B CONSTANTS & CONVERSION FACTORS

Contents

B.1. UNIVERSAL CONSTANTS

[from US National Institute of Standards and Technology (NIST), based on 2014 CODATA]

$c_o = 2.99792458\text{x}10^8$ m·s^{-1} = speed of light in a vacuum

c_1 = 3.741771790 x10^8 W·m^{-2}·µm^4 = first radiation constant (in Planck's law)

c_{1B} = 1.191042953 x10^8 W·m^{-2}·µm^4·sr^{-1} = first radiation constant for spectral radiance

c_2 = 1.43877736 x10^4 µm·K = second radiation constant (in Planck's law)

G = 6.67408 x10^{-11} m^3·s^{-2}·kg^{-1} = Newtonian gravitational constant

h = 6.626070040 x10^{-34} J·s = Planck constant

k_B = 1.38064852 x10^{-23} J·K^{-1}·molecule^{-1} = Boltzmann constant

N_A = 6.022140857 x10^{23} mol^{-1} = Avogadro constant

σ_{SB} = 5.670367 x10^{-8} W·m^{-2}·K^{-4} = Stefan-Boltzmann constant

T = –273.15°C = 0 K = absolute zero (not considered a true universal constant)

B.2. MATH CONSTANTS

[from *CRC Handbook of Chemistry and Physics*]

e = 2.718281828459 = base of natural logarithms

$1/e$ = 0.367879441 = e-folding ratio

π = 3.141592653589793238462643 = pi

sqrt(2) = 1.414213562373095

B.3. 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 = 149.5978707 Gm = average sun-Earth distance = 1 Astronomical Unit (AU) (NASA 2015)

$d_{aphelion}$ = 152.10 Gm = furthest sun-Earth distance, which occurs about 4 July (NASA 2015)

$d_{perihelion}$ = 147.09 Gm = closest sun-Earth distance, which occurs about 3 January (NASA 2015)

d_r = 173 = 22 June = approx. day of summer solstice

e = 0.0167 = eccentricity of Earth orbit around sun

g = –9.80665 m·s^{-2} = average gravitational acceleration on Earth at sea level (negative = downward) (from 2014 CODATA)

$|g| = g_o \cdot [1 + A\cdot\sin^2(\phi) - B\cdot\sin^2(2\phi)] - C\cdot H$ = variation of gravitational-acceleration magnitude with latitude ϕ & altitude H (in meters) above mean sea level. g_o = 9.7803184 m·s^{-2}, A = 0.0053024, B = 0.0000059, C = 3.086x10^{-6} s^{-2}.

M = 5.9726 x10^{24} kg = mass of Earth (NASA 2015)

P_{earth} = 365.256 days = Earth orbital period (2015)

P_{moon} = 27.3217 days = lunar orbital period (2015)

$P_{sidereal}$ = 23.9344696 h = sidereal day = period for one revolution of the Earth about its axis, relative to fixed stars

R_{earth} = 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·s^{-1} = kinematic solar constant (based on mean sea-level density)

T_e = 254.3 K = effective radiation emission black-body temperature of Earth system (NASA 2015)

Φ_r = 23.44° = 0.4091 radians = tilt of Earth axis = obliquity relative to the orbital plane (2015)

Ω = 0.7292107 x10^{-4} s^{-1} = sidereal rotation frequency of Earth (NASA 2015)

