

## Useful Equations, Formulae, and Constants

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### Useful Constants and Conversions

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Avogadro's number .....	6.023 x 10 <sup>23</sup> mol <sup>-1</sup>
Planck's constant .....	6.625 x 10 <sup>-34</sup> J s
volume of ideal gas (STP) .....	22.4 L mol <sup>-1</sup>
charge (e <sup>-1</sup> ).....	1.602 x 10 <sup>-19</sup> C
roentgen (STP).....	2.58 x 10 <sup>-4</sup> C kg <sup>-1</sup>
1 MeV.....	1.602 x 10 <sup>-13</sup> J
1 atm.....	760 mm Hg
w.....	33.7 eV ion pair <sup>-1</sup>
rad.....	6.242 x 10 <sup>7</sup> MeV g <sup>-1</sup>
1 m <sup>3</sup> .....	1000 L
1 ft <sup>3</sup> .....	28.32 L
universal gas constant (R).....	8.32 x 10 <sup>7</sup> erg °C <sup>-1</sup> g <sup>-1</sup> mol <sup>-1</sup>
standard temperature.....	0°C
standard pressure .....	1 atm
1 barn (b) .....	10 <sup>-24</sup> cm <sup>2</sup>

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### General

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$$PV = nRT$$

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

$$Q = AV$$

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

$$c = v \lambda$$

$$E = h\nu$$

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### Ionizing Radiation

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$$A = \lambda N$$

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

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

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### Ionizing Radiation (Cont.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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**Non-ionizing Radiation**

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**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**

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

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

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

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

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**Ultraviolet Radiation**

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

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**Statistics**

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

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

$$L_C = 2.33 \sigma_b$$

$$L_D = 2.71 + 4.65 \sigma_b$$

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

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**Miscellaneous Equations**

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

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

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

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

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

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

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

**Range of Alpha Particles**

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

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

**Range of Beta Particles**

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

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