SP-11
(Formerly H.O. Pub. No. 619)

SPECIAL PUBLICATION

TABLES FOR RAPID COMPUTATION OF DENSITY AND ELECTRICAL CONDUCTIVITY OF SEA WATER

Oceanographic Branch
Marine Surveys Division

MAY 1956

U. S. NAVY HYDROGRAPHIC OFFICE
WASHINGTON, D. C.
Price 30 cents

ABSTRACT

Tables are presented for the rapid computation on a machine calculator of density (sigma-t) and electrical conductivity of sea water from observed temperature and salinity values. Tables for sigma-t cover the salinity range from 10.00°/₀₀ to 40.00°/₀₀, those for electrical conductivity from 0°/₀₀ to 40°/₀₀. Computed values for sigma-t may have an error of 2 units in the second decimal place. Computed values for electrical conductivity may have an error of 2 or 3 units in the fourth decimal place.

FOREWORD

The tables in this publication provide a rapid means of computing the density and electrical conductivity of sea water on machine calculators. Their accuracy is sufficient for many computations in oceanographic work. Their usefulness is increased by the elimination of multiple entries and interpolations common to other tables used in determining density and electrical conductivity. The investigator who is interested in greater accuracy will have to resort to such tables as are provided in Hydrographic Office Publication Numbers 614, Processing Oceanographic Data, and 615, Tables for Sea Water Density.

J. B. COCHRAN
Captain, U. S. Navy
Hydrographer

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PART I

TABLE FOR DETERMINING DENSITY OF SEA WATER

BACKGROUND AND PURPOSE

The determination of density (σ_t) from observed temperature and salinity values has been done by using slide rules, nomograms, and tables. Both the slide rule and nomograms require frequent use on the part of the operator to develop and retain proficiency. Recent tables for determining sea water density eliminate much of the laborious interpolation required by earlier tables and provide a high degree of accuracy. However, interpolation tables must be used to obtain σ_t values equivalent to the decimal portion of given salinities (for salinity increments of 0.01‰). Such interpolations require additional entries in the tables to obtain the desired density value.

The density table in this publication requires but one entry at the given temperature to make the necessary computation. Computed values of σ_t may have an error of 2 units in the second decimal place, which is permissible for many applications. Sigma-t values of the above order of accuracy can be computed rapidly without subjection to possible reading errors encountered in numerous entries.

ARRANGEMENT

The table for determining density of sea water presents values of σ_t corresponding to temperatures from -2.00°C to 29.99°C and salinities from 10.00‰ to 39.99‰. The table is arranged in three parts by salinity intervals of 10.00‰. For a given temperature in column one the corresponding σ_t value, for the base of the salinity interval entered, is indicated in column two. As the salinity increases the σ_t value increases by an amount equal to the factor, f, in column three multiplied by the last three digits of the given salinity (observing decimal places). Temperature values are provided in column one for every hundredth (.01) increment in the σ_t value in column two. Where the given temperature is intermediate between the values provided, the lower value is used.

EXAMPLE OF COMPUTATION

Given a temperature of 15.70°C and a salinity of 36.47‰ compute the σ_t value.

1. Select the salinity interval of 30.00 to 39.99‰, pages 13 to 18.

2. In column one, find the temperature interval in which 15.70 falls (always use the <u>lower</u> limit of the interval). The <u>lower</u> limit is 15.69°C.

3. Entering column one at 15.69°C read the corresponding value of 22.00 in column two. This is the correct σ_t value for the base of the salinity interval, that is, for a salinity of 30.00‰, and temperature of 15.69°C.

4. To find the correct σ_t value for the given salinity of 36.47‰, multiply the designated f-factor in column three (.7680) by the last three digits of the given salinity (6.47), observing decimal places, and add the value obtained to the base value 22.00.

5. Round the value obtained (26.96896) to two decimal places. <u>ANSWER 26.97</u>.

Thus: Given 15.70°C and 36.47‰ S.

From table for Salinity 30.00 to 39.99‰, enter column one at lower limit of temperature interval (15.69)

obtain base value in column two	+	(f-factor of column three	x	last three digits of given S.)	=
22.00		.7680		6.47	

26.968960 (round to two decimal places) ANSWER 26.97

DENSITY (σ_t)

Salinity 10.00°/oo to 19.99°/oo

T. °C.	σ_t	f
-2.00	7.92	.8120
-1.91	.93	
-1.75	.94	
-1.59	7.95	.8110
-1.40	7.96	.8100
-1.21	.97	
-1.01	7.98	.8080
-0.79	.99	
-0.55	8.00	
-0.28	8.01	.8060
0.03	8.02	.8045
0.40	8.03	.8040
0.92	8.04	.8010
1.40	8.04	.8000
1.99	8.04	.7980
2.40	8.04	.7970
2.82	8.03	.7950
3.35	8.02	.7940
3.74	8.01	.7930
4.06	8.00	.7920
.35	7.99	
4.60	7.98	.7900
.83	.97	
5.05	7.96	.7890
.25	.95	
.44	.94	
5.63	7.93	.7870
.80	.92	
.97	.91	
6.13	7.90	.7860
.29	.89	
.44	.88	
6.59	7.87	.7840
.73	.86	
.87	.85	
7.01	7.84	.7830
.14	.83	
.27	.82	
.39	.81	
7.52	7.80	.7820
.64	.79	
.76	.78	
.88	.77	
.99	.76	
8.10	7.75	.7805
.22	.74	
.33	.73	
.43	.72	
8.54	7.71	.7790
.64	.70	
.75	.69	
.85	.68	
.95	.67	
9.05	7.66	.7780
.15	.65	
.24	.64	
.34	.63	
.43	.62	
9.53	7.61	.7770
.62	.60	
.71	.59	
.80	.58	
.89	.57	
.98	.56	
10.07	7.55	.7755
.16	.54	
.24	.53	
10.33	7.52	.7755
.41	.51	
10.50	7.50	.7745
.58	.49	
.66	.48	
.75	.47	
.83	.46	
.91	.45	
.99	.44	
11.07	7.43	.7730
.15	.42	
.23	.41	
.30	.40	
.38	.39	
.46	.38	
11.53	7.37	.7720
.61	.36	
.68	.35	
.76	.34	
.83	.33	
.91	.32	
.98	.31	
12.05	7.30	.7710
.12	.29	
.20	.28	
.27	.27	
.34	.26	
.41	.25	
.48	.24	
12.55	7.23	.7700
.62	.22	
.69	.21	
.76	.20	
.82	.19	
.89	.18	
.96	.17	
13.03	7.16	.7690
.09	.15	
.16	.14	
.23	.13	

