$c = 2.998 \times 10^8$ m/s $\quad e = 1.602 \times 10^{-19}$ C $\quad k = 1.381 \times 10^{-23}$ J/K $= 8.617 \times 10^{-5}$ eV/K

$h = 6.626 \times 10^{-34}$ J·s $= 4.136 \times 10^{-15}$ eV·s $\quad hc = 1240$ eV·nm $= 1240$ MeV·fm $\quad \hbar = h/2\pi$

1 eV $= 1.602 \times 10^{-19}$ J $\quad$ 1 u $= 931.50$ MeV/c^2 $= 1.6605 \times 10^{-27}$ kg

$m_e = 9.11 \times 10^{-31}$ kg $= 0.511$ MeV/c^2 $\quad m_p = 938.3$ MeV/c^2 $\quad m_n = 939.6$ MeV/c^2

$h/m_ec = 0.002426$ nm $\quad \sigma = 5.67 \times 10^{-8}$ W/m^2·K^4 $\quad$ 1 nm $= 10^{-9}$ m $\quad$ 1 fm $= 10^{-15}$ m

$N_A = 6.02 \times 10^{23}$ $\quad R = 8.314$ J/mole·K $\quad e^2/4\pi\varepsilon_0 = 1.44\ \text{eV}\cdot\text{nm}$

$a_0 = 4\pi\varepsilon_0\hbar^2/me^2 = 0.0529\,\text{nm}$ $\quad R_\infty = me^4/64\pi^3\varepsilon_0^2\hbar^3c = 1.097\times10^7\ \text{m}^{-1}$ $\quad \mu_B = e\hbar/2m = 9.274\times10^{-24}$ J/T

$$\Delta t = \frac{\Delta t_0}{\sqrt{1-u^2/c^2}} \qquad L = L_0\sqrt{1-u^2/c^2} \qquad v = \frac{v'+u}{1+v'u/c^2}$$

$$p = \frac{mv}{\sqrt{1-v^2/c^2}} \qquad K = E - E_0 \qquad E = \frac{mc^2}{\sqrt{1-v^2/c^2}} \qquad E_0 = mc^2 \qquad E = \sqrt{(pc)^2 + (mc^2)^2}$$

$$PV = nRT \qquad PV = NkT \qquad v_{\text{rms}} = \sqrt{3P/\rho} = \sqrt{3kT/m} \qquad \tfrac{1}{2}m(v^2)_{\text{av}} = \tfrac{3}{2}kT \qquad v_{\text{av}} = \sqrt{8kT/\pi m}$$

$$n(v) = 4\pi N(m/2\pi kT)^{3/2}v^2e^{-mv^2/2kT} \qquad N(v_1|v_2) = \int_{v_1}^{v_2} n(v)dv \qquad f(v_1|v_2) = \frac{1}{N}\int_{v_1}^{v_2} n(v)dv$$

$$N(E) = 2N\pi^{-1/2}(kT)^{-3/2}E^{1/2}e^{-E/kT} \qquad E_{\text{int}} = \tfrac{3}{2}nRT \text{ (monatomic gas)} \qquad C_V = \Delta E_{\text{int}}/n\Delta T$$

$$E = h\nu \qquad c = \lambda\nu \qquad K_{\max} = eV_s = h\nu - \phi \qquad p = h/\lambda \qquad I = \sigma T^4 \qquad \lambda_{\max}T = 2.898\times10^{-3}\,\text{m}\cdot\text{K}$$

$$R(\lambda) = \frac{2\pi hc^2}{\lambda^5(e^{hc/\lambda kT}-1)} \qquad \lambda' - \lambda = \frac{h}{m_ec}(1-\cos\theta) \qquad \frac{1}{E'} - \frac{1}{E} = \frac{1}{m_ec^2}(1-\cos\theta) \qquad \lambda_{\min} = \frac{hc}{eV}$$

$$\Delta x\Delta p_x \sim \hbar \qquad \Delta y\Delta p_y \sim \hbar \qquad \Delta E\Delta t \sim \hbar \qquad v_{\text{phase}} = \omega/k \qquad v_{\text{group}} = d\omega/dk$$

$$\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} + U(x)\psi(x) = E\psi(x) \qquad P(x)dx = |\psi|^2dx \qquad P = \int_{x_1}^{x_2}|\psi(x)|^2dx \qquad \int_{-\infty}^{+\infty}|\psi(x)|^2dx = 1$$

$$[f(x)]_{\text{av}} = \int_{-\infty}^{+\infty}|\psi(x)|^2 f(x)dx \qquad \text{Inf. well: } \psi_n(x) = \sqrt{\tfrac{2}{L}}\sin\frac{n\pi x}{L} \qquad E_n = \frac{\hbar^2\pi^2n^2}{2mL^2} \quad (n = 1,2,3...)$$

$$\Psi(x,t) = \psi(x)e^{-i\omega t} \qquad e^{i\theta} = \cos\theta + i\sin\theta \qquad \text{Osc.: } \psi_0(x) = Ae^{-ax^2} \quad E_n = (n+\tfrac{1}{2})\hbar\omega_0 \quad (n = 0,1,2,...)$$

$$b = \frac{zZe^2}{8\pi\varepsilon_0K}\cot\tfrac{1}{2}\theta \qquad f_{<b} = f_{>\theta} = nt\pi b^2 \qquad N(\theta) = \frac{nt}{4r^2}\left(\frac{e^2}{4\pi\varepsilon_0}\frac{zZ}{K}\right)^2\frac{1}{\sin^4\frac{1}{2}\theta} \qquad d = \frac{e^2}{4\pi\varepsilon_0}\frac{zZ}{K}$$

$$\lambda = \lambda_{\text{limit}}\frac{n^2}{n^2-n_0^2} \qquad E_n = \frac{-me^4Z^2}{32\pi^2\varepsilon_0^2\hbar^2}\frac{1}{n^2} = (-13.6\,\text{eV})\frac{Z^2}{n^2} \qquad r_n = \frac{a_0n^2}{Z} \qquad \lambda = \frac{1}{R_\infty}\frac{n_1^2n_2^2}{n_1^2-n_2^2}$$

$$P(r) = r^2|R_{n,l}(r)|^2 \qquad |\mathbf{L}| = \sqrt{l(l+1)}\hbar \qquad L_z = m_l\hbar \qquad f = \frac{3cR_\infty}{4}(Z-1)^2$$

$$f_{MB}(E) = 1/(Ae^{E/kT}) \qquad f_{FD}(E) = 1/(Ae^{E/kT}+1) \qquad f_{BE}(E) = 1/(Ae^{E/kT}-1)$$

$$R = R_oA^{1/3} \qquad A = \lambda N \qquad A = A_oe^{-\lambda t} \qquad N = N_oe^{-\lambda t} \qquad t_{1/2} = (\ln 2)/\lambda$$