

Part I
Engineering Mathematics

General Engineering Tables

Table 1.1. Dimensions of Physical quantities

<i>Physical Quantity</i>	<i>Symbol</i>	<i>Dimensional formula</i>	<i>Physical formula</i>	<i>Units</i>
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
Length, Displacement	l	L	—	m
Area	A	L^2	Length \times width	m^2
Volume	V	L^3	Length \times width \times height	m^3
Radius of gyration	K	L	$\sqrt{I/A}$ or $\sqrt{I/M}$	m
Linear velocity	v	LT^{-1}	Distance/Time	ms^{-1}
Angular velocity	w	T^{-1}	Angle/Time	$rad. s^{-1}$
Linear acceleration	a, f	LT^{-2}	Velocity/Time	$m. s^{-2}$
Angular acceleration	α	T^{-2}	Angular velocity/Time	$rad. s^{-2}$
Linear momentum	p	MLT^{-1}	Mass \times Velocity	$kg. m. s^{-1}$
Angular momentum	L	ML^2T^{-1}	lw, mvr	$kg. m^2. s^{-1}$
Force	F	MLT^{-2}	Mass \times Linear acceleration	$N = kg.m.s^{-2}$
Torque, Couple, Moment	T, C, M	ML^2T^{-2}	Force \times Distance	$N.m = kg.m^2. s^{-2}$
Work, Energy	W, E	ML^2T^{-2}	Force \times Distance	$J = N.m. = kg.m^2. s^{-2}$
Kinetic energy,	KE	ML^2T^{-2}	$\frac{1}{2}mv^2$	$J = kg. m^2.s^{-2}$
Potential energy	PE		mgh	
Heat energy	H or Q			
Surface energy	—	MT^{-2}	Work/Area	$J.m.^{-2} = m.s^{-2}$
Density	ρ	ML^{-3}	Mass/Volume	$kg.m^{-3}$

(Contd.)

1	2	3	4	5
Moment of inertia	I	ML^2	Mass \times (radius of gyration) ²	$kg.m^2$
Second moment of area	I	L^4	AK^2	m^4
Frequency	ν	T^{-1}	Number of cycles/Time	$Hz = s^{-1}$
Impulse	I	MLT^{-1}	Force \times Time	N.s
Power	P	ML^2T^{-3}	Work/Time	$N.m.s^{-1} = W$
Pressure	p	$ML^{-1}T^{-2}$	Force/Area	$N.m^{-2} = Pa$
Stress	σ, τ	$ML^{-1}T^{-2}$	Force/Area	$N.m^{-2} = Pa$
Elastic modulus	E	$ML^{-1}T^{-2}$	Stress/Strain	$N.m^{-2}$
Bulk modulus	K			
Shear modulus	G			
Strain	ϵ	$M^0L^0T^0$	Change in length/original length	—
Surface tension	σ	MT^{-2}	Force/Length	$N.m^{-1}$
Coefficient of dynamic viscosity	μ, η	$ML^{-1}T^{-1}$	Stress/Velocity gradient	$Pa.s = N.m^{-2}.s$
Kinematic viscosity	ν	L^2T^{-1}	Dynamic viscosity/Density	$m^2.s^{-1} = St$
Specific heat	C	$L^2T^{-2}K^{-1}$	Heat energy/ (mass \times temperature rise)	$J/(kg.K)$
Latent heat	L	L^2T^{-2}	Heat energy/mass	J/kg
Temperature, Kelvin	K	K	—	—
Force constant (stiffness)	k	MT^{-2}	Force/Displacement	$N.m^{-1}$
Gravitational constant	G	$M^{-1}L^3T^{-2}$	$F = G \cdot \frac{m_1 m_2}{r^2}$	$N.m^2 . kg^{-2}$
Planck's constant	h	ML^2T^{-1}	$E = h\nu$	J.s
Boltzmann's constant	σ	$MT^{-3}K^{-4}$	$E = \sigma AT^4$	$W/(m^2 . K^4)$
Thermal conductivity	k	$MLT^{-3}K^{-1}$	$Q = kA \frac{\Delta T}{\Delta x}$	$W/(m.K)$
Entropy	s	$ML^2T^{-2}K^{-1}$	$\int \frac{dQ}{T}$	J/K
Gas constant (molar)	R	$ML^2T^{-2}K^{-1} mol^{-1}$	$pV = nRT$	$J.mol^{-1} . K^{-1}$

Table 1.2. The Greek Alphabet

<i>Greek Name</i>	<i>Greek letter</i>		<i>Greek name</i>	<i>Greek letter</i>	
	<i>Lower case</i>	<i>Capital</i>		<i>Lower case</i>	<i>Capital</i>
Alpha	α	A	Nu	ν	N
Beta	β	B	Xi	ξ	Ξ
Gamma	γ	Γ	Omicron	\omicron	O
Delta	δ	Δ	Pi	π	Π
Epsilon	ϵ	E	Rho	ρ	P
Zeta	ζ	Z	Sigma	σ	Σ
Eta	η	H	Tau	τ	T
Theta	θ, ϑ	Θ	Upsilon	υ	Y
Iota	i	I	Phi	ϕ	Φ
Kappa	κ	K	Chi	χ	X
Lambda	λ	Λ	Psi	ψ	Ψ
Mu	μ	M	Omega	ω	Ω

Table 1.3. Prefixes. The names of multiples and submultiples of SI Units may be formed by application of the prefixes

<i>Factor by which unit is multiplied</i>	<i>Prefix</i>	<i>Symbol</i>
10^{12}	tera	T
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Table 1.4. Values of atmospheric pressure

Altitude (m)	Boiling point (°C)	Atmospheric pressure			
		(Atmosphere)	(N/cm ²)	(Metre of water)	(mm of mercury)
-325	101.1	1.04	10.536	10.74	790
0	100.0	1.00	10.134	10.33	760
340	98.9	0.96	9.732	9.92	730
690	97.8	0.92	9.339	9.52	700
1045	96.6	0.88	8.937	9.11	670
1420	95.4	0.84	8.535	8.70	640
1820	94.1	0.80	8.132	8.29	610
2240	92.8	0.76	7.730	7.88	580
2680	91.5	0.72	7.338	7.48	550
3140	90.1	0.68	6.936	7.07	520

Table 1.5. Physical properties of air at normal atmospheric pressure

Temperature		Density ρ (kg/m ³)	Specific weight, γ (N/m ³)	Dynamic viscosity μ		Kinematic viscosity ν	
(°F)	(°C)			poise (dyne. s/cm ²)	(N.s/m ²)	stokes (cm ² /s)	(m ² /s)
0	-17.8	1.381	13.548	1.62×10^{-4}	1.62×10^{-5}	0.117	1.17×10^{-5}
20	-6.67	1.325	12.998	1.68×10^{-4}	1.68×10^{-5}	0.127	1.27×10^{-5}
40	4.44	1.272	12.478	1.73×10^{-4}	1.73×10^{-5}	0.136	1.36×10^{-5}
60	15.6	1.222	11.988	1.79×10^{-4}	1.79×10^{-5}	0.147	1.47×10^{-5}
80	26.7	1.777	11.546	1.84×10^{-4}	1.84×10^{-5}	0.157	1.57×10^{-5}
100	38	1.136	11.144	1.90×10^{-4}	1.90×10^{-5}	0.166	1.66×10^{-5}
120	49	1.096	10.752	1.95×10^{-4}	1.95×10^{-5}	0.175	1.75×10^{-5}
150	66	1.043	10.232	2.03×10^{-4}	2.03×10^{-5}	0.193	1.93×10^{-5}
200	93	0.963	9.447	2.15×10^{-4}	2.15×10^{-5}	0.223	2.23×10^{-5}

Table 1.6. Atmosphere

Atmosphere :	
Percentage composition of dry air at sea level	<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;"> By volume, nitrogen 78.03, oxygen 20.99, argon 0.94 (By weight, nitrogen 75.5, oxygen 23.2, argon 1.3) </div> <div style="margin-left: 10px;"> Hydrogen — 0.01 Neon — 0.00123 Helium — 0.0004 </div> </div>
Density at 0°C and 76 cm Standard pressure	= 0.001 293 g/cm ³ = 760 mm of mercury at 0°C, lat. 45°, and sea level = 1.033 gf/cm ² = $1.013 2 \times 10^5$ dynes per cm ² = 101 3.2 millibars

