Useful Equations, Formulae, and Constants

Useful Constants and Conversions

Avogadro constant .... 6.022×10^{23} mol^{-1}
Planck constant .... 6.626×10^{-34} J s
volume of ideal gas (STP) ....22.4 L mol^{-1}
elementary charge .... 1.602×10^{-19} C
roentgen (STP) .... 2.58×10^{-4} C kg^{-1}
erg .... 1×10^{-7} J
1 MeV .... 1.602×10^{-13} J
1 atm ....760 mm Hg
$\overline{\omega}$ ....34 eV ion-pair^{-1}
1 ft^3 ....28.32 L
molar gas constant .... 8.314 J K^{-1} mol^{-1}
molar gas constant ....0.08205 atm L K^{-1} mol^{-1}
standard temperature ....0°C
standard pressure .... 1 atm

General

$$Q = V\,A$$

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

$$E = h\nu$$

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

Ionizing Radiation

$$SA\ \ (\text{Ci/g}) = \frac{1.14 \times 10^{13}}{T_{1/2}(s) \cdot Atomic\ Mass}$$

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

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

Ionizing Radiation (Cont.)

$$\dot{X}(d) = \frac{\Gamma\,C_l(\theta_1 + \theta_2)}{d}$$

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

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

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

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

$B = (1 + \mu\,x)$ Fe

$B = (1 + \mu\,x/3)$ Pb

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

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

Range of Alpha Particles

$R_\alpha = 0.56\,E \quad (E < 4\text{ MeV})$

$R_\alpha = 1.24\,E - 2.62$
$(4\text{ MeV} < E < 8\text{ MeV})$

Range of Beta Particles

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

$R_\beta = 530\,E - 106 \quad (E > 2.5\text{ MeV})$

Non-ionizing Radiation

RF/Microwave Radiation

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

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

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

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

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

Laser Radiation

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

$$r_{NOHD} = \frac{1}{\phi}\left[\left(\frac{4\Phi}{\pi\,MPE}\right) - a^2\right]^{1/2}$$

$$r_{NHZ} = \left(\frac{\rho\,\Phi\,cos\theta}{\pi\,MPE}\right)^{1/2}$$

Ultraviolet Radiation

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

Statistics

$$\sigma_s = \left[\frac{r_{s+b}}{t_{s+b}} + \frac{r_b}{t_b}\right]^{1/2}$$

$$\frac{t_{s+b}}{t_b} = \sqrt{\frac{r_{s+b}}{r_b}}$$

$$L_C = 2.326\,\sigma_b$$

$$L_D = 4.653\,\sigma_b + 2.706$$

$$\chi^2 = \frac{(n-1)S^2}{\sigma^2} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{\sigma^2}$$

$$LLD = 3.29\sqrt{\left(r_b\,t_g\left(1 + \frac{t_g}{t_b}\right)\right)} + 2.71$$

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

Miscellaneous Equation

$$\chi = \frac{Q}{2\,\pi\,\sigma_y\,\sigma_z\,\mu}\;exp\left(-\frac{y^2}{2\,\sigma_y^2}\right)\left\{exp\left[-\frac{(z-H)^2}{2\,\sigma_z^2}\right] + exp\left[-\frac{(z+H)^2}{2\,\sigma_z^2}\right]\right\}$$