DENSITY (σ_t)

Salinity 10.00°/oo to 19.99°/oo

T. °C.	σ_t	f
13.29	7.12	
.36	.11	.7690
.42	.10	
.49	.09	
13.55	7.08	
.62	.07	
.68	.06	
.74	.05	.7675
.81	.04	
.87	.03	
.93	.02	
14.00	7.01	
.06	.00	
.12	6.99	
.18	.98	
.24	.97	.7665
.30	.96	
.37	.95	
.43	.94	
.49	.93	
14.55	6.92	
.61	.91	
.67	.90	
.73	.89	.7655
.79	.88	
.84	.87	
.90	.86	
.96	.85	
15.02	6.84	
.08	.83	
.14	.82	
.19	.81	
.25	.80	.7645
.31	.79	
.37	.78	
.42	.77	
.48	.76	
15.54	6.75	
.59	.74	.7635
.65	.73	

T. °C.	σ_t	f
15.70	6.72	
.76	.71	
.82	.70	.7635
.87	.69	
.93	.68	
.98	.67	
16.04	6.66	
.09	.65	
.14	.64	
.20	.63	
.25	.62	.7625
.31	.61	
.36	.60	
.41	.59	
.47	.58	
16.52	6.57	
.57	.56	
.63	.55	
.68	.54	
.73	.53	.7615
.79	.52	
.84	.51	
.89	.50	
.94	.49	
.99	.48	
17.05	6.47	
.10	.46	
.15	.45	
.20	.44	
.25	.43	.7610
.30	.42	
.35	.41	
.40	.40	
.45	.39	
17.50	6.38	
.56	.37	
.61	.36	
.66	.35	.7600
.71	.34	
.76	.33	
.81	.32	

T. °C.	σ_t	f
17.85	6.31	
.90	.30	.7600
.95	.29	
18.00	6.28	
.05	.27	
.10	.26	
.15	.25	
.20	.24	
.25	.23	.7595
.30	.22	
.34	.21	
.39	.20	
.44	.19	
.49	.18	
18.54	6.17	
.58	.16	
.63	.15	
.68	.14	
.73	.13	
.77	.12	.7585
.82	.11	
.87	.10	
.92	.09	
.96	.08	
19.01	6.07	
.06	.06	
.10	.05	
.15	.04	
.20	.03	
.24	.02	.7575
.29	.01	
.33	.00	
.38	5.99	
.43	.98	
.47	.97	
19.52	5.96	
.56	.95	
.61	.94	.7565
.65	.93	
.70	.92	
.75	.91	

DENSITY (σ_t)

Salinity 10.00°/oo to 19.99°/oo

T. °C.	σ_t	f
19.79	5.90	
.84	.89	
.88	.88	.7565
.93	.87	
.97	.86	
20.01	5.85	
.06	.84	
.10	.83	
.15	.82	
.19	.81	
.24	.80	.7555
.28	.79	
.33	.78	
.37	.77	
.41	.76	
.46	.75	
20.50	5.74	
.54	.73	
.59	.72	
.63	.71	
.68	.70	
.72	.69	
.76	.68	.7550
.81	.67	
.85	.66	
.89	.65	
.93	.64	
.98	.63	
21.02	5.62	
.06	.61	
.11	.60	
.15	.59	
.19	.58	
.23	.57	
.28	.56	.7545
.32	.55	
.36	.54	
.40	.53	
.44	.52	
.49	.51	

T. °C.	σ_t	f
21.53	5.50	
.57	.49	
.61	.48	
.65	.47	
.70	.46	
.74	.45	
.78	.44	.7535
.82	.43	
.86	.42	
.90	.41	
.94	.40	
.98	.39	
22.03	5.38	
.07	.37	
.11	.36	
.15	.35	
.19	.34	
.23	.33	
.27	.32	.7525
.31	.31	
.35	.30	
.39	.29	
.43	.28	
.47	.27	
22.51	5.26	
.55	.25	
.59	.24	
.63	.23	
.67	.22	
.71	.21	
.75	.20	.7515
.79	.19	
.83	.18	
.87	.17	
.91	.16	
.95	.15	
.99	.14	
23.03	5.13	
.07	.12	.7515
.11	.11	

T. °C.	σ_t	f
23.15	5.10	
.19	.09	
.23	.08	
.27	.07	
.31	.06	.7515
.35	.05	
.39	.04	
.42	.03	
.46	.02	
23.50	5.01	
.54	.00	
.58	4.99	
.62	.98	
.66	.97	
.70	.96	
.73	.95	.7505
.77	.94	
.81	.93	
.85	.92	
.89	.91	
.93	.90	
.96	.89	
24.00	4.88	
.04	.87	
.08	.86	
.12	.85	
.15	.84	
.19	.83	
.23	.82	.7495
.27	.81	
.31	.80	
.34	.79	
.38	.78	
.42	.77	
.46	.76	
.49	.75	
24.53	4.74	
.57	.73	.7490
.61	.72	
.64	.71	

DENSITY (σ_t)

Salinity 10.00°/oo to 19.99°/oo

T. °C.	σ_t	f
24.68	4.70	
.72	.69	
.76	.68	
.79	.67	
.83	.66	.7490
.87	.65	
.90	.64	
.94	.63	
.98	.62	
25.01	4.61	
.05	.60	
.09	.59	
.12	.58	
.16	.57	
.20	.56	
.23	.55	
.27	.54	.7485
.31	.53	
.34	.52	
.38	.51	
.42	.50	
.45	.49	
.49	.48	
25.53	4.47	
.56	.46	
.60	.45	
.63	.44	
.67	.43	
.71	.42	
.74	.41	
.78	.40	.7475
.81	.39	
.85	.38	
.89	.37	
.92	.36	
.96	.35	
.99	.34	
26.03	4.33	
.06	.32	.7470
.10	.31	
.13	.30	