Table 1.7. Refractive Indices (Against Air) for Mean D Lines ($\lambda = 5893 \times 10^{-8}$ cm)

Canada Balsam	1.530	Calcite (ord)	1.658
Crown Glass	1.500	Calcite (ext)	1.486
Diamond	2.417	Quartz (ord)	1.504
Felspar	1.524	Quartz (ext)	1.553
Flint Glass	1.560	Rock Salt	1.544 2
Fluorspar	1.433 9	Ruby	1.764
Ice	1.310	Sylvine (KCl)	1.490 3

Table 1.8. Wavelengths of Important Spectral Lines

<i>Line</i>	<i>Wavelength in Angstrom Units*</i>	<i>Line</i>	<i>Wavelength in Angstrom Units*</i>
(1)	(2)	(1)	(2)
K red	7 664.91	Mg green (B ₁)	5 183.62
O red (A)	7 593.97	(B ₂)	5 172.70
(B)	6 869.00	(B ₃)	5 167.33
Li red	6 707.86	Cd green	5 285.82
Ha red (C)	6 562.82	H blue green	4 861.33
Cd red	6 438.47	Cd blue	4 799.91
Li orange	6 103.64	Sr blue	4 607.33
Na (D ₁)	5 889.95	Li blue	4 602.99
(D ₂)	5 895.92	Hr blue (G)	4 340.47
He yellow (D ₃)	5 375.62	Fe and Ca blue (G)	4 307.75
Tl green	5 350.47	Ca blue (G)	4 226.74
Fe and Ca green (E)	5 269.56	K violet	4 047.16

* One Angstrom unit : 10^{-8} cm.

Table 1.9. Earth, Sun and Moon

<i>Mean Radius cm</i>	<i>Density</i>	<i>Mass g</i>	<i>Mass (Earth = 1)</i>	<i>Gravity at Equator (Earth = 1)</i>
Earth 6.368×10^5	5.52	5.977×10^{27}	1	1
Moon 1.738×10^5	3.33	7.180	$\frac{1}{81.5}$	$\frac{1}{6.04}$
Sun $6.963 5 \times 10^{10}$	1.408 9	1.993×10^{33}	3.3×10^5	2.7410×10^4 cm/s ²

Distance of Earth from Sun = 147 to 152×10^6 km. Distance of Moon from Earth = 384 700 km.

Mean solar second = $\frac{1}{86,400}$ of mean solar day.

Sidereal day = 23 h 56 m 4.1 s.

Mean synodical or lunar month = 29.531 mean solar days.

Tropical and civil year = 365.242 195 7 means solar days.

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Table 1.10. Gravitation
Acceleration (g) due to Gravity and Length (L) of Seconds Pendulum

	<i>Latitude</i>	<i>g, cm/s²</i>	<i>L, cm</i>		<i>Latitude</i>	<i>g, cm/s²</i>	<i>L, cm</i>
Equator	0° 0'	978.030	99.094	Montreal	45°30'.3	980.672	99.363
Madras	13°4'.1	978.277	99.12	Paris	48°50'.2	980.943	99.390
Calcutta	22°32'.8	978.815	99.175	Greenwich	51°28'.6	981.188	99.415
Sydney	-33°51'.7	978.684	99.161	London	51°31'.1	981.199	99.416
Tokyo	35°42'.6	978.801	99.275	Cambridge	52°12'.9	981.25	99.419
Melbourne	-37°49'.9	979.987	99.293	Dublin	53°23'.1	981.36	99.433
Washington	38°53'.2	980.112	99.206	Liverpool	53°24'.1	981.35	99.431
New York	40°48'.5	980.247	99.320	Glasgow	55°51'.5	981.605	99.458
Wellington (N.Z.)	-41°17'.1	980.27	99.322	Edinburgh	55°57'.4	981.584	99.455
Chicago	41°50'.0	980.283	99.323	Aberdeen	57°9'	981.68	99.460
Toronto	43°39'.6	980.46	99.341	Leningrad	59°6'.5	981.929	99.490
	45°0'	980.616	99.357	North Pole	90°0'	983.216	99.620

Attraction of two masses, each 1 gram, concentrated at points 1 centimetre apart (G) -6.658×10^{-8} dynes. Mass which, concentrated 1 centimetre apart from equal mass, will give attraction of 1 dyne - 3 872 grams.

Table 1.11. Magnetic Elements

<i>Station</i>	<i>Earth's Horizontal Intensity Gauss</i>	<i>Angle of Dip in Degrees N. Pole Down</i>	<i>Declination in Degrees</i>
Allahabad	0.355	35	—
Bangalore	0.376	11	1.7 W
Bombay	0.367	22	0.3 W
Calcutta	0.369	31	1.2 E
Dacca	0.367	33	0.1 W
Dehra Dun	0.331	43	2.0 E
Delhi	0.347	38	1.4 E
Hyderabad	0.374	20	1.0 W
Madras	0.379	11	1.9 W
Peshawar	0.306	49	3.8 E
Trichinopoly	0.379	6	2.2 W
Vizagapatam	0.380	20	1.0 W

Table 1.12. Insulators and Dielectrics
K = dielectric constant (vacuum = 1)

<i>Substance</i>	<i>K</i>	<i>Substance</i>	<i>K</i>	<i>Substance</i>	<i>K</i>
Ebonite	2.7	Ethyl Alcohol (20°C)	25.8	Air (0°C)	1.000 594
Glass	7.6	Benzene (20°C)	2.283	Air (20°C)	1.000 528
Ice (- 2°C)	93.9	Ether (20°C)	4.34	Carbon Dioxide (25°C)	1.000 904
Mica	6.0	Glycerin ($\lambda = 200$) (15°C)	39.1	Carbon Monoxide (25°C)	1.000 634
Parafin	2.1	Turpentine	2.2-2.3	Hydrogen (0°C)	1.000 265
Shellac	3.2	Vaseline Oil	1.9	Helium (25°C)	1.000 067
Sulphur	3.9	Water	81	Sulphur Dioxide (22°C)	1.008 18

Table 1.13. Velocity of Sound

<i>Substance</i>	<i>Velocity in Metres per Second</i>	<i>Temperature, C°</i>
(1)	(2)	(3)
Air	332	0
Hydrogen	1 262	0
Oxygen	316	0
Water	1 447	20
Alcohol	1 275	15
Copper	3 560	20
Iron	5 130	20
Wood	3 000-5 000	10-20
Glass	5 000	20

Note : - The velocity of sound increases with temperature at the following rates : Air 0.61, Carbon dioxide 0.47, Nitrogen 0.61 and Oxygen 0.60 metres per second per 1 deg rise of temperature.

Table 1.14. Standard Diameters and Resistances of Wire

<i>Standard Dia</i> <i>mm</i>	<i>Area of Cross Section</i> <i>mm²</i>	<i>Copper</i> <i>(at 20°C)</i>	<i>Aluminium</i> <i>(at 20°C)</i>	<i>Resistance ohm/km</i>			
				<i>Eureka or Constantan</i> <i>(at 0°C)</i>	<i>German Silver</i> <i>(at 20°C)</i>	<i>Manganin</i> <i>(at 20°C)</i>	<i>Platinoid</i> <i>(at 18°C)</i>
0.200	0.031 4	548.8	905.7	14 039	10 505	14 007	10 951
0.300	0.070 7	243.9	402.5	6 239	4 669	6 225	4 867
0.450	0.159 0	108.4	178.9	2 774	2 076	2 767	2 164
0.750	0.441 8	39.02	64.39	998.1	746.9	995.9	778.6
0.850	0.567 5	30.38	50.13	777.1	581.5	775.4	606.2
1.060	0.882 5	19.54	32.24	499.8	374.0	498.7	389.9
1.120	0.985 2	17.50	28.88	447.7	335.0	446.6	349.2
1.400	1.539	11.20	18.48	286.5	214.4	285.9	223.5
1.700	2.270	7.596	12.53	194.3	145.4	193.9	151.6
1.800	2.545	6.775	11.18	173.3	129.7	172.9	135.2
2.060	3.333	5.173	8.54	132.3	99.02	132.0	103.2
2.240	3.941	4.375	7.22	111.9	83.74	111.7	87.30
2.500	4.909	3.512	5.80	87.84	67.22	89.63	70.08
2.650	5.516	3.126	5.16	79.96	59.83	79.77	62.37
2.800	6.157	2.800	4.62	71.62	53.60	71.46	55.87
3.000	7.069	2.439	4.02	62.39	46.69	62.25	48.67
3.350	8.814	1.956	3.23	50.04	37.44	49.93	39.03

