

Appendix B

PHYSICAL CONSTANTS AND UNITS

B.1 Some Useful Constants (IUPAC)

B.2 Dimension and Units of Physical Quantities

B.3 Specific Properties of Water at 20°C

B.4 Specific Properties of Dry Air

B.1 Some Useful Constants (IUPAC)

Atomic mass	m_u	$\cong 1.6605402 \times 10^{-27} \text{ kg}$
Avogadro's number	N_A	$\cong 6.0221367 \times 10^{23} \text{ mol}^{-1}$
Boltzmann's constant	k	$\cong 1.380658 \times 10^{-23} \text{ J K}^{-1}$
Elementary charge	e	$\cong 1.60217733 \times 10^{-19} \text{ C}$
Faraday's constant	F	$\cong 9.6485309 \times 10^4 \text{ C mol}^{-1}$
Gas (molar) constant	R	$= k \times N = 8.314510 \text{ J mol}^{-1} \text{ K}^{-1}$ $\approx 0.083145 \text{ L bar mol}^{-1} \text{ K}^{-1}$
Gravitational acceleration	g	$= 9.80665 \text{ m s}^{-2}$
Molar volume of an ideal gas at 1 bar and 25°C	$\bar{V}_{\text{ideal gas}}$	$= 24.465 \text{ L mol}^{-1}$
Permittivity of vacuum	ϵ_0	$\cong 8.854187 \times 10^{-12} \text{ C V}^{-1} \text{ m}^{-1}$
Planck's constant	h	$\cong 6.6260755 \times 10^{-34} \text{ J s}$
Zero of Celsius scale	0°C	$= 273.15 \text{ K}$

B.2 Dimension and Units of Physical Quantities

Dimensions are: M = mass; L = length; T = time; I = current

Physical Quantity	Name of Unit	Symbol	Dimensions	SI Units
Amount of photons	einstein	einstein		mol photons
Concentration	molar	M	ML^{-3}	10^3 mol m^{-3}
Dipole moment	debye	D	LTI	$\sim 3.34 \times 10^{30} \text{ C m}$
Electric charge	coulomb	C	TI	A s
Electric potential	volt	V	$\text{ML}^2 \text{T}^{-3} \text{I}^{-1}$	$\text{J C}^{-1} = \text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$
Energy	joule	J		$\text{N m} = \text{kg m}^2 \text{s}^{-2}$
	volt-coulomb	VC		J
	watt-second	Ws		J
	erg	erg	$\text{ML}^2 \text{T}^{-2}$	10^{-7} J
	liter-atmosphere	L atm		101.325 J
	calorie	cal		4.184 J
	electron-volt	eV		$\sim 1.60 \times 10^{-19} \text{ J}$
Force	newton	N	MLT^{-2}	kg m s^{-2}
	dyne	dyn		10^{-5} N
Frequency	hertz	Hz	T^{-1}	s^{-1}

Physical Quantity	Name of Unit	Symbol	Dimensions	SI Units
Length	angstrom	Å		10^{-10} m
	nanometer	nm		10^{-9} m
	micrometer	µm		10^{-6} m
	millimeter	mm	L	10^{-3} m
	centimeter	cm		10^{-2} m
	kilometer	km		10^3 m
Mass	ton (metric)	t	M	10^3 kg
Pressure	pascal	Pa		$\text{N m}^{-2} = \text{kg m}^{-1} \text{s}^{-2}$
	bar	bar		10^5 Pa
	atmosphere	atm		101,325 Pa
	torr	torr	$\text{ML}^{-1}\text{T}^{-2}$	133.32 Pa
	millimeter mercury	mm Hg		~ 133.32 Pa
	pounds per square inch	psi		~ 6.89×10^3 Pa
Time	minute	min		60 s
	hour	h	T	3,600 s
	day	d		86,400 s
	year (365.25 d)	yr		31,557,600 s
Dynamic viscosity	centipoise	cp	$\text{ML}^{-1}\text{T}^{-1}$	$10^{-3} \text{ kg m}^{-1} \text{s}^{-1}$
Volume	liter	L		10^{-3} m^3
	milliliter	mL	L^3	10^{-6} m^3
	microliter	µL		10^{-9} m^3

B.3 Specific Properties of Water at 20°C

Table B.3a Specific Properties of Water as a Function of Temperature
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Density	ρ_w	998.205	kg m^{-3}
Thermal expansivity	$\alpha = -\frac{1}{\rho_w} \left(\frac{\partial \rho_w}{\partial T} \right)_p$	206.78×10^{-6}	K^{-1}
Dynamic viscosity	η_w	1.002×10^{-3}	$\text{kg m}^{-1} \text{s}^{-1}$
Kinematic viscosity	$\nu_w = \eta_w / \rho_w$	1.004×10^{-6}	$\text{m}^2 \text{s}^{-1}$
Specific heat (at constant pressure)	c_{pw}	4.18×10^3	$\text{J kg}^{-1} \text{K}^{-1}$
Specific thermal conductivity	λ_w	0.592	$\text{W m}^{-1} \text{K}^{-1}$
Thermal diffusivity	$D_{thw} = \frac{\lambda_w}{c_{pw} \rho_w}$	0.142×10^{-6}	$\text{m}^2 \text{s}^{-1}$
Equilibrium concentration of water vapor in air in contact with liquid water	$C_{\text{H}_2\text{Oa}}^{\text{eq}}$	17.3	g m^{-3}

Table B.3b Water Phase Schmidt Numbers of Solutes
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B.4 Specific Properties of Dry Air

Mean pressure at sea level	p_o	$1.0133 \times 10^5 \text{ Pa}$	
		1.293 kg m^{-3}	$T = 0^\circ\text{C}$
		1.270	5°C
		1.247	10°C
Density	ρ_a	1.226	15°C
		1.205	20°C
		1.184	25°C
Kinematic viscosity	ν_a	$0.13 \text{ cm}^2 \text{ s}^{-1}$	$T = 0^\circ\text{C}$
		0.15	20°C
Specific heat (at constant pressure)	c_{pa}	$1.005 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$	$T = 20^\circ\text{C}$
Specific thermal conductivity	λ_a	$2.56 \times 10^2 \text{ W m}^{-1} \text{ K}^{-1}$	$T = 20^\circ\text{C}$
Thermal diffusivity	D_{tha}	$2.11 \times 10^{-5} \text{ m}^2 \text{ s}^{-1}$	$T = 20^\circ\text{C}$