

STANDARD AND REFERENCE ATMOSPHERES

Table 14-14. Atmospheric temperature, density and composition as functions of height and exospheric temperature.

Height km	Temp K	LogN(N ₂) m ⁻³	LogN(O ₂) m ⁻³	LogN(O) m ⁻³	LogN(Ar) m ⁻³	LogN(HE) m ⁻³	LogN(H) m ⁻³	Mean Mol Wt	Density kg/m ³
Exospheric Temperature = 500 K									
120	267.1	17.536	16.672	17.169	15.073	13.579		25.10	2.25E-08
130	328.3	16.981	16.051	16.814	14.320	13.457		23.74	6.80E-09
140	378.8	16.531	15.545	16.530	13.704	13.363		22.51	2.67E-09
150	411.9	16.149	15.114	16.296	13.174	13.291		21.39	1.25E-09
160	433.1	15.804	14.723	16.089	12.691	13.231		20.40	6.51E-10
180	457.7	15.170	14.002	15.717	11.798	13.129		18.78	2.13E-10
200	471.4	14.576	13.325	15.372	10.956	13.038		17.62	8.13E-11
250	488.1	13.169	11.721	14.562	8.956	12.830		15.79	1.05E-11
300	494.6	11.823	10.184	13.791	7.039	12.635		13.30	1.72E-12
350	497.3	10.512	8.686	13.041		12.446		8.33	3.29E-13
400	498.5	9.226	7.218	12.306		12.262		3.82	8.10E-14
500	499.5	6.718		10.873		11.903	12.860	1.44	1.94E-14
600	499.8			9.484		11.555	12.772	1.19	1.24E-14
800	499.9			6.822		10.889	12.604	1.06	7.24E-15
1000	500.0					10.260	12.445	1.03	4.79E-15
1500	500.0					8.827	12.084	1.01	2.04E-15
2000	500.0					7.565	11.767	1.01	9.78E-16
Exospheric Temperature = 600 K									
120	285.2	17.549	16.690	17.165	15.103	13.567		25.21	2.30E-08
130	359.6	17.018	16.098	16.818	14.389	13.443		23.98	7.29E-09
140	423.6	16.597	15.627	16.547	13.817	13.349		22.87	3.00E-09
150	468.4	16.246	15.232	16.328	13.336	13.278		21.89	1.48E-09
160	498.6	15.937	14.883	16.140	12.906	13.221		20.99	8.10E-10

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Table 14-14. (Continued)