Table 1.15. Values of Fundamental Physical Constants

Quantity	Symbol	Value
Permeability of vacuum	μ_0	$12.566\ 3706144 \times 10^{-7} \text{ Hm}^{-1}$
Speed of light in vacuum	c	$2.99792458 \text{ m.s.}^{-1}$
Permittivity of vacuum	$\epsilon_0 = (\mu_0 c^2)^{-1}$	$8.85418782 \times 10^{-12} \text{ Fm}^{-1}$
Elementary (electron) charge	e	$1.6021892 \times 10^{-19} \text{ C}$
Planck's Constant	h	$6.626176 \times 10^{-34} \text{ J.s.}$
Avogadro's number	N_A	$6.022045 \times 10^{23} \text{ mol}^{-1}$
Atomic Mass Unit	$1\mu = (10^{-3} \text{ kgmol}^{-1})/N_A$	$1.6605655 \times 10^{-27} \text{ kg.}$
Faraday constant	$F = N_A/e$	$9.648456 \times 10^4 \text{ C mol}^{-1}$
Magnetic Flux Quantum	$\Phi_0 = \frac{h}{2e}$	$2.0678506 \times 10^{-15} \text{ Wb}$
Molar Gas constant	R	$8.31441 \text{ J mol}^{-1} \text{ K}^{-1}$
Molar Volume, Ideal Gas ($T_0 = 273.15 \text{ K}$, $p_0 = 1 \text{ atm}$)	$V_m = R T_0/p_0$	$0.02241383 \text{ m}^3 \cdot \text{mol}^{-1}$
Boltzmann Constant	$k = R/N_A$	$1.380\ 662 \times 10^{-23} \text{ J K}^{-1}$
Stefan-Boltzmann Constant	$\sigma = (\pi^2/60) k^4/h^3 c^2$	$5.67032 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Gravitational Constant	G	$6.6720 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Electron Radius	r_e	$2.8179380 \times 10^{-15} \text{ m.}$
Acceleration due to gravity	g	9.80665 m/s^2
First Bohr electron radius	$a_0 = h^2/(4\pi^2 m e^2)$	$0.5292 \times 10^{-10} \text{ m}$
Electron rest mass	m_e	$9.1096 \times 10^{-31} \text{ kg}$
Electron volt	1 eV	$1.6022 \times 10^{-19} \text{ J}$
Temperature associated with 1 eV	$1 \text{ eV}/k$	11605 K
Ionization potential of hydrogen atom	–	13.606 eV
Wien-displacement-law constant	$\lambda_{max} T = b$	$0.289782 \times 10^{-2} \text{ m-deg}$
Rydberg constant for hydrogen	R_H	$1.09678 \times 10^2 \text{ m}$

Table 1.16. Conversion Factors for Length

	<i>Mile. mi</i>	<i>Kilometre. km</i>	<i>Metre. m</i>	<i>Foot. ft</i>	<i>Inch. in</i>
1 mile =	1	1.609	1609	5280	6.336×10^4
1 kilometre =	0.6214	1	10^3	3.281×10^3	3.937×10^4
1 metre =	6.214×10^{-4}	10^{-3}	1	3.281	39.37
1 foot =	1.894×10^{-4}	3.048×10^{-4}	0.3048	1	12
1 inch =	1.578×10^{-5}	2.540×10^{-5}	2.540×10^{-2}	8.333×10^{-2}	1
1 centimetre =	6.214×10^{-6}	10^{-5}	10^{-2}	3.281×10^{-2}	0.3937
1 millimetre =	6.214×10^{-7}	10^{-6}	10^{-3}	3.281×10^{-3}	0.03937
1 micrometre =	6.214×10^{-10}	10^{-9}	10^{-6}	3.281×10^{-6}	3.937×10^{-5}
1 nanometre =	6.214×10^{-13}	10^{-12}	10^{-9}	3.281×10^{-9}	3.937×10^{-8}
1 angstrom =	6.214×10^{-14}	10^{-13}	10^{-10}	3.281×10^{-10}	3.937×10^{-9}
	<i>Centimetre cm</i>	<i>Millimetre mm</i>	<i>Micrometre μm</i>	<i>Nanometre. nm</i>	<i>Angstrom. \AA</i>
1 mile =	1.609×10^5	1.609×10^6	1.609×10^9	1.609×10^{12}	1.609×10^{13}
1 kilometre =	10^5	10^6	10^9	10^{12}	10^{13}
1 metre =	10^2	10^3	10^6	10^9	10^{10}
1 foot =	30.48	3.048×10^2	3.048×10^5	3.048×10^8	3.048×10^9
1 inch =	2.540	25.40	2.540×10^4	2.540×10^7	2.540×10^8
1 centimetre =	1	10	10^4	10^7	10^8
1 millimetre =	10^{-1}	1	10^3	10^5	10^7
1 micrometre =	10^{-4}	10^{-3}	1	10^3	10^4
1 nanometre =	10^{-7}	10^{-6}	10^{-3}	1	10
1 angstrom =	10^{-8}	10^{-7}	10^{-4}	10^{-1}	1

Table 1.17. Seconds to Radian

<i>Seconds</i>	<i>Radian</i>								
1	0.00000	13	0.00006	25	0.00012	37	0.00018	49	0.00024
2	01	14	07	26	13	38	18	50	24
3	01	15	07	27	13	39	19	51	25
4	02	16	08	28	14	40	19	52	25
5	02	17	08	29	14	41	20	53	26
6	03	18	09	30	15	42	20	54	26
7	03	19	09	31	15	43	21	55	27
8	04	20	10	32	16	44	21	56	27
9	04	21	10	33	16	45	22	57	28
10	05	22	11	34	16	46	22	58	28
11	05	23	11	35	17	47	23	59	29
12	0.00006	24	0.00012	36	0.00017	48	0.00023	60	0.00029

Table 1.18. Decimal Equivalents of Common Fractions

<i>Fractions</i>	<i>Decimals</i>	<i>Fractions</i>	<i>Decimals</i>	<i>Fractions</i>	<i>Decimals</i>	<i>Fractions</i>	<i>Decimals</i>
1/64	0.0156	17/64	0.2656	33/64	0.5156	49/64	0.7656
1/32	0.0312	9/32	0.2813	17/32	0.5313	25/32	0.7813
3/64	0.0469	19/64	0.2969	35/64	0.5469	51/64	0.7969
1/16	0.0625	5/16	0.3125	9/16	0.5625	13/16	0.8125
5/64	0.0781	21/64	0.3281	37/64	0.5781	53/64	0.8281
3/32	0.0938	11/32	0.3438	19/32	0.5938	27/32	0.8438
7/64	0.1094	23/64	0.3594	39/64	0.6094	55/64	0.8594
1/8	0.1250	3/8	0.3750	5/8	0.6250	7/8	0.8750
9/64	0.1406	25/64	0.3906	41/64	0.6406	57/64	0.8906
5/32	0.1563	13/32	0.4063	21/32	0.6563	29/32	0.9063
11/64	0.1719	27/64	0.4219	43/64	0.6719	59/64	0.9219
3/16	0.1875	7/16	0.4375	11/16	0.6875	15/16	0.9375
13/64	0.2031	29/64	0.4531	45/64	0.7031	61/64	0.9531
7/32	0.2188	15/32	0.4688	23/32	0.7188	31/32	0.9688
15/64	0.2344	31/64	0.4844	47/64	0.7344	63/64	0.9844
1/4	0.2500	1/2	0.5000	3/4	0.7500	1	1.000

Table 1.19. Conversion Factors for Barometric Pressure Units.