T. °C.	σ_t	f
26.17	4.29	
.21	.28	
.24	.27	
.28	.26	
.31	.25	.7470
.35	.24	
.38	.23	
.42	.22	
.45	.21	
.49	.20	
26.52	4.19	
.56	.18	
.59	.17	
.63	.16	
.66	.15	
.70	.14	
.73	.13	.7465
.77	.12	
.80	.11	
.84	.10	
.87	.09	
.91	.08	
.94	.07	
.98	.06	
27.01	4.05	
.04	.04	
.08	.03	
.11	.02	
.15	.01	
.18	.00	
.22	3.99	
.25	.98	.7460
.28	.97	
.32	.96	
.35	.95	
.39	.94	
.42	.93	
.46	.92	
.49	.91	
27.52	3.90	.7450
.56	.89	

T. °C.	σ_t	f
27.59	3.88	
.63	.87	
.66	.86	
.69	.85	
.73	.84	
.76	.83	
.79	.82	.7450
.83	.81	
.86	.80	
.90	.79	
.93	.78	
.96	.77	
28.00	3.76	
.03	.75	
.06	.74	
.10	.73	
.13	.72	
.16	.71	
.20	.70	
.23	.69	.7445
.26	.68	
.30	.67	
.33	.66	
.36	.65	
.40	.64	
.43	.63	
.46	.62	
28.50	3.61	
.53	.60	
.56	.59	
.59	.58	
.63	.57	
.66	.56	
.69	.55	
.73	.54	.7440
.76	.53	
.79	.52	
.82	.51	
.86	.50	
.89	.49	
.92	.48	
.95	.47	

DENSITY (σ_t)

Salinity 10.00°/oo to 19.99°/oo

T. °C.	σ_t	f
28.99	3.46	.7440
29.02	3.45	
.05	.44	
.08	.43	
.12	.42	
.15	.41	
.18	.40	
.21	.39	
.25	.38	.7430
.28	.37	
.31	.36	
.34	.35	
.38	.34	
.41	.33	
.44	.32	
.47	.31	
29.50	3.30	
.54	.29	
.57	.28	
.60	.27	
.63	.26	
.66	.25	
.70	.24	
.73	.23	
.76	.22	.7430
.79	.21	
.82	.20	
.86	.19	
.89	.18	
.92	.17	
.95	.16	
.98	.15	

DENSITY (σ_t)

Salinity 20.00°/oo to 29.99°/oo

T. °C.	σ_t	f
-2.00	16.04	.8100
-1.95	.05	
-1.52	16.06	
-0.75	16.07	.8060
0.14	16.06	.8040
0.92	16.05	.8000
1.37	16.04	
1.72	16.03	.7970
2.03	16.02	
.30	.01	
2.54	16.00	.7950
.77	15.99	
.98	.98	
3.18	15.97	.7930
.37	.96	
3.55	15.95	
.72	.94	
.89	.93	
4.05	15.92	.7890
.21	.91	
.36	.90	
4.50	15.89	
.64	.88	
.78	.87	
.92	.86	
5.05	15.85	
.18	.84	
.30	.83	
.43	.82	
5.55	15.81	.7860
.67	.80	
5.78	15.79	.7860
.90	.78	
6.01	15.77	.7850
.12	.76	
.23	.75	
.34	.74	
.45	.73	
.55	.72	
.66	.71	
.76	.70	
.86	.69	
.96	.68	
7.06	15.67	.7820
.15	.66	
.25	.65	
.35	.64	
.44	.63	
7.53	15.62	
.62	.61	
.72	.60	
.81	.59	
.89	.58	
.98	.57	
8.07	15.56	.7800
.16	.55	
.24	.54	
.33	.53	
.41	.52	
8.50	15.51	.7790
.58	.50	
.66	.49	
.74	.48	
.83	.47	
.91	.46	
.99	.45	
9.07	15.44	.7780
.14	.43	
.22	.42	
.30	.41	
9.38	15.40	.7780
.45	.39	
9.53	15.38	.7760
.61	.37	
.68	.36	
.76	.35	
.83	.34	
.90	.33	
.98	.32	
10.05	15.31	
.12	.30	
.19	.29	
.27	.28	
.34	.27	
.41	.26	
.48	.25	
10.55	15.24	.7740
.62	.23	
.69	.22	
.75	.21	
.82	.20	
.89	.19	
.96	.18	
11.03	15.17	
.09	.16	
.16	.15	
.23	.14	
.29	.13	
.36	.12	
.42	.11	
.49	.10	
11.55	15.09	.7720
.62	.08	
.68	.07	
.75	.06	
.81	.05	
.87	.04	
.94	.03	
12.00	15.02	.7710

DENSITY (σ_t)

Salinity 20.00°/oo to 29.99°/oo

T. °C.	σ_t	f
12.06	15.01	
.12	.00	
.19	14.99	
.25	.98	
.31	.97	.7710
.37	.96	
.42	.95	
.49	.94	
12.55	14.93	
.61	.92	
.67	.91	
.73	.90	
.79	.89	.7700
.85	.88	
.91	.87	
.97	.86	
13.03	14.85	
.09	.84	
.14	.83	
.20	.82	
.26	.81	.7690
.32	.80	
.38	.79	
.43	.78	
.49	.77	
13.55	14.76	
.60	.75	
.66	.74	
.72	.73	
.77	.72	.7680
.83	.71	
.88	.70	
.94	.69	
.99	.68	
14.05	14.67	
.10	.66	
.16	.65	
.21	.64	.7670
.27	.63	
.32	.62	
.38	.61	

