

# APPENDIX

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Table 1: International System of Units (SI)

INTERNATIONAL SYSTEM OF UNITS (SI)

Quantity	Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s or sec
electric current	ampere	A
temperature	degree Kelvin	degree K
luminous intensity	candela	cd

Supplementary

plane angle	radian	rad
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Derived Units

acceleration	meter per second squared	m/sec <sup>2</sup>
angular acceleration	radian per second squared	rad/sec <sup>2</sup>
area	square meter	m <sup>2</sup>
density	kilogram per cubic meter	kg/m <sup>3</sup>
electric capacitance	farad	F
electric charge	coulomb	C
electric field strength	volt per meter or newton per coulomb	V/m or N/C
electric resistance	ohm	Ω or V/A
force	newton	N or kg*m/sec <sup>2</sup>
frequency	hertz	Hz
illumination	lux	lx or lm/m <sup>2</sup>
inductance	henry	H or V*sec/A
luminance	candela per square meter	cd/m <sup>2</sup>
luminous flux	lumen	lm
magnetic field strength	ampere per meter	A/m
magnetic flux	weber	Wb or v*sec
magnetic flux density	tesla	T
magnetomotive force	ampere	A
power	watt	W or J/sec
pressure	newton per square meter	N/m <sup>2</sup>
velocity	meter per second	m/sec
angular velocity	radian per second	rad/sec
dynamic viscosity	newton second per square meter	N*s/m <sup>2</sup>
kinematic viscosity	square meter per second	m <sup>2</sup> /sec
voltage, potential difference		
electromotive force	volt	V
volume	cubic meter	m <sup>3</sup>
work or energy	joule	J
quantity of heat	calorie or kilocalorie	cal or Kcal

Table 2: SI Prefixes and Greek Symbols

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

THE GREEK ALPHABET AND COMMON SYMBOLS

alpha	α	nu	ν
beta	β	xi	ξ
gamma	γ or Γ	omicron	ο
delta	δ or Δ	pi	π
epsilon	ε	rho	ρ
zeta	ζ	sigma	σ or σ
eta	η	tau	τ
theta	θ	upsilon	υ
iota	ι	phi	φ
kappa	κ	chi	χ
lambda	λ	psi	ψ
mu	μ	omega	Ω or ω

**PHYSICS UNIT OF MECHANICS**

System	Length s	Mass m	Time t	Velocity v=s/t	Acceleration a=Δv/t	Force F=ma	Momentum p=mv	Energy or Work W=Fs	Power P=W/t
MKS (SI)	meter (m)	kilo-gram (kg)	second (sec/s)	m/sec	m/sec <sup>2</sup>	Newton (Nt) kg*m/sec <sup>2</sup>	Nt*sec kg*m/sec	Nt*m Joule (j)	joule/sec j/sec or wal (w)
CGS	centimeter (cm)	gram (g)	second (sec)	cm/sec	cm/sec <sup>2</sup>	dyne g*cm/sec <sup>2</sup>	gm*cm/sec dyne*sec	erg dyne*cm	erg/sec 10 <sup>-7</sup> watts
FPS (English)	foot (ft)	slug <u>lb*sec<sup>2</sup></u> ft	second (sec)	ft/sec	ft/sec <sup>2</sup>	pound (lb) slug*ft/s <sup>2</sup>	slug*ft/sec lb*sec	ft*lb	ft*lb/sec

At sea level on the Earth:  $g = 9.80 \text{ m/sec}^2 = 980 \text{ cm/sec}^2 = 32.17 \text{ ft/sec}^2$

Note: New symbol for second is "s"      550 ft\*lb/sec = 1 horsepower (hp)