	<i>Atm</i>	<i>N/m²</i>	<i>bars</i>	<i>mb</i>	<i>kg/cm²</i>	<i>g/cm²</i> <i>(cm H₂O)</i>	<i>mm Hg</i>	<i>in. Hg</i>	<i>lb/in²</i> <i>(psi)</i>
1 Atmosphere =	1	1.013×10^5	1.013	1013	1.033	1033	760	29.92	14.70
1 Newton/m ² = (N/m ²)	0.9869×10^{-5}	1	10^{-5}	0.01	1.02×10^{-5}	0.0102	0.0075	0.2953×10^{-3}	0.1451×10^{-3}
1 bar =	0.9869	10^5	1	1000	1.02	1020	750.1	29.53	14.51
1 millibar = (mb)	0.9869×10^{-3}	100	0.001	1	0.00102	1.02	0.7501	0.02953	0.01451
1 kg/cm ²	0.9681	0.9807×10^5	0.9807	980.7	1	1000	735	28.94	14.22
1 g/cm ² = (1 cm H ₂ O)	968.1	98.07	0.9807×10^{-3}	0.9807	0.001	1	0.735	0.02894	0.01422
1 mm Hg =	0.001316	133.3	0.001333	1.333	0.00136	1.36	1	0.03937	0.01934
1 in. Hg =	0.0334	3368	0.03386	33.86	0.03453	34.53	25.4	1	0.4910
1 lb/in ² =	0.06804	6895	0.06895	68.95	0.0703	70.3	51.70	2.035	1

Table 1.20. Conversion Factors for Various Quantities

<i>From</i>	<i>To</i>	<i>Multiply by</i>
Acceleration-		
Linear :		
ft/s ²	m/s ²	0.3048
in/s ²		0.0254
cm/s ²		0.01
Angular :		
rev./s ²	rad/s ²	6.2832
rev./min ²		0.17453
Area		
cm ²		10 ⁻⁴
Square foot		9.2903 × 10 ⁻²
Square inch	m ²	6.4516 × 10 ⁻⁴
Square yard		0.8361
Concentration		
lb/ft ³	kg/m ³	16.02
Convection coefficient		
BTU/hr.ft ² .R°	W/(m. ² K)	5.678
Cal/(s.cm ² .C°)		4.1868 × 10 ⁴
Density		
gram/cm ³		1.0 × 10 ³
gram/ml		1.0 × 10 ³
lbm/in ³	kg/m ³	2.76799 × 10 ⁴
lbm/ft ³		16.018463
Energy		
BTU		1.05435 × 10 ³
Calorie		4.184
ft. lbf	Joule	1.3558179
kWh		3.60 × 10 ⁶
kgf.m		9.80665
erg		10 ⁻⁷
electron volt		1.602 × 10 ⁻¹⁹
Energy/area/Time <i>(Heat flux)</i>		
BTU/ft. ² .s		1.1348931 × 10 ⁴
BTU/ft. ² .min		1.8914885 × 10 ²
BTU/ft. ² .hr	W/m ²	3.1524808
BTU/in. ² .s		1.6342462 × 10 ⁶
Cal/cm. ² .min		6.9733333 × 10 ²
Watt/cm ²		1.0 × 10 ⁴
Force		
lbf.		4.44822
dyne	N	10 ⁻⁵
kgf		9.80665

(Contd...)

<i>From</i>	<i>To</i>	<i>Multiply by</i>
Length		
cm		10^{-2}
mm		10^{-3}
foot		0.3048
inch	m	0.0254
yard		0.9144
mile		1.609344×10^3
angstrom		10^{-10}
Mass		
gram		1.0×10^{-3}
lbm	kg	0.4536
quintal		10^2
tonne		10^3
slug		14590×10^{-3}
Moment of Inertia		
kgf-m-s ²	kg-m ²	9.80665
Power or Heat flow rate		
BTU/s		1.05435×10^3
BTU/h		2.92875×10^{-1}
Cal/s		4.184
Cal/min.	W (J/s)	6.97333×10^{-2}
ft.lbf/h		3.76616×10^{-4}
ft.lbf/min		2.25969×10^{-2}
ft.lbf/s		1.35582
kgf.m/s		9.80665
erg/s		10^{-7}
kcal/hr		1.163
H.P. (metric)		735.499
H.P. (550 ft. lbf/s)		7.457×10^2
Pressure		
atmosphere		1.01325×10^5
bar		1×10^5
cm of mercury (0°C)	Pa (N/m ²)	1.33322×10^3
cm of water (4°C)		$9.80638 \times 10^{+1}$
dyne/cm ²		1×10^{-1}
lbf/ft ²		4.7880258×10^1
lbf/in ² (psi)		6.8947572×10^3
torr (0°C)		1.33322×10^2
kgf/cm ²		9.81×10^4
Quantity of Heat		
Calorie		4.1868
kilocalorie	J	4.1868×10^3

(Contd...)

<i>From</i>	<i>To</i>	<i>Multiply by</i>			
<i>Specific Heat Capacity</i> kcal/(kg. °C) BTU/(lb.°F)	J/(kg.K)	4.1868×10^3			
<i>Specific weight</i> kgf/m ³			N/m ³	9.80665	
<i>Speed</i> Linear- ft/h	m/s	8.4667×10^{-5}			
ft/min			5.08×10^{-3}		
ft/s			0.3048		
in/s			2.54×10^{-2}		
km/h			2.77778×10^{-1}		
mile/h			4.4704×10^{-1}		
knot			5.14444×10^{-1}		
Angular- rev./day			rad/s	7.2722×10^{-5}	
rev./min					0.10472
rev./s					6.2832
deg/s	1.7453×10^{-2}				
<i>Stress</i> kgf/cm ²	N/m ²	9.80665×10^4			
<i>Surface Tension</i> dyne/cm	N/m	10^{-3}			
<i>Temperature</i> Celsius, °C	Kelvin (K)	C + 273.15			
Fahrenheit, °F			$5/9 (F + 459.67)$		
Rankine, R			$\frac{5}{9} R$		
<i>Thermal conductivity</i> BTU/(hr.ft.°F) Cal/(s.cm.°C)	W/(m.K)	1.731 4.1868×10^4			
<i>Thermal diffusivity</i> ft ² /s	m ² /s	9.29×10^{-2}			
ft ² /h			2.581×10^{-5}		
<i>Thermal Resistance</i> hour.°F/BTU	K/W	1.8958			
<i>Time</i> day (mean solar)	s (mean solar)	8.64×10^4			
hour (mean solar)			3.60×10^3		
Minute (mean solar)			60		
Month (mean calendar)			2.628×10^6		
Year (calendar)			3.1536×10^7		

(Contd...)

<i>From</i>	<i>To</i>	<i>Multiply by</i>
Viscosity :		
Kinematic-		
Centistoke (cSt)	m ² /s	1.0×10^{-6}
Stoke (St)		1.0×10^{-4}
ft ² /s		9.290304×10^{-2}
Dynamic		
Centipoise (cP)	N.s/m ²	1.0×10^{-3}
lbm/ft.s		1.4881639
lbf.s/ft ²		4.7880258×10^{-1}
Poise		0.10
Volume		
ft ³	m ³	2.83168×10^{-2}
inch ³		1.63871×10^{-5}
litre		1.0×10^{-3}
Yard ³		7.64555×10^{-1}
Work		
erg	J	10^{-7}
kgf-m		9.80665
kWh		3.6×10^6

Table 1.21. Conversion Factors for SI to British Units

<i>Physical Quantity</i>	<i>Symbol for SI Unit</i>	<i>Conversion factor</i>	<i>Symbol for British units</i>
Acceleration	m/s ²	3.28	ft/s ²
Angular acceleration	rad/s ²	57.3	deg/s ²
Angular velocity	rad/s	57.3	deg/s
Area	m ²	10.8	ft ²
Coefficient of heat transfer	W/m ² K	0.176	Btu/hft ² °F
Coefficient of linear expansion	$\frac{1}{K}$	0.556	1/°F
Density	kg/m ³	6.24×10^{-2}	lb/ft ³
Dynamic viscosity	Ns/m ²	10 ³	cP
Energy, work	J	0.737	ft lbf
		2.78×10^{-7}	k Wh
Force	N	0.225	lbf
Heat capacity	J/K	5.27×10^{-4}	Btu/°F or CHU/°C
Heat flow rate	W	3.41	Btu/h
Heat flux	W/m ²	0.317	Btu/h ft ²
Heat quantity	J	9.48×10^{-4}	Btu
		5.27×10^{-4}	CHU
Kinematic viscosity	m ² /s	10 ⁶	cSt
		10.8	ft ² /s
Length	m	3.28	ft
Mass	kg	2.20	lb
Moment, torque	N.m.	0.738	lbft ²
Moment of inertia	kg m ²	23.7	lb ft ²
Power	W	1.34×10^{-3}	hp
Pressure	N/m ²	1.45×10^{-4}	lbf/in ²
Second moment of area	m ⁴	2.40×10^6	in ⁴
Specific heat capacity	J/kg K	2.39×10^{-4}	Btu/lb°F
Specific heat/unit volume	J/m ³ K.	1.49×10^{-5}	Btu/ft ³ °F
Stress	N/m ²	1.45×10^{-4}	lbf/in ²
Surface tension	N/m	6.85×10^{-2}	lbf/ft
Thermal conductivity	W/mK	0.578	Btu/h ft °F
Velocity	m/s	3.28	ft/s
Volume	m ³	35.3	ft ³
Volumetric flowrate	m ³ /s	1.32×10^4	Imp. gall./min.