T. °C.	σ_t	f
14.43	14.60	.7670
.49	.59	
14.54	14.58	
.59	.57	
.65	.56	
.70	.55	
.75	.54	.7660
.81	.53	
.86	.52	
.91	.51	
.96	.50	
15.01	14.49	
.07	.48	
.12	.47	
.17	.46	
.22	.45	
.27	.44	.7650
.33	.43	
.38	.42	
.43	.41	
.48	.40	
15.53	14.39	
.58	.38	
.63	.37	
.68	.36	
.73	.35	.7640
.78	.34	
.83	.33	
.88	.32	
.93	.31	
.98	.30	
16.03	14.29	
.08	.28	
.13	.27	
.18	.26	
.23	.25	.7630
.28	.24	
.33	.23	
.38	.22	
.43	.21	
.47	.20	

T. °C.	σ_t	f
16.52	14.19	
.57	.18	
.62	.17	
.67	.16	
.72	.15	.7620
.76	.14	
.81	.13	
.86	.12	
.91	.11	
.95	.10	
17.00	14.09	
.05	.08	
.10	.07	
.14	.06	
.19	.05	
.24	.04	.7610
.28	.03	
.33	.02	
.38	.01	
.42	.00	
.47	13.99	
17.52	13.98	
.56	.97	
.61	.96	
.65	.95	
.70	.94	
.75	.93	.7600
.79	.92	
.84	.91	
.88	.90	
.93	.89	
.97	.88	
18.02	13.87	
.06	.86	
.11	.85	
.15	.84	
.20	.83	
.24	.82	.7590
.29	.81	
.33	.80	
.38	.79	
.42	.78	

DENSITY (σ_t)

Salinity 20.00°/oo to 29.99°/oo

T. °C.	σ_t	f
18.47	13.77	.7590
18.51	13.76	
.55	.75	
.60	.74	
.64	.73	
.69	.72	
.73	.71	
.77	.70	.7580
.82	.69	
.86	.68	
.91	.67	
.95	.66	
.99	.65	
19.04	13.64	
.08	.63	
.12	.62	
.17	.61	
.21	.60	
.25	.59	.7570
.29	.58	
.34	.57	
.38	.56	
.42	.55	
.46	.54	
19.51	13.53	
.55	.52	
.59	.51	
.63	.50	
.68	.49	
.72	.48	
.76	.47	.7560
.80	.46	
.84	.45	
.89	.44	
.93	.43	
.97	.42	
20.01	13.41	
.05	.40	
.10	.39	.7560
.14	.38	
.18	.37	

T. °C.	σ_t	f
20.22	13.36	
.26	.35	
.30	.34	
.34	.33	.7560
.38	.32	
.42	.31	
.47	.30	
20.51	13.29	
.55	.28	
.59	.27	
.63	.26	
.67	.25	
.71	.24	
.75	.23	.7560
.79	.22	
.83	.21	
.87	.20	
.91	.19	
.95	.18	
.99	.17	
21.03	13.16	
.07	.15	
.11	.14	
.15	.13	
.19	.12	
.23	.11	
.27	.10	.7550
.31	.09	
.35	.08	
.39	.07	
.43	.06	
.47	.05	
21.51	13.04	
.55	.03	
.59	.02	
.63	.01	
.67	.00	
.71	12.99	.7540
.74	.98	
.78	.97	
.82	.96	
.86	.95	

T. °C.	σ_t	f
21.90	12.94	
.94	.93	.7540
.98	.92	
22.03	12.91	
.06	.90	
.09	.89	
.13	.88	.7540
.17	.87	
.21	.86	
.25	.85	
22.29	12.84	
.32	.83	
.36	.82	
.40	.81	
.44	.80	
.48	.79	
.51	.78	
.55	.77	
.59	.76	
.63	.75	.7530
.67	.74	
.70	.73	
.74	.72	
.78	.71	
.82	.70	
.85	.69	
.89	.68	
.93	.67	
.97	.66	
23.00	12.65	
.04	.64	
.08	.63	
.12	.62	
.15	.61	
.19	.60	
.23	.59	.7520
.27	.58	
.30	.57	
.34	.56	
.38	.55	
.41	.54	
.45	.53	

DENSITY (σ_t)

Salinity 20.00°/oo to 29.99°/oo

T. °C.	σ_t	f
23.49	12.52	.7520
23.52	12.51	
.56	.50	
.60	.49	
.63	.48	
.67	.47	
.71	.46	
.74	.45	.7510
.78	.44	
.82	.43	
.85	.42	
.89	.41	
.92	.40	
.96	.39	
24.00	12.38	
.03	.37	
.07	.36	
.11	.35	
.14	.34	
.18	.33	
.21	.32	
.25	.31	.7510
.29	.30	
.32	.29	
.36	.28	
.39	.27	
.43	.26	
.46	.25	
24.50	12.24	
.54	.23	
.57	.22	
.61	.21	
.64	.20	
.68	.19	
.71	.18	
.75	.17	.7500
.78	.16	
.82	.15	
.85	.14	
.88	.13	
.92	.12	

T. °C.	σ_t	f
24.96	12.11	.7500
.99	.10	
25.03	12.09	
.06	.08	
.10	.07	
.13	.06	
.17	.05	
.20	.04	
.23	.03	
.27	.02	.7500
.31	.01	
.34	.00	
.38	11.99	
.41	.98	
.45	.97	
.48	.96	
25.52	11.95	
.55	.94	
.59	.93	
.62	.92	
.65	.91	
.69	.90	
.72	.89	
.76	.88	.7490
.79	.87	
.83	.86	
.86	.85	
.89	.84	
.93	.83	
.96	.82	
26.00	11.81	
.03	.80	
.06	.79	
.10	.78	
.13	.77	
.17	.76	.7490
.20	.75	
.23	.74	
.27	.73	
.30	.72	
.34	.71	

T. °C.	σ_t	f
26.37	11.70	
.40	.69	.7490
.44	.68	
.47	.67	
26.50	11.66	
.54	.65	
.57	.64	
.60	.63	
.63	.62	
.66	.61	
.70	.60	
.74	.59	.7480
.77	.58	
.80	.57	
.83	.56	
.87	.55	
.90	.54	
.94	.53	
.97	.52	
27.00	11.51	
.04	.50	
.07	.49	
.10	.48	
.13	.47	
.17	.46	
.20	.45	
.23	.44	.7480
.27	.43	
.30	.42	
.33	.41	
.36	.40	
.40	.39	
.43	.38	
.46	.37	
27.50	11.36	
.53	.35	
.56	.34	
.59	.33	.7470
.63	.32	
.66	.31	
.69	.30	

