Vol. XXVI. [OCTOBER, 1904.] No. 10.

THE JOURNAL

OF THE

AMERICAN CHEMICAL SOCIETY.

ALCOHOMETRIC TABLES, FOR EACH INTEGRAL PERCENTAGE BY WEIGHT, AND FOR EACH DEGREE OF THE HYDROGEN THERMOMETER FROM 15° TO 22°.

BY EDWARD W. MORLEY.

Received August 23, 1904.

THE following tables have been found so convenient in my laboratory that they are printed for the use of others. They give the true specific gravity for each integral percentage by weight from 0 per cent. to 100 per cent., for each degree of the centigrade hydrogen thermometer from 15° to 22°, according to the results of Mendeléeff. The temperature of 15°, prescribed in many tables, is suitable to warehouses where alcohol is gauged, but too low for scientific laboratories. The specific gravity here given as the quotient of the weight of the alcohol divided by its volume, ncreased by the correction for displaced air; in other words, it is the weight of 1 cc. of alcohol, the weight being reduced to vacuum.[1]

[1] Several methods of determining the specific gravity may be used. The following convenient: Determine, first for all, the volume of a pycnometer at each degree from 25° to 22° (which requires but one weighing, but this must be corrected for displaced ir and for the cubical expansion of the glass). The specific gravity is then found by di- ding the weight of the alcohol, corrected for displaced air, by the capacity of the flask the temperature of the alcohol. The following table gives the correction for displaced ir, which is to be added for each gram of water or alcohol.

CORRECTION FOR DISPLACED AIR.

Specific gravity.	Correction for 1 gram. Gram.
0.80	+0.00109
0.85	+0.00108
0.90	+0.00107
0.95	+0.00106
1.00	+0.00106

Per cent.	$d\ \frac{15^\circ}{4^\circ}$.	$d\ \frac{16^\circ}{4^\circ}$.	$d\ \frac{17^\circ}{4^\circ}$.	$d\ \frac{18^\circ}{4^\circ}$.	Differences for 1 per cent.	Differences for 1°
0	0.99913	0.99898	0.99881	0.99863	191	17
1	0.99724	0.99707	0.99690	0.99671	183	18
2	0.99542	0.99525	0.99506	0.99487	177	19
3	0.99366	0.99348	0.99329	0.99309	170	20
4	0.99197	0.99178	0.99159	0.99138	164	20
5	0.99034	0.99014	0.98994	0.98973	157	21
6	0.98878	0.98857	0.98837	0.98816	151	21
7	0.98728	0.98707	0.98686	0.98664	145	22
8	0.98583	0.98562	0.98541	0.98518	140	23
9	0.98444	0.98423	0.98400	0.98376	135	23
10	0.98310	0.98288	0.98265	0.98240	133	24
11	0.98180	0.98156	0.98131	0.98105	130	26
12	0.98053	0.98027	0.98000	0.97972	127	28
13	0.97929	0.97901	0.97872	0.97843	125	29
14	0.97806	0.97777	0.97747	0.97716	124	31
15	0.97685	0.97654	0.97622	0.97588	123	33
16	0.97565	0.97532	0.97498	0.97463	122	34
17	0.97446	0.97410	0.97375	0.97338	123	37
18	0.97326	0.97289	0.97251	0.97212	124	39
19	0.97204	0.97166	0.97127	0.97085	125	42
20	0.97082	0.97042	0.97001	0.96958	128	43
21	0.96957	0.96914	0.96871	0.96827	130	44
22	0.96830	0.96785	0.96740	0.96695	132	45
23	0.96700	0.96654	0.96608	0.96559	136	49
24	0.96567	0.96519	0.96471	0.96421	140	50
25	0.96431	0.96380	0.96330	0.96279	143	51
26	0.96291	0.96239	0.96186	0.96133	147	53
27	0.96147	0.96093	0.96038	0.95983	152	55
28	0.95997	0.95942	0.95886	0.95828	155	58
29	0.95845	0.95787	0.95729	0.95671	159	58
30	0.95688	0.95629	0.95569	0.95509	164	60