Table 1.22. Elastic Constants of Solids

<i>Substance</i>	<i>Young's Modulus' E</i> (N/mm^2) $\times 10^4$	<i>Rigidity Modulus' G</i> (N/mm^2) $\times 10^4$	<i>Bulk Modulus' K</i> (N/mm^2) $\times 10^4$	<i>Poisson's ratio' v</i>	<i>Breaking stress for wires</i> (N/mm^2)
Aluminium	6.9-7.2	2.4-2.7	7.3-7.7	0.33-0.35	170-200
Brass	9.0-10.2	3.4-3.5	8.0-11.0	0.3-0.4	310-390
Constantan	16.2-16.4	6.0-6.2	15.4-15.6	0.31-0.38	—
Copper	11.0-12.9	3.4-4.6	13.0-14.3	0.25-0.35	280-460
German Silver	11.0-11.6	4.3-4.7	14.9-15.1	0.36-0.38	440-480
Gold	7.8-8.2	2.7-2.9	16.5-16.7	0.41-0.43	250-270
Iron (cast)	10-13	3.5-5.3	9.5-9.7	0.23-0.31	80-230
Iron (Wrought)	19-22	7.7-8.3	14.6-16.0	0.27-0.29	460-620
Lead	1.5-1.7	0.5-0.7	4.0-5.0	0.43-0.46	20-22
Manganin	12.3-12.5	4.6-4.8	12.0-12.2	0.32-0.34	—
Phosphor-Bronze	11.9-12.1	4.3-4.5	—	0.37-0.39	690-1080
Platinoid	13.5-13.7	3.5-3.7	—	0.36-0.38	—
Platinum	16.8	6.1	24.7	0.368	330
Silver	7.7-7.9	2.8-3.0	10.8-11.0	0.37-0.39	270-310
Steel (Mild)	21-23	8.0-9.0	16.0-19.0	0.25-0.31	1000-1200
Tin	5.3-5.5	1.9-2.1	5.1-5.5	0.32-0.34	24-26
Zinc	8-11	3.6-3.8	3.0-6.0	0.20-0.30	110-150
Glass (crown)	6.0-7.8	2.6-3.2	4.0-5.9	0.20-0.27	30-90
India Rubber	0.048-0.052	0.00016	—	0.46-0.49	—

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Table 1.23. Properties of Solids

Substance	Density, kg/m^3	Specific heat kJ (kg. K)	Melting Point K	Latent Heat of fusion kJ/kg	Coefficient of Linear Expansion $\times 10^{-6}$	Thermal Conductivity $\text{kW/(m}^2. K)$
Aluminium	2699	0.896	932.85	332.85	22.5	20.599
Antimony	6618	0.2148	903.65	163.28	11.5	1.675
Bismuth	9800	0.1231	544.45	52.92	15.7	0.674
Brass	8440-8700	0.3839	1178.15-1303.15	—	17.8	10.299
Carbon (Graphite)	2250	0.712	73773.15	—	7.9	0.502
Cobalt	8710	0.491	1768.15	242.83	12.3	—
Copper	8920	0.3856	1356.15	175.84	16.7	38.02
German Silver	8300-8450	0.3936	1373.15	—	18.4	3.726
Invar	8000	0.5024	—	—	0.9	—
Iron (cast)	7030-7730	0.4978	—	—	0.4	4.522
Iron (wrought)	7800-7900	0.4823	1808.15	—	11.9	5.987
Lead	11347	1.281	600.58	24.52	28	3.433
Manganin	8500	3.9775	924.15	—	—	26.419
Nickel	8600-8900	0.4396	1728.15	308.98	12.8	5.778
Phosphor Bronze	8700-8800	—	1023.15	—	—	—
Platinum	21370	1.3565	2046.65	113.88	8.9	7.423
Silver	10503	0.2336	1233.95	88.21	19	41.533
Tin	7300	0.2416	505.04	58.61	22	6.071
Zinc	7130	0.3873	692.62	117.77	26	10.965

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Table 1.24. Area of the Circle when Diameter is given

<i>d</i>	0	1	2	3	4	5	6	7	8	9
1.0	0.7854	0.8012	0.8171	0.8332	0.8495	0.8659	0.8825	0.8992	0.9161	0.9331
1.1	0.9503	0.9677	0.9852	1.003	1.021	1.039	1.057	1.075	1.094	1.112
1.2	1.131	1.150	1.169	1.183	1.208	1.227	1.247	1.267	1.287	1.307
1.3	1.327	1.348	1.368	1.389	1.410	1.431	1.453	1.474	1.496	1.517
1.4	1.539	1.561	1.584	1.606	1.629	1.651	1.674	1.697	1.720	1.744
1.5	1.767	1.791	1.815	1.839	1.863	1.887	1.911	1.936	1.961	1.986
1.6	2.011	2.036	2.061	2.087	2.112	2.138	2.164	2.190	2.217	2.243
1.7	2.270	2.297	2.324	2.352	2.378	2.405	2.433	2.461	2.488	2.516
1.8	2.545	2.573	2.602	2.630	2.659	2.688	2.717	2.746	2.776	2.806
1.9	2.835	2.865	2.895	2.926	2.956	2.986	3.017	3.048	3.079	3.110
2.0	3.142	3.173	3.205	3.237	3.269	3.301	3.333	3.365	3.398	3.431
2.1	3.464	3.497	3.530	3.563	3.597	3.631	3.664	3.698	3.733	3.767
2.2	3.801	3.836	3.871	3.906	3.941	3.976	4.011	4.047	4.083	4.119
2.3	4.155	4.191	4.227	4.264	4.301	4.337	4.374	4.412	4.449	4.486
2.4	4.524	4.562	4.600	4.638	4.676	4.714	4.753	4.792	4.831	4.870
2.5	4.909	4.948	4.988	5.027	5.067	5.107	5.147	5.187	5.228	5.269
2.6	5.309	5.350	5.391	5.433	5.474	5.515	5.557	5.599	5.641	5.683
2.7	5.726	5.768	5.811	5.853	5.896	5.940	5.983	6.026	6.070	6.114
2.8	6.158	6.202	6.246	6.290	6.335	6.379	6.424	6.469	6.514	6.560
2.9	6.605	6.651	6.697	6.743	6.789	6.835	6.881	6.928	6.975	7.022
3.0	7.069	7.116	7.163	7.211	7.258	7.306	7.354	7.402	7.451	7.499
3.1	7.548	7.596	7.645	7.694	7.744	7.793	7.843	7.892	7.942	7.992
3.2	8.042	8.093	8.143	8.194	8.245	8.296	8.347	8.398	8.450	8.501
3.3	8.553	8.605	8.657	8.709	8.762	8.814	8.867	8.920	8.973	9.026
3.4	9.079	9.133	9.186	9.240	9.294	9.348	9.402	9.457	9.511	9.566
3.5	9.621	9.676	9.731	9.787	9.842	9.898	9.954	10.01	10.07	10.12
3.6	10.18	10.24	10.29	10.35	10.41	10.46	10.52	10.58	10.64	10.69
3.7	10.75	10.81	10.87	10.93	10.99	11.04	11.10	11.16	11.22	11.28
3.8	11.34	11.40	11.46	11.52	11.58	11.64	11.70	11.76	11.82	11.88
3.9	11.95	12.01	12.07	12.13	12.19	12.25	12.32	12.38	12.44	12.50
4.0	12.57	12.63	12.69	12.76	12.82	12.88	12.95	13.01	13.07	13.14
4.1	13.20	13.27	13.33	13.40	13.46	13.53	13.59	13.66	13.72	13.79
4.2	13.85	13.92	13.99	14.05	14.12	14.19	14.25	14.32	14.39	14.45
4.3	14.52	14.59	14.66	14.73	14.79	14.86	14.93	15.00	15.07	15.14
4.4	15.21	15.27	15.34	15.41	15.48	15.55	15.62	15.69	15.76	15.83
4.5	15.90	15.98	16.05	16.12	16.19	16.26	16.33	16.40	16.47	16.55
4.6	16.62	16.69	16.76	16.81	16.91	16.98	17.06	17.13	17.30	17.28
4.7	17.35	17.42	17.50	17.57	17.65	17.72	17.80	17.88	17.95	18.02
4.8	18.10	18.17	18.25	18.32	18.40	18.47	18.55	18.63	18.70	18.78
4.9	18.86	18.93	19.01	19.09	19.17	19.24	19.32	19.40	19.48	19.56
5.0	19.63	19.71	19.79	19.87	19.95	20.03	20.11	20.19	20.27	20.35
5.1	20.43	20.51	20.59	20.67	20.75	20.83	20.91	20.99	21.07	21.16
5.2	21.24	21.32	21.40	21.48	21.57	21.65	21.73	21.81	21.90	21.98
5.3	22.06	22.15	22.23	22.31	22.40	22.48	22.56	22.65	22.73	22.82
5.4	22.90	22.99	23.07	23.16	23.24	23.33	23.41	23.50	23.59	23.67
5.5	23.76	23.84	23.93	24.02	24.11	24.19	24.28	24.37	24.45	24.54