Table 3: Units of Mechanics

Table 4: Physical Constants

acceleration due to gravity (Earth at sea level), g	9.806 65 m/sec <sup>2</sup>
alpha particle rest mass	6.644 2 X 10 <sup>-27</sup> kg
atmospheric pressure (normal), atm	1.013 25 X 10 <sup>5</sup> N/m <sup>2</sup>
atomic mass unit, amu	1.660 540 2 X 10 <sup>-27</sup> kg
Avogadro number, N <sub>A</sub>	6.022 52 X 10 <sup>23</sup> /mole
Boltzmann constant, k	1.380 54 X 10 <sup>-23</sup> J/°K
calorie, thermochemical	4.184 0 J
charge to mass ration for electron, e/m <sub>e</sub>	1.758 819 62 X 10 <sup>11</sup> C/kg
Coulomb's Law constant, k	8.987 6 X 10 <sup>9</sup> N·m <sup>2</sup> /C <sup>2</sup>
electron rest mass, m <sub>e</sub>	9.109 39 X 10 <sup>-31</sup> kg
	5.485 799 X 10 <sup>-4</sup> u
electron charge, eV	1.602 18 X 10 <sup>-19</sup> J
Faraday constant, F	9.648 53 X 10 <sup>4</sup> C/mole
gas constant, universal, R	6.236 X 10 <sup>4</sup> mm·cm <sup>3</sup> /mole·K
	8.314 510 J/mole·K
gas, normal volume, V <sub>0</sub> , (perfect gas)	22.413 6 L/mole
mechanical equivalent of heat, J	4.186 8 J/cal
neutron rest mass, m <sub>n</sub>	1.674 828 6 X 10 <sup>-27</sup> kg
	1.008 664 904 u
Planck's constant, h	6.626 075 5 X 10 <sup>-34</sup> J·sec
proton rest mass, m <sub>p</sub>	1.672 623 1 X 10 <sup>-27</sup> kg
	1.007 276 470 u
ratio of proton mass to electron mass	1836
speed of light in vacuum, c	2.997 924 58 X 10 <sup>8</sup> m/sec
speed of sound in air at STP	3.314 5 X 10 <sup>2</sup> m/sec
at 20°C	3.44 X 10 <sup>2</sup> m/sec
universal gravitational constant, G	6.672 59 X 10 <sup>-11</sup> N·m <sup>2</sup> /kg <sup>2</sup>
	6.672 59 X 10 <sup>-11</sup> m <sup>3</sup> /kg·s <sup>2</sup>
water, ice point	273.15°K
	0.00°C
water, triple point	273.16°K
	0.01°C

**Table 5: Useful Geometric Formulas**

**Circle**

circumference =  $2\pi r$        $r$  = radius  
     $d$  = diameter  
     $\pi = 3.14159$   
 area =  $\pi r^2$   
       =  $\pi d^2 / 4$

**Cube**

lateral area =  $6e^2$        $e$  = side of cube  
 volume =  $e^3$

**Cylinder**

volume =  $\pi r^2 h$        $r$  = radius  
     $d$  = diameter  
     $h$  = height  
       =  $\pi d^2 h / 4$

lateral area =  $2\pi r h$   
               =  $\pi d h$

total area =  $2\pi r (h + r)$

**Ellipse**

area =  $\pi a b$        $a$  = semi-major axis  
     $b$  = semi-minor axis

circumference =  $2\pi \sqrt{\frac{a^2 + b^2}{2}}$  (approx.)

**Parallelogram**

area =  $b h$        $b$  = base  
     $h$  = altitude to base  
       =  $a b \sin \theta$        $\theta$  = included angle of  
    sides  $a$  and  $b$

**Sphere**

volume =  $\frac{4\pi r^3}{3}$        $r$  = radius  
     $d$  = diameter  
    =  $\frac{\pi d^3}{6}$

surface area =  $4\pi r^2$   
    =  $\pi d^2$

**Trapezoid**

area =  $(a + b) h / 2$        $a, b$  = parallel sides  
     $h$  = altitude

**Triangle**

area =  $b h / 2$        $b$  = base  
     $h$  = altitude  
     $a, b, c$  = sides opposite  
    angles  $A, B, C$   
    =  $ab \sin C / 2$

Hero's Area Formula:  $s = (a + b + c) / 2$

=  $\sqrt{s(s-a)(s-b)(s-c)}$

Table 6: Conversions Factors 1

**Acceleration**

1 ft/sec<sup>2</sup> = 3.038 X 10<sup>-1</sup> m/sec<sup>2</sup>

1 in/sec<sup>2</sup> = 2.54 X 10<sup>-2</sup> m/sec<sup>2</sup>

**Angular**

1 degree = 1.745 X 10<sup>-2</sup> radians  
= 2.778 X 10<sup>-3</sup> revolutions

