66.23: Round-Number Handbook of Physics

The one-page Round Number Handbook of Physics on the following page is by Edward M. Purcell of Harvard University, and appeared in the January 1983 issue of the American Journal of Physics. It is intended as a brief reference for doing quick "back of the envelope", order-of-magnitude calculations.

ROUND-NUMBER HANDBOOK OF PHYSICS

CONSTANTS

$c = 3 \times 10^{10}\ \mathrm{cm\ s^{-1}}$

$\hbar = 10^{-27}\mathrm{ergs}$

$N_0 = 6 \times 10^{23}\ \mathrm{mole^{-1}}$

$n_0 = 3 \times 10^{19}\ \mathrm{cm^{-3}}$

$g = 10^{3}\ \mathrm{cm\ s^{-2}}$

$e = 4.8 \times 10^{-10}\mathrm{esu}$

$= 1.6 \times 10^{-19}\mathrm{C}$

$k = 1.4 \times 10^{-16}\mathrm{ergdeg^{-1}}$

$\alpha = e^2/\hbar c = 1/137$

$(\mu_0/\epsilon_0)^{1/2} = 377\Omega$

$G = 7 \times 10^{-8}\ \mathrm{g\ cm^{-4}\ s^{-2}}$

$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{N\ A^{-2}}$

$\epsilon_0 = 8.8 \times 10^{-12}\ \mathrm{N^{-1}\ A^2\ m^{-2}\ s^2}$

$R = 2\mathrm{cal/moledeg}$

CONVERSIONS

$1\mathrm{cal} = 4\ \mathrm{J} = 4 \times 10^{7}\mathrm{erg}$

$1\ \mathrm{N} = 10^{5}\ \mathrm{dyn}$

$680\ \mathrm{lumens} = 1\ \mathrm{W}(5550\text{Å})$

$1\mathrm{ft} = 30\ \mathrm{cm}$

$1\mathrm{lb} = 4.4\ \mathrm{N}$

$1\mathrm{ci} = 4 \times 10^{10}\mathrm{disint/s}$

$1\mathrm{eV} = 1.6 \times 10^{-12}\mathrm{erg}$

$1\Omega^{-1} = 9 \times 10^{11}\ \mathrm{cm/s}$

$\mathrm{pc(eV)} = 300\mathrm{Br(Gcm)}$

MASSES

$m_e = 10^{-27}\ \mathrm{g}$

$m_{\mathrm{pion}} = 270m$

$m_{\mathrm{kaon}} = 1000m_e$

$m_{\mathrm{nucleon}} = 2000m_e$

$m_e c^2 = 0.5\mathrm{MeV}$

$m_{\mathrm{muon}} = 200m_e$

USEFUL NUMBERS

classical electron radius $= r_0 = e^2/m_e c^2 = 3 \times 10^{-13}$ cm

Bohr radius $= a_0 = \hbar^2/m_e e^2 = 5 \times 10^{-9}$ cm

Rydberg wavelength $= \pi_R = \hbar^3 \mathrm{c}/\mathrm{m}_e e^4 = 7 \times 10^{-7}$ cm

Compton wavelength $= \lambda_c = \hbar/m_e c = 4 \times 10^{-11}$ cm

Bohr magneton $= e\hbar/2mc = 10^{-20}\mathrm{erg/G}$

Stefan-Boltzman const $= 6 \times 10^{-12}$ W/deg^4 cm^2

Min. ionization loss: $2\mathrm{MeV/gcm}^2$

$kT_{\text{room}} = 0.025\mathrm{eV}$

$R_{\text{nuclear}} = A^{1/3} \times 10^{-13}$ cm

$e^2/a_0 = 26\mathrm{eV}$ $h\nu$ (visible) $= 2\mathrm{eV}$

Band gaps: Si $= 1.1\mathrm{eV}$; Ge $= 0.7\mathrm{eV}$

Spin precession: e : $3\mathrm{MHz/G}$; p : $4\mathrm{kHz/G}$

MATERIALS

Resistivities in Ωcm : Cu: 2×10^{-6} (room temp.)

$\mathrm{H_2O}$ (pure): 2×10^7 ; seawater: $25\Omega\mathrm{cm}$

Specific heat (solid or liquid) $= 0.5\mathrm{cal/cm^3 deg}$

Linear expansion (solid or liquid) $= 2 \times 10^{-5}/\mathrm{deg}$

Heat conduction (insulator) $= 10^{-2}\mathrm{cal/scm\,deg}$ (metal) $= 1.0\ (\rho_{\mathrm{Cu}}/\rho_{\text{metal}})\ \mathrm{cal/scmdeg}$

Heat of combustion (food or fuel) $= 10^4\mathrm{cal/g}$

Heat of vaporization $= 10^4\mathrm{cal/mole}$

Elastic moduli (solids) $= 10^{11} - 10^{12}\mathrm{dyn/cm^2}$

Tensile strength (solids) $= 10^8 - 10^{10}\mathrm{dyn/cm^2}$

Surface tension: $\mathrm{H_2O} = 50\mathrm{dyn/cm}$

Diffusion: $\mathrm{H_2O}10^{-5}$, air: 0.2 cm^2/s

Viscosity: $\mathrm{H_2O}10^{-2}$, air:2 2×10^{-4} dyn s/cm

ASTRONOMICAL

$1\mathrm{pc} = 3 \times 10^{18}$ cm

$1\mathrm{mag} = -4$ dB

$m_{\text{abs}} = m$ at $10\mathrm{pc}$

m_{abs} (sun $) = +5$

B_{Earth} (pole) $= 0.5\mathrm{G}$

$M_{\text{Earth}} = 6 \times 10^{27}$ g

$R_{\text{Earth}} = 6 \times 10^8$ cm

$M_\odot = 2 \times 10^{33}$ g

$R_\odot = 8 \times 10^{10}$ cm

$L_\odot = 2 \times 10^{33}\mathrm{erg/s} = 1$ kW/m^2 at Earth

$r_{\text{moon}} = 4 \times 10^{10}$ cm

$r_{\text{sun}} = 1\text{AU} = 1.5 \times 10^{13}$ cm

$M_{\text{Galaxy}} = 2 \times 10^{44}$ g

Distance to center of galaxy $= 3 \times 10^{22}$ cm

Distance between galaxies $= 10^{25}$ cm

Energy density: starlight $= 10^{-12} \text{erg}/\text{cm}^3$

Primary cosmic rays: $1/\text{cm}^2$ s

$R_{\text{Universe}} = 3000\text{Mpc}$

ATMOSPHERE (STP)

$P_{\text{atm}} = 10^6 \text{dyn}/\text{cm}^2 = 15\text{psi}$

$V_{\text{sound}} = V_{\text{molec}} = 4 \times 10^4$ cm/s

Radiation length $= 36$ g/cm^2

Density $= 10^{-3}$ g/cm^3

Mean free path $= 7 \times 10^{-6}$ cm

Scale height $= 8$ km
