

## Physical Constants and Conversion Factors

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10/15/2003

### Physical Constants

$c$  = speed of light =  $(2.99793 \pm 0.00001) \times 10^{10}$  [cm/s] = 186,284 [mi/s]  
 $e$  = elementary (electron) charge =  $(1.60207 \pm 0.00007) \times 10^{-19}$  [abs coulombs] =  $(4.80288 \pm 0.00021) \times 10^{-10}$  [esu]  
 $r_0$  = classical electron radius =  $e^2 / m_0 c^2 = 2.818 \times 10^{-13}$  [cm]  
 $e/m$  = specific elementary charge =  $(1.75888 \pm 0.00005) \times 10^{11}$  [abs coulombs/kg]  
 $g$  = acceleration due to gravity (standard) = 32.174 [ft/s<sup>2</sup>] = 980.665 [cm/s<sup>2</sup>] = 386.09 [in/s<sup>2</sup>] = 21.94 [mi/h-s]  
 $N_a$  = Avogadro's number =  $(6.02472 \pm 0.00036) \times 10^{23}$  [molecules/g-mole] (physical scale) =  $(6.02308 \pm 0.00040) \times 10^{23}$  [molecules/g-mole] (chemical scale)  
 $k$  = Boltzmann's constant =  $(1.38042 \pm 0.00010) \times 10^{-16}$  [ergs/<sup>0</sup>K]  
 $h$  = Planck's constant =  $(6.6262 \pm 0.00005) \times 10^{-27}$  [erg.s]  
 $hc = 12.4$  [keV.Å]  
 $h/2\pi = \hbar = 1.0544 \times 10^{-27}$  [erg.sec] =  $0.6582 \times 10^{-15}$  [eV.sec]  
 $\sigma$  = Stefan-Boltzmann Law (for blackbody) =  $(5.6686 \pm 0.0005) \times 10^{-5}$  [erg/cm<sup>2</sup> s(<sup>0</sup>K)<sup>4</sup>]  
 $F$  = Faraday constant =  $(96.520 \pm 3)$  [abs coulombs/g equivalent]  
 $\epsilon_0$  = permittivity of free space =  $1/\mu_0 c^2 = (8.8542 \pm 0.0001) \times 10^{-12}$  [farad/m]  
 $\mu_0$  = permeability of free space =  $12.5664 \times 10^{-7}$  [henry/m]  
 $\alpha_0 = h^2/4\pi m e^2$  = first Bohr's radius =  $(5.29171 \pm 0.00006) \times 10^{-9}$  [cm]  
 $R_0$  = gas constant per mole =  $(8.31662 \pm 0.00038) \times 10^7$  [erg/<sup>0</sup>K-mole] (physical scale) =  $(8.20545 \pm 0.00037) \times 10^{-2}$  [liter atm/<sup>0</sup>K-mole] (chemical scale)  
Fine structure constant =  $e^2/\hbar c = 2\pi e^2/hc = 1/137$

### Conversions

1 [barn (b) cross section] =  $10^{-24}$  [cm<sup>2</sup>]  
1 [Curie (Ci) activity] =  $3.7 \times 10^{10}$  [transformations/s] =  $3.7 \times 10^{10}$  [Becquerel (Bq)] =  $2.22 \times 10^{12}$  [transformations/min] =  $3.7 \times 10^4$  [Rutherford]  
1 [Bq] = 1 [transformation/s]  
1 [Röntgen of exposure] = ionization by x or gamma rays resulting in 1 esu of charge in 1 cm<sup>3</sup> of air (STP) =  $1.61 \times 10^{12}$  [ion pairs/gm of air]  
STP = standard temperature and pressure = 0 <sup>0</sup>C and 760 [mm Hg]  
Rest energy of the electron = 0.51098 [MeV]  
Electron mass =  $m_e = (9.1085 \pm 0.0006) \times 10^{-28}$  [g] = 0.51098 [MeV] =  $5.48760 \times 10^{-4}$  [amu]  
Proton mass =  $(1.67243 \pm 0.00010) \times 10^{-24}$  [g] = 938.232 [MeV] = 1.00727 [amu]  
Neutron mass =  $(1.67474 \pm 0.00010) \times 10^{-24}$  [g] = 939.526 [MeV] = 1.00866 [amu]  
Alpha particle mass =  $(6.6442 \pm 0.0012) \times 10^{-24}$  [g] = 3727.377 [MeV] = 4.00260 [amu]  
Hydrogen atomic mass =  $(1.67335 \pm 0.00010) \times 10^{-24}$  [g] = 938.743 [MeV] = 1.00782 [amu]  
1 [amu (Atomic Mass Unit)] =  $1.6605 \times 10^{-27}$  [kg] =  $1.6605 \times 10^{-24}$  [gm] = 931.48 [MeV]

$M = \text{mass of the earth} = 5.983 \times 10^{24} \text{ [kg]} = 6.595 \times 10^{21} \text{ [tons]}$   
 $G = \text{Newton's gravity constant} = (6.670 \pm 0.005) \times 10^{-8} \text{ [cm}^3/\text{g.s]}$   
 $1 \text{ [kWh]} = 4.2 \times 10^5 \text{ g U}^{235} \text{ fission}$   
 $= 6.4 \times 10^6 \text{ g T in DT fusion reaction}$   
 $= \text{Average noon insolation in 1 h on horizontal plane of } 1 \text{ m}^2 \text{ area}$   
 $= 0.74 \text{ lb (highest power station efficiency on 12,500 [Btu/lb] coal)}$   
 $1 \text{ eV} = 1.61 \times 10^{-12} \text{ [erg]}$   
 $\pi = 3.1415926535$   
 $e = 2.7182818284$   
 $\log_e n = \log_e 10 \times \log_{10} n = 2.3026 \log_{10} n$