DENSITY (σ_t)

Salinity 20.00°/oo to 29.99°/oo

T. °C.	σ_t	f
27.72	11.29	
.75	.28	
.78	.27	
.82	.26	
.85	.25	.7470
.88	.24	
.92	.23	
.95	.22	
.98	.21	
28.01	11.20	
.05	.19	
.08	.18	
.11	.17	
.14	.16	
.17	.15	
.21	.14	
.24	.13	
.27	.12	.7460
.30	.11	
.33	.10	
.36	.09	
.40	.08	
.43	.07	
.46	.06	
.49	.05	
28.52	11.04	
.56	.03	
.59	.02	
.62	.01	
.65	.00	
.68	10.99	
.71	.98	.7460
.75	.97	
.78	.96	
.81	.95	
.84	.94	
.87	.93	

T. °C.	σ_t	f
28.90	10.92	
.93	.91	.7460
.97	.90	
29.00	10.89	
.03	.88	
.06	.87	
.09	.86	
.12	.85	
.15	.84	
.18	.83	
.21	.82	
.25	.81	.7450
.28	.80	
.31	.79	
.34	.78	
.37	.77	
.40	.76	
.43	.75	
.46	.74	
.49	.73	
29.52	10.72	
.56	.71	
.59	.70	
.62	.69	
.65	.68	
.68	.67	
.71	.66	
.74	.65	
.77	.64	.7450
.80	.63	
.83	.62	
.86	.61	
.89	.60	
.92	.59	
.96	.58	
.99	.57	

DENSITY (σ_t)

Salinity 30.00°/oo to 39.99°/oo

T. °C.	σ_t	f
-2.00	24.15	.8120
-1.75	.14	
-1.13	24.13	.8100
-0.71	24.12	.8090
-0.37	24.11	.8070
-0.08	.10	
0.18	24.09	.8050
0.42	.08	
0.64	24.07	.8040
0.85	.06	
1.05	24.05	.8020
.24	.04	
.41	.03	
1.58	24.02	.8010
.75	.01	
.91	24.00	
2.06	23.99	.8000
.21	.98	
.35	.97	
2.50	23.96	.7980
.63	.95	
.77	.94	
.90	.93	
3.03	23.92	.7970
.15	.91	
.27	.90	
.40	.89	
3.51	23.88	.7950
.62	.87	
.74	.86	
.86	.85	
.97	.84	
4.07	23.83	.7940
.18	.82	
.29	.81	
.40	.80	
4.50	23.79	.7930
.60	.78	
.70	.77	
.80	.76	
.90	.75	
5.00	23.74	.7910
.09	.73	
.19	.72	
.27	.71	
.37	.70	
.46	.69	
5.56	23.68	.7900
.65	.67	
.73	.66	
.82	.65	
.91	.64	
6.00	23.63	.7890
.08	.62	
.17	.61	
.25	.60	
.34	.59	
.42	.58	
6.50	23.57	.7880
.59	.56	
.67	.55	
.75	.54	
.83	.53	
.91	.52	
.99	.51	
7.06	23.50	.7860
.14	.49	
.22	.48	
.30	.47	
7.37	23.46	.7860
.45	.45	
7.52	23.44	.7850
.60	.43	
.67	.42	
.75	.41	
.82	.40	
.89	.39	
.96	.38	
8.04	23.37	.7840
.11	.36	
.18	.35	
.25	.34	
.32	.33	
.39	.32	
.46	.31	
8.53	23.30	.7830
.60	.29	
.67	.28	
.74	.27	
.80	.26	
.87	.25	
.94	.24	
9.01	23.23	.7820
.07	.22	
.14	.21	
.20	.20	
.27	.19	
.34	.18	
.40	.17	
.47	.16	
9.53	23.15	.7810
.59	.14	
.66	.13	
.72	.12	
.79	.11	
.85	.10	
.91	.09	

DENSITY (σ_t)

Salinity 30.00°/oo to 39.99°/oo

T. °C.	σ_t	f
9.97	23.08	.7810
10.04	23.07	
.10	.06	
.16	.05	
.22	.04	.7790
.28	.03	
.34	.02	
.40	.01	
.47	.00	
10.53	22.99	
.59	.98	
.65	.97	
.71	.96	
.77	.95	.7780
.82	.94	
.88	.93	
.94	.92	
11.00	22.91	
.06	.90	
.12	.89	
.18	.88	
.23	.87	.7770
.29	.86	
.35	.85	
.41	.84	
.46	.83	
11.52	22.82	
.58	.81	
.63	.80	
.69	.79	
.74	.78	.7760
.80	.77	
.86	.76	
.91	.75	
.97	.74	
12.02	22.73	
.08	.72	
.13	.71	.7750
.19	.70	
12.24	22.69	
.30	.68	
.35	.67	.7750
.40	.66	
.46	.65	
12.51	22.64	
.57	.63	
.62	.62	
.67	.61	
.73	.60	
.78	.59	.7740
.83	.58	
.88	.57	
.94	.56	
.99	.55	
13.04	22.54	
.09	.53	
.15	.52	
.20	.51	
.25	.50	.7730
.30	.49	
.35	.48	
.40	.47	
.46	.46	
13.51	22.45	
.56	.44	
.61	.43	
.66	.42	
.71	.41	
.76	.40	.7720
.81	.39	
.86	.38	
.91	.37	
.96	.36	
14.01	22.35	
.06	.34	
.11	.33	
.16	.32	.7710
.21	.31	
.26	.30	
14.31	22.29	
.36	.28	
.40	.27	.7710
.45	.26	
14.50	22.25	
.55	.24	
.60	.23	
.65	.22	
.70	.21	
.74	.20	.7700
.79	.19	
.84	.18	
.89	.17	
.94	.16	
.98	.15	
15.03	22.14	
.08	.13	
.13	.12	
.17	.11	
.22	.10	
.27	.09	.7690
.31	.08	
.36	.07	
.41	.06	
.45	.05	
15.50	22.04	
.55	.03	
.59	.02	
.64	.01	
.69	.00	
.73	21.99	.7680
.78	.98	
.82	.97	
.87	.96	
.92	.95	
.96	.94	
16.01	21.93	
.05	.92	
.10	.91	.7680
.14	.90	

