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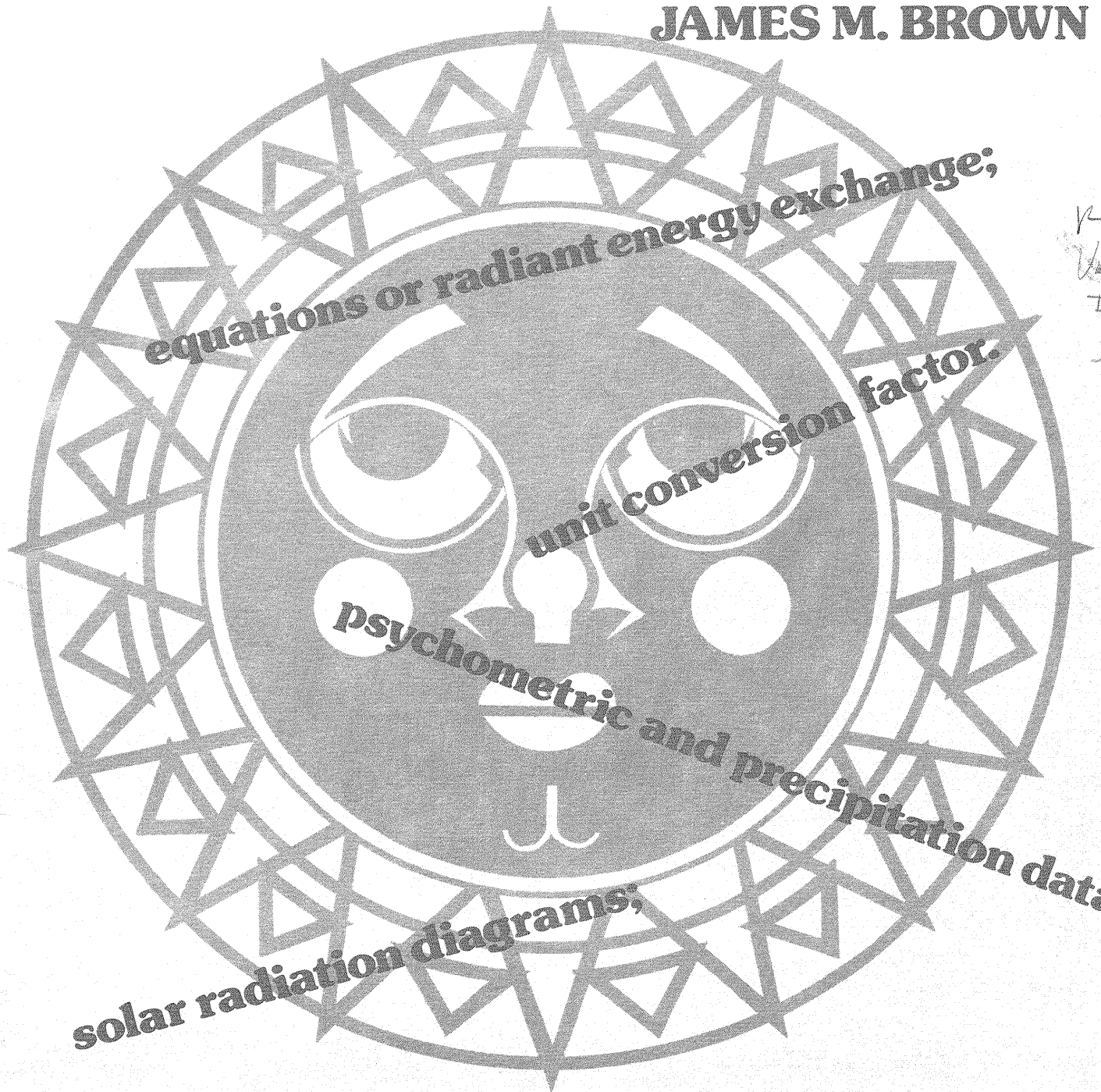
TABLES AND CONVERSIONS FOR MICROCLIMATOLOGY

JAMES M. BROWN



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U.S. Department of Agriculture

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TABLES AND CONVERSIONS FOR MICROCLIMATOLOGY

James M. Brown

INTRODUCTION

This collection of tables and conversion factors will aid climatologists, foresters, biologists, and others who are concerned with measuring and evaluating microclimate. Much of the material here has not been presented before, or has not been given with sufficient detail to serve as a useful reference. Other material is easily available but has been incorporated here to enhance the usefulness of this collection as a single source reference.

Unless otherwise noted, all constants used in the calculation of the tables and figures are from List (1968). The topic of solar beam irradiation on sloping surfaces has been omitted from this collection and the user is referred to the tables of Fons *et al.* (1960) and Frank and Lee (1966). The items within the lists of conversion factors are arranged alphabetically.

The author assumes full responsibility for any errors or inaccuracies and would appreciate having them called to his attention.

RADIANT ENERGY

Rate--Stefan-Boltzmann Law

Any substance warmer than absolute zero (-273.2° C) radiates energy at a rate directly proportional to the fourth power of its absolute temperature. For a perfect radiator, or "black body," the rate of radiant energy emission may be found by the Stefan-Boltzmann law:

$$W = \sigma T^4$$

where W is the rate of radiant energy emission (cal cm^{-2} min^{-1}); σ is the Stefan-Boltzmann constant (8.132×10^{-11} cal cm^{-2} min^{-1} $°K^{-4}$); and T is the absolute temperature (°K) of the radiating surface.

Table 1 is the solution of the Stefan-Boltzmann equation for various temperatures in degrees Centigrade, and tenths, and table 2 presents W values for Fahrenheit temperatures.

For less-than-perfect radiators, or "gray bodies," the rate of radiant energy emission may be found by multiplying the maximum or "black body" values by the appropriate emissivity factor.

Spectral Distribution--Planck's Law

The intensity of energy emitted by a black body at various wavelengths is described by Planck's law:

$$W\lambda = c_1\lambda^{-5} \left(\exp \frac{c_2}{\lambda T} - 1\right)^{-1}$$

where $W\lambda$ is the intensity of energy emitted at wavelength λ, c_1 and c_2 are constants, and T is the absolute temperature (°K) of the black body source.

Tables 3 and 4 are solutions of Planck's law for a range of typical terrestrial temperatures, in degrees Centigrade. Table 3 gives values for $W\lambda$ in ergs cm^{-2} sec^{-1} cm of wavelength^{-1}, where constant $c_1 = 3.740 \times 10^{-1}$ erg cm^{-2} sec^{-1} and $c_2 = 1.4835$ cm °K. In table 4 these values have been converted to give $W\lambda$ in cal cm^{-2} min^{-1} micron of wavelength^{-1}.

Peak Intensity--Wien's Displacement Law

The wavelength of maximum emission may be found by Wien's displacement law:

$$\lambda_{max} = 2897 \text{ micron } °K\ T^{-1}$$

where λ_{max} is the wavelength of maximum emission (microns), and T is the absolute temperature (°K) of the radiating body.

Table 5 presents λ_{max} values for various temperatures. This table also includes the total energy radiated at these temperatures, the frequency of maximum emission (reciprocal of wavelength), and the intensity of the radiant energy flux at maximum emission.

Table 1.--*Solution of the Stefan-Boltzmann law, $W = \sigma T^4$, for temperatures in degrees Centigrade. W is the rate of energy emission in cal cm^{-2} min^{-1} for a black body*

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
-40	0.2397	0.2393	0.2389	0.2384	0.2380	0.2376	0.2372	0.2368	0.2364	0.2360
-39	.2438	.2434	.2430	.2426	.2422	.2417	.2413	.2409	.2405	.2401
-38	.2480	.2476	.2472	.2467	.2463	.2459	.2455	.2451	.2446	.2442
-37	.2523	.2518	.2514	.2510	.2506	.2501	.2497	.2493	.2489	.2484
-36	.2566	.2561	.2557	.2553	.2548	.2544	.2540	.2535	.2531	.2527
-35	.2609	.2605	.2600	.2596	.2592	.2587	.2583	.2579	.2574	.2570
-34	.2653	.2649	.2644	.2640	.2636	.2631	.2627	.2622	.2618	.2614
-33	.2698	.2694	.2689	.2685	.2680	.2676	.2671	.2667	.2662	.2658
-32	.2743	.2739	.2734	.2730	.2725	.2721	.2716	.2712	.2707	.2703
-31	.2789	.2784	.2780	.2775	.2771	.2766	.2762	.2757	.2752	.2748
-30	.2835	.2831	.2826	.2821	.2817	.2812	.2808	.2803	.2798	.2794
-29	.2882	.2878	.2873	.2868	.2864	.2859	.2854	.2849	.2845	.2840
-28	.2930	.2925	.2920	.2916	.2911	.2906	.2901	.2897	.2892	.2887
-27	.2978	.2973	.2968	.2964	.2959	.2954	.2949	.2944	.2940	.2935
-26	.3027	.3022	.3017	.3012	.3007	.3002	.2998	.2993	.2988	.2983
-25	.3076	.3071	.3066	.3061	.3056	.3051	.3046	.3042	.3037	.3032
-24	.3126	.3121	.3116	.3111	.3106	.3101	.3096	.3091	.3086	.3081
-23	.3177	.3171	.3166	.3161	.3156	.3151	.3146	.3141	.3136	.3131
-22	.3228	.3223	.3217	.3212	.3207	.3202	.3197	.3192	.3187	.3182
-21	.3279	.3274	.3269	.3264	.3259	.3253	.3248	.3243	.3238	.3233
-20	.3332	.3327	.3321	.3316	.3311	.3306	.3300	.3295	.3290	.3285
-19	.3385	.3379	.3374	.3369	.3364	.3358	.3353	.3348	.3342	.3337
-18	.3438	.3433	.3428	.3422	.3417	.3412	.3406	.3401	.3395	.3390
-17	.3493	.3487	.3482	.3476	.3471	.3465	.3460	.3455	.3449	.3444
-16	.3548	.3542	.3537	.3531	.3526	.3520	.3515	.3509	.3504	.3498
-15	.3603	.3598	.3592	.3586	.3581	.3575	.3570	.3564	.3559	.3553
-14	.3659	.3654	.3648	.3642	.3637	.3631	.3625	.3620	.3614	.3609
-13	.3716	.3710	.3705	.3699	.3693	.3688	.3682	.3676	.3671	.3665
-12	.3774	.3768	.3762	.3756	.3751	.3745	.3739	.3733	.3728	.3722
-11	.3832	.3826	.3820	.3814	.3808	.3803	.3797	.3791	.3785	.3779
-10	.3891	.3885	.3879	.3873	.3867	.3861	.3855	.3849	.3844	.3838
-9	.3950	.3944	.3938	.3932	.3926	.3920	.3914	.3908	.3902	.3897
-8	.4010	.4004	.3998	.3992	.3986	.3980	.3974	.3968	.3962	.3956
-7	.4071	.4065	.4059	.4053	.4047	.4041	.4035	.4029	.4022	.4016
-6	.4133	.4127	.4120	.4114	.4108	.4102	.4096	.4090	.4083	.4077
-5	.4195	.4189	.4183	.4176	.4170	.4164	.4158	.4151	.4145	.4139
-4	.4258	.4252	.4245	.4239	.4233	.4226	.4220	.4214	.4208	.4201
-3	.4322	.4315	.4309	.4303	.4296	.4290	.4283	.4277	.4271	.4264
-2	.4386	.4380	.4373	.4367	.4360	.4354	.4347	.4341	.4334	.4328
-1	.4451	.4445	.4438	.4432	.4425	.4419	.4412	.4406	.4399	.4393
-0	.4517	.4510	.4504	.4497	.4491	.4484	.4477	.4471	.4464	.4458
+0	.4517	.4524	.4530	.4537	.4544	.4550	.4557	.4563	.4570	.4577
1	.4584	.4590	.4597	.4604	.4610	.4617	.4624	.4631	.4637	.4644
2	.4651	.4658	.4664	.4671	.4678	.4685	.4692	.4698	.4705	.4712
3	.4719	.4726	.4733	.4739	.4746	.4753	.4760	.4767	.4774	.4781
4	.4788	.4795	.4801	.4808	.4815	.4822	.4829	.4836	.4843	.4850
5	.4857	.4864	.4871	.4878	.4885	.4892	.4899	.4906	.4913	.4920
6	.4927	.4934	.4942	.4949	.4956	.4963	.4970	.4977	.4984	.4991
7	.4998	.5006	.5013	.5020	.5027	.5034	.5041	.5049	.5056	.5063
8	.5070	.5077	.5085	.5092	.5099	.5106	.5114	.5121	.5128	.5135
9	.5143	.5150	.5157	.5165	.5172	.5179	.5187	.5194	.5201	.5209
10	.5216	.5223	.5231	.5238	.5246	.5253	.5260	.5268	.5275	.5283
11	.5290	.5298	.5305	.5313	.5320	.5328	.5335	.5343	.5350	.5358
12	.5365	.5373	.5380	.5388	.5395	.5403	.5410	.5418	.5426	.5433
13	.5441	.5448	.5456	.5464	.5471	.5479	.5487	.5494	.5502	.5510

Continued on next page

Table 1 continued

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
14	0.5517	0.5525	0.5533	0.5540	0.5548	0.5556	0.5564	0.5571	0.5579	0.5587
15	.5595	.5602	.5610	.5618	.5626	.5634	.5641	.5649	.5657	.5665
16	.5673	.5681	.5688	.5696	.5704	.5712	.5720	.5728	.5736	.5744
17	.5752	.5760	.5767	.5775	.5783	.5791	.5799	.5807	.5815	.5823
18	.5831	.5839	.5847	.5855	.5863	.5872	.5880	.5888	.5896	.5904
19	.5912	.5920	.5928	.5936	.5944	.5953	.5961	.5969	.5977	.5985
20	.5993	.6002	.6010	.6018	.6026	.6034	.6043	.6051	.6059	.6067
21	.6076	.6084	.6092	.6100	.6109	.6117	.6125	.6134	.6142	.6150
22	.6159	.6167	.6175	.6184	.6192	.6201	.6209	.6217	.6226	.6234
23	.6243	.6251	.6259	.6268	.6276	.6285	.6293	.6302	.6310	.6319
24	.6327	.6336	.6344	.6353	.6362	.6370	.6379	.6387	.6396	.6404
25	.6413	.6422	.6430	.6439	.6448	.6456	.6465	.6473	.6482	.6491
26	.6500	.6508	.6517	.6526	.6534	.6543	.6552	.6561	.6569	.6578
27	.6587	.6596	.6605	.6613	.6622	.6631	.6640	.6649	.6657	.6666
28	.6675	.6684	.6693	.6702	.6711	.6720	.6729	.6737	.6746	.6755
29	.6764	.6773	.6782	.6791	.6800	.6809	.6818	.6827	.6836	.6845
30	.6854	.6863	.6872	.6882	.6891	.6900	.6909	.6918	.6927	.6936
31	.6945	.6954	.6964	.6973	.6982	.6991	.7000	.7010	.7019	.7028
32	.7037	.7046	.7056	.7065	.7074	.7083	.7093	.7102	.7111	.7121
33	.7130	.7139	.7149	.7158	.7167	.7177	.7186	.7195	.7205	.7214
34	.7224	.7233	.7242	.7252	.7261	.7271	.7280	.7290	.7299	.7309
35	.7318	.7328	.7337	.7347	.7356	.7366	.7375	.7385	.7394	.7404
36	.7414	.7423	.7433	.7442	.7452	.7462	.7471	.7481	.7491	.7500
37	.7510	.7520	.7529	.7539	.7549	.7559	.7568	.7578	.7588	.7598
38	.7607	.7617	.7627	.7637	.7647	.7656	.7666	.7676	.7686	.7696
39	.7706	.7716	.7726	.7735	.7745	.7755	.7765	.7775	.7785	.7795
40	.7805	.7815	.7825	.7835	.7845	.7855	.7865	.7875	.7885	.7895
41	.7905	.7915	.7925	.7936	.7946	.7956	.7966	.7976	.7986	.7996
42	.8006	.8017	.8027	.8037	.8047	.8057	.8068	.8078	.8088	.8098
43	.8109	.8119	.8129	.8139	.8150	.8160	.8170	.8181	.8191	.8201
44	.8212	.8222	.8232	.8243	.8253	.8264	.8274	.8284	.8295	.8305
45	.8316	.8326	.8337	.8347	.8358	.8368	.8379	.8389	.8400	.8410
46	.8421	.8431	.8442	.8453	.8463	.8474	.8484	.8495	.8506	.8516
47	.8527	.8538	.8548	.8559	.8570	.8580	.8591	.8602	.8613	.8623
48	.8634	.8645	.8656	.8666	.8677	.8688	.8699	.8710	.8721	.8731
49	.8742	.8753	.8764	.8775	.8786	.8797	.8808	.8818	.8829	.8840
50	.8851	.8862	.8873	.8884	.8895	.8906	.8917	.8928	.8939	.8950
51	.8961	.8973	.8984	.8995	.9006	.9017	.9028	.9039	.9050	.9061
52	.9073	.9084	.9095	.9106	.9117	.9129	.9140	.9151	.9162	.9173
53	.9185	.9196	.9207	.9219	.9230	.9241	.9253	.9264	.9275	.9287
54	.9298	.9309	.9321	.9332	.9344	.9355	.9366	.9378	.9389	.9401
55	.9412	.9424	.9435	.9447	.9458	.9470	.9481	.9493	.9504	.9516
56	.9528	.9539	.9551	.9562	.9574	.9586	.9597	.9609	.9621	.9632
57	.9644	.9656	.9667	.9679	.9691	.9702	.9714	.9726	.9738	.9750
58	.9761	.9773	.9785	.9797	.9809	.9820	.9832	.9844	.9856	.9868
59	.9880	.9892	.9904	.9916	.9928	.9939	.9951	.9963	.9975	.9987
60	.9999	1.0011	1.0023	1.0035	1.0048	1.0060	1.0072	1.0084	1.0096	1.0108
61	1.0120	1.0132	1.0144	1.0156	1.0169	1.0181	1.0193	1.0205	1.0217	1.0230
62	1.0242	1.0254	1.0266	1.0279	1.0291	1.0303	1.0315	1.0328	1.0340	1.0352
63	1.0365	1.0377	1.0389	1.0402	1.0414	1.0426	1.0439	1.0451	1.0464	1.0476
64	1.0489	1.0501	1.0514	1.0526	1.0538	1.0551	1.0563	1.0576	1.0589	1.0601
65	1.0614	1.0626	1.0639	1.0651	1.0664	1.0677	1.0689	1.0702	1.0714	1.0727
66	1.0740	1.0752	1.0765	1.0778	1.0791	1.0803	1.0816	1.0829	1.0842	1.0854
67	1.0867	1.0880	1.0893	1.0905	1.0918	1.0931	1.0944	1.0957	1.0970	1.0983
68	1.0995	1.1008	1.1021	1.1034	1.1047	1.1060	1.1073	1.1086	1.1099	1.1112