Table 1.25. Circumference of the Circle when Diameter is given :

<i>d</i>	0	1	2	3	4	5	6	7	8	9
1.0	3.142	3.173	3.204	3.236	3.267	3.299	3.330	3.362	3.393	3.424
1.1	3.456	3.487	3.519	3.550	3.581	3.613	3.644	3.676	3.707	3.738
1.2	3.770	3.801	3.833	3.864	3.896	3.927	3.958	3.990	4.021	4.053
1.3	4.084	4.115	4.147	4.178	4.210	4.241	4.273	4.304	4.335	4.367
1.4	4.398	4.430	4.461	4.492	4.524	4.555	4.587	4.618	4.650	4.681
1.5	4.712	4.744	4.775	4.807	4.838	4.869	4.901	4.932	4.964	4.995
1.6	5.027	5.058	5.089	5.121	5.152	5.184	5.215	5.246	5.278	5.309
1.7	5.341	5.372	5.404	5.435	5.466	5.498	5.529	5.561	5.592	5.623
1.8	5.655	5.686	5.718	5.749	5.781	5.812	5.843	5.875	5.906	5.938
1.9	5.969	6.000	6.032	6.063	6.095	6.126	6.158	6.189	6.220	6.252
2.0	6.283	6.315	6.346	6.377	6.409	6.440	6.472	6.503	6.535	6.566
2.1	6.597	6.629	6.660	6.692	6.723	6.754	6.786	6.817	6.849	6.880
2.2	6.912	6.913	6.974	7.006	7.037	7.069	7.100	7.131	7.163	7.194
2.3	7.226	7.257	7.288	7.320	7.351	7.383	7.414	7.446	7.477	7.508
2.4	7.540	7.571	7.603	7.634	7.665	7.697	7.728	7.760	7.791	7.823
2.5	7.854	7.885	7.917	7.948	7.980	8.011	8.042	8.074	8.105	8.137
2.6	8.168	8.200	8.231	8.262	8.294	8.325	8.357	8.388	8.419	8.451
2.7	8.482	8.514	8.545	8.577	8.608	8.639	8.671	8.702	8.734	8.765
2.8	8.796	8.828	8.859	8.891	8.922	8.954	8.985	9.016	9.048	9.079
2.9	9.111	9.142	9.173	9.205	9.236	9.268	9.299	9.331	9.362	9.393
3.0	9.425	9.456	9.488	9.519	9.550	9.582	9.613	9.645	9.676	9.708
3.1	9.739	9.770	9.802	9.833	9.865	9.896	9.927	9.959	9.990	10.02
3.2	10.05	10.08	10.12	10.15	10.18	10.21	10.24	10.27	10.30	10.34
3.3	10.37	10.40	10.43	10.46	10.49	10.52	10.56	10.59	10.62	10.65
3.4	10.68	10.71	10.74	10.78	10.81	10.84	10.87	10.90	10.93	10.96
3.5	11.00	11.03	11.06	11.09	11.12	11.15	11.18	11.22	11.25	11.28
3.6	11.31	11.34	11.37	11.40	11.44	11.47	11.50	11.53	11.56	11.59
3.7	11.62	11.66	11.69	11.72	11.75	11.78	11.81	11.84	11.88	11.91
3.8	11.94	11.97	12.00	12.03	12.06	12.10	12.13	12.16	12.19	12.22
3.9	12.25	12.28	12.32	12.35	12.38	12.41	12.44	12.47	12.50	12.53
4.0	12.57	12.60	12.63	12.66	12.69	12.72	12.75	12.79	12.82	12.85
4.1	12.88	12.91	12.94	12.97	13.01	13.04	13.07	13.10	13.13	13.16
4.2	13.19	13.23	13.26	13.29	13.32	13.35	13.38	13.41	13.45	13.48
4.3	13.51	13.54	13.57	13.60	13.63	13.67	13.70	13.73	13.76	13.79
4.4	13.82	13.85	13.89	13.92	13.95	13.98	14.01	14.04	14.07	14.11
4.5	14.14	14.17	14.20	14.23	14.26	14.29	14.33	14.26	14.39	14.42
4.6	14.45	14.48	14.51	14.55	14.58	14.61	14.64	14.67	14.70	14.73
4.7	14.77	14.80	14.83	14.86	14.89	14.92	14.95	14.99	15.02	15.05
4.8	15.08	15.11	15.14	15.17	15.21	15.24	15.27	15.30	15.33	15.36
4.9	15.39	15.43	15.46	15.49	15.52	15.55	15.58	15.61	15.65	15.68
5.0	15.71	15.74	15.77	15.80	15.83	15.87	15.90	15.93	15.96	15.99
5.1	16.02	16.05	16.08	16.12	16.15	16.18	16.21	16.24	16.27	16.30
5.2	16.34	16.37	16.40	16.43	16.46	16.49	16.52	16.56	16.59	16.62
5.3	16.65	16.68	16.71	16.74	16.78	16.81	16.84	16.87	16.90	16.93
5.4	16.96	17.00	17.03	17.06	17.09	17.12	17.15	17.18	17.22	17.25
5.5	17.28	17.31	17.34	17.37	17.40	17.44	17.47	17.50	17.53	17.56

(Contd...)

