B

CONSTANTS & CONVERSION FACTORS

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UNIVERSAL CONSTANTS

[from US National Institute of Standards and Technology (NIST), based on 2014 CODATA]
c₀ = 299,792,458. m/s = speed of light in a vacuum
c₁ = 3.741 771 790 x10⁸ W·m⁻²·µm⁻¹ = first radiation constant (in Planck’s law)
c₁B = 1.191 042 953 x10⁸ W·m⁻²·µm⁻¹·s⁻¹ = first radiation constant for spectral radiance
c₂ = 1.438 777 36 x10⁴ µm·K = second radiation constant (in Planck’s law)
G = 6.674 08 x10⁻¹¹ m³·s⁻²·kg⁻¹ = Newtonian gravitational constant
h = 6.626 070 040 x10⁻³⁴ J·s = Planck constant
kB = 1.380 648 52 x10⁻²³ J·K⁻¹·molecule⁻¹ = Boltzmann constant
NA = 6.022 140 857 x10²³ mol⁻¹ = Avogadro constant
σSB = 5.670 367 x10⁻⁸ W·m⁻²·K⁻⁴ = Stefan-Boltzmann constant
T = –273.15°C = 0 K = absolute zero (not considered a true universal constant)

MATH CONSTANTS

[from CRC Handbook of Chemistry and Physics]
e = 2.718 281 828 459 = base of natural logarithms
1/e = 0.367 879 441 = e-folding ratio
π = 3.141 592 653 589 793 238 462 643 = pi
sqrt(2) = 1.414 213 562 373 095

Earth Characteristics

1° latitude = 111 km = 60 nautical miles (nm) [Caution: This relationship does NOT hold for degrees longitude.]
a = 149,598 Gm = semi-major axis of Earth orbit
A = 0.306 = Bond albedo (NASA 2015)
A = 0.367 = visual geometric albedo (NASA 2015)
b = 149,090 Gm = semi-minor axis of Earth orbit
d = 149,597 870.7 Gm = average sun-Earth distance
= 1 Astronomical Unit (AU) (NASA 2015)
daphelion = 152.10 Gm = furthest sun-Earth distance, which occurs about 4 July (NASA 2015)
dperihelion = 147.09 Gm = closest sun-Earth distance, which occurs about 3 January (NASA 2015)
dₚ = 173 = 22 June = approx. day of summer solstice
e = 0.0167 = eccentricity of Earth orbit around sun
g = –9.806 65 m·s⁻² = average gravitational acceleration on Earth at sea level (negative = downward). (from 2014 CODATA)
|g| = g₀ [1 + A·sin²(φ) – B·sin²(2φ)] – CH
= variation of gravitational-acceleration magnitude with latitude φ and altitude H(m) above mean sea level. g₀ = 9.780 318 4 m·s⁻², A = 0.005 3024, B = 0.000 0059, C = 3.086x10⁻⁶ m⁻²
M = 5.9726 x10²⁴ kg = mass of Earth (NASA 2015)
Pearth = 365.256 days = Earth orbital period (2015)
Pmoon = 27.3217 days = lunar orbital period (2015)
Psidereal = 23.934 469 6 h = sidereal day = period for one revolution of the Earth about its axis, relative to fixed stars
Rearth = 6371.0 km = volumetric average Earth radius (from NASA 2015)
                   = 6378.1 km = Earth radius at equator
                   = 6356.8 km = Earth radius at poles
S = 1367.6 W·m⁻² = solar irradiance (solar constant) at top of atmosphere (NASA 2015)
                   = 1.125 K·m⁻²·s⁻¹ = kinematic solar constant (based on mean sea-level density)
Tₑ = 254.3 K = effective radiation emission black-body temperature of Earth system (NASA 2015)
Φₑ = 23.44° = 0.4091 radians = tilt of Earth axis = obliquity relative to the orbital plane (2015)
Ω = 0.729 210.7 x10⁻⁴ s⁻¹ = sidereal rotation frequency of Earth (NASA 2015)
2Ω = 1.458 421 x10⁻⁴ s⁻¹ = Coriolis factor
2Ω / Rₑarth = 2.289 x10⁻¹¹ m⁻¹·s⁻¹ = beta factor
AIR AND WATER CHARACTERISTICS

\[ a = 0.0337 \text{ (mm/day) } \cdot (W/m^2)^{-1} = \text{ water depth evaporation per latent heat flux} \]

\[ B = 3 \times 10^9 \text{ V/km} = \text{ breakdown potential for dry air} \]

\[ C_{vd} = 717 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat for dry air at constant volume} \]

\[ C_{pd} = 1003 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat for dry air at constant pressure at } -23^\circ\text{C} \]

\[ C_{pd} = 1004 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat for dry air at constant pressure at } 0^\circ\text{C} \]

\[ C_{pd} = 1005 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat for dry air at constant pressure at } 27^\circ\text{C} \]

\[ C_{pd} = 1850 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat for water vapor at constant pressure at } 0^\circ\text{C} \]

\[ C_{pd} = 1875 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat for water vapor at constant pressure at } 15^\circ\text{C} \]

\[ L_{lq} = 4217.6 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat of liquid water at } 0^\circ\text{C} \]

\[ C_{ice} = 2106 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1} = \text{ specific heat of ice at } 0^\circ\text{C} \]

\[ D = 2.11 \times 10^{-5} \text{ m}^2 \cdot \text{s}^{-1} = \text{ molecular diffusivity of water vapor in air in standard conditions} \]

\[ e_o = 0.611 \text{ kPa} = \text{ reference vapor pressure at } 0^\circ\text{C} \]