DENSITY (σ_t)

Salinity 30.00°/oo to 39.99°/oo

T. °C.	σ_t	f
16.19	21.89	
.23	.88	
.28	.87	
.32	.86	.7680
.37	.85	
.41	.84	
.46	.83	
16.50	21.82	
.55	.81	
.59	.80	
.63	.79	
.68	.78	
.72	.77	
.77	.76	.7670
.81	.75	
.86	.74	
.90	.73	
.94	.72	
.99	.71	
17.03	21.70	
.07	.69	
.12	.68	
.16	.67	
.20	.66	
.25	.65	.7660
.29	.64	
.33	.63	
.38	.62	
.42	.61	
.46	.60	
17.51	21.59	
.55	.58	
.59	.57	
.63	.56	
.68	.55	
.72	.54	
.76	.53	.7650
.80	.52	
.85	.51	
.89	.50	
.93	.49	
.97	.48	

T. °C.	σ_t	f
18.01	21.47	
.06	.46	
.10	.45	
.14	.44	
.18	.43	
.22	.42	
.27	.41	.7640
.31	.40	
.35	.39	
.39	.38	
.43	.37	
.47	.36	
18.51	21.35	
.55	.34	
.60	.33	
.64	.32	
.68	.31	
.72	.30	
.76	.29	.7630
.80	.28	
.84	.27	
.88	.26	
.92	.25	
.96	.24	
19.00	21.23	
.04	.22	
.08	.21	
.13	.20	
.17	.19	
.21	.18	
.25	.17	.7630
.29	.16	
.33	.15	
.37	.14	
.41	.13	
.45	.12	
.49	.11	
19.53	21.10	
.57	.09	
.60	.08	.7620
.64	.07	
.68	.06	

T. °C.	σ_t	f
19.72	21.05	
.76	.04	
.80	.03	
.84	.02	.7620
.88	.01	
.92	.00	
.96	20.99	
20.00	20.98	
.04	.97	
.08	.96	
.12	.95	
.15	.94	
.19	.93	
.23	.92	.7610
.27	.91	
.31	.90	
.35	.89	
.39	.88	
.43	.87	
.46	.86	
20.50	20.85	
.54	.84	
.58	.83	
.62	.82	
.66	.81	
.69	.80	
.73	.79	.7600
.77	.78	
.81	.77	
.85	.76	
.89	.75	
.92	.74	
.96	.73	
21.00	20.72	
.04	.71	
.07	.70	
.11	.69	
.15	.68	.7600
.19	.67	
.22	.66	
.26	.65	
.30	.64	

DENSITY (σ_t)

Salinity 30.00°/oo to 39.99°/oo

T. °C.	σ_t	f
21.34	20.63	
.37	.62	
.41	.61	.7600
.45	.60	
.49	.59	
21.52	20.58	
.56	.57	
.60	.56	
.64	.55	
.67	.54	
.71	.53	
.75	.52	.7590
.78	.51	
.82	.50	
.86	.49	
.89	.48	
.93	.47	
.97	.46	
22.00	20.45	
.04	.44	
.08	.43	
.11	.42	
.15	.41	
.19	.40	
.22	.39	
.26	.38	.7580
.30	.37	
.33	.36	
.37	.35	
.40	.34	
.44	.33	
.48	.32	
22.51	20.31	
.55	.30	
.59	.29	
.62	.28	
.66	.27	.7580
.69	.26	
.73	.25	
.76	.24	
.80	.23	

T. °C.	σ_t	f
22.84	20.22	
.87	.21	
.91	.20	.7580
.94	.19	
.98	.18	
23.01	20.17	
.05	.16	
.09	.15	
.12	.14	
.16	.13	
.19	.12	
.23	.11	
.26	.10	.7570
.30	.09	
.33	.08	
.37	.07	
.40	.06	
.44	.05	
.47	.04	
23.51	20.03	
.54	.02	
.58	.01	
.61	.00	
.65	19.99	
.68	.98	
.72	.97	
.75	.96	.7560
.79	.95	
.82	.94	
.86	.93	
.89	.92	
.93	.91	
.96	.90	
24.00	19.89	
.03	.88	
.07	.87	
.10	.86	
.13	.85	.7560
.17	.84	
.20	.83	
.24	.82	

T. °C.	σ_t	f
24.27	19.81	
.30	.80	
.34	.79	
.37	.78	.7560
.41	.77	
.44	.76	
.48	.75	
24.51	19.74	
.54	.73	
.58	.72	
.61	.71	
.65	.70	
.68	.69	
.71	.68	
.75	.67	.7550
.78	.66	
.81	.65	
.85	.64	
.88	.63	
.92	.62	
.95	.61	
.98	.60	
25.02	19.59	
.05	.58	
.08	.57	
.12	.56	
.15	.55	
.18	.54	
.22	.53	
.25	.52	.7550
.28	.51	
.32	.50	
.35	.49	
.38	.48	
.42	.47	
.45	.46	
.48	.45	
25.52	19.44	
.55	.43	
.58	.42	.7540
.62	.41	

DENSITY (σ_t)

Salinity 30.00°/oo to 39.99°/oo

T. °C.	σ_t	f
25.65	19.40	
.68	.39	
.71	.38	
.75	.37	
.78	.36	
.81	.35	.7540
.85	.34	
.88	.33	
.91	.32	
.94	.31	
.98	.30	
26.01	19.29	
.04	.28	
.08	.27	
.11	.26	
.14	.25	
.17	.24	
.21	.23	
.24	.22	.7530
.27	.21	
.30	.20	
.34	.19	
.37	.18	
.40	.17	
.43	.16	
.46	.15	
26.50	19.14	
.53	.13	
.56	.12	
.59	.11	
.63	.10	
.66	.09	
.69	.08	
.72	.07	
.75	.06	.7530
.79	.05	
.82	.04	
.85	.03	
.88	.02	
.91	.01	
.95	.00	
.98	18.99	