Continued on next page

Table 1 continued

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
69	1.1125	1.1138	1.1151	1.1164	1.1177	1.1190	1.1203	1.1216	1.1230	1.1243
70	1.1256	1.1269	1.1282	1.1295	1.1308	1.1322	1.1335	1.1348	1.1361	1.1374
71	1.1388	1.1401	1.1414	1.1427	1.1441	1.1454	1.1467	1.1481	1.1494	1.1507
72	1.1521	1.1534	1.1547	1.1561	1.1574	1.1587	1.1601	1.1614	1.1628	1.1641
73	1.1655	1.1668	1.1682	1.1695	1.1709	1.1722	1.1736	1.1749	1.1763	1.1776
74	1.1790	1.1804	1.1817	1.1831	1.1844	1.1858	1.1872	1.1885	1.1899	1.1913
75	1.1927	1.1940	1.1954	1.1968	1.1981	1.1995	1.2009	1.2023	1.2037	1.2050
76	1.2064	1.2078	1.2092	1.2106	1.2120	1.2133	1.2147	1.2161	1.2175	1.2189
77	1.2203	1.2217	1.2231	1.2245	1.2259	1.2273	1.2287	1.2301	1.2315	1.2329
78	1.2343	1.2357	1.2371	1.2385	1.2400	1.2414	1.2428	1.2442	1.2456	1.2470
79	1.2484	1.2499	1.2513	1.2527	1.2541	1.2555	1.2570	1.2584	1.2598	1.2613
80	1.2627	1.2641	1.2656	1.2670	1.2684	1.2699	1.2713	1.2727	1.2742	1.2756
81	1.2771	1.2785	1.2799	1.2814	1.2828	1.2843	1.2857	1.2872	1.2886	1.2901
82	1.2915	1.2930	1.2945	1.2959	1.2974	1.2988	1.3003	1.3018	1.3032	1.3047
83	1.3062	1.3076	1.3091	1.3106	1.3120	1.3135	1.3150	1.3165	1.3179	1.3194
84	1.3201	1.3224	1.3239	1.3253	1.3268	1.3283	1.3298	1.3313	1.3328	1.3343
85	1.3358	1.3373	1.3388	1.3402	1.3417	1.3432	1.3447	1.3462	1.3477	1.3492
86	1.3508	1.3523	1.3538	1.3553	1.3568	1.3583	1.3598	1.3613	1.3628	1.3643
87	1.3659	1.3674	1.3689	1.3704	1.3719	1.3735	1.3750	1.3765	1.3780	1.3796
88	1.3811	1.3826	1.3842	1.3857	1.3872	1.3888	1.3903	1.3918	1.3934	1.3949
89	1.3965	1.3980	1.3996	1.4011	1.4027	1.4042	1.4058	1.4073	1.4089	1.4104
90	1.4120	1.4135	1.4151	1.4166	1.4182	1.4198	1.4213	1.4229	1.4244	1.4260
91	1.4276	1.4292	1.4307	1.4323	1.4339	1.4354	1.4370	1.4386	1.4402	1.4418
92	1.4433	1.4449	1.4465	1.4481	1.4497	1.4513	1.4529	1.4544	1.4560	1.4576
93	1.4592	1.4608	1.4624	1.4640	1.4656	1.4672	1.4688	1.4704	1.4720	1.4736
94	1.4752	1.4768	1.4785	1.4801	1.4817	1.4833	1.4849	1.4865	1.4881	1.4898
95	1.4914	1.4930	1.4946	1.4963	1.4979	1.4995	1.5011	1.5028	1.5044	1.5060
96	1.5077	1.5093	1.5109	1.5126	1.5142	1.5158	1.5175	1.5191	1.5208	1.5224
97	1.5241	1.5257	1.5274	1.5290	1.5307	1.5323	1.5340	1.5356	1.5373	1.5390
98	1.5406	1.5423	1.5439	1.5456	1.5473	1.5489	1.5506	1.5523	1.5539	1.5556
99	1.5573	1.5590	1.5606	1.5623	1.5640	1.5657	1.5674	1.5690	1.5707	1.5724
100	1.5741	1.5758	1.5775	1.5792	1.5809	1.5826	1.5843	1.5860	1.5876	1.5893

Table 2.--*Solution of the Stefan-Boltzmann law, $W = \sigma T^4$, for temperatures in degrees Fahrenheit. W is the rate of energy emission in cal cm^{-2} min^{-1} for a black body*

°F	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
-30	0.2635	0.2611	0.2586	0.2562	0.2538	0.2515	0.2491	0.2468	0.2444	0.2421
-20	.2889	.2863	.2837	.2811	.2785	.2760	.2735	.2709	.2685	.2660
-10	.3161	.3133	.3105	.3077	.3050	.3023	.2996	.2969	.2942	.2915
-0	.3451	.3421	.3392	.3362	.3333	.3304	.3275	.3246	.3217	.3189
+0	.3451	.3481	.3512	.3542	.3573	.3604	.3635	.3666	.3698	.3730
10	.3762	.3794	.3826	.3858	.3891	.3924	.3957	.3991	.4024	.4058
20	.4092	.4126	.4161	.4195	.4230	.4265	.4301	.4336	.4372	.4408
30	.4444	.4480	.4517	.4554	.4591	.4628	.4666	.4703	.4741	.4780
40	.4818	.4857	.4896	.4935	.4974	.5014	.5054	.5094	.5134	.5175
50	.5215	.5256	.5298	.5339	.5381	.5423	.5465	.5508	.5550	.5593
60	.5637	.5680	.5724	.5768	.5812	.5857	.5901	.5946	.5992	.6037
70	.6083	.6129	.6175	.6222	.6269	.6316	.6363	.6411	.6459	.6507
80	.6555	.6604	.6653	.6702	.6752	.6802	.6852	.6902	.6953	.7004
90	.7055	.7106	.7158	.7210	.7262	.7315	.7368	.7421	.7474	.7528
100	.7582	.7636	.7691	.7746	.7801	.7857	.7912	.7968	.8025	.8081
110	.8138	.8196	.8253	.8311	.8369	.8428	.8487	.8546	.8605	.8665
120	.8725	.8785	.8846	.8907	.8968	.9030	.9092	.9154	.9216	.9279
130	.9342	.9406	.9470	.9534	.9598	.9663	.9728	.9794	.9860	.9926
140	.9992	1.0059	1.0126	1.0194	1.0261	1.0330	1.0398	1.0467	1.0536	1.0605
150	1.0675	1.0746	1.0816	1.0887	1.0958	1.1030	1.1102	1.1174	1.1247	1.1320
160	1.1393	1.1467	1.1541	1.1615	1.1690	1.1765	1.1840	1.1916	1.1992	1.2069
170	1.2146	1.2223	1.2301	1.2379	1.2457	1.2536	1.2615	1.2695	1.2775	1.2855
180	1.2936	1.3017	1.3098	1.3180	1.3262	1.3345	1.3428	1.3511	1.3595	1.3679
190	1.3764	1.3849	1.3934	1.4020	1.4106	1.4192	1.4279	1.4366	1.4454	1.4542

Table 3.--*Solution of Planck's law, $W\lambda = c_1\lambda^{-5}(\exp \frac{c_2}{\lambda T} - 1)^{-1}$, for temperatures in degrees C and wavelengths in cm. $W\lambda$ is the intensity of black body energy emission in ergs cm^{-2} sec^{-1} cm of $wavelength^{-1}$*

Wavelength (cm)	Wave number cm^{-1}	Temperature (°C)												
		-10	0	10	20	30	40	50	60	70	80	90	100	x
0.0002	5,000.00	0.0006	0.0019	0.0048	0.0118	0.0273	0.0597	0.1243	0.2477	0.4742	0.8750	1.5610	2.6997	10^5
.0004	2,500.00	.0274	.0460	.0743	.1162	.1765	.2610	.3766	.5317	.7357	.9994	1.3348	1.7555	10^8
.0006	1,666.67	.3975	.5609	.7724	1.0408	1.3752	1.7850	2.2797	2.8693	3.5632	4.3712	5.3025	6.3663	10^8
.0008	1,250.00	.9900	1.2822	1.6304	2.0398	2.5146	3.0591	3.6770	4.3715	5.1455	6.0016	6.9418	7.9679	10^8
.0010	1,000.00	1.3326	1.6398	1.9888	2.3809	2.8171	3.2983	3.8250	4.3973	5.0154	5.6790	6.3880	7.1418	10^8
.0012	833.33	1.3788	1.6407	1.9290	2.2438	2.5848	2.9518	3.3443	3.7618	4.2039	4.6698	5.1590	5.6709	10^8
.0014	714.29	1.2596	1.4641	1.6846	1.9205	2.1716	2.4373	2.7172	3.0107	3.3173	3.6366	3.9680	4.3110	10^8
.0016	625.00	1.0819	1.2362	1.3999	1.5729	1.7546	1.9446	2.1426	2.3482	2.5610	2.7807	3.0070	3.2395	10^8
.0018	555.56	.9014	1.0166	1.1376	1.2641	1.3958	1.5322	1.6734	1.8190	1.9686	2.1221	2.2793	2.4400	10^8
.0020	500.00	.7405	.8268	.9167	1.0099	1.1062	1.2055	1.3075	1.4121	1.5192	1.6286	1.7401	1.8536	10^8
.0030	333.33	.2771	.3007	.3247	.3492	.3741	.3993	.4249	.4507	.4768	.5032	.5298	.5566	10^8
.0040	250.00	.1179	.1264	.1349	.1435	.1521	.1609	.1697	.1785	.1875	.1964	.2054	.2145	10^8
.0050	200.00	.5727	.6091	.6458	.6828	.7199	.7573	.7948	.8325	.8704	.9084	.9465	.9847	10^7
.0060	166.67	.3083	.3264	.3446	.3629	.3813	.3997	.4182	.4368	.4554	.4740	.4927	.5115	10^7
.0070	142.86	.1797	.1896	.1996	.2097	.2198	.2298	.2400	.2501	.2603	.2705	.2807	.2909	10^7
.0080	125.00	.1115	.1174	.1233	.1293	.1352	.1412	.1472	.1532	.1592	.1652	.1712	.1772	10^7
.0090	111.11	.7267	.7640	.8013	.8387	.8762	.9137	.9512	.9889	1.0266	1.0643	1.1020	1.1398	10^6
.0100	100.00	.4935	.5181	.5427	.5674	.5921	.6168	.6416	.6664	.6912	.7160	.7408	.7657	10^6
.1000	10.00	.6445	.6697	.6949	.7201	.7453	.7705	.7957	.8210	.8412	.8714	.8966	.9218	10^2

Table 4.--*Solution of Planck's law, $W\lambda = c_1\lambda^{-5}(\exp \frac{c_2}{\lambda T} - 1)^{-1}$, for temperatures in degrees C and wavelengths in microns. $W\lambda$ is the intensity of black body emission in cal cm^{-2} min^{-1} $micron^{-1}$*

Wavelength (microns)	Wave number μ^{-1}	Temperature (°C)												
		-10	0	10	20	30	40	50	60	70	80	90	100	x
2	0.5000	0.0010	0.0027	0.0069	0.0170	0.0391	0.0855	0.1782	0.3551	0.6797	1.2543	2.2377	3.8701	10^{-5}
4	.2500	.0393	.0659	.1065	.1666	.2530	.3741	.5399	.7622	1.0546	1.4326	1.9135	2.5165	10^{-2}
6	.1667	.5698	.8041	1.1073	1.4921	1.9714	2.5588	3.2680	4.1131	5.1080	6.2662	7.6013	9.1262	10^{-2}
8	.1250	.1419	.1838	.2337	.2924	.3605	.4385	.5271	.6267	.7376	.8603	.9951	1.1422	10^{-1}
10	.1000	.1910	.2351	.2851	.3413	.4038	.4728	.5483	.6304	.7190	.8141	.9157	1.0238	10^{-1}
12	.0833	.1977	.2352	.2765	.3217	.3705	.4232	.4794	.5393	.6026	.6694	.7396	.8129	10^{-1}
14	.0714	.1806	.2099	.2415	.2753	.3113	.3494	.3895	.4316	.4755	.5213	.5688	.6180	10^{-1}
16	.0625	.1551	.1772	.2007	.2255	.2515	.2788	.3072	.3366	.3671	.3986	.4311	.4644	10^{-1}
18	.0556	.1292	.1457	.1631	.1812	.2001	.2197	.2399	.2608	.2822	.3042	.3267	.3498	10^{-1}
20	.0500	.1062	.1185	.1314	.1448	.1586	.1728	.1874	.2024	.2178	.2335	.2495	.2657	10^{-1}
30	.0333	.3972	.4311	.4555	.5006	.5363	.5724	.6091	.6461	.6835	.7214	.7595	.7979	10^{-2}
40	.0250	.1690	.1812	.1934	.2057	.2180	.2307	.2433	.2559	.2688	.2815	.2945	.3075	10^{-2}
50	.0200	.8210	.8732	.9258	.9788	1.0321	1.0856	1.1394	1.1934	1.2477	1.3021	1.3568	1.4116	10^{-3}
60	.0167	.4420	.4679	.4940	.5202	.5466	.5730	.5995	.6261	.6528	.6795	.7063	.7333	10^{-3}
70	.0143	.2576	.2719	.2860	.3006	.3150	.3295	.3440	.3585	.3731	.3877	.4023	.4170	10^{-3}
80	.0125	.1598	.1683	.1768	.1853	.1938	.2024	.2110	.2196	.2282	.2368	.2454	.2541	10^{-3}
90	.0111	.1042	.1095	.1149	.1202	.1256	.1310	.1364	.1418	.1472	.1526	.1580	.1634	10^{-3}
100	.0100	.7074	.7427	.7780	.8134	.8488	.8842	.9198	.9553	.9909	1.0264	1.0620	1.0977	10^{-4}
1,000	.0010	.9239	.9600	.9962	1.0323	1.0685	1.1046	1.1407	1.1769	1.2130	1.2491	1.2852	1.3214	10^{-8}

Table 5.--*Total radiant energy (W), wave number ($\tilde{\nu}$) and wavelength (λ) of maximum emission, and intensity of maximum emission (W_{max}) from a black body source*