\[ k = 0.0253 \text{ W m}^{-1} \cdot \text{K}^{-1} = \text{ molecular conductivity of air at sea level in standard conditions} \]

\[ L_d = 2.834 \times 10^6 \text{ J} \cdot \text{kg}^{-1} = \text{ latent heat of deposition at } 0^\circ\text{C} \]

\[ L_f = 3.34 \times 10^5 \text{ J} \cdot \text{kg}^{-1} = \text{ latent heat of fusion at } 0^\circ\text{C} \]

\[ L_v = 2.501 \times 10^6 \text{ J} \cdot \text{kg}^{-1} = \text{ latent heat of vaporization at } 0^\circ\text{C} \]

\[ n = 3.3 \times 10^{28} \text{ molecules m}^{-3} = \text{ liquid water at } 0^\circ\text{C} \]

\[ n_{water} = 1.000 \text{ molar} = \text{ index of refraction for air} \]

\[ n_{ice} = 1.336 = \text{ index of refraction for liquid water} \]

\[ n_{air} = 1.312 = \text{ index of refraction for ice} \]

\[ P_{STP} = 101.325 \text{ kPa} = \text{ standard sea-level pressure (STP = Standard Temperature & Pressure)} \]

\[ \mathcal{R}_d = 0.287 \text{ kPa} \cdot \text{K}^{-1} \cdot \text{m}^3 \cdot \text{kg}^{-1} = C_{pd} - C_{vd} \]

\[ \mathcal{R}_v = 461.5 \text{ J} \cdot \text{K}^{-1} \cdot \text{kg}^{-1} = \text{ gas constant for dry air} \]

\[ \mathcal{R}_v = 287.053 \text{ J} \cdot \text{K}^{-1} \cdot \text{kg}^{-1} = \text{ gas constant for dry air} \]

\[ \rho_{air} = 1.225 \text{ kg m}^{-3} = \text{ density of liquid water at } 0^\circ\text{C} \]

\[ = 1004 \text{ J} \cdot \text{kg}^{-1} = \text{ density of liquid water at } 0^\circ\text{C} \]

\[ = 998.21 \text{ kg m}^{-3} = \text{ density of liquid water at } 20^\circ\text{C} \]

\[ = 992.22 \text{ kg m}^{-3} = \text{ density of liquid water at } 40^\circ\text{C} \]

\[ = 983.20 \text{ kg m}^{-3} = \text{ density of liquid water at } 60^\circ\text{C} \]

\[ = 971.82 \text{ kg m}^{-3} = \text{ density of liquid water at } 80^\circ\text{C} \]

\[ = 958.40 \text{ kg m}^{-3} = \text{ density of liquid water at } 100^\circ\text{C} \]

\[ \rho_{water} = 1025 \text{ kg m}^{-3} = \text{ density of water, on average} \]

\[ \rho_{ice} = 916.8 \text{ kg m}^{-3} \]

\[ \sigma = 0.076 \text{ N} \cdot \text{m}^{-1} = \text{ surface tension of pure water } 0^\circ\text{C} \]

CONVERSION FACTORS & COMBINED PARAMETERS

\[ \frac{C_{pd}}{C_{vd}} = k = 1.400 \text{ (dimensionless)} \]

\[ \frac{C_{pd}}{g} = \gamma = 102.52 \text{ m} \cdot \text{K}^{-1} \]

\[ \frac{C_{pd}}{L_v} = 0.0004 (g_{water g_{air}^{-1}}) \cdot \text{K}^{-1} = \gamma \]

\[ \gamma = 0.4 (g_{water g_{air}^{-1}}) \cdot \text{K}^{-1} = \text{ psychrometric constant} \]

\[ \frac{C_{pd}}{R_d} = 3.50 \text{ (dimensionless)} \]

\[ \frac{C_{vd}}{C_{pd}} = 1/k = 0.714 \text{ (dimensionless)} \]

\[ \frac{L_v}{C_{pd}} = 2.5 \text{ K} \cdot (g_{water/kg_{air}^{-1}}) \]

\[ L_v / R_d = 5423 \text{ K} = \text{ Clausius-Clapeyron parameter for vaporization} \]

\[ R_d / C_{pd} = 0.28571 \text{ (dimensionless)} = \text{ potential-temperature constant} \]

\[ R_d / g = \varepsilon = 0.622 \text{ (dimensionless)} = \text{ gas-constant ratio} \]

\[ R_d / |g| = 29.29 \text{ m km}^{-1} = \text{ hypsometric constant} \]

\[ \rho_{air} C_{pd} = 1231 \text{ (W m}^{-2}) / [(\text{K m s}^{-1})] \text{ at sea level} \]

\[ 12.31 \text{ mb K}^{-1} \text{ at sea level} \]

\[ 1.231 \text{ kPa K}^{-1} \text{ at sea level} \]

\[ \rho_{air} |g| = 12.0 \text{ kg m}^{-2} \cdot \text{s}^{-2} \text{ at sea level} \]

\[ 0.12 \text{ mb m}^{-1} \text{ at sea level} \]

\[ 0.012 \text{ kPa m}^{-1} \text{ at sea level} \]

\[ \rho_{air} L_v = 3013.5 \text{ (W m}^{-2}) / [(\text{g water kg air}^{-1})(\text{m s}^{-1})] \text{ at sea level} \]

\[ 1 \text{ megaton nuclear explosion } = 4 \times 10^{15} \text{ J} \]

\[ 2\pi \text{ radians } = 360^\circ \]

\[ (1-\varepsilon)/\varepsilon = 0.61 = \text{ virtual temperature constant} \]