.70	92.62	87.00
5	211.3	196.1	182.2	169.5	157.8	147.2	137.3	128.3	120.1	112.4	105.4
6	264.9	245.2	227.2	210.8	195.8	182.0	169.5	158.0	147.4	137.7	128.8
7	336.3	310.3	286.7	265.1	245.7	227.8	211.5	196.6	183.0	170.5	159.1
8	432.6	397.7	366.3	337.8	312.0	288.5	267.1	247.6	229.8	213.5	198.7
9	564.0	517.0	474.5	436.1	401.5	370.1	341.6	315.7	292.1	270.7	251.1
70	746.9	682.2	623.9	571.5	524.2	481.6	443.1	408.2	376.5	347.7	321.6
1	1006.	914.9	833.5	760.6	695.2	636.3	583.4	535.5	492.3	453.2	417.8
2	1379.	1249.	1133.	1030.	937.7	854.9	780.6	714.0	654.0	599.9	551.0
3	1929.	1740.	1571.	1421.	1288.	1170.	1064.	968.8	883.8	807.4	738.9
4	2759.	2475.	2223.	2002.	1805.	1631.	1478.	1340.	1216.	1107.	1009.
5	4039.	3603.	3220.	2884.	2588.	2328.	2097.	1893.	1711.	1549.	1405.

TABLE 131 (revised 1957). *Viscosity of Sucrose Solutions at 20° C Relative to Water* (η/η_{H_2O})

Values below 20 percent are calculated by the equation $\log \eta/\eta_{H_2O}=1.089\ x/1-x+0.395x^2$; those values 20 to 75 percent are calculated from the 20° C values in table 130 by multiplying by the factor 1.0000/1.0020, or 0.998004.

Sucrose		Sucrose		Sucrose	
%		%		%	
0	1.000				
1	1.026	26	2.568	51	17.20
2	1.053	27	2.703	52	19.30
3	1.082	28	2.849	53	21.75
4	1.112	29	3.009	54	24.63
5	1.144	30	3.181	55	28.02
6	1.177	31	3.369	56	32.06
7	1.213	32	3.574	57	36.88
8	1.251	33	3.798	58	42.69
9	1.291	34	4.044	59	49.74
10	1.333	35	4.314	60	58.37
11	1.378	36	4.612	61	69.03
12	1.426	37	4.940	62	82.26
13	1.477	38	5.304	63	98.88
14	1.531	39	5.707	64	119.9
15	1.589	40	6.15	65	146.9
16	1.650	41	6.66	66	181.7
17	1.716	42	7.22	67	227.3
18	1.786	43	7.85	68	287.9
19	1.861	44	8.56	69	369.4
20	1.941	45	9.36	70	480.6
21	2.027	46	10.28	71	635.0
22	2.120	47	11.31	72	853.2
23	2.220	48	12.49	73	1168.
24	2.326	49	13.84	74	1628.
25	2.442	50	15.40	75	2323.

TABLE 132 (revised 1957). *Viscosity, in Centipoises, of Sucrose Solutions From 0° to 40° C in 5-Degree Intervals*

These values are based on the same measurements employed in table 130. The values are extrapolated below the temperature range of the measurements. Above 35° C the tabulated values are based largely on the results of Bingham and Jackson [4], Landt [5], and Bennett and Nees [6].

