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Standard Atmosphere Table

ICAO standard atmosphere (ISA) temperature, pressure, density and speed of sound by altitude, with density altitude

For: Pilots, flight students, aerospace engineers, meteorology and physics students

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KEY RELATIONSHIP	FORMULA	REVERSE	WORKED EXAMPLE
Sea level 15 °C, 1013.25 hPa (29.92 inHg), 1.225 kg/m³; −6.5 °C per km up to 11 km, then −56.5 °C	T = 288.15 − 0.0065 × h; p = 1013.25 × (T ÷ 288.15)^5.2559	h = (288.15 − T) ÷ 0.0065 (troposphere)	At 10,000 ft: −4.8 °C, 696.8 hPa, density 0.7385 of sea level

Geopotential altitude, as used for pressure altitude. About −2 °C per 1,000 ft and roughly 1 hPa per 30 ft near sea level.

Standard atmosphere by altitude in feet

Altitude (ft)	Metres	Temp. (°C)	Temp. (°F)	Pressure (hPa)	Pressure (inHg)	Density ratio σ	Speed of sound (kt)
−1,000	−305	17.0	62.6	1,050.41	31.02	1.0296	663.7
0	0	15.0	59.0	1,013.25	29.92	1.0000	661.5
1,000	305	13.0	55.4	977.17	28.86	0.9711	659.2
2,000	610	11.0	51.9	942.13	27.82	0.9428	656.9
3,000	914	9.1	48.3	908.12	26.82	0.9151	654.6
4,000	1,219	7.1	44.7	875.11	25.84	0.8881	652.3
5,000	1,524	5.1	41.2	843.07	24.90	0.8617	650.0
6,000	1,829	3.1	37.6	812.00	23.98	0.8359	647.7
7,000	2,134	1.1	34.0	781.85	23.09	0.8106	645.4
8,000	2,438	−0.8	30.5	752.62	22.22	0.7860	643.0
9,000	2,743	−2.8	26.9	724.28	21.39	0.7620	640.7
10,000	3,048	−4.8	23.3	696.82	20.58	0.7385	638.3
11,000	3,353	−6.8	19.8	670.20	19.79	0.7156	636.0
12,000	3,658	−8.8	16.2	644.41	19.03	0.6932	633.6
13,000	3,962	−10.8	12.6	619.43	18.29	0.6713	631.2
14,000	4,267	−12.7	9.1	595.24	17.58	0.6500	628.8
15,000	4,572	−14.7	5.5	571.82	16.89	0.6292	626.4
16,000	4,877	−16.7	1.9	549.15	16.22	0.6090	624.0
17,000	5,182	−18.7	−1.6	527.22	15.57	0.5892	621.6
18,000	5,486	−20.7	−5.2	506.00	14.94	0.5699	619.2
19,000	5,791	−22.6	−8.8	485.48	14.34	0.5511	616.8
20,000	6,096	−24.6	−12.3	465.63	13.75	0.5328	614.3
21,000	6,401	−26.6	−15.9	446.45	13.18	0.5150	611.9
22,000	6,706	−28.6	−19.5	427.91	12.64	0.4976	609.4
23,000	7,010	−30.6	−23.0	410.01	12.11	0.4807	606.9
24,000	7,315	−32.5	−26.6	392.71	11.60	0.4642	604.4
25,000	7,620	−34.5	−30.2	376.01	11.10	0.4481	601.9
26,000	7,925	−36.5	−33.7	359.89	10.63	0.4325	599.4
27,000	8,230	−38.5	−37.3	344.33	10.17	0.4173	596.9
28,000	8,534	−40.5	−40.9	329.32	9.72	0.4025	594.4
29,000	8,839	−42.5	−44.4	314.85	9.30	0.3881	591.9
30,000	9,144	−44.4	−48.0	300.90	8.89	0.3741	589.3
31,000	9,449	−46.4	−51.6	287.45	8.49	0.3605	586.8
32,000	9,754	−48.4	−55.1	274.49	8.11	0.3473	584.2
33,000	10,058	−50.4	−58.7	262.01	7.74	0.3345	581.6
34,000	10,363	−52.4	−62.2	249.99	7.38	0.3220	579.0
35,000	10,668	−54.3	−65.8	238.42	7.04	0.3099	576.4