Temperature (°C)	W	$\tilde{\nu}$ max	λ max	W_{max}	W_{max}
	Cal cm^{-2} min^{-1}	*Wave number* cm^{-1}	μ	*Erg* cm^{-2} sec^{-1} cm^{-1} x 10^7	*Cal* cm^{-2} min^{-1} μ^{-1} x 10^{-1}
-40	0.2397	804.3	12.4335	7.5608	0.1084
-39	.2438	807.7	12.3803	7.7245	.1107
-38	.2480	811.2	12.3277	7.8909	.1131
-37	.2523	814.6	12.2754	8.0602	.1155
-36	.2566	818.1	12.2236	8.2325	.1180
-35	.2609	821.5	12.1723	8.4076	.1205
-34	.2653	825.0	12.1213	8.5857	.1231
-33	.2698	828.4	12.0708	8.7669	.1257
-32	.2743	831.9	12.0207	8.9510	.1283
-31	.2789	835.3	11.9711	9.1383	.1310
-30	.2835	838.8	11.9218	9.3287	.1337
-29	.2882	842.3	11.8730	9.5222	.1365
-28	.2930	845.7	11.8245	9.7189	.1393
-27	.2978	849.2	11.7764	9.9189	.1422
-26	.3027	852.6	11.7287	10.1222	.1451
-25	.3076	856.1	11.6815	10.3287	.1481
-24	.3126	859.5	11.6345	10.5386	.1511
-23	.3177	863.0	11.5880	10.7520	.1541
-22	.3228	866.4	11.5418	10.9687	.1572
-21	.3279	869.9	11.4960	11.1890	.1604
-20	.3332	873.3	11.4506	11.4128	.1636
-19	.3385	876.8	11.4055	11.6401	.1669
-18	.3438	880.2	11.3608	11.8711	.1702
-17	.3493	883.7	11.3164	12.1057	.1735
-16	.3548	887.1	11.2724	12.3440	.1770
-15	.3603	890.6	11.2287	12.5860	.1804
-14	.3659	894.0	11.1853	12.8318	.1839
-13	.3716	897.5	11.1423	13.0814	.1875
-12	.3774	900.9	11.0996	13.3350	.1912
-11	.3832	904.4	11.0573	13.5924	.1948
-10	.3891	907.8	11.0152	13.8537	.1986
-9	.3950	911.3	10.9735	14.1191	.2024
-8	.4010	914.7	10.9321	14.3886	.2063
-7	.4071	918.2	10.8910	14.6621	.2102
-6	.4133	921.6	10.8502	14.9398	.2142
-5	.4195	925.1	10.8097	15.2217	.2182
-4	.4258	928.5	10.7695	15.5078	.2223
-3	.4322	932.0	10.7296	15.7982	.2265
-2	.4386	935.5	10.6900	16.0929	.2307
-1	.4451	938.9	10.6507	16.3920	.2350
0	.4517	942.4	10.6117	16.6956	.2393
1	.4584	945.8	10.5730	17.0036	.2437
2	.4651	949.3	10.5345	17.3162	.2482
3	.4719	952.7	10.4964	17.6333	.2528
4	.4788	956.2	10.4585	17.9551	.2574
5	.4857	959.6	10.4209	18.2815	.2621
6	.4927	963.1	10.3835	18.6127	.2668
7	.4998	966.5	10.3464	18.9487	.2716
8	.5070	970.0	10.3096	19.2895	.2765
9	.5143	973.4	10.2730	19.6351	.2815

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Table 5 continued

Temperature (°C)	W	$\tilde{\nu}$ max	λ max	W_{max}	W_{max}
	Cal cm^{-2} min^{-1}	*Wave number cm^{-1}*	μ	*Erg cm^{-2} sec^{-1} cm^{-1} x 10^{7}*	*Cal cm^{-2} min^{-1} μ^{-1} x 10^{-1}*
10	0.5216	976.9	10.2367	19.9858	0.2865
11	.5290	980.3	10.2007	20.3414	.2916
12	.5365	983.8	10.1649	20.7020	.2968
13	.5441	987.2	10.1294	21.0678	.3020
14	.5517	990.7	10.0941	21.4387	.3073
15	.5595	994.1	10.0590	21.8148	.3127
16	.5673	997.6	10.0242	22.1961	.3182
17	.5752	1,001.0	9.9897	22.5829	.3237
18	.5831	1,004.5	9.9553	22.9749	.3293
19	.5912	1,007.9	9.9212	23.3724	.3350
20	.5993	1,011.4	9.8874	23.7753	.3408
21	.6076	1,014.8	9.8537	24.1838	.3467
22	.6159	1,018.3	9.8203	24.5979	.3526
23	.6243	1,021.7	9.7872	25.0177	.3586
24	.6327	1,025.2	9.7542	25.4431	.3647
25	.6413	1,028.7	9.7215	25.8744	.3709
26	.6500	1,032.1	9.6890	26.3115	.3772
27	.6587	1,035.6	9.6567	26.7544	.3835
28	.6675	1,039.0	9.6246	27.2033	.3900
29	.6764	1,042.5	9.5927	27.6582	.3965
30	.6854	1,045.9	9.5611	28.1191	.4031
31	.6945	1,049.4	9.5296	28.5862	.4098
32	.7037	1,052.8	9.4984	29.0595	.4166
33	.7130	1,056.3	9.4673	29.5390	.4234
34	.7224	1,059.7	9.4365	30.0248	.4304
35	.7318	1,063.2	9.4058	30.5170	.4375
36	.7414	1,066.6	9.3754	31.0157	.4446
37	.7510	1,070.1	9.3452	31.5208	.4519
38	.7607	1,073.5	9.3151	32.0325	.4592
39	.7706	1,077.0	9.2853	32.5508	.4666
40	.7805	1,080.4	9.2556	33.0758	.4741
41	.7905	1,083.9	9.2261	33.6075	.4818
42	.8006	1,087.3	9.1968	34.1461	.4895
43	.8109	1,090.8	9.1677	34.6916	.4973
44	.8212	1,094.2	9.1388	35.2440	.5052
45	.8316	1,097.7	9.1101	35.8034	.5132
46	.8421	1,101.1	9.0815	36.3699	.5214
47	.8527	1,104.6	9.0531	36.9435	.5296
48	.8634	1,108.0	9.0249	37.5244	.5379
49	.8742	1,111.5	8.9969	38.1125	.5464
50	.8851	1,114.9	8.9690	38.7080	.5549
51	.8961	1,118.4	8.9414	39.3110	.5635
52	.9073	1,121.9	8.9138	39.9213	.5723
53	.9185	1,125.3	8.8865	40.5393	.5811
54	.9298	1,128.5	8.8593	41.1649	.5901
55	.9412	1,132.2	8.8323	41.7982	.5992
56	.9528	1,135.7	8.8055	42.4393	.6084
57	.9644	1,139.1	8.7788	43.0882	.6177
58	.9761	1,142.6	8.7523	43.7450	.6271
59	.9880	1,146.0	8.7259	44.4098	.6366

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Table 5 continued

Temperature (°C)	W	$\tilde{\nu}$ max	λ max	W_{max}	W_{max}
	Cal cm^{-2} min^{-1}	*Wave number cm^{-1}*	μ	*Erg cm^{-2} sec^{-1} cm^{-1} x 10^{7}*	*Cal cm^{-2} min^{-1} μ^{-1} x 10^{-1}*
60	0.9999	1,149.5	8.6997	45.0827	0.6463
61	1.0120	1,152.9	8.6737	45.7637	.6560
62	1.0242	1,156.4	8.6478	46.4529	.6659
63	1.0365	1,159.8	8.6220	47.1503	.6759
64	1.0489	1,163.3	8.5964	47.8562	.6860
65	1.0614	1,166.7	8.5710	48.5704	.6963
66	1.0740	1,170.2	8.5457	49.2932	.7066
67	1.0867	1,173.6	8.5206	50.0246	.7171
68	1.0995	1,177.1	8.4956	50.7645	.7277
69	1.1125	1,180.5	8.4708	51.5133	.7385
70	1.1256	1,184.0	8.4461	52.2708	.7493
71	1.1388	1,187.4	8.4215	53.0372	.7603
72	1.1521	1,190.9	8.3971	53.8126	.7714
73	1.1655	1,194.3	8.3728	54.5970	.7827
74	1.1790	1,197.8	8.3487	55.3906	.7940
75	1.1927	1,201.2	8.3247	56.1933	.8055
76	1.2064	1,204.7	8.3009	57.0054	.8172
77	1.2203	1,208.1	8.2771	57.8267	.8290
78	1.2343	1,211.6	8.2536	58.6576	.8409
79	1.2484	1,215.1	8.2301	59.4979	.8529
80	1.2627	1,218.5	8.2068	60.3479	.8651
81	1.2771	1,222.0	8.1836	61.2075	.8774
82	1.2915	1,225.4	8.1606	62.0770	.8899
83	1.3062	1,228.9	8.1376	62.9561	.9025
84	1.3209	1,232.3	8.1148	63.8454	.9152
85	1.3358	1,235.8	8.0922	64.7446	.9281
86	1.3508	1,239.2	8.0696	65.6539	.9412
87	1.3659	1,242.7	8.0472	66.5734	.9543
88	1.3811	1,246.1	8.0249	67.5032	.9677
89	1.3965	1,249.6	8.0028	68.4434	.9812
90	1.4120	1,253.0	7.9807	69.3939	.9948
91	1.4276	1,256.5	7.9588	70.3551	1.0086
92	1.4433	1,260.0	7.9370	71.3268	1.0225
93	1.4592	1,263.4	7.9153	72.3093	1.0366
94	1.4752	1,266.8	7.8937	73.3025	1.0508
95	1.4914	1,270.3	7.8723	74.3067	1.0652
96	1.5077	1,273.7	7.8509	75.3217	1.0798
97	1.5241	1,277.2	7.8297	76.3479	1.0945
98	1.5406	1,280.6	7.8086	77.3852	1.1093
99	1.5573	1,284.1	7.7876	78.4338	1.1244
100	1.5741	1,287.5	7.7668	79.4937	1.1396

Atmospheric Radiation--Empirical Formulas

Empirical equations for estimating clear-sky atmospheric radiation differ primarily on the inclusion of a water vapor factor. Table 6 presents the Brunt equation, which includes a water vapor factor:

$$I_{\downarrow} = \sigma T^4 \ (a + b\sqrt{e})$$

where $I_{\downarrow}$ is the long-wave sky radiation in cal cm^{-2} min^{-1}, σ is the Stefan-Boltzmann constant (8.132 x 10^{-11} cal cm^{-2} min^{-1} °K^{-4}), T is the screen-height air temperature (°K), a and b are constants with values of 0.660 and 0.039 respectively, and e is the screen-height vapor pressure in millibars. The values in table 6 are presented in terms of screen-height air temperature in °C and screen-height relative humidity.

Table 6.--*Brunt equation, $I\downarrow = \sigma T^4 (a + b\sqrt{e})$, for atmospheric radiation*

(In cal cm^{-2} min^{-1})

°C	Percent relative humidity										
	100	90	80	70	60	50	40	30	20	10	1
-40	0.1622	0.1620	0.1618	0.1616	0.1613	0.1611	0.1608	0.1604	0.1600	0.1595	0.1586
-39	.1653	.1650	.1648	.1646	.1643	.1640	.1637	.1633	.1629	.1623	.1614
-38	.1683	.1681	.1679	.1676	.1673	.1670	.1666	.1662	.1658	.1652	.1642
-37	.1715	.1712	.1710	.1707	.1704	.1700	.1696	.1692	.1687	.1681	.1670
-36	.1747	.1744	.1741	.1738	.1735	.1731	.1727	.1723	.1717	.1710	.1699
-35	.1779	.1776	.1773	.1770	.1766	.1762	.1758	.1753	.1748	.1740	.1728
-34	.1812	.1809	.1806	.1802	.1798	.1794	.1790	.1785	.1778	.1770	.1757
-33	.1846	.1842	.1839	.1835	.1831	.1827	.1822	.1816	.1810	.1801	.1787
-32	.1880	.1876	.1873	.1869	.1864	.1860	.1854	.1849	.1842	.1832	.1817
-31	.1915	.1911	.1907	.1903	.1898	.1893	.1888	.1881	.1874	.1864	.1848
-30	.1950	.1946	.1942	.1937	.1933	.1927	.1921	.1915	.1907	.1896	.1879
-29	.1986	.1982	.1978	.1973	.1967	.1962	.1956	.1948	.1940	.1929	.1911
-28	.2023	.2019	.2014	.2009	.2003	.1997	.1990	.1983	.1974	.1962	.1943
-27	.2061	.2056	.2051	.2045	.2039	.2033	.2026	.2018	.2008	.1996	.1975
-26	.2099	.2094	.2088	.2082	.2076	.2069	.2062	.2053	.2043	.2030	.2008
-25	.2138	.2132	.2127	.2120	.2114	.2106	.2098	.2089	.2078	.2064	.2041
-24	.2178	.2172	.2166	.2159	.2152	.2144	.2136	.2126	.2114	.2099	.2075
-23	.2218	.2212	.2205	.2198	.2191	.2183	.2174	.2163	.2151	.2135	.2109
-22	.2259	.2253	.2246	.2238	.2230	.2222	.2212	.2201	.2188	.2171	.2143
-21	.2302	.2295	.2287	.2279	.2271	.2261	.2251	.2240	.2226	.2208	.2178
-20	.2345	.2337	.2323	.2321	.2312	.2302	.2291	.2279	.2264	.2245	.2214
-19	.2388	.2380	.2372	.2363	.2353	.2343	.2332	.2318	.2303	.2283	.2249
-18	.2433	.2425	.2416	.2406	.2396	.2385	.2373	.2359	.2342	.2321	.2286
-17	.2478	.2470	.2460	.2450	.2439	.2428	.2415	.2400	.2383	.2360	.2322
-16	.2525	.2516	.2506	.2495	.2484	.2471	.2457	.2442	.2423	.2399	.2360
-15	.2572	.2562	.2552	.2541	.2529	.2515	.2501	.2484	.2465	.2439	.2397
-14	.2621	.2610	.2599	.2587	.2574	.2561	.2545	.2528	.2507	.2480	.2436
-13	.2670	.2659	.2647	.2635	.2621	.2606	.2590	.2572	.2550	.2521	.2474
-12	.2721	.2709	.2696	.2683	.2669	.2653	.2636	.2617	.2593	.2563	.2514
-11	.2772	.2760	.2746	.2732	.2717	.2701	.2683	.2662	.2638	.2606	.2553
-10	.2825	.2811	.2800	.2789	.2767	.2749	.2730	.2708	.2683	.2649	.2593
-9	.2878	.2864	.2850	.2834	.2817	.2799	.2779	.2756	.2728	.2693	.2634
-8	.2933	.2918	.2903	.2886	.2869	.2849	.2828	.2804	.2775	.2737	.2675
-7	.2989	.2974	.2957	.2940	.2921	.2901	.2878	.2852	.2822	.2783	.2717
-6	.3046	.3030	.3013	.2994	.2974	.2953	.2929	.2902	.2870	.2828	.2760
-5	.3105	.3087	.3069	.3050	.3029	.3006	.2981	.2953	.2919	.2875	.2802
-4	.3164	.3146	.3127	.3107	.3085	.3061	.3034	.3004	.2969	.2922	.2846
-3	.3225	.3206	.3186	.3164	.3141	.3116	.3088	.3057	.3019	.2970	.2890
-2	.3288	.3268	.3246	.3224	.3199	.3173	.3143	.3110	.3070	.3019	.2934
-1	.3351	.3330	.3308	.3284	.3258	.3230	.3199	.3164	.3123	.3069	.2979
0	.3417	.3394	.3371	.3345	.3318	.3289	.3257	.3220	.3176	.3119	.3025
1	.3483	.3460	.3435	.3408	.3380	.3349	.3315	.3276	.3230	.3170	.3071
2	.3551	.3527	.3500	.3473	.3443	.3410	.3374	.3333	.3285	.3222	.3118
3	.3621	.3595	.3567	.3538	.3507	.3473	.3435	.3392	.3341	.3275	.3165
4	.3692	.3665	.3636	.3605	.3572	.3536	.3497	.3451	.3398	.3328	.3213
5	.3765	.3736	.3706	.3674	.3639	.3601	.3559	.3512	.3456	.3383	.3262
6	.3840	.3809	.3778	.3744	.3707	.3667	.3624	.3574	.3515	.3438	.3311
7	.3916	.3884	.3851	.3815	.3777	.3735	.3689	.3637	.3575	.3494	.3363
8	.3994	.3961	.3925	.3888	.3848	.3804	.3756	.3701	.3636	.3551	.3411
9	.4074	.4039	.4002	.3963	.3920	.3874	.3824	.3766	.3698	.3609	.3462
10	.4155	.4119	.4080	.4039	.3995	.3947	.3893	.3833	.3761	.3668	.3514
11	.4239	.4200	.4160	.4117	.4070	.4020	.3964	.3901	.3826	.3728	.3566
12	.4324	.4284	.4242	.4196	.4148	.4095	.4036	.3970	.3891	.3789	.3619
13	.4412	.4370	.4325	.4278	.4227	.4171	.4110	.4041	.3958	.3851	.3673
14	.4501	.4457	.4411	.4361	.4308	.4250	.4185	.4112	.4026	.3913	.3727