Sucrose by weight in vacuum	° C								
	0	5	10	15	20	25	30	35	40
%									
20	3.782	3.137	2.642	2.254	1.945	1.695	1.493	1.325	1.184
1	3.977	3.293	2.768	2.357	2.031	1.769	1.555	1.379	1.231
2	4.187	3.460	2.904	2.469	2.124	1.846	1.622	1.436	1.281
3	4.415	3.642	3.050	2.589	2.224	1.931	1.692	1.497	1.333
4	4.661	3.838	3.208	2.719	2.331	2.021	1.769	1.563	1.390
5	4.931	4.051	3.380	2.859	2.447	2.118	1.852	1.634	1.451
6	5.223	4.282	3.565	3.010	2.573	2.223	1.941	1.709	1.516
7	5.542	4.533	3.767	3.175	2.708	2.336	2.037	1.791	1.587
8	5.889	4.807	3.986	3.352	2.855	2.459	2.140	1.880	1.663
9	6.271	5.107	4.225	3.546	3.015	2.592	2.251	1.974	1.744
30	6.692	5.435	4.487	3.757	3.187	2.735	2.373	2.078	1.833
1	7.148	5.794	4.772	3.988	3.376	2.892	2.504	2.188	1.927
2	7.653	6.187	5.084	4.239	3.581	3.062	2.645	2.306	2.029
3	8.214	6.623	5.428	4.515	3.806	3.246	2.799	2.437	2.141
4	8.841	7.106	5.808	4.818	4.052	3.448	2.967	2.578	2.260
5	9.543	7.645	6.230	5.154	4.323	3.670	3.150	2.732	2.390
6	10.31	8.234	6.693	5.524	4.621	3.914	3.353	2.901	2.532
7	11.19	8.904	7.212	5.933	4.950	4.182	3.573	3.083	2.687
8	12.17	9.651	7.791	6.389	5.315	4.476	3.815	3.285	2.856
9	13.27	10.49	8.436	6.895	5.718	4.803	4.082	3.506	3.039
40	14.55	11.44	9.166	7.463	6.167	5.164	4.375	3.747	3.241
1	16.00	12.53	9.992	8.102	6.671	5.565	4.701	4.014	3.461
2	17.67	13.76	10.93	8.821	7.234	6.014	5.063	4.310	3.706
3	19.58	15.17	11.98	9.630	7.867	6.515	5.467	4.639	3.977
4	21.76	16.77	13.18	10.55	8.579	7.077	5.917	5.004	4.277
5	24.29	18.60	14.55	11.59	9.383	7.710	6.421	5.412	4.611
6	27.22	20.72	16.11	12.77	10.30	8.423	6.988	5.869	4.983
7	30.60	23.15	17.91	14.12	11.33	9.231	7.628	6.381	5.400
8	34.56	25.99	19.98	15.67	12.51	10.15	8.350	6.960	5.868
9	39.22	29.30	22.39	17.47	13.87	11.20	9.171	7.613	6.395
50	44.74	33.18	25.21	19.53	15.43	12.40	10.11	8.358	6.991
1	51.29	37.76	28.48	21.94	17.24	13.78	11.18	9.203	7.669
2	59.11	43.18	32.34	24.76	19.34	15.37	12.41	10.17	8.439
3	68.51	49.64	36.91	28.08	21.79	17.23	13.84	11.28	9.321
4	79.92	57.42	42.38	32.00	24.68	19.39	15.49	12.57	10.34
5	93.86	66.82	48.90	36.65	28.07	21.93	17.42	14.06	11.50
6	111.0	78.27	56.79	42.23	32.12	24.92	19.68	15.80	12.86
7	132.3	92.35	66.39	48.96	36.95	28.48	22.35	17.83	14.44
8	159.0	109.5	78.15	57.12	42.78	32.73	25.51	20.22	16.29
9	192.5	131.5	92.70	67.12	49.84	37.83	29.28	23.06	18.46
60	235.7	159.1	110.9	79.49	58.49	44.03	33.82	26.46	21.04
1	291.6	194.2	133.8	94.91	69.16	51.60	39.32	30.53	24.11
2	364.6	239.5	163.0	114.3	82.42	60.92	46.02	35.45	27.80
3	461.6	298.6	200.4	138.9	99.08	72.49	54.27	41.46	32.26
4	591.5	376.5	249.0	170.4	120.1	87.00	64.48	48.84	37.69
5	767.7	480.7	313.1	211.3	147.2	105.4	77.29	57.97	44.36
6	[a] 1013.	[a] 621.9	[a] 398.5	264.9	182.0	128.8	93.45	69.40	52.61
7	[a] 1355.	[a] 816.1	[a] 513.7	336.3	227.8	159.1	114.1	83.82	62.94
8	[a] 1846.	[a] 1088.	[a] 672.1	432.6	288.5	198.7	140.7	102.3	75.97
9	[a] 2561.	[a] 1476.	[a] 892.5	564.0	370.1	251.1	175.6	126.0	92.58
70	[a] 3628.	[a] 2038.	[a] 1206.	746.9	481.6	321.6	221.6	157.0	114.0
1	[a] 5253.	[a] 2871.	[a] 1658.	[a] 1006.	636.3	417.8	283.4	198.0	142.0
2	[a] 7792.	[a] 4136.	[a] 2329.	[a] 1379.	854.9	551.0	367.6	253.0	178.9
3	[a] 11876.	[a] 6103.	[a] 3340.	[a] 1929.	1170.	738.9	484.3	327.9	228.5
4	[a] 18639.	[a] 9245.	[a] 4906.	[a] 2759.	1631.	1009.	648.5	431.6	296.0
5	[a] [b] 30207.	[a] 14428.	[a] 7402.	[a] 4039.	2328.	1405.	884.8	577.4	389.5

[a] Values extrapolated below the temperature range of the measurements.
[b] In the original table in C440, p. 673, the tabulated value for 75% at 0° C (31,410) was incorrect. It should have been 30,420.

TABLE 133 (revised 1957). *Viscosity, in Centipoises, of Sucrose Solutions, From 45° to 80° C in 5-Degree Intervals*

The tabulated values are based on the results of Bingham and Jackson [4], Landt [5], and Bennett and Nees [6].