1 radian = 57.3 degrees  
= 1.592 X 10<sup>-1</sup> revolution

1 revolution = 360 degrees  
= 6.283 radians

**Area**

1 acre = 4.0468564224 X 10<sup>3</sup> meters

1 are = 1.00 X 10<sup>2</sup> meters

1 barn = 1.00 X 10<sup>-28</sup> meter<sup>2</sup>

1 foot<sup>2</sup> = 9.2903 X 10<sup>-2</sup> meter<sup>2</sup>

1 hectare = 1.00 X 10<sup>4</sup> meters<sup>2</sup>

1 meter<sup>2</sup> = 1 X 10<sup>4</sup> cm<sup>2</sup>

1 yard<sup>2</sup> = 8.3613 X 10<sup>-1</sup> meter<sup>2</sup>

**Electrical**

1 ampere = 6.2418 X 10<sup>18</sup> elem. ch/sec

1 ampere-hour = 3.60 X 10<sup>3</sup> coulombs

1 coulomb = 6.2418 X 10<sup>18</sup> elem. ch

1 electron-volt = 1.6021 X 10<sup>-19</sup> joules

1 faraday = 9.65 X 10<sup>4</sup> coulomb

1 volt = 1.6021 X 10<sup>-19</sup> joule/elem. ch  
= 1.6021 X 10<sup>-19</sup> electron-volt

**Energy**

1 British Thermal Unit = 1.055 X 10<sup>3</sup> joules  
or 1 Btu = 2.520 X 10<sup>-1</sup> Kcal

1 calorie = 4.184 joules  
= 1.163 X 10<sup>-3</sup> kilowatt

1 electron-volt = 1.6021 X 10<sup>-19</sup> joules  
= 1.6021 X 10<sup>-12</sup> erg

**Energy (con't)**

1 joule = 1 X 10<sup>7</sup> ergs  
= 0.2389 calories  
= 2.389 X 10<sup>-4</sup> kcal  
= 2.778 X 10<sup>-7</sup> kwh

1 kilowatt-hr = 3.60 X 10<sup>6</sup> joules  
= 860.2 kilocalorie  
= 34.3 Btu

**Force**

1 dyne = 1.00 X 10<sup>-5</sup> newton  
1 newton = 1.00 X 10<sup>5</sup> dynes  
= 0.2248 pound force (lb)

1 pound (lb) = 4.448 newtons

**Length**

1 angstrom = 1.00 X 10<sup>-10</sup> meter  
= 1.00 X 10<sup>-8</sup> cm

1 astronomical unit = 1.4960 X 10<sup>11</sup> m

1 foot = 30.48 centimeters  
= 3.048 X 10<sup>-1</sup> meter

1 inch = 2.54 cm  
= 2.54 X 10<sup>-2</sup> meter

1 light year = 9.4606 X 10<sup>15</sup> meters  
= 5.8798 X 10<sup>12</sup> miles

1 meter = 39.37 inches  
= 3.281 feet  
= 6.2137 X 10<sup>-4</sup> mile  
= 1.093611 yards  
= 1.00 X 10<sup>10</sup> angstroms  
= 100 centimeters  
= 1000 millimeters

1 mile = 1.609 X 10<sup>3</sup> meters  
= 1.609 kilometers

1 parsec = 3.0837 X 10<sup>16</sup> meters

Table 7: Conversions Factors 2

**Magnetism**

1 gauss =  $1.00 \times 10^{-4}$  tesla  
 =  $1.00 \times 10^{-4}$  weber/m<sup>2</sup>  
 1 maxwell =  $1.00 \times 10^{-8}$  weber (Wb)  
 1 unit pole =  $1.257 \times 10^{-7}$  weber  
 1 weber =  $1.00 \times 10^8$  maxwell

**Mass**

1 kilogram =  $6.852 \times 10^{-2}$  slugs  
 1 kilogram = 1000. grams  
 1 metric ton = 1000. kg  
 1 slug = 14.594 kilograms  
 (1 slug weighs 32.17 lbs at sea level)  
 1 unified atomic mass unit =  $1.660 \times 10^{-27}$  kg

**Mass-Energy**

1 joule =  $1.113 \times 10^{-27}$  kilogram  
 =  $6.705 \times 10^9$  amu  
 1 kilogram =  $6.0025 \times 10^{26}$  amu  
 =  $8.987 \times 10^{16}$  joules  
 1 unified atomic mass unit =  $1,492 \times 10^{-10}$  j