Continued on next page

Table 6 continued

°C	Percent relative humidity										
	100	90	80	70	60	50	40	30	20	10	1
15	0.4593	0.4547	0.4498	0.4446	0.4390	0.4329	0.4262	0.4186	0.4095	0.3977	0.3782
16	.4687	.4639	.4588	.4533	.4475	.4411	.4340	.4261	.4166	.4042	.3838
17	.4783	.4733	.4679	.4622	.4561	.4494	.4420	.4337	.4238	.4108	.3895
18	.4882	.4829	.4773	.4713	.4649	.4579	.4502	.4414	.4311	.4175	.3952
19	.4982	.4927	.4868	.4806	.4739	.4666	.4585	.4494	.4385	.4244	.4010
20	.5086	.5028	.4966	.4901	.4831	.4755	.4670	.4575	.4461	.4313	.4069
21	.5191	.5131	.5067	.4998	.4925	.4845	.4757	.4657	.4538	.4383	.4128
22	.5300	.5236	.5169	.5098	.5021	.4938	.4846	.4741	.4617	.4455	.4188
23	.5410	.5344	.5274	.5200	.5120	.5032	.4936	.4827	.4697	.4528	.4253
24	.5524	.5455	.5382	.5304	.5220	.5129	.5028	.4914	.4779	.4602	.4311
25	.5640	.5568	.5492	.5410	.5323	.5228	.5123	.5004	.4862	.4678	.4373
26	.5759	.5684	.5604	.5519	.5428	.5329	.5219	.5095	.4947	.4754	.4437
27	.5881	.5802	.5719	.5631	.5535	.5432	.5317	.5187	.5033	.4832	.4501
28	.6006	.5924	.5837	.5745	.5645	.5537	.5418	.5282	.5121	.4912	.4566
29	.6134	.6048	.5958	.5861	.5758	.5645	.5520	.5379	.5211	.4992	.4631
30	.6265	.6176	.6081	.5981	.5873	.5755	.5625	.5478	.5303	.5075	.4698
31	.6399	.6306	.6208	.6103	.5990	.5868	.5732	.5578	.5396	.5158	.4765
32	.6537	.6440	.6337	.6228	.6110	.5983	.5841	.5681	.5491	.5243	.4834
33	.6678	.6577	.6470	.6356	.6233	.6100	.5953	.5786	.5588	.5329	.4903
34	.6822	.6717	.6605	.6487	.6359	.6221	.6067	.5893	.5686	.5417	.4973
35	.6970	.6860	.6744	.6621	.6488	.6343	.6184	.6002	.5787	.5507	.5044
36	.7122	.7007	.6887	.6758	.6619	.6469	.6303	.6114	.5890	.5598	.5116
37	.7277	.7158	.7032	.6898	.6754	.6597	.6424	.6228	.5994	.5690	.5189
38	.7436	.7312	.7181	.7042	.6892	.6729	.6548	.6344	.6101	.5785	.5262
39	.7599	.7470	.7334	.7188	.7033	.6863	.6675	.6462	.6210	.5881	.5337
40	.7766	.7632	.7490	.7339	.7176	.7000	.6805	.6583	.6321	.5978	.5413
41	.7937	.7797	.7650	.7493	.7324	.7140	.6937	.6707	.6434	.6077	.5489
42	.8112	.7967	.7814	.7650	.7475	.7284	.7073	.6833	.6549	.6179	.5567
43	.8292	.8141	.7981	.7811	.7629	.7430	.7211	.6962	.6666	.6281	.5646
44	.8475	.8319	.8153	.7976	.7787	.7568	.7352	.7093	.6786	.6386	.5725
45	.8664	.8501	.8328	.8145	.7948	.7734	.7497	.7228	.6908	.6493	.5806
46	.8857	.8687	.8508	.8318	.8113	.7890	.7644	.7365	.7033	.6601	.5888
47	.9054	.8878	.8693	.8495	.8282	.8051	.7795	.7505	.7160	.6711	.5971
48	.9257	.9074	.8881	.8676	.8455	.8215	.7949	.7647	.7290	.6824	.6054
49	.9464	.9274	.9074	.8861	.8631	.8382	.8106	.7793	.7422	.6938	.6139
50	.9677	.9480	.9272	.9050	.8812	.8553	.8267	.7942	.7557	.7054	.6225

In table 7 the long-wave clear-sky radiation has been derived solely from screen-height air temperature as calculated by the Idso-Jackson formula (Idso and Jackson 1969):

$$I_{\downarrow} = \sigma T^4 \{1.0 - 0.261 \exp [-7.77 \times 10^{-4} (273 - T)^2]\}$$

where $I_{\downarrow}$ is the clear-sky radiation in cal cm^{-2} min^{-1}, σ is the Stefan-Boltzmann constant, and T is the screen-height air temperature in °K. The values presented in table 7 have been supplied by S. B. Idso[1] and were calculated with a σ value of 8.17×10^{-11} cal cm^{-2} min^{-1} $°K^{-4}$.

[1] *Personal communication with S. B. Idso.*

Table 7.--*Idso-Jackson formula, $I\downarrow = \sigma T^4 \{1.0-0.261 \exp [-7.77 \times 10^{-4} (273-T)^2]\}$, for atmospheric radiation*

(In cal cm^{-2} min^{-1})

°C	°K	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
-40	233	0.222	0.222	0.222	0.222	0.221	0.221	0.221	0.220	0.220	0.220
-39	234	.225	.225	.225	.224	.224	.224	.223	.223	.223	.223
-38	235	.228	.227	.227	.227	.227	.226	.226	.226	.226	.225
-37	236	.230	.230	.230	.230	.229	.229	.229	.229	.228	.228
-36	237	.233	.233	.232	.232	.232	.232	.231	.231	.231	.231
-35	238	.235	.235	.235	.235	.234	.234	.234	.234	.233	.233
-34	239	.238	.238	.237	.237	.237	.237	.236	.236	.236	.236
-33	240	.240	.240	.240	.240	.239	.239	.239	.239	.238	.238
-32	241	.243	.243	.242	.242	.242	.242	.241	.241	.241	.241
-31	242	.245	.245	.245	.245	.244	.244	.244	.244	.243	.243
-30	243	.248	.247	.247	.247	.247	.247	.246	.246	.246	.246
-29	244	.250	.250	.250	.249	.249	.249	.249	.248	.248	.248
-28	245	.252	.252	.252	.252	.252	.251	.251	.251	.251	.250
-27	246	.255	.254	.254	.254	.254	.254	.254	.253	.253	.253
-26	247	.257	.257	.256	.256	.256	.256	.256	.255	.255	.255
-25	248	.259	.259	.259	.259	.258	.258	.258	.258	.257	.257
-24	249	.261	.261	.261	.261	.261	.260	.260	.260	.260	.259
-23	250	.264	.263	.263	.263	.263	.263	.262	.262	.262	.262
-22	251	.266	.266	.265	.265	.265	.265	.265	.264	.264	.264
-21	252	.268	.268	.268	.268	.267	.267	.267	.267	.266	.266
-20	253	.270	.270	.270	.270	.270	.269	.269	.269	.269	.268
-19	254	.273	.273	.272	.272	.272	.272	.271	.271	.271	.271
-18	255	.275	.275	.275	.274	.274	.274	.274	.273	.273	.273
-17	256	.277	.277	.277	.277	.277	.276	.276	.276	.276	.275
-16	257	.280	.280	.279	.279	.279	.279	.278	.278	.278	.278
-15	258	.282	.282	.282	.282	.281	.281	.281	.281	.280	.280
-14	259	.285	.285	.284	.284	.284	.284	.283	.283	.283	.283
-13	260	.288	.287	.287	.287	.287	.286	.286	.286	.286	.285
-12	261	.290	.290	.290	.290	.289	.289	.289	.288	.288	.288
-11	262	.293	.293	.293	.292	.292	.292	.291	.291	.291	.291
-10	263	.296	.296	.296	.295	.295	.295	.294	.294	.294	.294
-9	264	.299	.299	.299	.298	.298	.298	.297	.297	.297	.296
-8	265	.303	.302	.302	.302	.301	.301	.301	.300	.300	.300
-7	266	.306	.306	.305	.305	.305	.304	.304	.304	.303	.303
-6	267	.309	.309	.309	.308	.308	.308	.307	.307	.307	.306
-5	268	.313	.313	.312	.312	.312	.311	.311	.311	.310	.310
-4	269	.317	.317	.316	.316	.316	.315	.315	.314	.314	.314
-3	270	.321	.321	.320	.320	.320	.319	.319	.318	.318	.318
-2	271	.326	.325	.325	.324	.324	.323	.323	.323	.322	.322
-1	272	.330	.330	.329	.329	.328	.328	.327	.327	.326	.326
-0	273	.335	.334	.334	.333	.333	.332	.332	.332	.331	.331
+0	273	.335	.336	.336	.337	.337	.338	.338	.339	.339	.340
1	274	.340	.341	.341	.342	.342	.343	.344	.344	.345	.345
2	275	.346	.346	.347	.347	.348	.349	.349	.350	.350	.351
3	276	.351	.352	.352	.353	.353	.354	.355	.355	.356	.356
4	277	.357	.358	.358	.359	.359	.360	.361	.361	.362	.362
5	278	.363	.364	.364	.365	.366	.366	.367	.367	.368	.369
6	279	.369	.370	.371	.371	.372	.373	.373	.374	.375	.375
7	280	.376	.377	.377	.378	.379	.379	.380	.381	.381	.382
8	281	.383	.384	.384	.385	.386	.386	.387	.388	.389	.389
9	282	.390	.391	.392	.392	.393	.394	.394	.395	.396	.397
10	283	.397	.398	.399	.400	.401	.401	.402	.403	.404	.404
11	284	.405	.406	.407	.408	.408	.409	.410	.411	.412	.412
12	285	.413	.414	.415	.416	.417	.417	.418	.419	.420	.421
13	286	.422	.422	.423	.424	.425	.426	.427	.427	.428	.429
14	287	.430	.431	.432	.433	.434	.434	.435	.436	.437	.438

Continued on next page

Table 7 continued

°C	°K	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
15	288	0.439	0.440	0.441	0.442	0.443	0.443	0.444	0.445	0.446	0.447
16	289	.448	.449	.450	.451	.452	.453	.454	.455	.455	.456
17	290	.457	.458	.459	.460	.461	.462	.463	.464	.465	.466
18	291	.467	.468	.469	.470	.471	.472	.473	.474	.475	.476
19	292	.477	.478	.479	.480	.481	.482	.483	.484	.485	.486
20	293	.487	.488	.489	.490	.491	.492	.493	.494	.495	.496
21	294	.297	.498	.499	.500	.502	.503	.504	.505	.506	.507
22	295	.508	.509	.510	.511	.512	.513	.514	.515	.516	.518
23	296	.519	.520	.521	.522	.523	.524	.525	.526	.527	.529
24	297	.530	.531	.532	.533	.534	.535	.536	.537	.539	.540
25	298	.541	.542	.543	.544	.545	.546	.548	.549	.550	.551
26	299	.552	.553	.554	.556	.557	.558	.559	.560	.561	.563
27	300	.564	.565	.566	.567	.568	.570	.571	.572	.573	.574
28	301	.575	.577	.578	.579	.580	.581	.583	.584	.585	.586
29	302	.587	.589	.590	.591	.592	.593	.595	.596	.597	.598
30	303	.599	.601	.602	.603	.604	.605	.607	.608	.609	.610
31	304	.611	.613	.614	.615	.616	.618	.619	.620	.621	.622
32	305	.624	.625	.626	.627	.629	.630	.631	.632	.634	.635
33	306	.636	.637	.639	.640	.641	.642	.644	.645	.646	.647
34	307	.649	.650	.651	.652	.654	.655	.656	.657	.659	.660
35	308	.661	.662	.664	.665	.666	.667	.669	.670	.671	.673
36	309	.674	.675	.676	.678	.679	.680	.681	.683	.684	.685
37	310	.687	.688	.689	.690	.692	.693	.694	.695	.697	.698
38	311	.699	.701	.702	.703	.704	.706	.707	.708	.710	.711
39	312	.712	.713	.715	.716	.717	.719	.720	.721	.723	.724
40	313	.725	.726	.728	.729	.730	.732	.733	.734	.735	.737
41	314	.738	.739	.741	.742	.743	.745	.746	.747	.748	.750
42	315	.751	.752	.754	.755	.756	.758	.759	.760	.761	.763
43	316	.764	.765	.767	.768	.769	.771	.772	.773	.775	.776
44	317	.777	.778	.780	.781	.782	.784	.785	.786	.788	.789
45	318	.790	.792	.793	.794	.796	.797	.798	.799	.801	.802
46	319	.803	.805	.806	.807	.809	.810	.811	.813	.814	.815
47	320	.817	.818	.819	.820	.822	.823	.824	.826	.827	.828
48	321	.830	.831	.832	.834	.835	.836	.838	.839	.840	.842
49	322	.843	.844	.845	.847	.848	.849	.851	.852	.853	.855

SOLAR RADIATION

Time Correction

The Earth is divided into 24 standard time zones, each 15° wide and extending 7½° on either side of a standard meridian. Because the Sun takes 1 hour to cross a time zone, it crosses 1° of longitude in 4 minutes. Therefore, in order to obtain "true local time" (mean solar time) it is necessary to add 4 minutes for each degree of longitude east of the standard meridian, or subtract 4 minutes for each degree of longitude west of the standard meridian.

The first standard meridian (0° longitude) passes through Greenwich, with successive meridians being multiples of 15° of longitude west of the 0° meridian of Greenwich. It should be noted that over land masses the standard time zones seldom extend exactly 7°30' from either side of the standard meridian, but rather follow geographical or political boundaries.

To obtain true (apparent) solar time it is necessary to algebraically add a correction for the "equation of time" to the true local time. These corrections are listed in table 8, in minutes (M) and seconds (S).

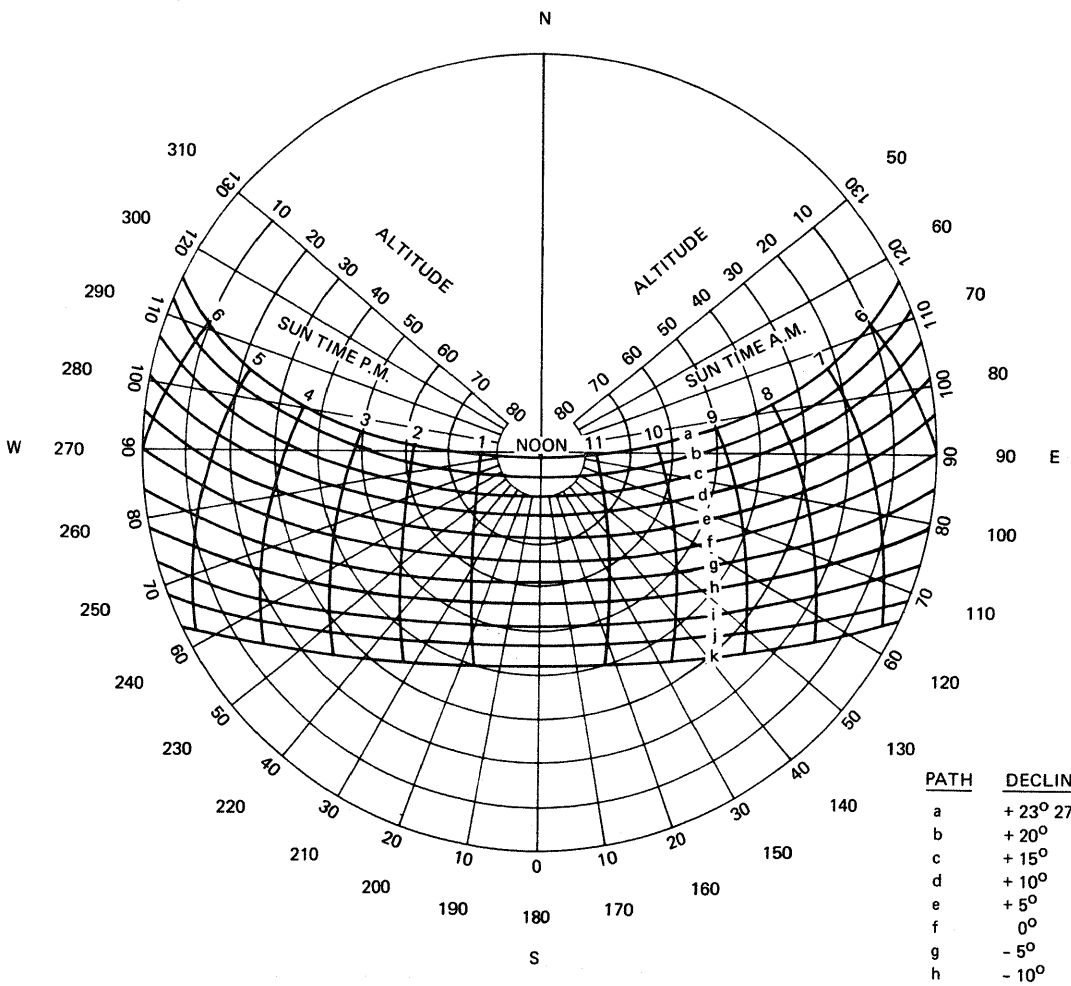
Position

The overhead position of the Sun is shown in figures 1 through 6 (redrawn from List, 1968) for various latitudes. The altitude and azimuth can be determined for any time or date from these diagrams. The altitude or elevation of the Sun above the horizon, in degrees, is determined from the concentric circles, and the azimuth from the radial lines. The outer circle (0° elevation) obviously represents true sunrise or sunset, rather than apparent sunrise or sunset which is due to atmospheric refraction. Under average conditions, in the latitudes covered by these diagrams, apparent sunrise or sunset will occur when the Sun is less than 1 degree below the horizon.