Altitude (ft)	Metres	Temp. (°C)	Temp. (°F)	Pressure (hPa)	Pressure (inHg)	Density ratio σ	Speed of sound (kt)
36,000	10,973	−56.3	−69.4	227.29	6.71	0.2981	573.8
37,000	11,278	−56.5	−69.7	216.63	6.40	0.2844	573.6
38,000	11,582	−56.5	−69.7	206.46	6.10	0.2710	573.6
39,000	11,887	−56.5	−69.7	196.77	5.81	0.2583	573.6
40,000	12,192	−56.5	−69.7	187.54	5.54	0.2462	573.6
41,000	12,497	−56.5	−69.7	178.74	5.28	0.2346	573.6
42,000	12,802	−56.5	−69.7	170.35	5.03	0.2236	573.6
43,000	13,106	−56.5	−69.7	162.36	4.79	0.2131	573.6
44,000	13,411	−56.5	−69.7	154.74	4.57	0.2031	573.6
45,000	13,716	−56.5	−69.7	147.48	4.35	0.1936	573.6
50,000	15,240	−56.5	−69.7	115.97	3.42	0.1522	573.6
55,000	16,764	−56.5	−69.7	91.20	2.69	0.1197	573.6
60,000	18,288	−56.5	−69.7	71.72	2.12	0.0941	573.6
65,000	19,812	−56.5	−69.7	56.40	1.67	0.0740	573.6

Standard atmosphere by altitude in metres

Altitude (m)	Feet	Temp. (°C)	Pressure (hPa)	Density (kg/m^3)	Density ratio σ	Speed of sound (m/s)
0	0	15.00	1,013.3	1.225	1.0000	340.3
500	1,640	11.75	954.61	1.167	0.9529	338.4
1,000	3,281	8.50	898.75	1.112	0.9075	336.4
1,500	4,921	5.25	845.56	1.058	0.8637	334.5
2,000	6,562	2.00	794.95	1.006	0.8216	332.5
2,500	8,202	−1.25	746.83	0.9569	0.7811	330.6
3,000	9,843	−4.50	701.09	0.9091	0.7421	328.6
3,500	11,483	−7.75	657.64	0.8632	0.7047	326.6
4,000	13,123	−11.00	616.40	0.8191	0.6687	324.6
4,500	14,764	−14.25	577.28	0.7768	0.6341	322.6
5,000	16,404	−17.50	540.20	0.7361	0.6009	320.5
5,500	18,045	−20.75	505.07	0.6971	0.5691	318.5
6,000	19,685	−24.00	471.81	0.6597	0.5385	316.4
6,500	21,325	−27.25	440.35	0.6238	0.5093	314.4
7,000	22,966	−30.50	410.61	0.5895	0.4812	312.3
7,500	24,606	−33.75	382.51	0.5566	0.4544	310.2
8,000	26,247	−37.00	356.00	0.5252	0.4287	308.1
8,500	27,887	−40.25	330.99	0.4951	0.4042	305.9
9,000	29,528	−43.50	307.42	0.4663	0.3807	303.8
9,500	31,168	−46.75	285.24	0.4389	0.3583	301.6
10,000	32,808	−50.00	264.36	0.4127	0.3369	299.5
10,500	34,449	−53.25	244.74	0.3877	0.3165	297.3
11,000	36,089	−56.50	226.32	0.3639	0.2971	295.1
11,500	37,730	−56.50	209.16	0.3363	0.2746	295.1
12,000	39,370	−56.50	193.30	0.3108	0.2537	295.1
12,500	41,010	−56.50	178.65	0.2873	0.2345	295.1
13,000	42,651	−56.50	165.10	0.2655	0.2167	295.1
13,500	44,291	−56.50	152.59	0.2454	0.2003	295.1
14,000	45,932	−56.50	141.02	0.2268	0.1851	295.1
14,500	47,572	−56.50	130.33	0.2096	0.1711	295.1
15,000	49,213	−56.50	120.45	0.1937	0.1581	295.1
15,500	50,853	−56.50	111.31	0.1790	0.1461	295.1
16,000	52,493	−56.50	102.87	0.1654	0.1350	295.1
16,500	54,134	−56.50	95.075	0.1529	0.1248	295.1
17,000	55,774	−56.50	87.867	0.1413	0.1153	295.1

