Physics 305: Reference Sheet

$m_e = 9.1094 \times 10^{-31} kg$

$m_e = 0.511 MeV/c^2$

$m_p = 1.6727 \times 10^{-27} kg$

$m_n = 1.6749 \times 10^{-27} kg$

$N_A = 6.022 \times 10^{23} Mol^{-1}$

$c = 2.9979 \times 10^{8} m/s$

$e = 1.6022 \times 10^{-19} C$

$h = 6.6261 \times 10^{-34} J \cdot s$

$h = 4.1361 \times 10^{-15} eV \cdot s$

$\hbar = h/2\pi$

$\hbar = 1.05457 \times 10^{-34} J \cdot s$

$\frac{1}{4\pi\epsilon_\circ} = 8.9876 \times 10^{9} N m^2 C^{-2}$

$k_B = 1.381 \times 10^{-23} J/K$

$k_B = 8.617 \times 10^{-5} eV/K$

$a_\circ = 5.2918 \times 10^{-11} m$

$u = 1.6605 \times 10^{-27} kg$

$u = 931.494 MeV/c^2$

$R_\infty = 1.097373 \times 10^{7} m^{-1}$

$\sigma = 5.6704 \times 10^{-8} W m^{-2} K^{-4}$

$hc = 1240 eV \cdot nm$

$uc^2 = 931.49 MeV$

$m_e c^2 = 0.511 MeV$

$m_p c^2 = 938 MeV$

$1eV = 1.602 \times 10^{-19} J$

$\gamma = \frac{1}{\sqrt{1-u^2/c^2}}$

$x' = \gamma(x - ut)$

$y' = y \quad z' = z$

$t' = \gamma(t - ux/c^2)$

$x = \gamma(x' + ut')$

$t = \gamma(t' + ux'/c^2)$

$\Delta t = \gamma \Delta t_\circ$

$L = L_\circ/\gamma$

$v' = \frac{v-u}{1-uv/c^2}$

$v = \frac{v'+u}{1+uv'/c^2}$

$c = f\lambda$

$f' = f\sqrt{\frac{1 \pm u/c}{1 \mp u/c}}$

$\lambda' = \lambda\sqrt{\frac{1 \mp u/c}{1 \pm u/c}}$

$\vec{p} = \frac{m\vec{v}}{\sqrt{1-v^2/c^2}}$

$K = \frac{mc^2}{\sqrt{1-v^2/c^2}} - mc^2 = E - E_\circ$

$E_\circ = mc^2$

$E = \gamma mc^2$

$K = (\gamma - 1)mc^2$

$E^2 = p^2c^2 + m^2c^4$

$dsin\theta = n\lambda$

$2dsin\theta = n\lambda$

$E = hf = \frac{hc}{\lambda}$

$K_{max} = \frac{1}{2}mv_{max}^2 = hf - \phi$

$K_{max} = eV_s$

$I = Power/Area$

$I = \int R(\lambda) d\lambda = \sigma T^4$

$\lambda_{max} T = 2.8978 \times 10^{-3} m \cdot K$

$I(\lambda) = \frac{2\pi hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda kT}} - 1}$

$\frac{1}{E'} - \frac{1}{E} = \frac{1}{m_e c^2}(1 - cos\theta)$

$\lambda' - \lambda = \frac{h}{m_e c}(1 - cos\theta)$

$tan\phi = \frac{E' sin\theta}{E - E' cos\theta}$

$\lambda_{x-ray} = \frac{hc}{K - K'}$

$\lambda_{min} = \frac{hc}{\Delta K} = \frac{hc}{e\Delta V}$

$\lambda = \frac{h}{p}$

$dsin\phi = n\lambda$

$\Delta p \Delta x \geq \frac{\hbar}{2}$

$\Delta E \Delta t \geq \frac{\hbar}{2}$

$\lambda_c = \frac{h}{\sqrt{2mE_k}}$

$\lambda_r = \frac{hc}{\sqrt{2E_\circ E_k + E_k^2}}$

$-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + U\psi = E\psi(x)$

$\psi(x,t) = \psi(x)e^{-i\omega t}$

$P(x)dx = |\psi(x)|^2 dx$

$P(x_1 : x_2) = \int_{x_1}^{x_2} |\psi(x)|^2 dx$

$\int_{-\infty}^{+\infty} |\psi(x)|^2 dx = 1$

$E_n = \frac{\hbar^2\pi^2}{2mL^2}n^2$

$\lambda_n = \frac{2L}{n}$

$\psi(x) = \sqrt{\frac{2}{L}} sin(\frac{n\pi x}{L})$

$E_{n_x,n_y} = \frac{\hbar^2\pi^2}{2mL^2}(n_x^2 + n_y^2)$

$E_{n_x,n_y} = E_\circ(n_x^2 + n_y^2)$

$E_\circ = \frac{\hbar^2\pi^2}{2mL^2}$

$\psi_{n_x,n_y}(x,y) = \frac{2}{L} sin(\frac{n_x\pi x}{L}) sin(\frac{n_y\pi x}{L})$

$E_{n_x,n_y,n_z} = \frac{\hbar^2\pi^2}{2m}(\frac{n_x^2}{L_1^2} + \frac{n_y^2}{L_2^2} + \frac{n_z^2}{L_3^2})$