Per cent.	$d\ \frac{19°}{4°}$.	$d\ \frac{20°}{4°}$.	$d\ \frac{21°}{4°}$.	$d\ \frac{22°}{4°}$.	Differences for 1 per cent.	Differences for 1°.
0	0.99844	0.99824	0.99802	0.99780	194	21
1	0.99651	0.99630	0.99608	0.99585	186	22
2	0.99466	0.99445	0.99422	0.99399	180	22
3	0.99288	0.99265	0.99242	0.99218	172	23
4	0.99116	0.99093	0.99070	0.99045	166	23
5	0.98951	0.98927	0.98903	0.98878	159	24
6	0.98793	0.98768	0.98743	0.98718	153	25
7	0.98640	0.98615	0.98590	0.98564	148	25
8	0.98493	0.98468	0.98442	0.98415	143	26
9	0.98351	0.98326	0.98300	0.98271	137	26
10	0.98215	0.98189	0.98162	0.98133	140	27
11	0.98078	0.98049	0.98021	0.97991	137	28
12	0.97944	0.97913	0.97883	0.97852	133	30
13	0.97813	0.97781	0.97749	0.97716	133	32
14	0.97683	0.97649	0.97616	0.97581	131	34
15	0.97554	0.97519	0.97485	0.97448	130	35
16	0.97427	0.97390	0.97354	0.97316	129	37
17	0.97301	0.97262	0.97224	0.97185	130	38
18	0.97173	0.97134	0.97094	0.97052	131	40
19	0.97046	0.97003	0.96962	0.96919	132	42
20	0.96916	0.96872	0.96829	0.96784	135	44
21	0.96784	0.96738	0.96693	0.96645	137	46
22	0.96649	0.96601	0.96555	0.96506	140	47
23	0.96512	0.96462	0.96414	0.96364	143	49
24	0.96371	0.96320	0.96270	0.96218	146	51
25	0.96228	0.96175	0.96123	0.96068	150	53
26	0.96080	0.96025	0.95972	0.95916	155	54
27	0.95928	0.95872	0.95816	0.95759	159	56
28	0.95772	0.95713	0.95656	0.95596	163	58
29	0.95612	0.95552	0.95493	0.95432	166	60
30	0.95448	0.95387	0.95326	0.95263	169	62

Per cent.	$d\ \frac{15°}{4°}$.	$d\ \frac{16°}{4°}$.	$d\ \frac{17°}{4°}$.	$d\ \frac{18°}{4°}$.	Differences for 1 per cent.	Differences for 1°.
30	0.93688	0.95629	0.95569	0.95509	164	60
31	0.95527	0.95466	0.95405	0.95343	168	61
32	0.95361	0.95299	0.95236	0.95173	172	63
33	0.95191	0.95127	0.95063	0.94999	176	64
34	0.95018	0.94952	0.94886	0.94821	180	66
35	0.94840	0.94772	0.94705	0.94639	184	67
36	0.94658	0.94589	0.94522	0.94453	189	68
37	0.94472	0.94401	0.94332	0.94262	192	70
38	0.94282	0.94211	0.94140	0.94069	195	71
39	0.94089	0.04016	0.93944	0.93872	198	72
40	0.93893	0.93818	0.93746	0.93672	201	74
41	0.93694	0.93618	0.93544	0.93471	204	74
42	0.93491	0.93415	0.93340	0.93266	207	75
43	0.93284	0.93209	0.93134	0 93058	208	75
44	0.93078	0.93001	0.92925	0.92848	211	76
45	0.92868	0.92790	0.92714	0.92637	213	77
46	0.92655	0.92577	0.92501	0.92423	216	77
47	0.92440	0.92362	0.92285	0.92206	217	78
48	0.92224	0.92145	0.92068	0.91988	219	79
49	0.92006	0.91927	0.91849	0.91768	221	79
50	0.91786	0.91706	0.91627	0.91546	221	80
51	0.91565	0.91485	0.91405	0.91325	223	80
52	0.91343	0.91263	0.91182	0.91102	224	80
53	0.91119	0.91038	0.90957	0.90877	224	81
54	0.90895	0.90814	0.90733	0.90652	226	81
55	0.90669	0.90588	0.90506	0.90425	227	82
56	0.90442	0.90360	0.90279	0.90198	227	82
57	0.90215	0.90133	0.90052	0.89970	229	82
58	0 89987	0.89904	0.89822	0.89741	230	82
59	0.89757	0.89674	0.89593	0.89511	230	83
60	0.89527	0.89444	0.89362	0.89280	231	83