Table 1.26. Reciprocal Values

<i>n</i>	0	1	2	3	4	5	6	7	8	9
1.0	1.0000	0.9901	0.9804	0.9709	0.9615	0.9524	0.9434	0.9346	0.9259	0.9174
1.1	0.9091	0.9009	0.8929	0.8850	0.8772	0.8696	0.8621	0.8547	0.8475	0.8103
1.2	0.8333	0.8264	0.8197	0.8130	0.8065	0.8000	0.7937	0.7874	0.7812	0.7752
1.3	0.7692	0.7634	0.7576	0.7519	0.7463	0.7407	0.7353	0.7299	0.7246	0.7194
1.4	0.7143	0.7092	0.7042	0.6993	0.6944	0.6897	0.6849	0.6803	0.6756	0.6711
1.5	0.6667	0.6623	0.6579	0.6536	0.6494	0.6452	0.6410	0.6369	0.6329	0.6289
1.6	0.6250	0.6211	0.6173	0.6135	0.6098	0.6061	0.6024	0.5988	0.5952	0.5917
1.7	0.5882	0.5818	0.3814	0.5780	0.5747	0.5714	0.5682	0.5650	0.5618	0.5587
1.8	0.5566	0.5525	0.3495	0.5464	0.5435	0.5405	0.5376	0.5348	0.5319	0.5291
1.9	0.5263	0.5236	0.3208	0.5181	0.5155	0.5128	0.5102	0.5076	0.5051	0.5025
2.0	0.5000	0.4975	0.4950	0.4926	0.4902	0.4878	0.4854	0.4831	0.4808	0.4785
2.1	0.4762	0.4739	0.4717	0.4695	0.4673	0.4651	0.4630	0.4608	0.4587	0.4566
2.2	0.4545	0.4525	0.4505	0.4484	0.4464	0.4444	0.4425	0.4405	0.4386	0.4367
2.3	0.4348	0.4329	0.4310	0.4292	0.4274	0.4255	0.4237	0.4219	0.4202	0.4184
2.4	0.4167	0.4149	0.4132	0.4115	0.4098	0.4082	0.4065	0.4049	0.4032	0.4016
2.5	0.4000	0.3984	0.3968	0.3953	0.3937	0.3922	0.3906	0.3891	0.3876	0.3861
2.6	0.3846	0.3831	0.3817	0.3802	0.3788	0.3774	0.3759	0.3745	0.3731	0.3717
2.7	0.3704	0.3690	0.3676	0.3663	0.3650	0.3636	0.3623	0.3610	0.3597	0.3584
2.8	0.3571	0.3559	0.3546	0.3534	0.3521	0.3509	0.3497	0.3484	0.3472	0.3460
2.9	0.3448	0.3436	0.3425	0.3413	0.3401	0.3390	0.3378	0.3367	0.3356	0.3344
3.0	0.3333	0.3322	0.3311	0.3300	0.3289	0.3279	0.3268	0.3257	0.3247	0.3236
3.1	0.3226	0.3215	0.3205	0.3195	0.3185	0.3175	0.3165	0.3155	0.3145	0.3135
3.2	0.3125	0.3115	0.3106	0.3096	0.3086	0.3077	0.3067	0.3058	0.3049	0.3040
3.3	0.3030	0.3021	0.3012	0.3003	0.2994	0.2985	0.2976	0.2967	0.2959	0.2950
3.4	0.2911	0.2933	0.2924	0.2915	0.2907	0.2899	0.2890	0.2882	0.2874	0.2865
3.5	0.2857	0.2819	0.2841	0.2833	0.2825	0.2817	0.2809	0.2801	0.2793	0.2786
3.6	0.2778	0.2770	0.2762	0.2755	0.2747	0.2740	0.2732	0.2725	0.2717	0.2710
3.7	0.2703	0.2695	0.2688	0.2681	0.2674	0.2667	0.2660	0.2653	0.2646	0.2639
3.8	0.2632	0.2625	0.2618	0.2611	0.2604	0.2597	0.2591	0.2584	0.2577	0.2571
3.9	0.2564	0.2558	0.2551	0.2545	0.2538	0.2532	0.2525	0.2519	0.2513	0.2506
4.0	0.2500	0.2494	0.2488	0.2481	0.2475	0.2469	0.2463	0.2457	0.2451	0.2445
4.1	0.2439	0.2433	0.2427	0.2421	0.2415	0.2410	0.2404	0.2398	0.2392	0.2387
4.2	0.2381	0.2375	0.2370	0.2364	0.2358	0.2353	0.2347	0.2342	0.2336	0.2331
4.3	0.2326	0.2320	0.2315	0.2309	0.2304	0.2299	0.2294	0.2288	0.2283	0.2278
4.4	0.2273	0.2268	0.2262	0.2257	0.2252	0.2247	0.2242	0.2237	0.2232	0.2227
4.5	0.2222	0.2217	0.2212	0.2208	0.2203	0.2198	0.2193	0.2188	0.2183	0.2179
4.6	0.2174	0.2169	0.2165	0.2160	0.2155	0.2151	0.2146	0.2141	0.2137	0.2132
4.7	0.2128	0.2123	0.2119	0.2114	0.2110	0.2105	0.2101	0.2096	0.2092	0.2088
4.8	0.2083	0.2079	0.2070	0.2072	0.2066	0.2062	0.2058	0.2053	0.2049	0.2015
4.9	0.2041	0.2037	0.2033	0.2028	0.2024	0.2020	0.2016	0.2012	0.2008	0.2004
5.0	0.2000	0.1996	0.1992	0.1988	0.1984	0.1980	0.1976	0.1972	0.1969	0.1965
5.1	0.1961	0.1957	0.1953	0.1919	0.1916	0.1912	0.1908	0.1905	0.1901	0.1927
5.2	0.1923	0.1919	0.1916	0.1912	0.1908	0.1905	0.1901	0.1898	0.1894	0.1890
5.3	0.1887	0.1883	0.1880	0.1876	0.1873	0.1869	0.1866	0.1862	0.1859	0.1855
5.4	0.1852	0.1818	0.1845	0.1842	0.1838	0.1835	0.1832	0.1828	0.1825	0.1821
5.5	0.1818	0.1815	0.1812	0.1808	0.1805	0.1802	0.1799	0.1795	0.1792	0.1789

(Contd...)

Table 1.27. Squares, Cubes, Square Roots and Cube Roots

n	n^2	n^3	\sqrt{n}	$\sqrt[3]{n}$
1	1	1	1.0000	1.0000
2	4	8	1.4142	1.2599
3	9	27	1.7321	1.4422
4	16	64	2.0000	1.5874
5	25	125	2.2361	1.7100
6	36	216	2.4495	1.8171
7	49	343	2.6458	1.9129
8	64	512	2.8284	2.0000
9	81	729	3.0000	2.0801
10	100	1000	3.1623	2.1544
11	121	1331	3.3166	2.2240
12	144	1728	3.4641	2.2894
13	169	2197	3.6056	2.3513
14	196	2744	3.7417	2.4101
15	225	3375	3.8730	2.4662
16	256	4096	4.0000	2.5198
17	289	4913	4.1231	2.5713
18	324	5832	4.2426	2.6207
19	361	6859	4.3589	2.6684
20	400	8000	4.4721	2.7144
21	441	9261	4.5826	2.7589
22	484	10648	4.6904	2.8020
23	529	12167	4.7958	2.8439
24	576	13824	4.8990	2.8845
25	625	15625	5.0000	2.9240
26	676	17576	5.0990	2.9625
27	729	19683	5.1962	3.0000
28	784	21952	5.2915	3.0366
29	841	24389	5.3852	3.0723
30	900	27000	5.4772	3.1072
31	961	29791	5.5678	3.1414
32	1024	32768	5.6569	3.1748
33	1089	35937	5.7446	3.2075
34	1156	39304	5.8310	3.2396
35	1225	42875	5.9161	3.2711
36	1296	46656	6.0000	3.3019
37	1369	50653	6.0828	3.3322
38	1444	54872	6.1644	3.3620
39	1521	59319	6.2450	3.3912
40	1600	64000	6.3246	3.4200
41	1681	68921	6.4031	3.4482
42	1764	74088	6.4807	3.4760
43	1849	79507	6.5574	3.5034
44	1936	85184	6.6332	3.5303
45	2025	91125	6.7082	3.5569
46	2116	97336	6.7823	3.5830
47	2209	103823	6.8557	3.6088
48	2304	110592	6.9282	3.6342
49	2401	117649	7.0000	3.6593
50	2500	125000	7.0711	3.6840

(Contd...)