**Power**

1 horsepower = 550 foot-lbs/sec  
 =  $7.457 \times 10^2$  watts  
 =  $7.457 \times 10^{-1}$  kilowatt  
 =  $1.782 \times 10^{-1}$  kcal/sec  
 1 kilowatt =  $3.412 \times 10^3$  Btu  
 = 1.341 horsepower  
 1 watt = 1 joule/sec  
 =  $1 \times 10^7$  ergs/sec

**Pressure**

1 atmosphere =  $1.01325 \times 10^5$  nt/m<sup>2</sup>  
 = 760 mm Hg (0°C)  
 = 760 torrs  
 1 mm of Hg (@ 0°C) =  $1.333 \times 10^2$  nt/m<sup>2</sup>  
 =  $1.934 \times 10^{-2}$  lb/in<sup>2</sup>  
 = 1 torr  
 1 torr = 1 mm of Hg (0°C)

**Time**

1 day (ephemeris) = 1.440 minutes  
 =  $8.64 \times 10^4$  sec  
 1 year = 365.242 days  
 =  $8.766 \times 10^3$  hours  
 =  $5.259 \times 10^5$  minutes  
 =  $3.1536 \times 10^7$  seconds

**Volume**

1 foot<sup>3</sup> =  $2.8317 \times 10^{-2}$  meter<sup>3</sup>  
 1 gallon (US) = 3.7854 liters  
 =  $3.7854 \times 10^{-3}$  m<sup>3</sup>  
 1 liter =  $1.00 \times 10^{-3}$  meter<sup>3</sup>  
 = 1000 cubic cm  
 = 1000 milliliters  
 = 1.0567 quarts (US liquid)  
 1 quart (US) =  $9.463 \times 10^{-1}$  liter

**Miscellaneous**

60. mi/hr = 88 ft/sec  
 1 kg = 2.20 lbs (@ earth sea level)  
 1 lb = 454 grams

**Gravity @ Earth Sea Level**

1 g = 32.17 ft/sec<sup>2</sup>  
 1 g = 9.80 m/sec<sup>2</sup> = 980. cm/sec<sup>2</sup>

Table 8: Solar System Data

Data Regarding the Solar System							
Solar Object	Mass (kg)	Distance from Sun (km)	Period of Revolution (sec)	Mean Specific Gravity (gm/cc)	Radius (m)	Period of Rotation (sec)	Gravitational Acceleration (m/sec <sup>2</sup> )
Sun	$1.98 \times 10^{30}$	...	...	1.42	$6.95 \times 10^8$	$2.14 \times 10^6$	274.40
Mercury	$3.28 \times 10^{23}$	$5.79 \times 10^{10}$	$7.60 \times 10^6$	5.61	$2.57 \times 10^6$	$5.05 \times 10^6$	3.92
Venus	$4.83 \times 10^{24}$	$1.08 \times 10^{11}$	$1.94 \times 10^7$	5.16	$6.31 \times 10^6$	$2.1 \times 10^7$	8.82
Earth	$5.98 \times 10^{24}$	$1.49 \times 10^{11}$	$3.16 \times 10^7$	5.52	$6.38 \times 10^6$	$8.61 \times 10^4$	9.80
Mars	$6.37 \times 10^{23}$	$2.28 \times 10^{11}$	$5.94 \times 10^7$	3.95	$3.43 \times 10^6$	$8.85 \times 10^4$	3.92
Jupiter	$1.90 \times 10^{27}$	$7.78 \times 10^{11}$	$3.74 \times 10^8$	1.34	$7.18 \times 10^7$	$3.54 \times 10^4$	26.46
Saturn	$5.67 \times 10^{26}$	$1.43 \times 10^{12}$	$9.30 \times 10^8$	0.69	$6.03 \times 10^7$	$3.60 \times 10^4$	11.76
Uranus	$8.80 \times 10^{25}$	$2.87 \times 10^{12}$	$2.66 \times 10^9$	1.36	$2.67 \times 10^7$	$3.88 \times 10^4$	9.80
Neptune	$1.03 \times 10^{26}$	$4.50 \times 10^{12}$	$5.20 \times 10^9$	1.3	$2.48 \times 10^7$	$5.69 \times 10^4$	9.80
Pluto	$6 \times 10^{23}$	$5.9 \times 10^{12}$	$7.82 \times 10^9$	...	$3 \times 10^6$	$5.51 \times 10^5$	...
Moon of Earth	$7.34 \times 10^{22}$	$3.80 \times 10^8$	$2.36 \times 10^6$	3.36	$1.72 \times 10^6$	$2.36 \times 10^6$	1.67

