Useful Equations, Formulae, and Constants

Useful Constants and Conversions

Avogadro's number .... 6.022×10^{23} mol^{-1}
Planck's constant .... 6.626×10^{-34} J s
volume of ideal gas (STP) .... 22.4 L mol^{-1}
charge (e^{-1}) .... 1.602×10^{-19} C
roentgen (STP) .... 2.58×10^{-4} C kg^{-1}
1 MeV .... 1.602×10^{-13} J
1 atm .... 760 mm Hg
w .... 33.7 eV ion pair^{-1}
rad .... 6.242×10^{7} MeV g^{-1}
1 m^3 .... 1000 L
1 ft^3 .... 28.32 L
universal gas constant (R) .... 8.314 J °K^{-1} mol^{-1}
standard temperature .... 0°C
standard pressure .... 1 atm
1 barn (b) .... 10^{-24} cm^2

General

$$P V = n \mathrm{R} T$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$Q = A V$$

$$V = 4005 \sqrt{V_p}$$

$$\mathrm{c} = v \lambda$$

$$E = \mathrm{h} v$$

Ionizing Radiation

$$A = \lambda N$$

$$T_{1/2}^{p} = \frac{0.693}{\lambda_p}$$

$$A(t) = A_0 \mathrm{e}^{-\lambda t}$$

Ionizing Radiation (Cont.)

$$\frac{1}{T_{1/2}^{e}} = \frac{1}{T_{1/2}^{p}} + \frac{1}{T_{1/2}^{b}}$$

$$X_2 = X_1 \frac{d_1^2}{d_2^2}$$

$$SA(\mathrm{Ci/g}) = \frac{1.129 \times 10^{13}}{T_{1/2}^{p}(\mathrm{s})\ AtomicMass}$$

$$\dot{X}(d) = A \frac{\Gamma}{d^2}$$

$$\dot{X}(d) = \frac{\Gamma C_L (\Theta_1 + \Theta_2)}{d}$$

$$\dot{X}(d) = \pi \Gamma C_a \ln\left[\frac{(r^2 + d^2)}{d^2}\right]$$

$$D = 73.8\, C\, E_\gamma\, n_\gamma\, \Phi\, T_{1/2}^{e} (1 - e^{-\lambda_e t})$$

$$D = 73.8\, C\, E_\beta\, T_{1/2}^{e} (1 - e^{-\lambda_e t})$$

$$N_{HVL} = \frac{\log_{10}(\eta)}{\log_{10}(0.5)}$$

$$I = \beta I_0 e^{-\mu x}$$

$$\beta = (1 + \mu x) \qquad \text{Fe}$$

$$\beta = (1 + \mu x / 3) \qquad \text{Pb}$$

$$K_{\mu x} = \frac{P\ (d_{pri})^2}{W\ U\ T}$$

Non-ionizing Radiation

RF/Microwave Radiation

$$S = \frac{E^2}{120\ \pi} = 120\ \pi\ H^2$$

$$G_{dB} = 10\ \log_{10}(G_a)$$

$$P_{ave} = P_{peak} \bullet PW \bullet PRF$$

$$S = \frac{4\ P_{ave}}{A}$$

$$S = \frac{P_{ave}\ G_a}{4\pi\ d^2}$$

Laser Radiation

$$d_{1/e^2} = \sqrt{2}\ d_{1/e}$$

$$NOHD = \frac{1}{\phi}\sqrt{\frac{1.27\ \Phi}{MPE} - d_a^2}$$

$$NHZ = \sqrt{\frac{\rho_\lambda\ \Phi\ \cos(\theta_v)}{\pi\ MPE}}$$

$$OD = \log_{10}\left(\frac{E\ or\ H}{MPE}\right)$$

Ultraviolet Radiation

$$E_{eff} = \sum_\lambda E_\lambda\ S_\lambda\ \Delta\lambda$$

Statistics

$$\sigma_s = \left[\frac{C_{S+B}}{T_{S+B}} + \frac{C_B}{T_B}\right]^{1/2}$$

$$\frac{T_{S+B}}{T_B} = \sqrt{\frac{C_{S+B}}{C_B}}$$

$$L_C = 2.33\ \sigma_b$$

$$L_D = 2.71 + 4.65\ \sigma_b$$

$$\chi^2 = \frac{(N-1)\ S^2}{\bar{x}} = \sum_i^N \frac{(\bar{x} - x_i)^2}{\bar{x}}$$

$$LLD = 3.29\sqrt{\left(r_b t_g\left(1 + \frac{t_g}{t_b}\right)\right)} + 3$$

Miscellaneous Equations

$$\sigma_u^2 = \left(\frac{\partial u}{\partial x}\right)^2 \sigma_x^2 + \left(\frac{\partial u}{\partial y}\right)^2 \sigma_y^2 + \left(\frac{\partial u}{\partial z}\right)^2 \sigma_z^2 + ...$$

$$\chi = \frac{Q'}{2\ \pi\ \sigma_y\ \sigma_z\ u} \exp\left(-\frac{y^2}{2\ \sigma_y^2}\right) \left[\exp\left(-\frac{(z - h)^2}{2\ \sigma_z^2}\right) + \exp\left(-\frac{(z + h)^2}{2\ \sigma_z^2}\right)\right]$$

$$\dot{X} = \frac{2\ \pi\ \Gamma\ C}{\mu_{en}} (1 - e^{-\mu_{en} R})$$

$$E'_\gamma = \frac{E_\gamma}{1 + \frac{E_\gamma}{m_0\ c^2}\left[1 - \cos(\theta)\right]}$$

$$A = N_a\ \sigma_a\ \phi\ \left(1 - e^{-\lambda t}\right) e^{-\lambda \tau}$$

$$N_2(t) = \frac{N_1^0\ \lambda_1}{\lambda_2 - \lambda_1} \left[e^{-\lambda_1 t} - e^{-\lambda_2 t}\right]$$

$$T_{\max} = \frac{1}{\lambda_2 - \lambda_1} \ln\left[\frac{\lambda_2}{\lambda_1}\right]$$

Range of Alpha Particles

$R_\alpha = 0.56E$ ($E < 4$ MeV)

$R_\alpha = 1.24E - 2.62$ (4 MeV $< E <$ 8 MeV)

Range of Beta Particles

$R_\beta = 412E^{(1.265 - 0.0954 \ln E)}$ (0.01 MeV $< E <$ 2.5 MeV)

$R_\beta = 530E - 106$ ($E >$ 2.5 MeV)