$E_n = (n + \frac{1}{2})\hbar\omega_\circ \qquad \omega_\circ = \sqrt{\frac{k}{m}}$

$\delta x \approx \frac{1}{a} = \frac{h}{\sqrt{2m(U_\circ - E)}}$

$T = \left[1 + \frac{U_\circ^2 sinh^2(\kappa L)}{4E(U_\circ - E)}\right]^{-1}$

$\kappa = \frac{\sqrt{2m(U_\circ - E)}}{\hbar}$

$T \sim e^{-2\kappa L}$

$b = \frac{zZ}{2K}\frac{e^2}{4\pi\epsilon_\circ}cot(\frac{\theta}{2})$

$f_{>\theta} = nt\pi b^2$

$n = \frac{N_A \rho}{M_{mol}}$

$N(\theta) = \frac{nt}{4\pi r^2}\left(\frac{zZ}{2K}\right)^2\left(\frac{e^2}{4\pi\epsilon_\circ}\right)^2 \frac{1}{sin^4(\frac{\theta}{2})}$

$d = \frac{1}{4\pi\epsilon_\circ}\frac{zZe^2}{K}$

$\lambda = (364.5nm)\frac{n^2}{n^2-4}$

$L = n\hbar$

$r_n = \frac{4\pi\epsilon_\circ \hbar^2}{m_e e^2}n^2 = a_\circ n^2$

$v_n = \frac{\hbar}{m_e a_\circ}\frac{1}{n}$

$E_n = -\frac{m_e e^4}{32\pi^2\epsilon_\circ^2\hbar^2}\frac{1}{n^2} = -\frac{13.6eV}{n^2}$

$E_n = -(13.6eV)\frac{Z^2}{n^2}$

$r_n = \frac{a_\circ}{Z}n^2$

$\lambda = \frac{1}{R_\infty}\frac{n_1^2 n_2^2}{n_1^2 - n_2^2}$

$n = 1, 2, 3, ...$

$l = 0, 1, 2, 3, ..n-1$

$s, p, d, f, g..$

$m_l = 0, \pm 1, \pm 2, \pm 3, .. \pm l$

$m_s = \pm\frac{1}{2}$

$|\vec{L}| = \sqrt{l(l+1)}\hbar$

$L_z = m_l\hbar$

$cos(\theta) = \frac{L_z}{L} = \frac{m_l}{\sqrt{l(l+1)}}$

$|\vec{S}| = \sqrt{s(s+1)}\hbar = \sqrt{3/4}\hbar$

$S_z = m_s\hbar$

$\mu_{L,z} = -\frac{e\hbar}{2m}m_l = -\mu_B m_l$

$\mu_{S,z} = -\frac{e\hbar}{2m}$

$\mu_B = -\frac{e\hbar}{2m}$

$\mu_B = 9.271 \times 10^{-24} J/T$

$\Delta l = \pm 1$

$\Delta m_l = 0, \pm 1$

$E_{K_\alpha} = (10.2eV)(Z-1)^2$

$E_{K_\alpha} = \frac{hc}{\lambda_{K_\alpha}}$

$E_{rot} = E_l = \frac{\hbar^2 l(l+1)}{2I}$

$I = \sum_i m_i r_i^2$

$I = \mu R_{eq}^2$

$\mu = \frac{m_1 m_2}{m_1 + m_2}$

$E_{vib} = E_n = (n + \frac{1}{2})\hbar\omega$

$E_{vib} = E_n = (n + \frac{1}{2})\hbar\sqrt{\frac{k}{\mu}}$

$N_{microstates} = \frac{N!}{n_1! n_2! n_3! ....}$

$\overline{n_i} = \sum_i n_{ij} p_j$

$F_{MB}(E) = Ae^{\frac{-E}{kT}}$

$\bar{v} = \sqrt{\frac{8k_B T}{\pi m}}$

$\overline{v^2} = \frac{3k_B T}{m}$

$KE_{avg} = \frac{3}{2}k_B T$

$F_{FD}(E) = \frac{1}{e^{\frac{E-E_F}{kT}}+1}$

$F_{BE}(E) = \frac{1}{A_{BE}e^{\frac{E}{kT}}-1}$

$N(E) = V\frac{8\sqrt{2}\pi m_e^{3/2}}{h^3}E^{1/2}$

$E_F = \frac{0.121h^2}{m_e}n^{2/3}$

$E_F = \frac{1}{2}m_e v_F^2$

$E_F = k_B T_F$

$\sigma = \frac{1}{\rho} = \frac{ne^2\tau}{m}$

$\tau = \frac{l}{v_{avg}}$

$R = \frac{\rho L}{A}$

$R = R_\circ A^{1/3}, \quad R_\circ = 1.2fm$

$B_{nuc} = \left[Zm_H + Nm_n - m(^A_Z X_N)\right]c^2$

$a = \lambda N, \quad \lambda = \frac{ln(2)}{t_{1/2}}$

$N = N_\circ e^{-\lambda t}$

$a = a_\circ e^{-\lambda t}$

$X \rightarrow X' + x + Q$

$Q = \left[m_X - m_{X'} - m_x\right]c^2$

$1Ci = 3.7 \times 10^{10} Bq$