Height km	Temp K	LogN(N ₂) m ⁻³	LogN(O ₂) m ⁻³	LogN(O) m ⁻³	LogN(Ar) m ⁻³	LogN(HE) m ⁻³	LogN(H) m ⁻³	Mean Mol Wt	Density kg/m ³
180	534.9	15.381	14.252	15.809	12.127	13.127		19.49	2.93E-10
200	555.8	14.869	13.670	15.510	11.404	13.046		18.35	1.23E-10
250	581.6	13.676	12.310	14.820	9.711	12.866		16.67	1.99E-11
300	591.6	12.546	11.021	14.171	8.103	12.701		15.72	4.15E-12
350	595.8	11.450	9.769	13.544	6.541	12.543		14.41	9.69E-13
400	597.7	10.377	8.543	12.931		12.389		11.79	2.46E-13
500	599.2	8.285	6.154	11.735		12.090	12.126	4.81	2.49E-14
600	599.6	6.257		10.577		11.800	12.053	2.37	7.08E-15
800	599.9			8.359		11.245	11.913	1.54	2.54E-15
1000	600.0			6.262		10.720	11.780	1.25	1.36E-15
1500	600.0					9.525	11.484	1.04	5.27E-16
2000	600.0					8.474	11.215	1.01	2.76E-16
Exospheric Temperature = 700 K									
120	300.5	17.559	16.705	17.161	15.126	13.558		25.29	2.35E-08
130	386.2	17.046	16.134	16.821	14.440	13.433		24.15	7.67E-09
140	462.0	16.644	15.686	16.558	13.900	13.338		23.14	3.27E-09
150	518.2	16.315	15.317	16.349	13.452	13.267		22.24	1.67E-09
160	557.8	16.029	14.995	16.172	13.058	13.211		21.43	9.46E-10
180	607.5	15.526	14.426	15.869	12.357	13.122		20.03	3.67E-10
200	636.8	15.072	13.910	15.601	11.718	13.047		18.92	1.65E-10
250	673.5	14.030	12.723	14.995	10.242	12.886		17.15	3.16E-11
300	688.0	13.054	11.610	14.434	8.854	12.742		16.24	7.80E-12
350	694.0	12.111	10.533	13.894	7.511	12.606		15.53	2.17E-12
400	696.8	11.189	9.481	13.367	6.198	12.473		14.50	6.46E-13
500	698.8	9.395	7.431	12.341		12.216	11.559	10.02	6.99E-14
600	699.5	7.656		11.348		11.968	11.496	5.19	1.26E-14
800	699.8			9.446		11.492	11.376	2.77	2.54E-15
1000	699.9			7.649		11.042	11.263	2.13	1.04E-15
1500	700.0					10.018	11.005	1.29	2.39E-16
2000	700.0					9.117	10.778	1.07	1.09E-16
Exospheric Temperature = 800 K									
120	313.5	17.567	16.716	17.158	15.145	13.550		25.35	2.39E-08
130	408.8	17.067	16.162	16.823	14.481	13.424		24.28	7.99E-09
140	495.1	16.680	15.731	16.566	13.964	13.329		23.35	3.50E-09
150	562.1	16.366	15.380	16.363	13.539	13.258		22.52	1.82E-09
160	611.3	16.096	15.078	16.194	13.171	13.202		21.77	1.06E-09
180	675.4	15.632	14.553	15.910	12.526	13.115		20.46	4.34E-10
200	714.4	15.218	14.084	15.664	11.948	13.044		19.39	2.06E-10
250	764.0	14.288	13.026	15.120	10.633	12.897		17.57	4.46E-11
300	783.7	13.427	12.043	14.623	9.410	12.769		16.59	1.25E-11
350	791.9	12.598	11.098	14.148	8.230	12.648		15.96	3.96E-12
400	795.6	11.791	10.175	13.686	7.079	12.532		15.33	1.34E-12
500	798.4	10.219	8.381	12.788		12.307	11.108	12.86	1.77E-13

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Table 14-14. (Continued)