Altitude (m)	Feet	Temp. (°C)	Pressure (hPa)	Density (kg/m³)	Density ratio σ	Speed of sound (m/s)
17,500	57,415	−56.50	81.205	0.1306	0.1066	295.1
18,000	59,055	−56.50	75.048	0.1207	0.0985	295.1
18,500	60,696	−56.50	69.358	0.1115	0.0910	295.1
19,000	62,336	−56.50	64.100	0.1031	0.0841	295.1
19,500	63,976	−56.50	59.240	0.09526	0.0778	295.1
20,000	65,617	−56.50	54.749	0.08803	0.0719	295.1

Density altitude (feet) from pressure altitude and temperature

Rows: pressure altitude (set 29.92 inHg / 1013 hPa and read the altimeter). Columns: outside air temperature. Calculated exactly from ISA density.

Pressure alt. (ft)	−10 °C	0 °C	10 °C	20 °C	30 °C	40 °C
0	−3,130	−1,840	−600	590	1,720	2,820
1,000	−1,870	−590	640	1,820	2,940	4,030
2,000	−620	660	1,880	3,040	4,160	5,230
3,000	640	1,900	3,110	4,270	5,380	6,440
4,000	1,900	3,150	4,340	5,490	6,590	7,640
5,000	3,150	4,390	5,580	6,710	7,800	8,850
6,000	4,400	5,630	6,800	7,930	9,010	10,050
7,000	5,650	6,870	8,030	9,150	10,220	11,240
8,000	6,890	8,100	9,260	10,360	11,420	12,440
9,000	8,140	9,330	10,480	11,570	12,630	13,630
10,000	9,380	10,560	11,700	12,790	13,830	14,830
11,000	10,620	11,790	12,920	13,990	15,030	16,020
12,000	11,850	13,020	14,130	15,200	16,220	17,200

ISA constants and formulas

Quantity	Value or formula
Sea-level temperature	288.15 K (15 °C, 59 °F)
Sea-level pressure	101,325 Pa = 1013.25 hPa = 29.921 inHg = 14.696 psi
Sea-level density	1.225 kg/m³ (0.002377 slug/ft³)
Lapse rate	6.5 K per km (1.98 °C per 1,000 ft) up to 11 km (36,089 ft)
Tropopause to 20 km	Constant 216.65 K (−56.5 °C); p = 22,632 Pa × e^(−(h − 11,000) ÷ 6,341.6 m)
Speed of sound	a = √(1.4 × 287.053 × T); 340.29 m/s = 661.5 kt at sea level
ISA deviation	ISA temperature at altitude: 15 − 1.98 × (altitude ÷ 1,000 ft) °C

Sources and method

- **ICAO Doc 7488, Manual of the ICAO Standard Atmosphere (3rd edition, 1993)** — Identical to ISO 2533:1975 up to 32 km; defining constants used for every value
- **FAA Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)** — Density altitude, crosswind and headwind components (www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak)

Every value is calculated from the ICAO Doc 7488 defining constants (T_0 288.15 K, p_0 101,325 Pa, R 287.052 87 J/(kg·K), g_0 9.806 65 m/s²); density altitude inverts the ISA density exactly. Interactive version, corrections and more charts: **allunitconversions.com/standard-atmosphere-chart**