$2\cdot\Omega$ = 1.458421 x10^{-4} s^{-1} = Coriolis factor

$2\cdot\Omega / R_{earth}$ = 2.289 x10^{-11} m^{-1}·s^{-1} = beta factor

B.4. AIR AND WATER CHARACTERISTICS

a = 0.0337 (mm/day) ·(W/m^2)$^{-1}$ = water-depth evaporation per unit latent-heat flux
B = 3 x10^9 V·km^{-1} = breakdown potential for dry air
C_{vd} = 717 J·kg^{-1}·K^{-1} = specific heat for dry air at constant volume
C_{pd} = 1003 J·kg^{-1}·K^{-1} = specific heat for dry air at constant pressure at –23°C
= 1004 J·kg^{-1}·K^{-1} = specific heat for dry air at constant pressure at 0°C
= 1005 J·kg^{-1}·K^{-1} = specific heat for dry air at constant pressure at 27°C
C_{pv} = 1850 J·kg^{-1}·K^{-1} = specific heat for water vapor at constant pressure at 0°C
= 1875 J·kg^{-1}·K^{-1} = specific heat for water vapor at constant pressure at 15°C
C_{liq} = 4217.6 J·kg^{-1}·K^{-1} = specific heat of liquid water at 0°C
C_{ice} = 2106 J·kg^{-1}·K^{-1} = specific heat of ice at 0°C
D = 2.11x10^{-5} m^2·s^{-1} = molecular diffusivity of water vapor in air in standard conditions
e_o = 0.611 kPa = reference vapor pressure at 0°C
k = 0.0253 W·m^{-1}·K^{-1} = molecular conductivity of air at sea level in standard conditions
L_d = 2.834x10^6 J·kg^{-1} = latent heat of deposition at 0°C
L_f = 3.34 x10^5 J·kg^{-1} = latent heat of fusion at 0°C
L_v = 2.501 x10^6 J·kg^{-1} = latent heat of vaporization at 0°C
n = 3.3 x10^{28} molecules ·m^{-3} for liquid water at 0°C
n_{air} ≈ 1.000277 = index of refraction for air
n_{water} ≈ 1.336 = index of refraction for liquid water
n_{ice} ≈ 1.312 = index of refraction for ice
P_{STP} = 101.325 kPa = standard sea-level pressure (STP = Standard Temperature & Pressure)
$\Re_d$ = 0.287053 kPa·K^{-1}·m^3·kg^{-1} = $C_{pd} - C_{vd}$
= 287.053 J·K^{-1} ·kg^{-1} = gas constant for dry air
$\Re_v$ = 461.5 J·K^{-1}·kg^{-1} = water-vapor gas constant
= 4.61 x10^{-4} kPa·K^{-1}·m^3·g^{-1}
Ri_c = 0.25 = critical Richardson number (dimensionless)
s_o = 343.15 m·s^{-1} = sound speed in standard, calm air
T_{STP} = 15°C = standard sea-level temperature
ε = 0.622 g_{water}·g_{air}^{-1} = $\Re_d$ / $\Re_v$ = gas-constant ratio
γ = 0.0004 (g_{water}·g_{air}^{-1})·K^{-1} = C_p / L_v
= 0.4 (g_{water}·kg_{air}^{-1})·K^{-1} = psychrometric constant
Γ_d = 9.75 K·km^{-1} = $|g|/C_p$ = dry adiabatic lapse rate
ρ_{STP} = 1.225 kg·m^{-3} = standard sea-level air density
ρ_{avg} = 0.689 kg·m^{-3} = air density averaged over the troposphere (over z = 0 to 11 km)
ρ_{liq} = 999.84 kg·m^{-3} = density of liquid water at 0°C
= 1000.0 kg·m^{-3} = density of liquid water at 4°C
= 998.21 kg·m^{-3} = density of liquid water at 20°C
= 992.22 kg·m^{-3} = density of liquid water at 40°C
= 983.20 kg·m^{-3} = density of liquid water at 60°C
= 971.82 kg·m^{-3} = density of liquid water at 80°C
= 958.40 kg·m^{-3} = density of liquid water at 100°C
$\rho_{sea\text{-}water}$ = 1025 kg·m^{-3} = avg. density of sea water (sea water contains 34.482 g of salt ions per kg of water, on average)
ρ_{ice} = 916.8 kg·m^{-3} = density of ice at 0°C
σ = 0.076 N·m^{-1} = surface tension of pure water at 0°C

B.5. CONVERSION FACTORS & COMBINED PARAMETERS

C_{pd} / C_{vd} = k = 1.400 (dimensionless)
= specific heat ratio
C_{pd} /$|g|$ = 102.52 m·K^{-1}
C_{pd} / L_v = 0.0004 (g_{water}·g_{air}^{-1})·K^{-1} = γ
= 0.4 (g_{water}·kg_{air}^{-1})·K^{-1}
= psychrometric constant
C_{pd} / $\Re_d$ = 3.50 (dimensionless)
C_{vd} / C_{pd} = 1/k = 0.714 (dimensionless)
$|g|/C_{pd}$ = Γ_d = 9.8 K·km^{-1} = dry adiabatic lapse rate
$|g|$/ $\Re_d$ = 0.0342 K·m^{-1} = 1/(hypsometric constant)
L_v / C_{pd} = 2.5 K/(g_{water}·kg_{air}^{-1})
L_v / $\Re_v$ = 5423 K = Clausius-Clapeyron parameter for vaporization
$\Re_d$ / C_{pd} = 0.28571 (dimensionless) = potential-temperature constant
$\Re_d$ /$\Re_v$ = ε = 0.622 g_{water}·g_{air}^{-1} = gas-constant ratio
$\Re_d$ /$|g|$ = 29.29 m·K^{-1} = hypsometric constant
ρ_{air} ·$C_{pd\ air}$ = 1231 (W·m^{-2}) / (K·m·s^{-1}) at sea level
= 12.31 mb·K^{-1} at sea level
= 1.231 kPa·K^{-1} at sea level
ρ_{air} ·$|g|$ = 12.0 kg·m^{-2}·s^{-2} at sea level
= 0.12 mb·m^{-1} at sea level
= 0.012 kPa·m^{-1} at sea level
ρ_{air} ·L_v = 3013.5 (W·m^{-2}) / [(g_{water}·kg_{air}^{-1})·(m·s^{-1})] at sea level
ρ_{liq} ·C_{liq} = 4.295 x10^6 (W·m^{-2}) / (K·m·s^{-1})
1 megaton nuclear explosion ≈ 4x10^{15} J
2π radians = 360°
(1–ε)/ε = 0.61 = virtual temperature constant