All diagram times are true (apparent) solar times and must be corrected for longitude and the "equation of time" for local standard time. Thus, by selecting the appropriate diagram and Sun path line, the position of the Sun, shading, slope exposure, etc. can be determined for any time of day. Interpolation is permissible.

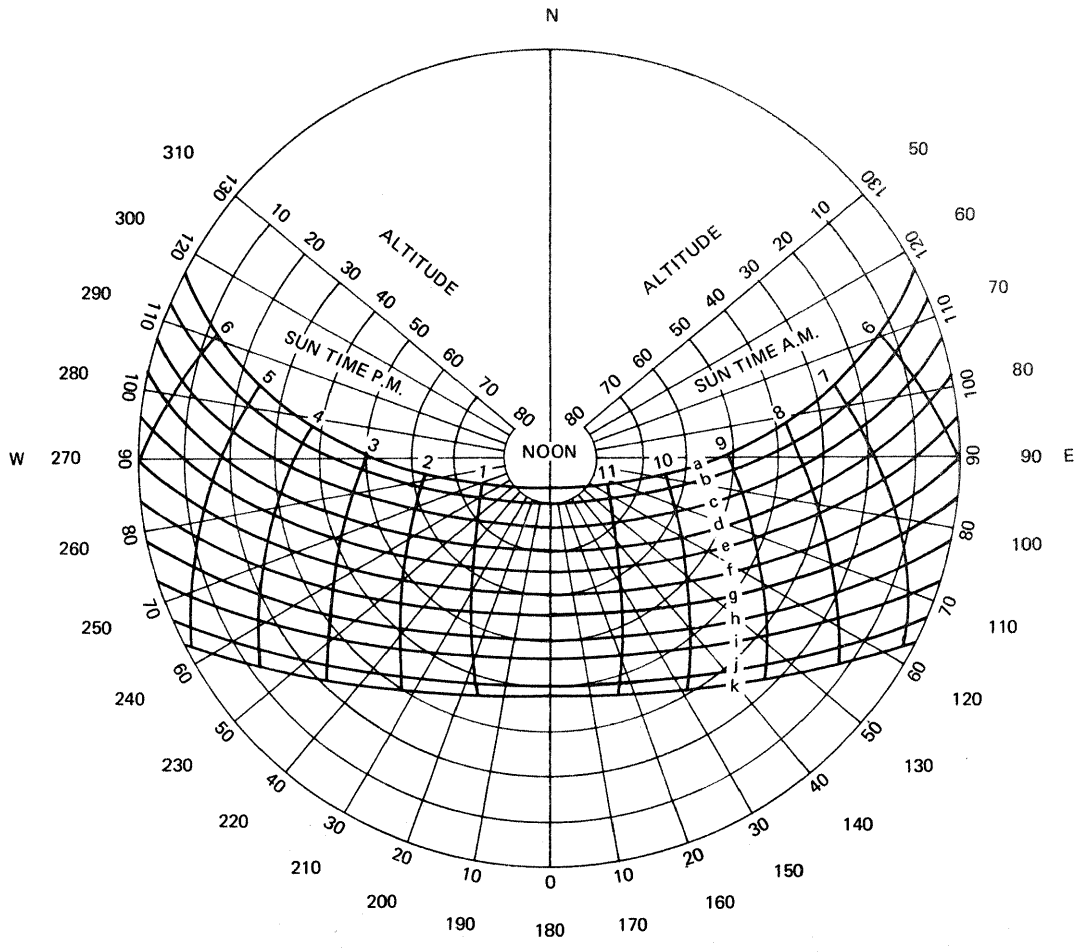
Table 8.--*Corrections in minutes (M) and seconds (S) to obtain true solar time from equation of time*

Month	Day 1		5		9		13		17		21		25		29	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
Jan.	-3	14	-5	6	-6	50	-8	27	-9	54	-11	10	-12	14	-13	5
Feb.	-13	34	-14	2	-14	17	-14	20	-14	10	-13	50	-13	19	--	--
March	-12	38	-11	48	-10	51	-9	49	-8	42	-7	32	-6	20	-5	7
April	-4	12	-3	1	-1	52	-0	47	+0	13	+1	6	+1	53	+2	33
May	+2	50	+3	17	+3	35	+3	44	+3	44	+3	34	+3	16	+2	51
June	+2	27	+1	49	+1	6	+0	18	-0	33	-1	25	-2	17	-3	7
July	-3	31	-4	16	-4	56	-5	30	-5	57	-6	15	-6	24	-6	23
Aug.	-6	17	-5	59	-5	33	-4	57	-4	12	-3	19	-2	18	-1	10
Sept.	-0	15	+1	2	+2	22	+3	45	+5	10	+6	35	+8	0	+9	22
Oct.	+10	1	+11	17	+12	27	+13	30	+14	25	+15	10	+15	46	+16	10
Nov.	+16	21	+16	23	+16	12	+15	47	+15	10	+14	18	+13	15	+11	59
Dec.	+11	16	+9	43	+8	1	+6	12	+4	17	+2	19	+0	20	-1	39



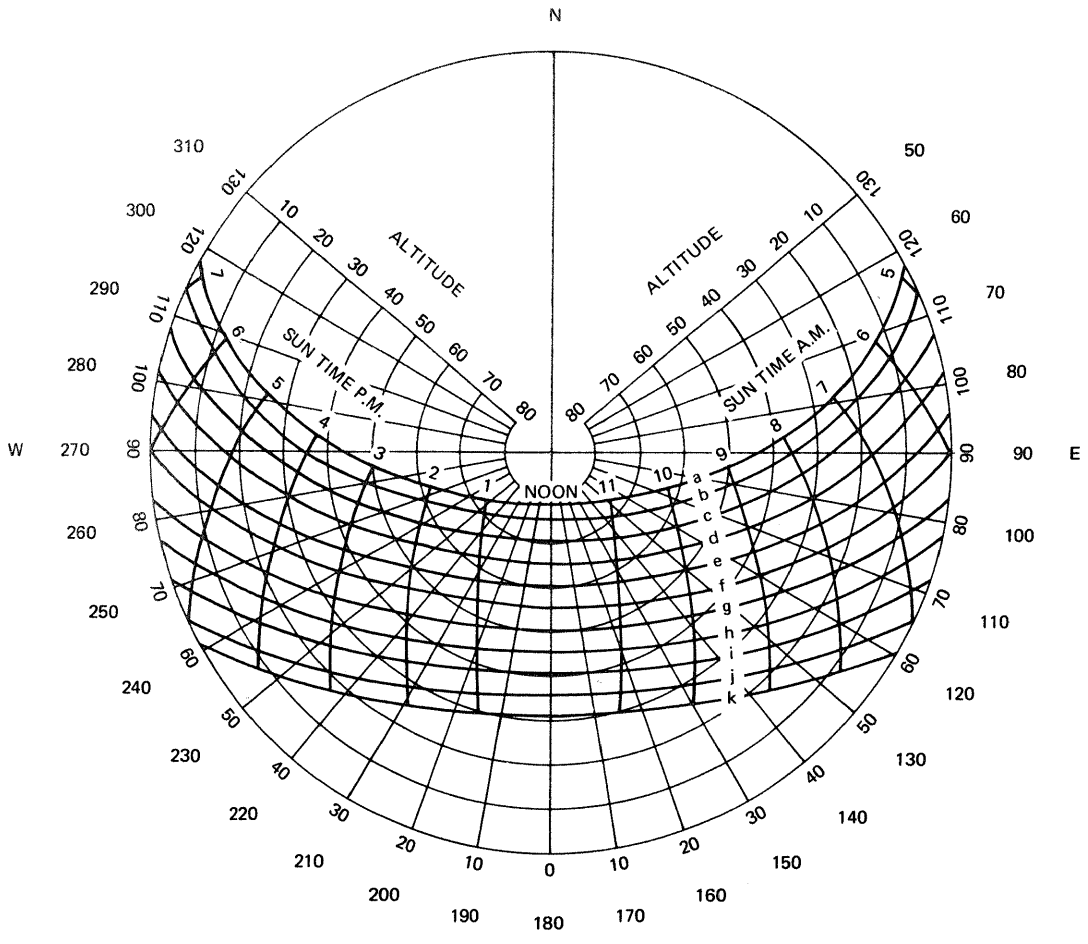
PATH	DECLINATION	DATES
a	+ 23° 27′	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27′	Dec. 22

Figure 1.--*Sun path diagram for 25° N. latitude.*



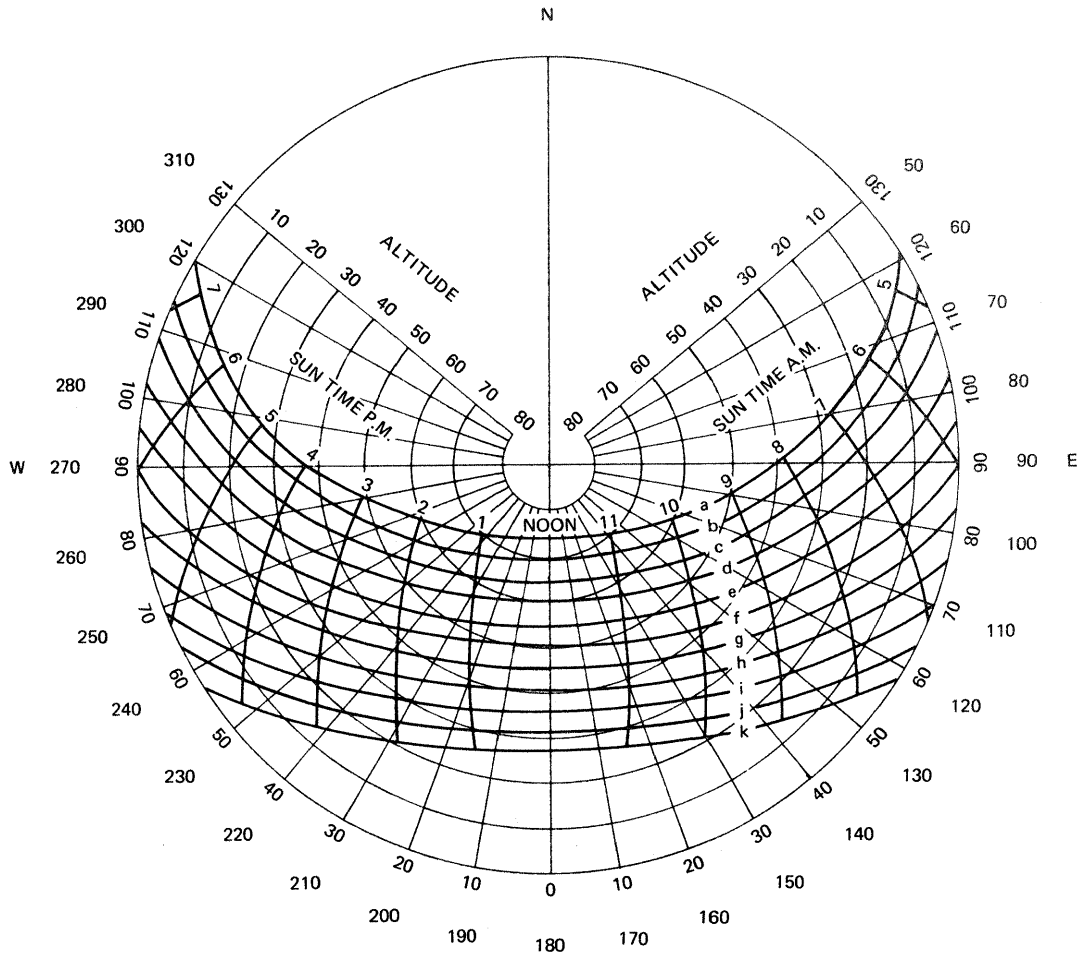
PATH	DECLINATION	DATES
a	+ 23° 27′	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27′	Dec. 22

Figure 2.--*Sun path diagram for 30° N. latitude.*



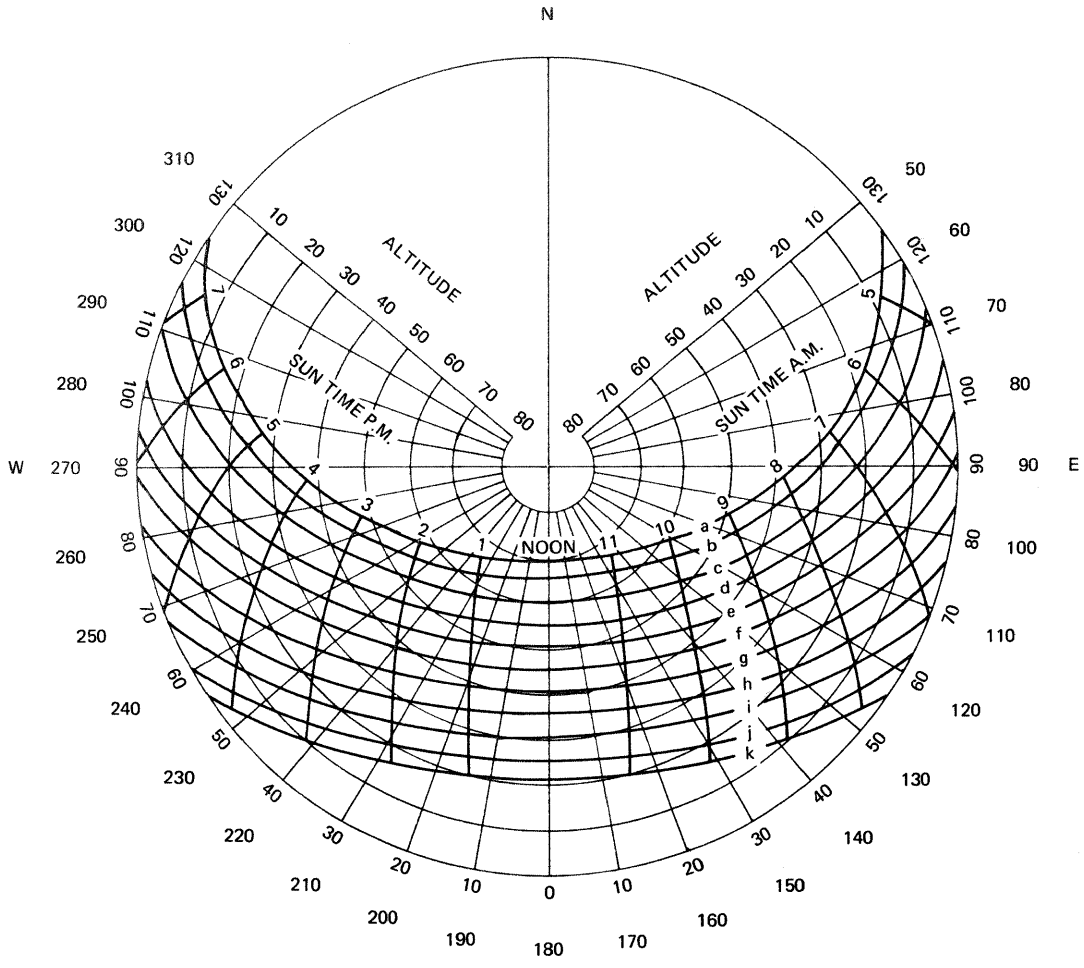
PATH	DECLINATION	DATES
a	+ 23° 27′	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27′	Dec. 22