T. °C.	σ_t	f
27.01	18.98	
.04	.97	
.07	.96	
.11	.95	
.14	.94	
.17	.93	
.20	.92	
.23	.91	
.26	.90	.7520
.30	.89	
.33	.88	
.36	.87	
.39	.86	
.42	.85	
.45	.84	
.48	.83	
27.52	18.82	
.55	.81	
.58	.80	
.61	.79	
.64	.78	
.67	.77	
.70	.76	
.74	.75	
.77	.74	.7520
.80	.73	
.83	.72	
.86	.71	
.89	.70	
.92	.69	
.95	.68	
.98	.67	
28.02	18.66	
.05	.65	
.08	.64	
.11	.63	
.14	.62	
.17	.61	.7510
.20	.60	
.23	.59	
.26	.58	
.29	.57	

T. °C.	σ_t	f
28.32	18.56	
.36	.55	
.39	.54	
.42	.53	.7510
.45	.52	
.48	.51	
28.51	18.50	
.54	.49	
.57	.48	
.60	.47	
.63	.46	
.66	.45	
.69	.44	
.72	.43	
.75	.42	.7510
.78	.41	
.81	.40	
.85	.39	
.88	.38	
.91	.37	
.94	.36	
.97	.35	
29.00	18.34	
.03	.33	
.06	.32	
.09	.31	
.12	.30	
.15	.29	
.18	.28	
.21	.27	
.24	.26	.7510
.27	.25	
.30	.24	
.33	.23	
.36	.22	
.39	.21	
.42	.20	
.45	.19	
.48	.18	
29.51	18.17	
.54	.16	.7500

DENSITY (σ_t)

Salinity 30.00°/oo to 39.99°/oo

T. °C.	σ_t	f
29.57	18.15	
.60	.14	
.63	.13	
.66	.12	
.69	.11	
.72	.10	
.75	.09	
.78	.08	.7500
.81	.07	
.84	.06	
.87	.05	
.90	.04	
.93	.03	
.96	.02	
.99	.01	

PART II

TABLE FOR DETERMINING ELECTRICAL CONDUCTIVITY OF SEA WATER

BACKGROUND AND PURPOSE

The determination of conductivity of sea water has been done by using graphic methods and tables. Conductivity values, accurate to 3 decimal places, can be read by the graphic method currently in use. Errors due to misjudgement of the space intervals on the graph may result, particularly when eyestrain and fatigue reduce efficiency of the operator, in determining extended series of conductances. Tables currently used provide conductivity values only for whole units of salinity (‰) and 5-degree (C) intervals of temperature. Interpolation is required to obtain conductances equivalent to intermediate values, that is, for salinity increments of .01 part per thousand and for integral and fractional parts of temperature within the 5-degree intervals.

The table in this publication makes possible the computation of conductivity to the fourth decimal place for a wide range of temperature and salinity values (to the second decimal place). Interpolation is not required. Only one entry in the table is necessary to make the computation. Computed conductance values may have an error of 2 or 3 units in the fourth decimal place, which is of sufficient accuracy for many applications.

ARRANGEMENT

The table for determining electrical conductivity of sea water presents values for temperatures from -2.00°C to 30.00°C and salinities from 0.00‰ to 39.99‰. The table is arranged in four parts by salinity intervals of 10.00‰. For a given temperature in column one the corresponding conductivity value, L, for the base of the salinity interval entered is indicated by column two. As the salinity value increases the L-value increases by an amount equal to the factor, f, in column three multiplied by the last three digits of the given salinity (observing decimal places). Temperature values provided in column one are in half-degree increments. Where the given temperature is intermediate between the values provided, use the nearer limit of the interval.

EXAMPLE OF COMPUTATION

Given a temperature of 19.90°C and a salinity of 34.26‰ compute the electrical conductivity or L-value.

1. Select the salinity interval of 30.00 to 39.99‰, page 24.

2. In column one find the temperature interval in which 19.90°C falls and round to the nearest (upper in this example) limit of the interval or 20.00°C.

3. Entering column one at 20.00°C read the corresponding L-value of .0417 in column two. This is the correct L-value for the base of the salinity interval, that is, for a salinity of 30.00‰ and temperature of 19.90°C.

4. To find the correct L-value for the given salinity of 34.26‰, multiply the designated f-factor (.001216) in column three by the last three digits of the given salinity (4.26), observing decimal places, and add the value obtained to the base value .0417.

5. Round the value obtained (.04688016) to four decimal places. ANSWER .0469.

Thus: Given 19.90°C and 34.26‰ S.

From table for Salinity 30.00‰ to 39.99‰, enter column one at nearest limit of temperature interval (20.00).

obtain base L-value in column two	+	(f-factor of column three	x	last three digits of given S.)	=
.0417		.001216		4.26	

.04688016 (round to four decimal places) ANSWER .0469

ELECTRICAL CONDUCTIVITY (L)

Salinity 0°/oo to 9.99°/oo

T. °C.	L	f
-2.00	.0002	.000842
-1.50		855
-1.00		868
-0.50		881
0.00	.0002	894
0.50		908
1.00	.0002	922
1.50		937
2.00	.0002	951
2.50		965
3.00	.0002	979
3.50		993
4.00	.0002	.001008
4.50		1022
5.00	.0002	1036
5.50		1051
6.00	.0002	1065
6.50		1080
7.00	.0002	1094
7.50	.0003	1109
8.00	.0003	1124
8.50		1138
9.00	.0003	1153
9.50		1167
10.00	.0003	1182
10.50		1197
11.00	.0003	1213
11.50		1228
12.00	.0003	1243
12.50		1259
13.00	.0003	1274
13.50		1289
14.00	.0003	1304
14.50		1320

