

Conversion Factors, Constants, and Fluid Properties

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A.1. CONVERSION FACTORS

<i>Length:</i>	1 m = 3.2808 ft 1 in. = 2.540 cm 1 mile = 1.609 km 1 nautical mile = 1.852 km
<i>Mass</i> ¹ :	1 kg = 0.06854 slug = 1000 g ↔ 2.205 lbs 1 metric ton = 1000 kg
<i>Time:</i>	1 day = 86,400 s
<i>Density</i> ¹ :	1 kg m ⁻³ = 1.941 × 10 ⁻³ slugs ft ⁻³ ↔ 0.06244 lbs/ft ³
<i>Velocity:</i>	1 knot = 0.5144 m/s
<i>Force:</i>	1 N = 10 ⁵ dyn = 0.2248 lbs
<i>Pressure:</i>	1 dyn cm ⁻² = 0.1 N/m ² = 0.1 Pa 1 bar = 10 ⁵ Pa
<i>Energy:</i>	1 J = 10 ⁷ erg = 0.2389 cal 1 cal = 4.186 J
<i>Energy flux:</i>	1 W m ⁻² = 2.39 × 10 ⁻⁵ cal cm ⁻² s ⁻¹

¹At the earth's surface, the weight of a 1 kg mass is 2.205 lbs.

A.2. PHYSICAL CONSTANTS

<i>Avogadro's Number:</i>	$6.023 \times 10^{23} \text{ gmole}^{-1}$
<i>Boltzmann's Constant:</i>	$1.381 \times 10^{-23} \text{ J K}^{-1}$
<i>Gravitational Acceleration:</i>	$9.807 \text{ m s}^{-2} = 32.17 \text{ ft s}^{-2}$ (at the surface of the earth)
<i>Gravitational Constant:</i>	$6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
<i>Planck's Constant:</i>	$6.626 \times 10^{-34} \text{ J s}$
<i>Speed of Light in Vacuum:</i>	$2.998 \times 10^8 \text{ m s}^{-1}$
<i>Universal Gas Constant:</i>	$8.314 \text{ J gmole}^{-1} \text{ K}^{-1}$

A.3. PROPERTIES OF PURE WATER AT ATMOSPHERIC PRESSURE

Here, ρ = density, α = coefficient of thermal expansion, μ = shear viscosity, ν = kinematic viscosity = μ/ρ , κ = thermal diffusivity = $k/(\rho C_p)$, (k is first defined in Section 1.5) Pr = Prandtl number, and 1.0×10^{-n} is written as $1.0E - n$.

$T \text{ } ^\circ\text{C}$	$\rho \text{ kg/m}^3$	$\alpha \text{ K}^{-1}$	$\mu \text{ kg m}^{-1} \text{ s}^{-1}$	$\nu \text{ m}^2/\text{s}$	$\kappa \text{ m}^2/\text{s}$	$C_p \text{ J kg}^{-1} \text{ K}^{-1}$	$Pr \text{ } \nu/\kappa$
0	1000	$-0.6E - 4$	$1.787E - 3$	$1.787E - 6$	$1.33E - 7$	4217	13.4
10	1000	$+0.9E - 4$	$1.307E - 3$	$1.307E - 6$	$1.38E - 7$	4192	9.5
20	998	$2.1E - 4$	$1.002E - 3$	$1.004E - 6$	$1.42E - 7$	4182	7.1
30	996	$3.0E - 4$	$0.799E - 3$	$0.802E - 6$	$1.46E - 7$	4178	5.5
40	992	$3.8E - 4$	$0.653E - 3$	$0.658E - 6$	$1.52E - 7$	4178	4.3
50	988	$4.5E - 4$	$0.548E - 3$	$0.555E - 6$	$1.58E - 7$	4180	3.5

Latent heat of vaporization at $100 \text{ } ^\circ\text{C} = 2.257 \times 10^6 \text{ J/kg}$.

Latent heat of melting of ice at $0 \text{ } ^\circ\text{C} = 0.334 \times 10^6 \text{ J/kg}$.

Density of ice = 920 kg/m^3 .

Surface tension between water and air at $20 \text{ } ^\circ\text{C} = 0.0728 \text{ N/m}$.

Sound speed at $20 \text{ } ^\circ\text{C} = 1481 \text{ m/s}$.

A.4. PROPERTIES OF DRY AIR AT ATMOSPHERIC PRESSURE

T °C	ρ kg/m ³	μ kg m ⁻¹ s ⁻¹	ν m ² /s	κ m ² /s	Pr ν/κ
0	1.293	1.71E - 5	1.33E - 5	1.84E - 5	0.72
10	1.247	1.76E - 5	1.41E - 5	1.96E - 5	0.72
20	1.200	1.81E - 5	1.50E - 5	2.08E - 5	0.72
30	1.165	1.86E - 5	1.60E - 5	2.25E - 5	0.71
40	1.127	1.87E - 5	1.66E - 5	2.38E - 5	0.71
60	1.060	1.97E - 5	1.86E - 5	2.65E - 5	0.71
80	1.000	2.07E - 5	2.07E - 5	2.99E - 5	0.70
100	0.946	2.17E - 5	2.29E - 5	3.28E - 5	0.70

<i>At 20°C and 1 atm:</i>	Specific heat capacity at constant pressure:	$C_p = 1004 \text{ J kg}^{-1} \text{ K}^{-1}$
	Specific heat capacity at constant volume:	$C_v = 717 \text{ J kg}^{-1} \text{ K}^{-1}$
	Ratio of specific heat capacities:	$\gamma = 1.40$
	Coefficient of thermal expansion:	$\alpha = 3.41 \times 10^{-3} \text{ K}^{-1}$
	Speed of sound:	$c = 343 \text{ m s}^{-1}$
<i>Constants for dry air:</i>	Gas constant:	$R = 287 \text{ J kg}^{-1} \text{ K}^{-1}$
	Molecular mass:	28.966 g gmole ⁻¹ or kg kmole ⁻¹

A.5. THE STANDARD ATMOSPHERE

The following average values are accepted by international agreement. Here, z is the height above sea level.

z km	T °C	p kPa	ρ kg/m ³
0	15.0	101.3	1.225
0.5	11.5	95.5	1.168
1	8.5	89.9	1.112
2	2.0	79.5	1.007
3	-4.5	70.1	0.909

(Continued)

z km	T °C	p kPa	ρ kg/m ³
4	−11.0	61.6	0.819
5	−17.5	54.0	0.736
6	−24.0	47.2	0.660
8	−37.0	35.6	0.525
10	−50.0	26.4	0.413
12	−56.5	19.3	0.311
14	−56.5	14.1	0.226
16	−56.5	10.3	0.165
18	−56.5	7.5	0.120
20	−56.5	5.5	0.088