Per cent.	$d\ \frac{19°}{4°}$.	$d\ \frac{20°}{4°}$.	$d\ \frac{21°}{4°}$.	$d\ \frac{22°}{4°}$.	Differences for 1 per cent.	Differences for 1°.
30	0.95448	0.85387	0.95326	0.95263	169	62
31	0.95282	0.95219	0.95156	0.95093	173	63
32	0.95110	0.95047	0.94982	0.94918	177	64
33	0.94935	0.94870	0.94804	0.94738	180	65
34	0.94756	0.94691	0.94623	0.94556	185	66
35	0.94573	0.94506	0.94437	0.94369	189	68
36	0.94385	0.94316	0.94248	0.94178	194	69
37	0.94193	0.94123	0.94053	0.93983	196	70
38	0.93999	0.93927	0.93856	0.93785	200	71
39	0.93800	0.93728	0.93655	0.93582	203	73
40	0.93599	0.93525	0.93451	0.93377	203	74
41	0.93397	0.93323	0.93248	0.93173	206	75
42	0.93192	0.93117	0.93041	0.92966	209	75
43	0.92983	0.92908	0.92833	0.92756	212	76
44	0.92773	0.92696	0.92621	0.92544	214	76
45	0.92560	0.92483	0.92406	0.92329	216	77
46	0.92346	0.92268	0.92190	0.92113	219	78
47	0.92128	0.92050	0.91971	0.91992	220	79
48	0.91910	0.91830	0.91752	0.91672	222	79
49	0.91689	0.91609	0.91530	0.91449	223	80
50	0.91467	0.91386	0.91306	0.91225	222	80
51	0.91245	0.91164	0.91084	0.91002	223	81
52	0.91022	0.90941	0.90860	0.90779	225	81
53	0.90797	0.90715	0.90635	0.90553	226	81
54	0.90572	0.90490	0.90409	0.90327	227	81
55	0.90345	0.90263	0.90182	0.90099	228	82
56	0.90117	0.90035	0.89954	0.89871	229	82
57	0.89889	0.89807	0.89725	0.89642	230	82
58	0.89659	0.89577	0.89494	0.89412	231	82
59	0.89429	0.89346	0.89263	0.89181	231	83
60	0.89198	0.89115	0.89032	0.88949	232	83