T. °C.	L	f
15.00	.0003	.001335
15.50		1351
16.00	.0003	1367
16.50		1383
17.00	.0003	1399
17.50	.0004	1415
18.00	.0004	1430
18.50		1446
19.00	.0004	1462
19.50		1478
20.00	.0004	1494
20.50		1510
21.00	.0004	1527
21.50		1543
22.00	.0004	1560
22.50		1576
23.00	.0004	1592
23.50		1609
24.00	.0004	1625
24.50		1642
25.00	.0004	1658
25.50		1674
26.00	.0004	1690
26.50		1706
27.00	.0004	1722
27.50	.0005	1738
28.00	.0005	1754
28.50		1770
29.00	.0005	1786
29.50		1802
30.00	.0005	1818

ELECTRICAL CONDUCTIVITY (L)

Salinity 10°/oo to 19.99°/oo

T. °C.	L	f
-2.00	.0086	.000778
-1.50	87	790
-1.00	89	802
-0.50	.0090	814
0.00	.0091	826
0.50	93	839
1.00	.0094	851
1.50	96	864
2.00	.0097	876
2.50	99	889
3.00	.0100	902
3.50	102	914
4.00	.0103	927
4.50	104	939
5.00	.0106	952
5.50	107	965
6.00	.0109	978
6.50	110	992
7.00	.0112	.001005
7.50	113	1018
8.00	.0115	1031
8.50	116	1044
9.00	.0118	1058
9.50	119	1071
10.00	.0121	1084
10.50	122	1098
11.00	.0124	1111
11.50	126	1125
12.00	.0127	1138
12.50	129	1152
13.00	.0130	1165
13.50	132	1179

T. °C.	L	f
14.00	.0133	.001192
14.50	135	1206
15.00	.0137	1219
15.50	138	1233
16.00	.0140	1247
16.50	141	1262
17.00	.0143	1276
17.50	145	1290
18.00	.0146	1304
18.50	148	1318
19.00	.0150	1333
19.50	151	1347
20.00	.0153	1361
20.50	155	1376
21.00	.0156	1390
21.50	158	1405
22.00	.0160	1420
22.50	161	1435
23.00	.0163	1449
23.50	165	1464
24.00	.0166	1479
24.50	168	1493
25.00	.0170	1508
25.50	171	1523
26.00	.0173	1538
26.50	175	1553
27.00	.0177	1568
27.50	178	1584
28.00	.0180	1599
28.50	182	1614
29.00	.0184	1629
29.50	185	1644
30.00	.0187	1659

ELECTRICAL CONDUCTIVITY (L)

Salinity 20°/oo to 29.99 °/oo

T. °C.	L	f
-2.00	.0164	.000738
-1.50	167	750
-1.00	169	761
-0.50	171	772
0.00	.0174	784
0.50	177	796
1.00	179	807
1.50	182	819
2.00	185	831
2.50	188	843
3.00	190	854
3.50	193	866
4.00	196	878
4.50	198	889
5.00	.0201	901
5.50	204	913
6.00	207	925
6.50	210	937
7.00	212	949
7.50	215	962
8.00	218	974
8.50	221	986
9.00	224	998
9.50	226	.001010
10.00	.0229	1022
10.50	232	1035
11.00	235	1048
11.50	238	1060
12.00	241	1073
12.50	244	1086
13.00	247	1099
13.50	250	1112

T. °C.	L	f
14.00	.0253	.001124
14.50	256	1137
15.00	259	1150
15.50	262	1163
16.00	265	1176
16.50	268	1189
17.00	271	1202
17.50	274	1215
18.00	277	1228
18.50	280	1241
19.00	283	1254
19.50	286	1267
20.00	.0289	1280
20.50	292	1294
21.00	295	1307
21.50	298	1321
22.00	302	1334
22.50	305	1348
23.00	308	1362
23.50	311	1375
24.00	314	1389
24.50	317	1402
25.00	.0320	1416
25.50	324	1430
26.00	327	1444
26.50	330	1458
27.00	333	1472
27.50	337	1486
28.00	340	1499
28.50	343	1513
29.00	346	1527
29.50	350	1541
30.00	.0353	1555

ELECTRICAL CONDUCTIVITY (L)

Salinity 30°/oo to 39.99°/oo

T. °C.	L	f
-2.00	.0236	.000708
-1.50	240	719
-1.00	244	730
-0.50	248	741
0.00	.0252	752
0.50	256	763
1.00	260	774
1.50	264	785
2.00	268	796
2.50	272	807
3.00	276	817
3.50	280	828
4.00	283	839
4.50	287	850
5.00	.0291	861
5.50	295	872
6.00	299	883
6.50	303	895
7.00	307	906
7.50	311	917
8.00	315	928
8.50	319	939
9.00	323	951
9.50	327	962
10.00	.0332	973
10.50	336	984
11.00	340	996
11.50	344	.001007
12.00	348	1018
12.50	353	1030
13.00	357	1041
13.50	361	1052

T. °C.	L	f
14.00	.0365	.001063
14.50	369	1075
15.00	374	1086
15.50	378	1099
16.00	382	1112
16.50	387	1125
17.00	391	1138
17.50	395	1151
18.00	400	1164
18.50	404	1177
19.00	408	1190
19.50	413	1203
20.00	.0417	1216
20.50	422	1229
21.00	426	1242
21.50	431	1255
22.00	435	1268
22.50	440	1281
23.00	444	1294
23.50	449	1307
24.00	453	1320
24.50	458	1333
25.00	.0462	1346
25.50	467	1359
26.00	471	1373
26.50	476	1386
27.00	481	1400
27.50	485	1413
28.00	490	1426
28.50	494	1440
29.00	499	1453
29.50	504	1467
30.00	.0508	1480

U. S. Navy Hydrographic Office
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Part I contains tables for determining density (sigma-t) of sea water for temperatures from -2.00°C to 29.99°C and salinities from 10.00‰ to 39.99‰.

Part II contains tables for determining electrical conductivity (mho-cm) of sea water for temperatures from -2.00°C to 30.00°C and for salinities from 0.00‰ to 39.99‰.

Computed values for sigma-t may have an error of 2 units in the second decimal place; values for electrical conductivity, 3 or 4 units in the fourth decimal place.

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2. Electrical conductivity tables - Sea water
3. Physical properties of sea water - density
4. Physical properties of sea water - electrical conductivity

i. title: Tables for Rapid Computation of Density and Electrical Conductivity of Sea Water

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