Height km	Temp K	LogN(N ₂) m ⁻³	LogN(O ₂) m ⁻³	LogN(O) m ⁻³	LogN(Ar) m ⁻³	LogN(HE) m ⁻³	LogN(H) m ⁻³	Mean Mol Wt	Density kg/m ³
Exospheric Temperature = 800 K									
600	799.3	8.697	6.642	11.918		12.089	11.053	8.43	3.04E-14
800	799.8			10.254		11.673	10.948	3.92	3.75E-15
1000	799.9			8.681		11.279	10.849	3.22	1.39E-15
1500	800					10.383	10.623	2.10	2.31E-16
2000	800.0					9.594	10.425	1.39	7.06E-17
Exospheric Temperature = 900 K									
120	324.7	17.574	16.726	17.156	15.160	13.544		25.41	2.41E-08
130	428.4	17.084	16.184	16.825	14.513	13.417		24.39	8.25E-09
140	523.9	16.708	15.766	16.572	14.013	13.321		23.51	3.68E-09
150	600.9	16.404	15.428	16.373	13.606	13.249		22.73	1.95E-09
160	659.6	16.147	15.140	16.209	13.257	13.193		22.03	1.16E-09
180	738.9	15.710	14.648	15.938	12.654	13.107		20.81	4.93E-10
200	788.5	15.328	14.216	15.708	12.122	13.039		19.79	2.44E-10
250	852.9	14.483	13.255	15.211	10.931	12.902		17.97	5.83E-11
300	878.6	13.710	12.374	14.764	9.835	12.786		16.91	1.80E-11
350	889.3	12.971	11.530	14.339	8.783	12.678		16.26	6.29E-12
400	894.2	12.251	10.709	13.927	7.758	12.574		15.74	2.36E-12
500	897.9	10.853	9.112	13.128		12.373	10.741	14.22	3.76E-13
600	899.0	9.500	7.566	12.355		12.179	10.692	11.08	7.04E-14
800	899.7	6.910		10.876		11.809	10.599	5.03	6.35E-15
1000	899.9			9.478		11.459	10.511	3.81	2.05E-15
1500	900.0			6.294		10.663	10.310	3.08	3.40E-16
2000	900.0					9.962	10.133	2.21	8.36E-17
Exospheric Temperature = 1000 K									
120	334.5	17.579	16.733	17.154	15.172	13.539		25.45	2.44E-08
130	445.4	17.098	16.202	16.826	14.539	13.411		24.48	8.47E-09
140	549.0	16.730	15.794	16.577	14.053	13.315		23.64	3.84E-09
150	635.2	16.435	15.467	16.381	13.660	13.242		22.91	2.06E-09
160	703.1	16.187	15.189	16.220	13.325	13.186		22.25	1.24E-09
180	798.1	15.770	14.721	15.959	12.755	13.100		21.10	5.44E-10
200	859.3	15.413	14.317	15.741	12.258	13.034		20.13	2.78E-10
250	940.2	14.634	13.434	15.279	11.164	12.904		18.33	7.21E-11
300	972.8	13.932	12.633	14.872	10.169	12.796		17.21	2.40E-11
350	986.5	13.263	11.871	14.488	9.219	12.698		16.52	9.09E-12
400	992.6	12.614	11.130	14.116	8.294	12.604		16.02	3.69E-12
500	997.3	11.355	9.692	13.396	6.499	12.423	10.438	14.94	6.89E-13
600	998.8	10.137	8.300	12.699		12.249	10.393	12.85	1.45E-13
800	999.6	7.805		11.368		11.915	10.309	6.55	1.17E-14
1000	999.9			10.109		11.601	10.229	4.24	3.02E-15
1500	1000.0			7.244		10.884	10.049	3.62	5.28E-16
2000	1000.0					10.253	9.890	3.10	1.32E-16

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Table 14-14. (Continued)