Per cent.	$d\ {}^{15°}_{4°}$	$d\ {}^{16°}_{4°}$	$d\ {}^{17°}_{4°}$	$d\ {}^{18°}_{4°}$	Differences for 1 per cent.	Differences for 1°.
60	0.89527	0.89444	0.89362	0.89280	231	82
61	0.89296	0.89213	0.89131	0.89048	231	83
62	0.89065	0.88982	0.88899	0.88817	232	83
63	0.88833	0.88749	0.88667	0.88584	233	83
64	0.88600	0.88516	0.88433	0.88350	233	83
65	0.88367	0.88283	0.88200	0.88116	234	84
66	0.88133	0.88049	0.87966	0.87882	235	84
67	0.87898	0.87814	0.87730	0.87646	235	84
68	0.87663	0.87578	0.87495	0.87411	236	84
69	0.87428	0.87343	0.87259	0.87175	237	84
70	0.87191	0.87106	0.87022	0.86938	238	84
71	0.86954	0.86869	0.86785	0.86700	239	85
72	0.86715	0.86630	0.86546	0.86461	239	85
73	0.86476	0.86391	0.86306	0.86221	239	85
74	0.86237	0.86152	0.86067	0.85982	242	85
75	0.85996	0.85910	0.85825	0.85740	242	85
76	0.85754	0.85669	0.85584	0.85497	242	85
77	0.85513	0.85427	0.85342	0.85256	243	86
78	0.85270	0.85184	0.85099	0.85012	245	86
79	0.85025	0.84939	0.84853	0.84767	245	86
80	0.84780	0.84694	0.84608	0.84521	246	86
81	0.84534	0.84448	0.84362	0.84274	248	87
82	0.84286	0.84189	0.84113	0.84026	249	87
83	0.84037	0.83950	0.83864	0.83776	251	87
84	0.83786	0.83699	0.83613	0.83525	253	87
85	0.83533	0.83446	0.83359	0.83271	255	87
86	0.83278	0.83191	0.83104	0.83016	258	87
87	0.83021	0.82934	0.82846	0.82758	261	87
88	0.82760	0.82673	0.82586	0.82498	263	87
89	0.82498	0.82411	0.82323	0.82235	265	87
90	0.82233	0.82146	0.82058	0.81970	268	87

Per cent.	$d\ \frac{19°}{4°}$.	$d\ \frac{20°}{4°}$.	$d\ \frac{21°}{4°}$.	$d\ \frac{22°}{4°}$.	Differences for 1 per cent.	Differences for 1°.
60	0.89198	0.89115	0.89032	0.88949	232	83
61	0.88966	0.88883	0.88800	0.88717	232	83
62	0.88734	0.88651	0.88568	0.88485	233	83
63	0.88501	0.88418	0.88334	0.88251	234	83
64	0.88267	0.88184	0.88100	0.88017	234	83
65	0.88033	0.87950	0.87866	0.87783	235	83
66	0.87799	0.87715	0.87631	0.87548	236	84
67	0.87563	0.87479	0.87395	0.87312	236	84
68	0.87327	0.87243	0.87159	0.87074	236	84
69	0.87092	0.87007	0.86923	0.86838	238	84
70	0.86854	0.86769	0.86685	0.86600	238	85
71	0.86616	0.86531	0.86447	0.86362	240	85
72	0.86376	0.86291	0.86206	0.86122	240	85
73	0.86137	0.86051	0.85966	0.85881	240	85
74	0.85897	0.85811	0.85726	0.85621	242	85
75	0.85655	0.85569	0.85483	0.85398	242	86
76	0.85413	0.85327	0.85241	0.85155	243	86
77	0.85171	0.85084	0.84998	0.84912	244	86
78	0.84927	0.84840	0.84754	0.84667	246	86
79	0.84681	0.84594	0.84507	0.84421	246	87
80	0.84435	0.84348	0.84261	0.84173	247	87
81	0.84188	0.84101	0.84014	0.83926	249	87
82	0.83940	0.83852	0.83765	0.83677	250	87
83	0.83690	0.83603	0.83515	0.83427	252	87
84	0.83439	0.83351	0.83263	0.83175	254	88
85	0.83185	0.83097	0.83009	0.82920	256	88
86	0.82929	0.82841	0.82754	0.82664	258	88
87	0.82672	0.82583	0.82496	0.82406	261	88
88	0.82411	0.82323	0.82235	0.82145	263	88
89	0.82149	0.82060	0.81972	0.81882	266	88
90	0.81883	0.81794	0.81706	0.81616	267	88