Sucrose by weight in vacuum	° C							
	45	50	55	60	65	70	75	80
%								
20	1.07	0.97	0.88	0.81	0.74	0.68	0.63	0.59
1	1.11	1.00	.91	.84	.77	.71	.65	.61
2	1.15	1.04	.95	.87	.79	.73	.68	.63
3	1.20	1.09	.98	.90	.82	.76	.70	.65
4	1.25	1.13	1.02	.93	.85	.79	.73	.67
5	1.30	1.17	1.06	.97	.89	.82	.75	.70
6	1.36	1.22	1.11	1.01	.92	.85	.78	.72
7	1.42	1.28	1.16	1.05	.96	.88	.81	.75
8	1.49	1.34	1.21	1.10	1.00	.92	.85	.78
9	1.56	1.40	1.26	1.14	1.04	.96	.88	.81
30	1.64	1.47	1.32	1.20	1.09	1.00	.92	.85
1	1.71	1.54	1.38	1.25	1.14	1.04	.96	.88
2	1.80	1.61	1.45	1.31	1.19	1.09	1.00	.92
3	1.89	1.69	1.52	1.37	1.25	1.14	1.04	.96
4	2.00	1.78	1.60	1.44	1.31	1.19	1.09	1.00
5	2.11	1.87	1.67	1.51	1.37	1.25	1.14	1.05
6	2.23	1.98	1.76	1.59	1.44	1.31	1.19	1.10
7	2.36	2.09	1.86	1.67	1.51	1.37	1.25	1.15
8	2.51	2.21	1.97	1.76	1.59	1.44	1.31	1.20
9	2.67	2.35	2.08	1.86	1.67	1.52	1.38	1.26
40	2.84	2.49	2.21	1.97	1.76	1.60	1.45	1.32
1	3.02	2.65	2.34	2.08	1.86	1.68	1.53	1.39
2	3.23	2.82	2.49	2.21	1.97	1.77	1.61	1.46
3	3.45	3.01	2.65	2.35	2.09	1.88	1.69	1.54
4	3.71	3.22	2.83	2.50	2.22	1.99	1.79	1.63
5	3.98	3.46	3.02	2.66	2.36	2.11	1.90	1.71
6	4.29	3.71	3.24	2.85	2.52	2.25	2.01	1.82
7	4.64	4.00	3.48	3.05	2.70	2.40	2.14	1.93
8	5.01	4.32	3.75	3.28	2.89	2.56	2.29	2.05
9	5.45	4.68	4.05	3.53	3.10	2.74	2.44	2.19
50	5.94	5.07	4.38	3.81	3.34	2.94	2.61	2.34
1	6.49	5.52	4.75	4.12	3.60	3.17	2.81	2.50
2	7.11	6.03	5.16	4.47	3.89	3.42	3.02	2.69
3	7.83	6.61	5.64	4.87	4.23	3.70	3.26	2.89
4	8.63	7.27	6.18	5.30	4.60	4.01	3.52	3.12
5	9.57	8.02	6.79	5.81	5.01	4.36	3.82	3.37
6	10.7	8.88	7.50	6.38	5.49	4.76	4.16	3.66
7	11.9	9.88	8.30	7.04	6.03	5.20	4.54	3.98
8	13.4	11.1	9.22	7.80	6.65	5.72	4.97	4.34
9	15.1	12.4	10.3	8.65	7.36	6.30	5.45	4.75
60	17.0	14.0	11.6	9.66	8.17	6.98	6.00	5.20
1	19.4	15.8	13.0	10.9	9.11	7.75	6.64	5.74
2	22.2	17.9	14.8	12.2	10.2	8.63	7.38	6.35
3	25.6	20.5	16.7	13.8	11.5	9.68	8.23	7.05
4	29.7	23.7	19.1	15.7	13.0	10.9	9.21	7.87
5	34.7	27.5	22.0	17.9	14.8	12.4	10.4	8.81
6	40.8	32.1	25.5	20.6	16.9	14.1	11.8	9.93
7	48.4	37.7	29.8	23.9	19.4	16.1	13.4	11.3
8	57.8	44.7	35.1	27.9	22.6	18.4	15.3	12.8
9	69.8	53.3	41.6	32.9	26.3	21.4	17.6	14.7
70	84.9	64.4	49.7	39.0	31.0	25.0	20.4	16.8
1	105	78.4	59.9	46.6	36.7	29.4	23.8	19.5
2	131	96.5	73.0	56.1	43.9	34.9	28.0	22.8
3	165	121	89.7	68.4	52.9	41.7	33.3	26.9
4	209	152	112	84.1	64.6	50.3	39.9	32.0
5	271	193	141	105	79.6	61.4	48.2	38.3

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