**Table 9: Earth and Gravity Data**

equatorial radius	6,378,388 m 3,963.34 miles	period of rotation (one sidereal day)	86,164 sec 23.94 hours
polar radius	6,356,912 m 3,949.99 miles	mean linear speed in orbit	29.77 km/sec
mean radius	6,371,221.3 m 3,958.89 miles	distance to the sun:	
mass of the earth	5.983 X 10 <sup>24</sup> kg	mean	1.495 X 10 <sup>8</sup> km 9.29 X 10 <sup>7</sup> miles
mean density	5.522 g/cm <sup>3</sup>	aphelion	1.521 X 10 <sup>8</sup> km 9.45 X 10 <sup>7</sup> miles
land area	1.48847 X 10 <sup>8</sup> km <sup>2</sup>	perihelion	1.471 X 10 <sup>8</sup> km 9.14 X 10 <sup>7</sup> miles
ocean area	3.61254 X 10 <sup>8</sup> km <sup>2</sup>		

Standard value for acceleration due to gravity, g      9.80665 m/sec<sup>2</sup>

**Values at Selected Locations**

**Latitudinal & Altitudinal Variations**

equator, sea level	9.78039 m/sec <sup>2</sup>
poles, sea level	9.83217 m/sec <sup>2</sup>
45° latitude, sea level	9.80621 m/sec <sup>2</sup>
correction for altitude	-0.000003086 m/s <sup>2</sup> per meter of altitude

Colorado Spring, Co	9.79490 m/s <sup>2</sup>
Chicago, IL	9.80278
Key West, FL	9.78970
New York, NY	9.80267
Princeton, NJ	9.80178
San Francisco, CA	9.79965
Denver, CO	9.796
Arctic Red River, Canada	9.82434 m/s <sup>2</sup>
Jakarta, Java	9.78178
Panama Canal Zone	9.78243
Stockholm, Sweden	9.81843
North Pole	9.832
New Zealand	9.800

Table 10: Indices of Refraction and Resistivity Values

### INDICES OF REFRACTION

(Room temperature of 20.0°C for sodium light of wavelength 5893 Å)

acetone	1.36	glycerin	1.475
air, dry (STP)	1.00029	ice	1.31
aluminum oxide	1.76	isopropyl alcohol	1.38
benzene	1.50	lucite	1.50
carbon dioxide (STP)	1.00045	methyl alcohol	1.33
carbon disulfide	1.63	oleic acid	1.46
carbon tetrachloride	1.46	palmitic acid	1.43
diamond	2.42	propionic acid	1.39
ethyl alcohol	1.36	quartz crystal	1.54
ethyl ether	1.35	sodium chloride	1.43
fluorite	1.43	water	1.33
glass, zinc crown	1.52		
light flint	1.57		
heavy flint	1.65		

### RESISTIVITY

(Various Material Resistivities at Temperature of 20°C)

Material	Resistivity ( $\Omega \cdot \text{cm}$ )	Melting Point (°C)
aluminum	$2.824 \times 10^{-6}$	660
brass	$7.00 \times 10^{-6}$	900
climax	$87 \times 10^{-6}$	1250
constantan (Cu 60, Ni 40)	$49 \times 10^{-6}$	1190
copper	$1.724 \times 10^{-6}$	1083
german silver	$33 \times 10^{-6}$	1100
gold	$2.44 \times 10^{-6}$	1063
iron	$10. \times 10^{-6}$	1535
magnesium	$4.6 \times 10^{-6}$	651
manganin	$44 \times 10^{-6}$	910
mercury	$95.783 \times 10^{-6}$	-39
monel metal	$42 \times 10^{-6}$	1300
nichrome	$115 \times 10^{-6}$	1500
nickel	$7.8 \times 10^{-6}$	1452
nickel silver	$49 \times 10^{-6}$	1190
platinum	$10. \times 10^{-6}$	1769
silver	$1.59 \times 10^{-6}$	961
tungsten	$5.6 \times 10^{-6}$	3410