Per cent.	$d\ \frac{15^\circ}{4^\circ}$	$d\ \frac{16^\circ}{4^\circ}$	$d\ \frac{17^\circ}{4^\circ}$	$d\ \frac{18^\circ}{4^\circ}$	Differences for 1 per cent	Differences for 1°.
90	0.82233	0.82146	0.82058	0.81970	268	87
91	0.81965	0.81878	0.81791	0.81703	271	87
92	0.81694	0.81607	0.81520	0.81432	276	87
93	0.81418	0.81331	0.81244	0.81157	280	87
94	0.81138	0.81051	0.80965	0.80878	283	87
95	0.80854	0.80768	0.80682	0.80595	289	86
96	0.80565	0.80479	0.80394	0.80306	294	86
97	0.80271	0.80185	0.80100	0.80013	298	86
98	0.79972	0.79887	0.79802	0.79715	304	85
99	0.79668	0.79583	0.79498	0.79412	310	85
100	0.79357	0.79272	0.79188	0.79102	...	85

Squibb made careful and elaborate studies of the specific gravity of absolute alcohol and of mixtures of alcohol and water. It was important to learn whether his skill as a manufacturer had produced an alcohol of lower specific gravity than that of Mendeléeff. First, I applied to Squibb's published results the correction for displaced air; then I selected all his values for alcohol of more than 90 per cent., computed the corresponding values according to Mendeléeff, found the difference of each pair of values and took the mean of these differences. If we consider all the 25 differences, Squibb's absolute alcohol appears lighter than that of Mendeléeff by 0.00005; if we select the 15 experiments of Squibb in which temperature errors were likely to be less, his alcohol appears heavier than that of Mendeléeff by 0.00003. Both these figures cannot be distinguished from Squibb's errors of observation, and afford ground for believing that Mendeléeff's absolute alcohol has not been surpassed. It may also be said that the scale of Squibb's thermometer is not sufficiently defined in the record, and that his reading of temperatures was not close.

These tables accordingly depend on Mendeléeff; they have been recomputed to the scale of the hydrogen thermometer, to which fine thermometers are now commonly adjusted. Interpolations have been made with care, by two different formulae where

Per cent.	$d\ \frac{19°}{4°}$.	$d\ \frac{20°}{4°}$.	$d\ \frac{21°}{4°}$.	$d\ \frac{22°}{4°}$.	Differences for 1 per cent.	Differences for 1°.
90	0.81883	0.81794	0.81706	0.81616	267	88
91	0.81616	0.81527	0.81440	0.81350	270	88
92	0.81345	0.81257	0.81170	0.81081	274	88
93	0.81071	0.80982	0.80895	0.80807	278	88
94	0.80792	0.80704	0.80617	0.80529	282	87
95	0.80509	0.80421	0.80335	0.80249	287	87
96	0.80221	0.80134	0.80049	0.79962	293	86
97	0.79928	0.79841	0.79756	0.79670	297	86
98	0.79631	0.79544	0.79458	0.79373	302	86
99	0.79328	0.79241	0.79156	0.79072	309	85
100	0.79018	0.78932	0.78847	0.78763		85

possible. But from 5 per cent. to 15 per cent., interpolation for expansion is uncertain at the higher temperatures, in some cases by as much as 0.0010. The same is true, in a less degree, near 40 per cent. For mixtures of these percentages, where special accuracy is required, observations may be made below 18°.

[CONTRIBUTION FROM THE DEPARTMENT OF FOOD AND DRUG INSPECTION OF THE MASSACHUSETTS STATE BOARD OF HEALTH.]

A COMPARATIVE REFRACTOMETER SCALE FOR USE WITH FATS AND OILS.

BY ALBERT E. LEACH AND HERMANN C. LYTHGOE.

Received July 27, 1904.

THE indices of refraction of substances vary with the temperature, the refraction becoming less as the temperature is raised. It has been shown by the work of Olds, Long, Proctor, and Tolman that this variation is a constant for certain oils and fats (notably the edible oil and fats) and its value is 0.000365 for each degree centigrade. This relation has been substantiated by the writers.

Recently the Zeiss butyro-refractometer has come into use to a large extent for the examination of oils and fats, partly on account of its cheapness in comparison with other instruments for the same purpose, but principally on account of its ease of manipu-