Table 1.27. (Contd...)

n	n^2	n^3	\sqrt{n}	$\sqrt[3]{n}$
51	2601	132651	7.1414	3.7084
52	2704	140608	7.2111	3.7325
53	2809	148877	7.2801	3.7563
54	2916	157464	7.3485	3.7798
55	3025	166375	7.4162	3.8030
56	3136	175616	7.4833	3.8259
57	3249	185193	7.5498	3.8185
58	3364	195112	7.6158	3.8709
59	3481	205379	7.6811	3.8930
60	3600	216000	7.7460	3.9149
61	3721	226981	7.8102	3.9365
62	3844	238328	7.8740	3.9579
63	3969	250047	7.9373	3.9791
64	4096	262144	8.0000	4.0000
65	4225	274625	8.0623	4.0207
66	4356	287496	8.1240	4.0412
67	4489	300763	8.1854	4.0615
68	4624	314432	8.2462	4.0817
69	4761	328509	8.3066	4.1016
70	4900	343000	8.3666	4.1213
71	5041	357911	8.4261	4.1403
72	5184	373218	8.4853	4.1602
73	5329	389017	8.5440	4.1793
74	5476	405224	8.6023	4.1983
75	5625	421875	8.6603	4.2172
76	5776	438976	8.7178	4.2358
77	5929	456533	8.7750	4.2513
78	6084	474552	8.8318	4.2727
79	6241	493039	8.8882	4.2908
80	6400	512000	8.9443	4.3089
81	6561	531441	9.0000	4.3267
82	6624	551368	9.0554	4.3445
83	6889	571787	9.1104	4.3621
84	7056	592704	9.1652	4.3795
85	7225	614125	9.2195	4.3968
86	7396	636056	9.2736	4.4140
87	7569	658503	9.3274	4.4310
88	7744	681472	9.3808	4.4480
89	7921	704969	9.4340	4.4647
90	8100	729000	9.4868	4.4814
91	8281	753571	9.5394	4.4979
92	8464	778688	9.5917	4.5144
93	8649	804357	9.6437	4.5307
94	8836	830584	9.6954	4.5468
95	9025	857375	9.7468	4.5629
96	9216	884736	9.7980	4.5789
97	9409	912673	9.8489	4.5947
98	9604	911192	9.8995	4.6001
99	9801	970299	9.9499	4.6261
100	10000	1000000	10.0000	4.6416

(Contd...)

Table 1.27. (Contd...)

n	n^2	n^3	\sqrt{n}	$\sqrt[3]{n}$
101	10201	1030301	10.0499	4.6570
102	10404	1061208	10.0995	4.6723
103	10609	1092727	10.1489	4.6875
104	10816	1124864	10.1980	4.7027
105	11025	1157625	10.2470	4.7177
106	11236	1191016	10.2956	4.7326
107	11449	1225043	10.3441	4.7475
108	11664	1259712	10.3923	4.7622
109	11881	1295029	10.4103	4.7769
110	12100	1331000	10.4881	4.7914
111	12321	1367631	10.5357	4.8059
112	12544	1404928	10.5830	4.8203
113	12769	1442897	10.6301	4.8346
114	12996	1481544	10.6771	4.8488
115	13225	1520875	10.7238	4.8629
116	13456	1560896	10.7703	4.8770
117	13689	1601613	10.8167	4.8910
118	13924	1643032	10.8628	4.9049
119	14161	1685459	10.9087	4.9187
120	14400	1728000	10.9545	4.9324
121	14641	1771561	11.0000	4.9461
122	14884	1815848	11.0454	4.9597
123	15129	1860867	11.0905	4.9732
124	15376	1906624	11.1355	4.9866
125	15625	1953125	11.1803	5.0000
126	15876	2000376	11.2250	5.0133
127	16129	2048383	11.2694	5.0265
128	16384	2097152	11.3137	5.0397
129	16641	2146689	11.3578	5.0528
130	16900	2197000	11.4018	5.0658
131	17161	2248091	11.4455	5.0788
132	17424	2299968	11.4891	5.0916
133	17689	2352637	11.5326	5.1045
134	17956	2406104	11.5758	5.1172
135	18225	2460375	11.6190	5.1299
136	18496	2515456	11.6619	5.1426
137	18769	2571353	11.7017	5.1551
138	19044	2628072	11.7473	5.1676
139	19321	2685619	11.7898	5.1801
140	19600	2744000	11.8322	5.1925
141	19881	2803221	11.8743	5.2018
142	20164	2863288	11.9164	5.2171
143	20149	2924207	11.9583	5.2293
144	20736	2985984	12.0000	5.2415
145	21025	3048625	12.0416	5.2536
146	21316	3112136	12.0830	5.2656
147	21609	3176523	12.1244	5.2776
148	21904	3241792	12.1655	5.2896
149	22201	3307949	12.2066	5.3015
150	22500	3375000	12.2474	5.3133

(Contd...)

Table 1.27. (Contd...)

n	n^2	n^3	\sqrt{n}	$\sqrt[3]{n}$
151	22801	3442951	12.2882	5.3251
152	23104	3511808	12.3288	5.3368
153	23409	3581577	12.3693	5.3485
154	23716	3652264	12.4097	5.3601
155	24025	3723875	12.4499	5.3717
156	24336	3796416	12.4900	5.3832
157	24649	3869893	12.5300	5.3947
158	24964	3944312	12.5698	5.4061
159	25281	4019679	12.6095	5.4175
160	25600	4096000	12.6491	5.4288
161	25921	4173281	12.6886	5.4401
162	26244	4251528	12.7279	5.4514
163	26569	4330747	12.7671	5.4626
164	26896	4410944	12.8062	5.4737
165	27225	4492125	12.8452	5.4848
166	27556	4574296	12.8841	5.4959
167	27889	4657463	12.9228	5.5069
168	28224	4741632	12.9615	5.5178
169	28561	4826809	13.0000	5.5288
170	28900	4913000	13.0384	5.5397
171	29241	5000211	13.0767	5.5505
172	29584	5088448	13.1149	5.5613
173	29929	5177717	13.1529	5.5721
174	30276	5268024	13.1909	5.5828
175	30625	5359375	13.2288	5.5934
176	30976	5451776	13.2665	5.6041
177	31329	5545233	13.3041	5.6147
178	31684	5639752	13.3417	5.6252
179	32041	5735339	13.3791	5.6357
180	32400	5832000	13.4164	5.6462
181	32761	5929741	13.4536	5.6567
182	33124	6028568	13.4907	5.6671
183	33489	6128487	13.5277	5.6774
184	33856	6229504	13.5647	5.6877
185	34225	6331625	13.6015	5.6980
186	34596	6434856	13.6382	5.7083
187	34969	6539203	13.6748	5.7185
188	35344	6644672	13.7113	5.7287
189	35721	6751269	13.7477	5.7388
190	36100	6859000	13.7840	5.7489
191	36481	6967871	13.8203	5.7590
192	36864	7077888	13.8564	5.7690
193	37249	7189057	13.8924	5.7790
194	37636	7301384	13.9284	5.7890
195	38025	7414875	13.9642	5.7989
196	38416	7529536	14.0000	5.8088
197	38809	7645373	14.0357	5.8186
198	39204	7762392	14.0712	5.8285
199	39601	7880599	14.1067	5.8383

Table 1.28. Random Numbers

51772	74640	42331	29044	46621	62898	93582	04186	19640	87056
24033	23491	83587	06568	21960	21387	76105	10863	97453	90581
45939	60173	52078	25424	11645	55870	56974	37428	93507	94271
30586	02133	75797	45406	31041	86707	12973	17169	88116	42187
03585	79353	81938	82322	96799	85659	36081	50884	14070	74950
64937	03355	95863	20296	65304	55189	00745	65253	11822	15804
15630	64759	51135	98527	62586	41889	25439	88036	24034	67283
09448	56301	57683	30277	94623	85418	68829	06652	41982	49159
21631	91157	77331	60710	52290	16835	48653	71590	16159	14676
91097	17480	29414	06829	87843	28195	27279	47152	35683	47280
50532	25496	95652	42457	73547	76552	50020	24819	52984	76168
07136	40876	79971	54195	25708	51817	36732	72484	94923	75936
27989	64728	10744	08396	56242	90985	28868	99431	50995	20507
85184	73949	36601	46253	00477	25234	09968	36574	72189	70185
54398	21154	97810	36764	32869	11785	55261	59009	38714	38723
65544	34371	09591	07839	58892	92843	72828	91341	34821	63886
08263	65952	85762	64236	39238	18776	84303	99247	46149	03229
39817	67906	48236	16057	81812	15815	63700	85915	19219	45943
62257	04077	79443	95203	02479	30763	92486	54083	23631	05825
53298	90276	62545	21944	16530	03878	07516	95715	02526	33537