### **Time (T)**

$1 \text{ [week]} = 7 \text{ [days]} = 168 \text{ [h]} = 10,080 \text{ [min]} = 604,800 \text{ [s]}$   
 $1 \text{ [mean solar day]} = 1440 \text{ [min]} = 86,400 \text{ [s]}$   
 $1 \text{ [calendar year]} = 365 \text{ [days]} = 8760 \text{ [h]} = 5.256 \times 10^5 \text{ [min]} = 3.1536 \times 10^7 \text{ [s]}$   
 $1 \text{ [sidereal year]} = 365.256 \text{ [days (mean solar)]} = 8766.14 \text{ [h (mean solar)]}$

### **Pressure (ML<sup>-1</sup>T<sup>-2</sup>)**

$1 \text{ [atmosphere (atm)]} = 1.0133 \text{ [bar]} = 14.696 \text{ [lb/in}^2\text{]} = 1.013246 \times 10^6 \text{ [dyn/cm}^2\text{]} = 760 \text{ [Torr]} =$   
 $1033.2 \text{ [g/cm}^2 \text{ (0 } ^\circ\text{C)}] = 760 \text{ [mm Hg (0 } ^\circ\text{C)}] = 29.921 \text{ [in Hg (0 } ^\circ\text{C)}] = 33.903 \text{ [ft water (0 } ^\circ\text{C)}]$   
 $1 \text{ [dyn/cm}^2\text{]} = 1.01971 \times 10^{-3} \text{ [g/cm}^2\text{]} = 1.4504 \times 10^{-5} \text{ [lb/in}^2\text{]}$   
 $1 \text{ [bar]} = 1.0 \times 10^6 \text{ [dyn/cm}^2\text{]} = 0.98692 \text{ [atm]}$   
 $1 \text{ [lb wt/ in}^2\text{]} = 70.307 \text{ [g/cm}^2\text{]} = 68.947 \text{ [dyn/cm}^2\text{]}$

### **Acceleration (LT<sup>-2</sup>)**

$1 \text{ [ft/s}^2\text{]} = 30.4801 \text{ [cm/s}^2\text{]} = 0.6818 \text{ [mi/h-s]}$

### **Work and Energy (MLT<sup>-2</sup>)**

$1 \text{ atomic mass unit [amu]} = 931.494 \text{ [MeV]} = 1.66054 \times 10^{-24} \text{ [gm]}$   
 $1 \text{ electron volt [eV]} = 1.60207 \times 10^{-19} \text{ [J (abs)]}$   
 $1 \text{ [Joule (International)]} = 1.000165 \text{ [Joule (abs)]}$   
 $1 \text{ [absolute (abs) Joule (J)]} = 1 \text{ [N meter (N.m)]} = 1 \times 10^7 \text{ [ergs]} = 1 \times 10^7 \text{ [dyn.cm]} = 1 \text{ [W.s]} = 1$   
 $\text{[V.coulomb]} = 0.73756 \text{ [ft.lb]} = 2.3889 \times 10^4 \text{ [kg.calorie (mean)]} = 9,4805 \times 10^4 \text{ [Btu (mean)]} =$   
 $23.730 \text{ [ft.poundal]} = 2.778 \times 10^{-7} \text{ [kWh]} = 3.725 \times 10^{-7} \text{ [hp.h]}$   
 $1 \text{ [g calorie]} = 4.186 \text{ [J (abs)]}$   
 $1 \text{ [g calorie (15 } ^\circ\text{C)}] = 4.1855 \text{ [J (abs)]} = 0.003968 \text{ [Btu]}$   
 $1 \text{ [kWh]} = 3413.0 \text{ [Btu (mean)]} = 2.6552 \times 10^6 \text{ [ft.lb]} = 1.3410 \text{ [hp.h]}$   
 $1 \text{ [liter atm (normal)]} = 3.7745 \times 10^{-5} \text{ [hp.h]} = 24.206 \text{ [g cal (mean)]} = 101.328 \text{ [J (abs)]}$

### **Mass (M)**

$1 \text{ [gram (g)]} = 2.20462 \times 10^{-3} \text{ [lb (av)]} = 0.03527 \text{ [oz (av)]} = 15.4324 \text{ [grains]}$

1 [pound (lb) avoirdupois (av)] = 16 [oz (av)] = 7000 [grains] = 256 [drams (av)] = 453.5924 [g]  
1 [ounce (oz) (av)] = 16 [drams (av)] = 437.5 [grains] = 28.34953 [g]  
1 [short ton] = 2000 [lb (av)] = 907.185 [kg] = 20 [hundredweight (long)]  
1 [long ton] = 2240 [lb (av)] = 1016.0470 [kg] = 20 [hundredweight (long)]  
1 [metric tonne] = 1,000 [kgs]  
1 [kg] = 1,000 [gms]

**Density (ML<sup>-3</sup>)**

1 [lb/ft<sup>3</sup>] = 5.787 x 10<sup>-4</sup> [lb/in<sup>3</sup>] = 16.018 [kg/m<sup>3</sup>] = 1.6018 x 10<sup>2</sup> [g/cm<sup>3</sup>]  
1 [g/cm<sup>3</sup>] = 0.03613 [lb/in<sup>3</sup>] = 64.23 [lb/ft<sup>3</sup>]