Figure 3.--*Sun path diagram for 35° N. latitude.*



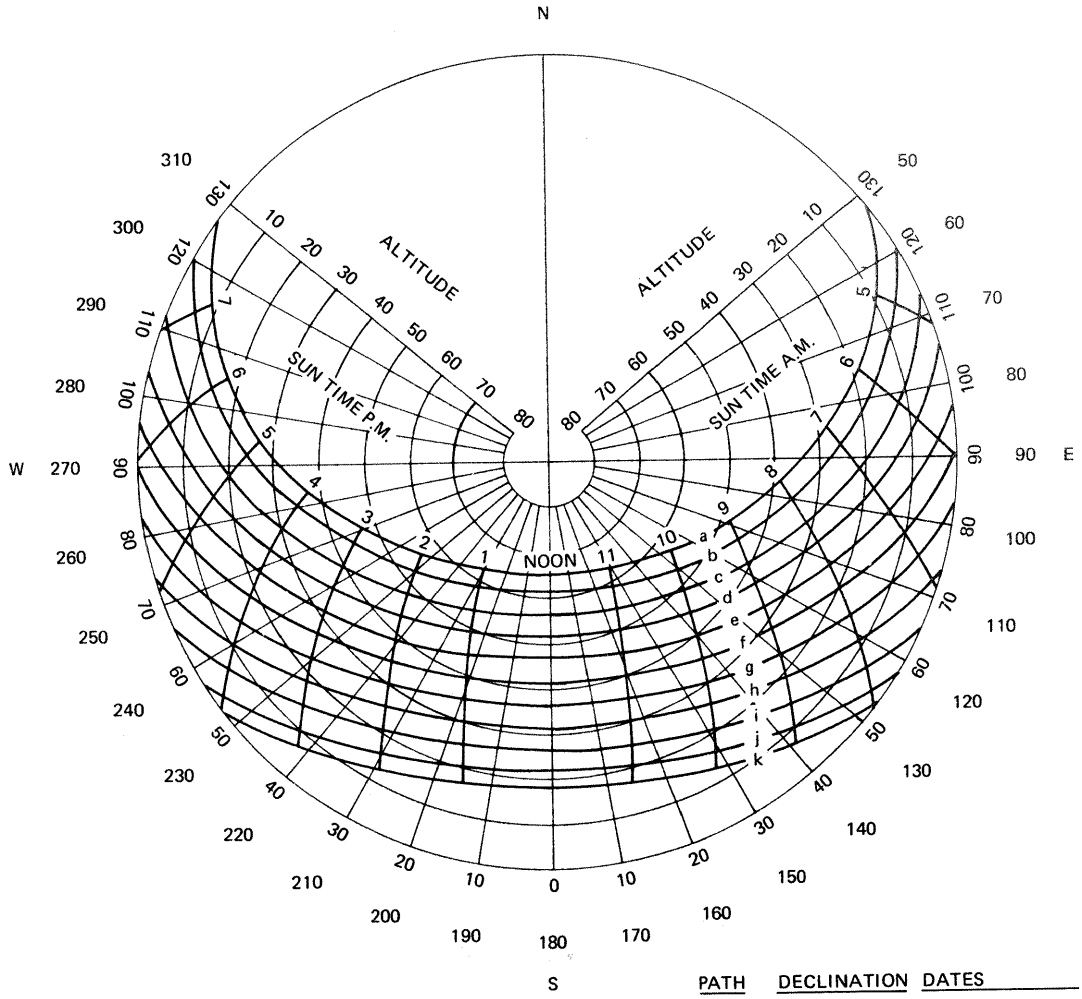
PATH	DECLINATION	DATES
a	+ 23° 27′	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	-10°	Feb. 23 & Oct. 20
i	-15°	Feb. 9 & Nov. 3
j	-20°	Jan. 21 & Nov. 22
k	-23° 27′	Dec. 22

Figure 4.--*Sun path diagram for 40° N. latitude.*



PATH	DECLINATION	DATES
a	+ 23° 27′	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27′	Dec. 22

Figure 5.--*Sun path diagram for 45° N. latitude.*



PATH	DECLINATION	DATES
a	+ 23° 27′	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27′	Dec. 22

Figure 6.--*Sun path diagram for 50° N. latitude.*

Potential Solar Radiation

The potential or amount of solar irradiation at the top of the atmosphere is shown in figure 7 for various latitudes in langleys day^{-1} (cal cm^{-2} day^{-1}). These data are from Frank and Lee (1966) and represent the potential radiation on a horizontal surface. By introducing factors to account for cloudiness and atmospheric turbidity, estimates of actual irradiation on a horizontal surface may be obtained. For solar irradiation on slopes see Frank and Lee (1966), Fons *et al.* (1960), and Buffo *et al.* (1972).

Spectral Distribution

The spectral distribution of direct beam sunlight, skylight, cloudlight, and the light transmitted through vegetation is shown in figure 8 from Gates (1965). In this figure the intensity is plotted by wave number, allowing the full spectrum to be shown. The different spectral distribution of sunlight, cloudlight, skylight, and the light transmitted through vegetation may have profound ecological consequences. These factors must also be considered when using energy sensors of different spectral sensitivities.

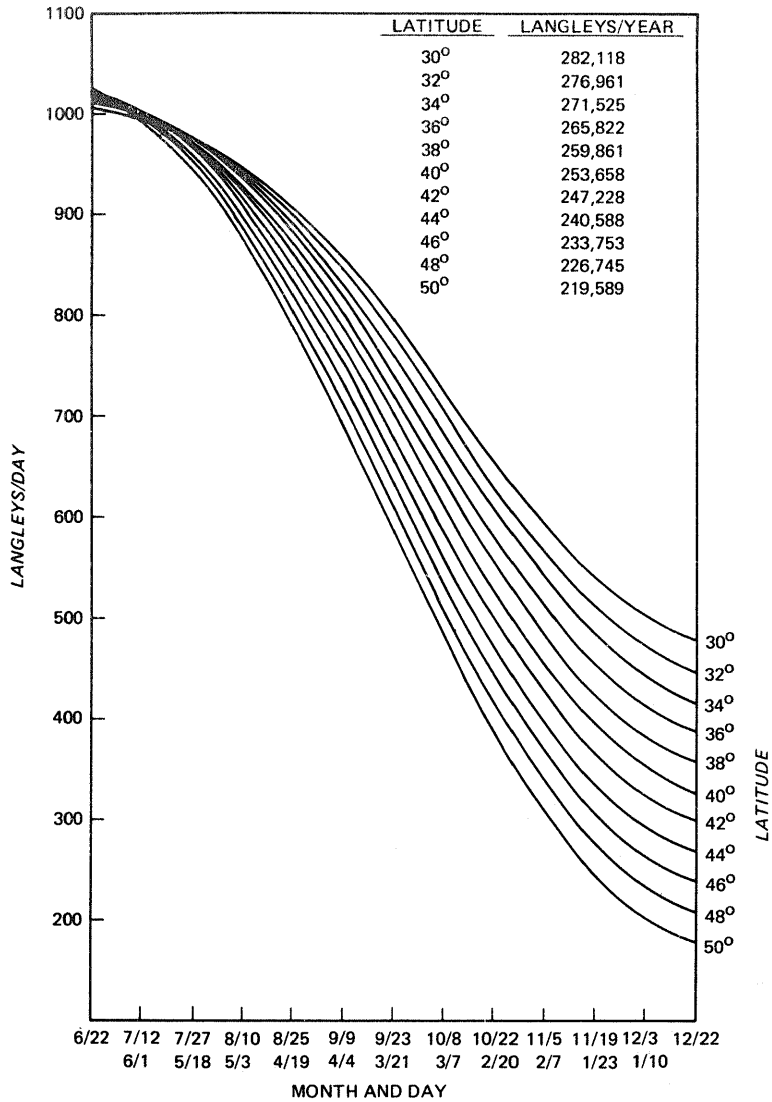


Figure 7.--*Potential solar beam irradiation on a horizontal surface for various latitudes and dates.*

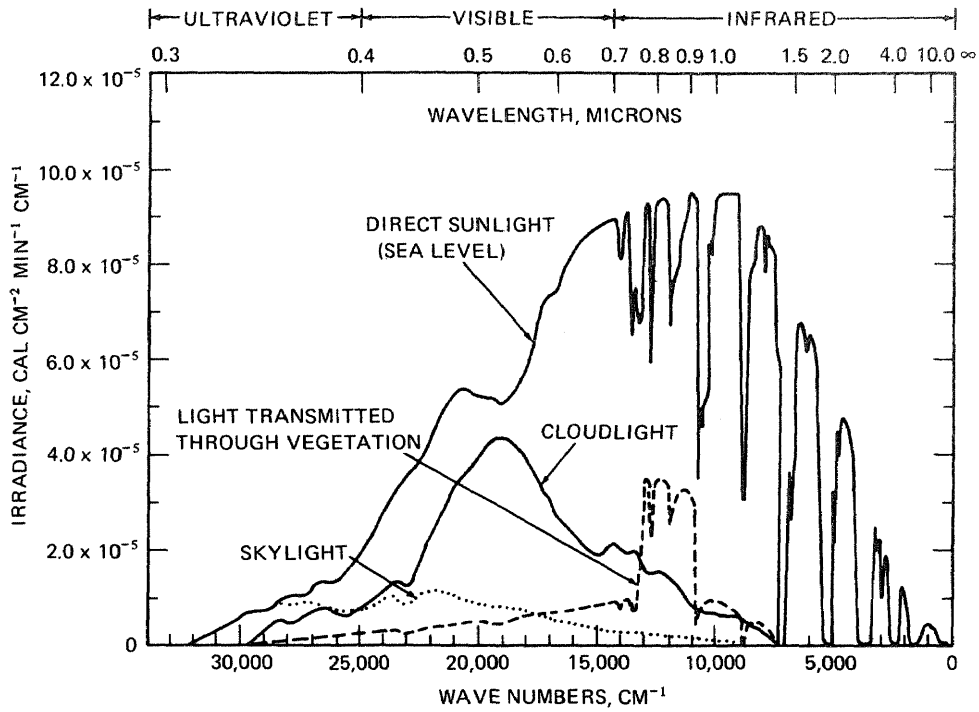


Figure 8.--*Spectral distribution of direct sunlight, skylight, cloudlight, and light transmitted through vegetation as a function of the frequency of radiation in wave numbers (Gates 1965).*

WATER

A psychometric chart (fig. 9) enables the user to determine various factors of water vapor in the air, when two factors are known. Dry bulb temperature, wet bulb temperature, relative humidity, dew point (in °C and °F), vapor pressure (in inches of mercury, millimeters of mercury, and millibars), and absolute humidity (in grams/cubic feet, grams/kilogram of air, and grams/cubic meter) are included on the chart. Although prepared for a barometric pressure of 30 inches of mercury, the chart may be used in most cases down to a barometric pressure of 28 inches of mercury without correction.

Inches of water per pound of rain or snow can be determined for rain gauges of various diameters (fig. 10).

Volumes and weights of water per surface area by depth of precipitation are in table 9.

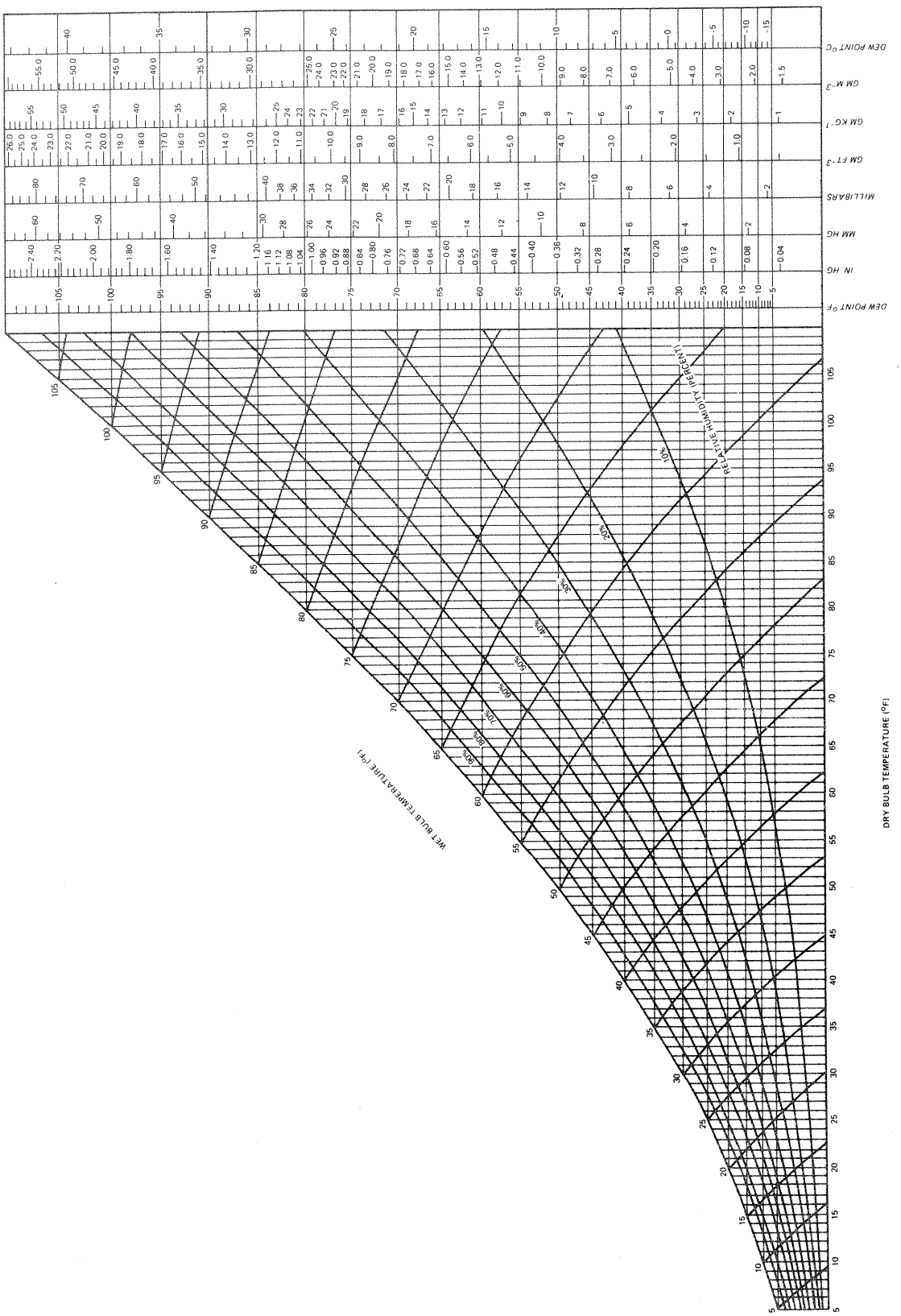


Figure 9.--*Psychometric chart (barometric pressure = 30.0 inches Hg) when any two factors are known, others may be found from the chart. Interpolate as necessary. Relative humidity may be found from the appropriate curves, at the intersection of the wet bulb and dry bulb temperatures. Dew point, vapor pressure, and absolute humidity may be determined from the horizontal lines.*

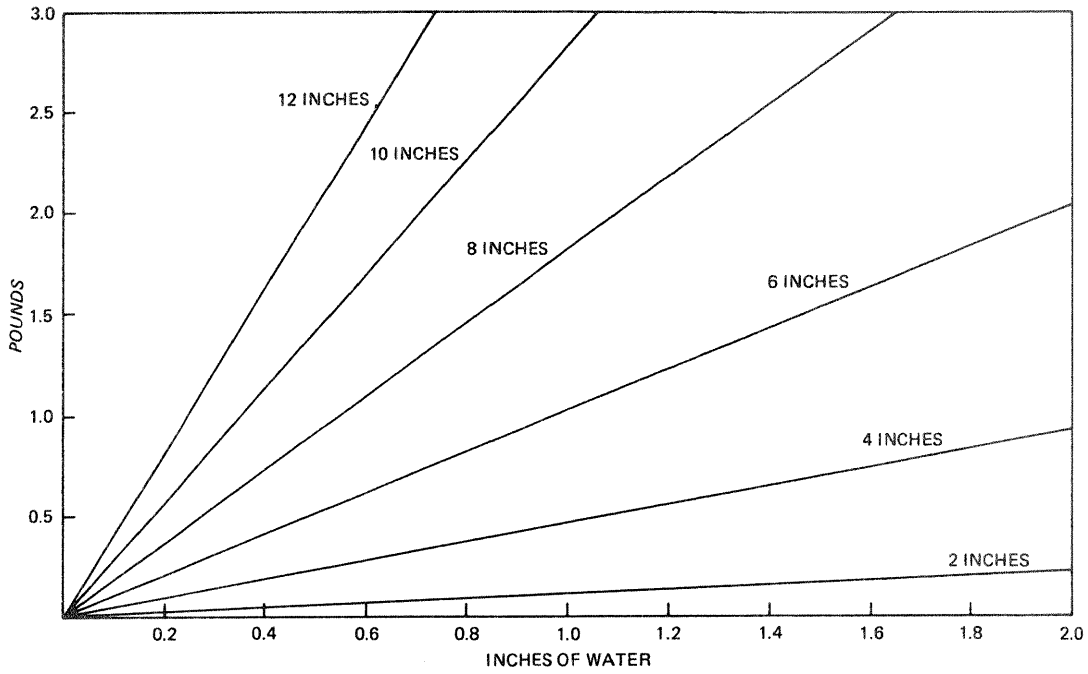


Figure 10.--*Inches of water from pounds of rain or snow collected in gauges of various diameters.*