Height km	Temp K	LogN(N ₂) m ⁻³	LogN(O ₂) m ⁻³	LogN(O) m ⁻³	LogN(Ar) m ⁻³	LogN(HE) m ⁻³	LogN(H) m ⁻³	Mean Mol Wt	Density kg/m ³
Exospheric Temperature = 1200 K									
120	350.9	17.587	16.745	17.150	15.192	13.530		25.52	2.48E-08
130	473.8	17.119	16.229	16.827	14.580	13.401		24.61	8.82E-09
140	591.1	16.764	15.837	16.583	14.115	13.304		23.84	4.09E-09
150	693.3	16.481	15.524	16.391	13.741	13.231		23.17	2.24E-09
160	778.3	16.245	15.262	16.235	13.426	13.173		22.57	1.37E-09
180	905.0	15.857	14.828	15.985	12.901	13.087		21.54	6.28E-10
200	991.4	15.533	14.463	15.783	12.455	13.021		20.65	3.36E-10
250	1110.3	14.851	13.691	15.373	11.504	12.901		18.95	9.84E-11
300	1159.1	14.253	13.011	15.023	10.659	12.806		17.79	3.70E-11
350	1179.6	13.691	12.370	14.699	9.860	12.722		17.01	1.57E-11
400	1188.9	13.147	11.750	14.387	9.087	12.643		16.47	7.19E-12
500	1195.9	12.096	10.549	13.785	7.589	12.491	9.966	15.67	1.70E-12
600	1198.2	11.080	9.388	13.205	6.140	12.346	9.929	14.62	4.46E-13
800	1199.4	9.136	7.169	12.095		12.068	9.858	10.17	4.09E-14
1000	1199.8	7.300		11.046		11.806	9.792	5.74	7.21E-15
1500	1200.0			8.658		11.208	9.642	3.96	1.09E-15
2000	1200.0			6.557		10.682	9.509	3.82	3.25E-16
Exospheric Temperature = 1400 K									
120	364.1	17.593	16.754	17.147	15.207	13.523		25.57	2.51E-08
130	496.8	17.134	16.250	16.827	14.611	13.393		24.71	9.10E-09
140	625.2	16.789	15.869	16.587	14.160	13.296		23.99	4.29E-09
150	740.8	16.514	15.566	16.398	13.800	13.222		23.36	2.38E-09
160	841.0	16.286	15.313	16.245	13.498	13.163		22.81	1.48E-09
180	998.5	15.916	14.901	16.001	13.003	13.075		21.86	6.93E-10
200	1111.9	15.613	14.562	15.809	12.591	13.009		21.05	3.82E-10
250	1274.4	14.998	13.867	15.431	11.738	12.893		19.45	1.22E-10
300	1342.6	14.473	13.271	15.122	10.999	12.807		18.30	5.00E-11
350	1371.4	13.986	12.716	14.840	10.309	12.733		17.48	2.32E-11
400	1384.4	13.518	12.182	14.571	9.643	12.664		16.89	1.15E-11
500	1394.3	12.614	11.151	14.054	8.356	12.534	9.621	16.09	3.23E-12
600	1397.4	11.743	10.155	13.555	7.113	12.409	9.588	15.39	9.98E-13
800	1399.2	10.077	8.252	12.603		12.171	9.528	12.79	1.17E-13
1000	1399.7	8.503	6.454	11.704		11.946	9.471	8.37	1.93E-14
1500	1399.9			9.658		11.434	9.342	4.18	1.93E-15
2000	1400.0			7.856		10.983	9.229	3.96	6.44E-16
Exospheric Temperature = 1600 K									
120	375.4	17.598	16.762	17.144	15.219	13.518		25.62	2.53E-08
130	516.4	17.147	16.266	16.827	14.635	13.387		24.79	9.32E-09
140	654.1	16.808	15.894	16.590	14.196	13.290		24.10	4.45E-09
150	781.1	16.540	15.598	16.404	13.846	13.215		23.51	2.50E-09
160	894.6	16.318	15.353	16.252	13.554	13.155		23.00	1.56E-09

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Table 14-14. (Continued)

Height km	Temp K	Log(N(N ₂) /m ³)	Log(N(O ₂) /m ³)	Log(N(O) /m ³)	Log(N(A) /m ³)	Log(N(HE) /m ³)	Log(N(H) /m ³)	Mean Mol Wt	Density kg/m ³
180	1081.3	15.960	14.956	16.012	13.080	13.065		22.11	7.46E-10
200	1222.4	15.672	14.635	15.825	12.692	12.998		21.36	4.20E-10
250	1433.1	15.103	13.995	15.470	11.910	12.884		19.87	1.43E-10
300	1523.5	14.633	13.461	15.190	11.250	12.804		18.75	6.27E-11
350	1561.9	14.201	12.970	14.939	10.640	12.737		17.91	3.10E-11
400	1579.2	13.790	12.500	14.702	10.055	12.676		17.28	1.64E-11
500	1592.4	12.997	11.596	14.248	8.926	12.561	9.361	16.43	5.21E-12
600	1596.5	12.234	10.724	13.811	7.838	12.452	9.333	15.82	1.82E-12
800	1599.0	10.776	9.059	12.978		12.243	9.280	14.21	2.67E-13
1000	1599.6	9.398	7.485	12.192		12.046	9.230	11.01	4.88E-14
1500	1599.9	6.263		10.401		11.598	9.117	4.71	3.30E-15
2000	1600.0			8.824		11.204	9.018	4.03	1.08E-15