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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

**allunitconversions.com/standard-atmosphere-chart**
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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 |

| Altitude (ft) | Metres | Temp. (°C) | Temp. (°F) | Pressure (hPa) | Pressure (inHg) | Density ratio σ | Speed of sound (kt) |
|---|---|---|---|---|---|---|---|
| **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 |
| **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 |

| Altitude (m) | Feet | Temp. (°C) | Pressure (hPa) | Density (kg/m³) | Density ratio σ | Speed of sound (m/s) |
|---|---|---|---|---|---|---|
| **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 |
| **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**