Table 9.--*Amounts of water by depth of precipitation*

Precipitation (inches)	Gal/acre	Tons/acre	1,000 gal/mile^2	Tons/mile^2	Acre ft/mile^2
0.01	272	1	1.7	723	0.5
.02	543	2	35	1,446	1.1
.03	815	3	52	2,170	1.6
.04	1,086	5	70	2,893	2.1
.05	1,358	6	87	3,616	2.7
.06	1,629	7	104	4,339	3.2
.07	1,901	8	122	5,062	3.7
.08	2,172	9	139	5,786	4.3
.09	2,444	10	156	6,509	4.8
.10	2,715	11	174	7,232	5.3
.20	5,431	23	348	14,464	10.7
.30	8,146	34	521	21,696	16.0
.40	10,862	45	695	28,928	21.3
.50	13,577	57	869	36,160	26.7
.60	16,292	68	1,043	43,392	32.0
.70	19,008	79	1,216	50,624	37.3
.80	21,723	91	1,390	57,856	42.7
.90	24,439	102	1,564	65,088	48.0
1.00	27,154	113	1,738	72,320	53.3
2.00	54,308	227	3,476	144,640	106.7
3.00	81,462	340	5,214	216,960	160.0
4.00	108,616	453	6,951	289,280	213.3
5.00	135,770	566	8,689	361,600	266.7
6.00	162,924	680	10,427	433,920	320.0
7.00	190,078	793	12,165	506,240	373.3
8.00	217,232	906	13,903	578,560	426.7
9.00	244,386	1,019	15,641	650,880	480.0

CONVERSION FACTORS

Angle

To Convert	Into	Multiply by
degrees	min	60.0
	quadrants	0.01111
	radians	0.01745
	sec	3,600.0
min	degrees	0.01667
	quadrants	1.852×10^{-4}
	radians	2.909×10^{-4}
	sec	60.0
quadrants	degrees	90.0
	min	5400.0
	radians	1.571
	sec	3.240×10^{5}
radians	degrees	57.2958
	min	3437.75
	quadrants	0.6366
	sec	2.0626×10^{5}
sec	degrees	2.778×10^{-4}
	min	0.01667
	quadrants	3.087×10^{-6}
	radians	4.8481×10^{-6}

Area

To Convert	Into	Multiply by
acres	ares	40.46873
	sq chains	10.0
	sq ft	43,560.0
	ha	0.4047
	sq link	1×10^{5}
	sq m	4,046.873
	sq mile	1.5625×10^{-3}
	sq rods	160.0
	sq yd	4,840.0
ha	acres	2.471044
	ares	100.0
	sq ft	1.076×10^{5}
	sq m	1×10^{4}
	sq yd	1.19599×10^{4}
sq cm	sq chains	2.4710×10^{-7}
	sq ft	1.076×10^{-3}
	sq in.	0.1550
	sq links	2.4710×10^{-3}
	sq m	0.0001
	sq miles	3.861×10^{-11}
	sq mm	100.0
	sq rods	3.9537×10^{-6}
	sq yd	1.196×10^{-4}
sq ft	acres	2.29568×10^{-5}
	ares	9.29034×10^{-4}
	sq chains	2.29568×10^{-4}
	sq cm	929.0341
	sq in.	144
	sq links	2.29568
	sq m	0.09290341
	sq miles	3.587×10^{-8}
	sq mm	9.290×10^{4}
	sq rods	3.67309×10^{-3}
	sq yd	0.1111
sq in.	sq chains	1.59423×10^{-6}
	sq cm	6.451626
	sq ft	6.9444×10^{-3}
	sq links	0.0159423
	sq m	6.451626×10^{-4}
	sq mm	645.1626
	sq yd	7.716×10^{-4}
sq km	acres	247.1004
	ares	1×10^{4}
	sq cm	1×10^{10}
	sq ft	10.764×10^{6}
	sq in.	1.550×10^{9}
	sq m	1×10^{6}
	sq miles	0.3861
	sq yd	1.196×10^{6}
sq links	acres	1×10^{-5}
	sq chains	1×10^{-4}
	sq cm	404.69
	sq ft	0.4356
	sq in.	62.7264
	sq m	0.040469
	sq rods	0.0016
	sq yd	0.0484
sq m	acres	2.471×10^{-4}
	ares	0.01
	sq chains	2.471×10^{-3}
	sq cm	1×10^{4}
	ha	1×10^{-4}
	sq ft	10.7639
	sq in.	1,550.0
	sq km	1×10^{-6}
	sq links	24.7104
	sq miles	3.861×10^{-7}
	sq mm	1×10^{6}
	sq rods	0.039537
	sq yd	1.195985
sq miles	acres	640.0
	sq chains	6400.0
	sq ft	2.78784×10^{7}
	ha	258.9998
	sq km	2.589998
	sq m	2.5899×10^{6}
	sq rods	1.0240×10^{5}
	sq yd	3.0976×10^{6}
sq mm	sq cm	0.01
	sq in.	1.550×10^{-3}
	sq ft	1.076×10^{-5}
	sq m	1×10^{-6}
sq rods	acres	6.25×10^{-3}
	sq chains	0.0625
	sq ft	272.25

Area (contd)

To Convert	Into	Multiply by
sq rods (contd)	ha	2.5293×10^{-3}
	sq in.	3.9204×10^{4}
	sq links	625.0
	sq m	25.293
	sq miles	9.7656×10^{-6}
	sq yd	30.250
sq yd	acres	2.06612×10^{-4}
	ares	8.3613×10^{-3}
	sq chains	2.06612×10^{-3}
	sq cm	8,361.0
	sq ft	9.0
	ha	8.3613×10^{-5}
	sq in.	1,296.0
	sq links	20.6612
	sq m	0.83613
	sq miles	3.2283×10^{-7}
	sq rods	0.033058
townships	sq km	93.240
	sq miles	36.0

Density

To Convert	Into	Multiply by
g/cu cm	lb/cu in.	0.03613
	lb/cu ft	62.43
	lb/gal	8.3452
g/l	lb/1,000 gal	8.345
	lb/cu ft	0.062427
	ppm	1,000.0
kg/cu m	g/cu cm	0.001
	lb/cu ft	0.06243
	lb/cu in.	3.613×10^{-5}
mg/l	ppm	1.0
ppm	lb/million gal	8.345
lb/cu ft	g/cu cm	0.01602
	kg/cu m	16.018
	lb/cu in.	5.787×10^{-4}
lb/cu in.	g/cu cm	27.680
	kg/cu m	2.768×10^{4}
	lb/cu ft	1,728.0
lb/gal	g/cu cm	0.119826

Flow

To Convert	Into	Multiply by
acre-ft/day	cu ft/day	43,560.0
	cu ft/sec	0.504
	gal/day	3.26×10^{5}
	gal/min	226.0
	cu m/sec	0.0143
cu ft/day	acre-ft/day	2.30×10^{-5}
	cu ft/sec	1.16×10^{-5}
	gal/day	7.48
	gal/min	5.19×10^{-3}

Flow (contd)

To Convert	Into	Multiply by
cu ft/day (contd)	cu m/sec	3.28×10^{-7}
cu ft/sec	acre-ft/day	1.98
	cu ft/day	86,400
	gal/day	6.46×10^{5}
	gal/min	448.83
	million gal/day	0.646317
	l/min	1699.3
	cu m/sec	0.0283
	cu yd/min	2.222
gal/day	acre-ft/day	3.07×10^{-6}
	cu ft/day	0.134
	cu ft/sec	1.55×10^{-6}
	gal/min	6.94×10^{-4}
	cu m/sec	4.38×10^{-8}
gal/min	acre-ft/day	4.42×10^{-3}
	cu ft/day	193.0
	cu ft/hr	8.0208
	cu ft/sec	2.228×10^{-3}
	gal/day	1,440.0
	l/sec	0.06308
	cu m/sec	6.308×10^{-5}
gal/sec	cu ft/min	8.0192
l/min	cu ft/sec	5.886×10^{-4}
	gal/sec	4.403×10^{-3}
l/sec	cu ft/min	2.12
	gal/min	15.85
cu m/sec	acre-ft/day	70.0
	cu ft/day	3.05×10^{6}
	cu ft/sec	35.3
	gal/day	2.28×10^{7}
	gal/min	15,800
million gal/day	cu ft/sec	1.54723
lb H_2O/min	cu ft/sec	2.670×10^{-4}
tons H_2O/day	cu ft/hr	1.3349
	gal/min	0.16643
	lb H_2O/hr	83.333

Force

To Convert	Into	Multiply by
dynes	g	1.0197×10^{-3}
	joules/cm	1×10^{-7}
	kg	1.0197×10^{-6}
	newtons	1×10^{-5}
g	dynes	980.665
	joules/cm	9.8066×10^{-5}
	newtons	9.086×10^{-3}
poundals	dynes	13,825.5
	g	14.098

Force (contd)

To Convert	Into	Multiply by
poundals (contd)	joules/cm	1.383×10^{-3}
	newtons	1.383
	lb	0.031081
lb	dynes	4.4482×10^{5}
	joules/cm	0.044482
	newtons	4.4482
	poundals	32.174
newtons	dynes	1×10^{5}
	joules/m	1.0

Illumination

ft-candles	lumens/sq ft	1.0
	lumens/sq m	10.764
	lux	10.764
	milliphots	1.0764
lumens/sq ft	ft-candles	1.0
	lumens/sq m	10.764
lumens/sq m	ft-candles	0.0929
	lux	1.0
	milliphot	0.1
	phot	1×10^{-4}
lux	ft-candles	0.0929
	lumens/sq m	1.0
	milliphot	0.1
	phot	1×10^{-4}
phot	ft-candles	929.0
	lumens/sq m	1×10^{4}
	lumens/sq cm	1.0
	lux	1×10^{4}

Length

Angstrom unit	in.	3.937×10^{-9}
	cm	1×10^{-8}
	m	1×10^{-10}
	microns	1×10^{-4}
cm	Angstrom units	1×10^{8}
	ft	3.281×10^{-2}
	in.	0.39370
	km	1×10^{-5}
	m	0.01
	miles	6.214×10^{-6}
	mm	10.0
	mils	393.70
	yd	1.094×10^{-2}
chains (surveyor's)	chains (engineer's)	0.66
	ft	66.0
	furlong	0.10
	in.	792.0
	links	100
	m	20.117
	miles	0.0125

Length (contd)

To Convert	Into	Multiply by
chains (surveyor's) (contd)	rods	4.0
	yd	22.0
fathoms	ft	6.0
	m	1.8288
ft	cm	30.4801
	chains	0.01515
	km	3.048×10^{-4}
	m	0.3048
	miles (statute)	1.894×10^{-4}
	mm	304.8006
	mils	1.2×10^{4}
	rods	0.06061
	yd	0.3333
in.	Angstrom units	2.540×10^{8}
	cm	2.540
	chains	1.2626×10^{-3}
	ft	0.08333
	links	0.126263
	m	2.540×10^{-2}
	miles	1.578×10^{-5}
	mm	25.40
	mils	1,000.0
	rods	5.05051×10^{-3}
	yd	2.778×10^{-2}
km	cm	1×10^{5}
	ft	3,281.0
	in.	39,370.
	m	1,000.0
	miles	0.6214
	mm	1×10^{6}
	yd	1,093.6
links (surveyor's)	chains	0.01
	cm	20.1168
	ft	0.66
	in.	7.92
	links (engineer's)	0.66
	m	0.201168
	miles	1.250×10^{-4}
	rods	0.04
	yd	0.22
m	Angstrom units	1×10^{10}
	chains	0.04971
	cm	100.0
	fathoms	0.54681
	ft	3.2808
	in.	39.370
	km	0.001
	links	4.97096
	miles (statute)	6.219×10^{-4}
	miles (nautical)	5.3961×10^{-4}
	microns	1×10^{6}
	mm	1,000.0

Length (contd)

To Convert	Into	Multiply by
m (contd)	rods	0.198838
	yd	1.09361
microns	Angstrom units	1×10^{4}
	cm	1×10^{-4}
	in.	3.937×10^{-5}
	m	1×10^{-6}
miles (statute)	chains	80.0
	cm	1.609×10^{5}
	ft	5,280.0
	furlongs	8.0
	in.	6.3360×10^{4}
	km	1.60935
	links	8,000
	m	1,609.35
	miles (nautical)	0.8684
	rods	320.0
	yd	1,760.0
millimicrons	Angstrom units	10.0
	cm	1×10^{-7}
	m	1×10^{-9}
	microns	0.001
mm	cm	0.1
	ft	3.281×10^{-3}
	in.	0.03937
	km	1×10^{-6}
	m	0.001
	microns	1,000.0
rods	chains	0.25
	ft	16.50
	furlongs	0.025
	in.	198.0
	links	25.0
	m	5.0292
	miles	3.125×10^{-3}
	yd	5.50
yd	chains	0.04545
	cm	91.440
	ft	3.0
	in.	36.0
	km	9.144×10^{-4}
	links	4.5454
	m	0.9144
	miles	5.682×10^{-4}
	rods	0.1818

Power

To Convert	Into	Multiply by
Btu/hr	ft-lb/sec	0.2162
	g-cal/sec	0.0700
	hp-hr	3.929×10^{-4}
	watts	0.2931
Btu/min	ft-lb/sec	12.96
	g-cal/min	252.08
	hp	0.02356

Power (contd)

To Convert	Into	Multiply by
Btu/min (contd)	watts	17.580
ergs/sec	Btu/min	5.688×10^{-9}
	dyne-cm/sec	1.0
	ft-lb/min	4.427×10^{-6}
	ft-lb/sec	7.3756×10^{-8}
	hp	1.341×10^{-10}
	kg-cal/min	1.433×10^{-9}
	kilowatts	1×10^{-10}
	watts	1×10^{-7}
ft-lb/min	Btu/min	1.285×10^{-3}
	ft-lb/sec	0.01667
	hp	3.030×10^{-5}
	kg-cal/min	3.239×10^{-4}
	kilowatts	2.2597×10^{-5}
	watts	0.022597
ft-lb/sec	Btu/hr	4.6263
	Btu/min	0.077124
	hp	1.8182×10^{-3}
	kg-cal/min	0.019433
	kilowatts	1.356×10^{-3}
	watts	1.35582
hp	Btu/min	42.418
	Btu/sec	0.70696
	ft-lb/min	3.30×10^{4}
	ft-lb/sec	550.0
	kg-cal/min	10.688
	kilowatts	0.7457
	watts	745.70
watts	Btu/hr	3.4129
	Btu/min	0.05688
	ergs/sec	1×10^{7}
	ft-lb/min	44.254
	ft-lb/sec	0.73756
	hp	1.341×10^{-3}
	joules/sec	1.0
	kg-cal/min	0.01433
	kilowatts	0.001

Pressure

To Convert	Into	Multiply by
atm	bars	1.0133
	cm Hg (0° C)	76.0
	dynes/sq cm	1.0325×10^{6}
	ft H_2O (4° C)	33.90
	g/sq cm	1,033.2
	in. Hg (0° C)	29.921
	kg/sq cm	1.0332
	kg/sq m	10,332.0
	mm Hg	760.0
	lb/sq ft	2,116.2
	lb/sq in.	14.696
	tons/sq ft	1.058
	tons/sq in.	0.007348
bars	atm	0.98692
	cm Hg (0° C)	75.006

Pressure (contd)

To Convert	Into	Multiply by
bars (contd)	dynes/sq cm	1×10^{6}
	ft H_2O (4° C)	33.456
	in. Hg (0° C)	29.5296
	kg/sq m	10,197
	lb/sq in.	14.5038
	lb/sq ft	2,082.0
cm Hg (0° C)	atm	0.013158
	bars	1.33322×10^{-2}
	dynes/sq cm	1.33322×10^{4}
	ft H_2O	0.4461
	kg/sq m	135.95
	lb/sq ft	27.85
	lb/sq in.	0.1934
dyne/sq cm	atm	9.8692×10^{-7}
	bars	1×10^{-6}
	cm H_2O (4° C)	1.01974×10^{-3}
	g/sq cm	1.01971×10^{-3}
	in. H_2O (4° C)	4.0148×10^{-4}
	in. Hg (0° C)	2.9530×10^{-5}
	kg/sq m	1.01971×10^{-2}
	lb/sq ft	2.0886×10^{-3}
	lb/sq in.	1.4504×10^{-5}
	mm Hg (0° C)	7.5006×10^{-4}
ft H_2O (4° C)	atm	0.02950
	in. Hg (0° C)	0.8826
	kg/sq cm	0.03048
	kg/sq m	304.8006
	lb/sq ft	62.426
	lb/sq in.	0.43352
g/sq cm	atm	9.6784×10^{-4}
	dynes/sq cm	980.665
	kg/sq m	10.0
	lb/sq ft	2.0481
	lb/sq in.	0.014223
	mm Hg (0° C)	0.73556
in. Hg (0° C)	atm	0.03342
	dynes/sq cm	3.3864×10^{4}
	ft H_2O (4° C)	1.1329
	kg/sq cm	0.03453
	kg/sq m	345.31
	lb/sq ft	70.73
	lb/sq in.	0.4912
in. H_2O (4° C)	atm	2.458×10^{-3}
	dynes/sq cm	2,490.82
	in. Hg (0° C)	0.07355
	kg/sq cm	2.540×10^{-3}
	oz/sq in.	0.5781
	lb/sq ft	5.204
	lb/sq in.	0.03613
kg/sq cm	atm	0.9678
	dynes/sq cm	9.8067×10^{5}
	cm Hg (0° C)	73.556
	ft H_2O (4° C)	32.81
	in. Hg (0° C)	28.96
	lb/sq ft	2,048.1

Pressure (contd)

To Convert	Into	Multiply by
kg/sq cm (contd)	lb/sq in.	14.223
kg/sq m	atm	9.678×10^{-5}
	bars	98.07×10^{-6}
	dynes/sq cm	98.0665
	ft H_2O (4° C)	3.281×10^{-3}
	g/sq cm	0.10
	in. Hg (0° C)	2.896×10^{-3}
	mm Hg (0° C)	0.073556
	lb/sq ft	0.2048
	lb/sq in.	1.422×10^{-3}
oz/sq in.	dynes/sq cm	4,309.2
	lb/sq in.	0.0625
lb/sq ft	atm	4.725×10^{-4}
	bars	4.7880×10^{-4}
	dynes/sq cm	478.80
	ft H_2O (4° C)	0.01602
	g/sq cm	0.48824
	in. Hg (0° C)	0.01414
	kg/sq m	4.8824
	mm Hg (0° C)	0.35913
	lb/sq in.	6.944×10^{-3}
lb/sq in.	atm	0.06804
	bars	0.068947
	cm Hg (0° C)	5.1715
	dynes/sq cm	6.8947×10^{4}
	ft H_2O (4° C)	2.3066
	g/sq cm	70.307
	in. Hg (0° C)	2.0360
	kg/sq m	703.07
	lb/sq ft	144.0

Time

To Convert	Into	Multiply by
days (mean solar)	hr	24.0
	min	1,440.0
	sec	86,400.0
hr (mean solar)	days	4.167×10^{-2}
	min	60.0
	sec	3,600.0
	weeks	5.952×10^{-3}
min (time)	day	6.9445×10^{-4}
	hr	0.01666
	sec	60.0
	weeks	9.9206×10^{-5}
months (mean)	days	30.42
	hr	730.0
	min	4.380×10^{4}
	sec	2.628×10^{6}
weeks	hr	168.0
	min	1.0080×10^{4}
	sec	6.0480×10^{5}

Velocity

To Convert	Into	Multiply by
cm/sec	ft/min	1.9685
	ft/sec	0.03281
	km/hr	0.0360
	knots	0.01944
	m/min	0.60
	miles/hr	0.02237
	miles/min	3.728×10^{-4}
ft/min	cm/sec	0.5080
	ft/sec	0.01667
	km/hr	0.01829
	knots	0.009868
	m/min	0.3048
	m/sec	0.005080
	miles/hr	0.01136
ft/sec	cm/sec	30.480
	km/hr	1.0973
	knots	0.5921
	m/min	18.29
	miles/hr	0.6818
	miles/min	0.01136
km/hr	cm/sec	27.778
	ft/min	54.68
	ft/sec	0.9113
	km/min	0.01667
	knots	0.5396
	m/min	16.667
	m/sec	0.2778
	miles/hr	0.6214
knots	cm/sec	51.48
	ft/hr	6,080.0
	ft/min	101.337
	ft/sec	1.689
	km/hr	1.8532
	m/sec	0.51479
	miles (nautical)/hr	1.0
	miles (statute)/hr	1.1516
m/min	cm/sec	1.6667
	ft/min	3.281
	ft/sec	0.05468
	km/hr	0.060
	knots	0.03238
	miles/hr	0.03728
m/sec	cm/sec	100.0
	ft/min	196.8
	ft/sec	3.281
	km/hr	3.60
	km/min	0.060
	knots	1.9425
	miles/hr	2.2369
	miles/min	0.03728
miles/hr	cm/sec	44.704
	ft/min	88.0
	ft/sec	1.4667

Velocity (contd)

To Convert	Into	Multiply by
miles/hr (contd)	km/hr	1.609
	km/min	0.02682
	knots	0.8684
	m/min	26.82
	miles/min	0.01667
miles/min	cm/sec	2,682.2
	ft/sec	88.0
	km/min	1.609
	knots	52.104
	knots/min	0.8684
	miles/hr	60.0

Volume

acre-ft	cu ft	43,560.0
	gal	3.259×10^{5}
	cu in.	7.53×10^{7}
	cu m	1,233.49
bd ft	cu cm	2,359.8
	cu ft	0.08333
	cu in.	144.0
	cu m	2.3598×10^{-3}
cords	cord ft	8.0
	cu ft	128.0
	cu m	3.625
cord ft	cords	0.125
	cu ft	16.0
cu cm	bd ft	4.2376×10^{-4}
	cu ft	3.53144×10^{-5}
	gal (US fluid)	2.642×10^{-4}
	cu in.	0.06102
	l	0.001
	cu m	1×10^{-6}
	cu mm	1,000.0
	oz (US fluid)	0.033814
	pt (US fluid)	2.1134×10^{-3}
	qt (US fluid)	1.0567×10^{-3}
	cu yd	1.3079×10^{-6}
cu ft	bd ft	12.0
	cords	0.0078125
	cord ft	0.0625
	cu cm	28,320.0
	gal (US fluid)	7.48052
	cu in.	1,728.0
	l	28.316
	cu m	0.028317
	pt (US fluid)	59.844
	qt (US fluid)	29.922
	cu yd	0.03704
cu in.	bd ft	6.944×10^{-3}
	cu cm	16.38716
	cu ft	5.7870×10^{-4}
	gal (US fluid)	4.3290×10^{-3}
	l	1.6387×10^{-2}
	cu m	1.6387×10^{-5}

Volume (Contd)

To Convert	Into	Multiply by
cu in. (contd)	cu mm	1.6387×10^{4}
	oz (US fluid)	0.5541
	pt (US fluid)	3.463×10^{-2}
	qt (US fluid)	1.732×10^{-2}
	cu yd	2.14335×10^{-5}
cu m	bd ft	423.76
	cords	0.2759
	cu cm	1×10^{6}
	cu ft	35.3144
	cu in.	6.1023×10^{4}
	l	1,000.0
	cu mm	1×10^{9}
	pt (US fluid)	2,113.4
	qt (US fluid)	1,056.7
	cu yd	1.3079
cu yd	cu ft	27.0
	gal (US fluid)	202.0
	cu in.	46,656.0
	l	764.54
	cu m	0.764559
	pt (US fluid)	1,616.0
	qt (US fluid)	807.9
gal	cu cm	3,785.4
	cu ft	0.13368
	cu in.	231.0
	l	3.785
	cu m	3.785×10^{-3}
	oz (US fluid)	128.0
	pt (US fluid)	8.0
	qt (US fluid)	4
	cu yd	4.951×10^{-3}
l	cu cm	1,000.0
	cu ft	0.03531
	gal (US fluid)	0.2642
	cu in.	61.02
	cu m	0.001
	oz (US fluid)	33.8147
	pt (US fluid)	2.113
	qt (US fluid)	1.057
	cu yd	1.308×10^{-3}
microliters	l	1×10^{-6}
ml	l	0.001
oz (US fluid)	cu cm	29.5737
	cu in.	1.80469
	l	0.02957
	pt (US fluid)	0.06250
pt (US fluid)	cu cm	473.179
	cu ft	0.01671
	gal	0.125
	cu in.	28.875
	l	0.4732
	cu m	4.732×10^{-4}
	oz (US fluid)	16.0
	qt (US fluid)	0.50

Volume (Contd)

To Convert	Into	Multiply by
qt (US fluid)	cu cm	946.358
	cu ft	0.03342
	gal (US fluid)	0.25
	cu in.	57.749
	l	0.94633
	cu m	9.4633×10^{-4}
	pt (US fluid)	2.0

Weight

To Convert	Into	Multiply by
gal H_2O (4° C)	kg H_2O	3.78533
	lb H_2O	8.34522
g	kg	0.001
	mg	1,000.0
	oz (avoirdupois)	0.03527
	oz (troy)	0.03215
	lb	2.205×10^{-3}
kg	g	1,000.0
	oz (avoirdupois)	35.2739
	oz (troy)	32.1507
	lb (avoirdupois)	2.2046
	tons (long)	9.842×10^{-4}
	tons (short)	1.102×10^{-3}
micrograms	g	1×10^{-8}
mg	g	0.001
oz (avoirdupois)	g	28.3495
	oz (troy)	0.91146
	lb	0.06250
lb (avoirdupois)	grains	7,000.0
	g	453.5924
	kg	0.4536
	oz (avoirdupois)	16.0
	oz (troy)	14.5833
	lb (troy)	1.2153
	tons (long)	4.4643×10^{-4}
	tons (short)	5.0×10^{-4}
lb H_2O	cu in.	27.68
	cu ft	0.01602
	gal	0.1198
tons (long)	kg	1,016.047
	lb	2,240.0
	tons (metric)	1.01605
	tons (short)	1.1200
tons (short)	kg	907.1848
	lb	2,000.0
	tons (long)	0.89287
	tons (metric)	0.9071848

Work; energy

To Convert	Into	Multiply by
Btu	ergs	1.0548×10^{10}
	ft-lb	777.97
	g-cal	251.98
	hp-hr	3.9292×10^{-4}
	joules	1,054.8
	kg-cal	0.25198
	kilowatt-hr	2.928×10^{-4}
ergs	Btu	9.4805×10^{-11}
	dyne-cm	1.0
	ft-lb	7.3756×10^{-8}
	ft-poundals	2.3730×10^{-6}
	g-cal	2.3889×10^{-8}
	g-cm	1.020×10^{-3}
	joules	1×10^{-7}
	kg-cal	2.3889×10^{-11}
	kg-m	1.020×10^{-8}
	kilowatt-hr	2.778×10^{-14}
	watt-hr	2.778×10^{-11}
ft-lb	Btu	1.286×10^{-3}
	ergs	1.356×10^{7}
	ft-poundals	32.174
	g-cal	0.32389
	hp-hr	5.050×10^{-7}
	joules	1.35582
	kg-cal	3.239×10^{-4}
	kg-m	0.1383
	kilowatt-hr	3.766×10^{-7}
g-cal (mean)	Btu	3.9685×10^{-3}
	ergs	4.1868×10^{7}
	ft-lb	3.0874
	ft-poundals	99.334
	hp-hr	1.5593×10^{-6}
	joules	4.186
	kg-cal	0.001
	kg-m	0.42685
	kilowatt-hr	1.1628×10^{-6}
	watt-hr	1.1628×10^{-3}

Work; energy (contd)

To Convert	Into	Multiply by
kg-cal (mean)	g-cal (mean)	1,000.0
g-cm	Btu	9.297×10^{-8}
	ergs	980.7
	ft-lb	7.233×10^{-5}
	g-cal	2.3427×10^{-5}
	joules	9.807×10^{-5}
	kg-cal	2.343×10^{-8}
	kg-m	1×10^{-5}
hp-hr	Btu	2,545.0
	ergs	2.6845×10^{13}
	ft-lb	1.980×10^{6}
	g-cal	6.41190×10^{5}
	joules	2.684×10^{6}
	kg-cal	641.30
	kg-m	2.737×10^{5}
	kilowatt-hr	0.7457
joules	Btu	9.480×10^{-4}
	ergs	1×10^{7}
joules (contd)	ft-lb	0.7376
	g-cal	0.23889
	g-cm	1.0197×10^{4}
	hp-hr	3.725×10^{-7}
	kg-cal	2.3889×10^{-4}
	kg-m	0.1020
	watt-hr	2.778×10^{-4}
watt-hr	Btu	3.4130
	ergs	3.60×10^{10}
	ft-lb	2,655.3
	g-cal	860.01
	hp-hr	1.341×10^{-3}
	joules	3,600.0
	kg-cal	0.86001
	kg-m	367.10
	kilowatt-hr	0.001

CONVERSION TABLES

Table 10.--*Conversion of temperature from Fahrenheit to Centigrade*

(In °C)

°F	0	1	2	3	4	5	6	7	8	9
-30	-34.44	-35.00	-35.56	-36.11	-36.67	-37.22	-37.78	-38.33	-38.89	-39.44
-20	-28.89	-29.44	-30.00	-30.56	-31.11	-31.67	-32.22	-32.78	-33.33	-33.89
-10	-23.33	-23.89	-24.44	-25.00	-25.56	-26.11	-26.67	-27.22	-27.78	-28.33
-0	-17.78	-18.33	-18.89	-19.44	-20.00	-20.56	-21.11	-21.67	-22.22	-22.78
+0	-17.78	-17.22	-16.67	-16.11	-15.56	-15.00	-14.44	-13.89	-13.33	-12.78
10	-12.22	-11.67	-11.11	-10.56	-10.00	-9.44	-8.89	-8.33	-7.78	-7.22
20	-6.67	-6.11	-5.56	-5.00	-4.44	-3.89	-3.33	-2.78	-2.22	-1.67
30	-1.11	-0.56	0.00	0.56	1.11	1.67	2.22	2.78	3.33	3.89
40	4.44	5.00	5.56	6.11	6.67	7.22	7.78	8.33	8.89	9.44
50	10.00	10.56	11.11	11.67	12.22	12.78	13.33	13.89	14.44	15.00
60	15.56	16.11	16.67	17.22	17.78	18.33	18.89	19.44	20.00	20.56
70	21.11	21.67	22.22	22.78	23.33	23.89	24.44	25.00	25.56	26.11
80	26.67	27.22	27.78	28.33	28.89	29.44	30.00	30.56	31.11	31.67
90	32.22	32.78	33.33	33.89	34.44	35.00	35.56	36.11	36.67	37.22
100	37.78	38.33	38.89	39.44	40.00	40.56	41.11	41.67	42.22	42.78

Table 11.--*Conversion of temperature from Centigrade to Fahrenheit*

(In °F)

°C	0	1	2	3	4	5	6	7	8	9
-30	-22.00	-23.80	-25.60	-27.40	-29.20	-31.00	-32.80	-34.60	-36.40	-38.20
-20	-4.00	-5.80	-7.60	-9.40	-11.20	-13.00	-14.80	-16.60	-18.40	-20.20
-10	14.00	12.20	10.40	8.60	6.80	5.00	3.20	1.40	-0.40	-2.20
-0	32.00	30.20	28.40	26.60	24.80	23.00	21.20	19.40	17.60	15.80
+0	32.00	33.80	35.60	37.40	39.20	41.00	42.80	44.60	46.40	48.20
10	50.00	51.80	53.60	55.40	57.20	59.00	60.80	62.60	64.40	66.20
20	68.00	69.80	71.60	73.40	75.20	77.00	78.80	80.60	82.40	84.20
30	86.00	87.80	89.60	91.40	93.20	95.00	96.80	98.60	100.40	102.20
40	104.00	105.80	107.60	109.90	111.20	113.00	114.80	116.60	118.40	120.20

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NORTH CENTRAL FOREST EXPERIMENT STATION
50
YEARS
1923
1973