Formulas:

Relativistic energy - momentum relation $\quad E = \sqrt{m^2 c^4 + p^2 c^2}$ $\qquad ; \qquad$ $c = 3 \times 10^8 \, m/s$

Electron rest mass : $m_e = 0.511 \, MeV/c^2$; Proton : $m_p = 938.26 \, MeV/c^2$; Neutron : $m_n = 939.55 \, MeV/c^2$

Planck's law : $\quad u(\lambda) = n(\lambda) \, \bar{E}(\lambda) \quad ; \quad n(\lambda) = \dfrac{8\pi}{\lambda^4} \quad ; \quad \bar{E}(\lambda) = \dfrac{hc}{\lambda} \dfrac{1}{e^{hc/\lambda k_B T} - 1}$

Energy in a mode/oscillator : $\; E_f = nhf \;$; probability $\; P(E) \propto e^{-E/k_B T}$

Stefan's law : $R = \sigma T^4 \;$; $\sigma = 5.67 \times 10^{-8} W/m^2 K^4 \; ; \; R = cU/4 \; , \; U = \displaystyle\int_0^\infty u(\lambda) d\lambda$

Wien's displacement law : $\lambda_m T = \dfrac{hc}{4.96 k_B}$

Photons : $\quad E = pc \; ; \; E = hf \; ; \quad p = h/\lambda \quad ; \quad f = c/\lambda$

Photoelectric effect : $\; eV_0 = (\dfrac{1}{2} mv^2)_{max} = hf - \phi \; , \quad \phi \equiv$ work function

Compton scattering : $\qquad \lambda' - \lambda = \dfrac{h}{m_e c} (1 - \cos\theta)$

Rutherford scattering: $\quad b = \dfrac{kq_\alpha Q}{m_\alpha v^2} \cot(\theta/2) \quad ; \quad \Delta N \propto \dfrac{1}{\sin^4(\theta/2)}$

Constants : $\; hc = 12,400 \, eV A \; ; \; \hbar c = 1,973 \, eV A \; ; \; k_B = 1/11,600 \; eV/K \; ; \; ke^2 = 14.4 eVA$

Electrostatics : $\; F = \dfrac{kq_1 q_2}{r^2}$ (force) ; $\; U = q_0 V$ (potential energy) ; $\; V = \dfrac{kq}{r}$ (potential)

Hydrogen spectrum : $\; \dfrac{1}{\lambda} = R(\dfrac{1}{m^2} - \dfrac{1}{n^2}) \qquad ; \qquad R = 1.097 \times 10^7 \, m^{-1} = \dfrac{1}{911.3 A}$

Bohr atom : $E_n = -\dfrac{ke^2 Z}{2 r_n} = -\dfrac{Z^2 E_0}{n^2} \; ; \; E_0 = \dfrac{ke^2}{2a_0} = \dfrac{mk^2 e^4}{2\hbar^2} = 13.6 eV \; ; \; E_n = E_{kin} + E_{pot}, E_{kin} = -E_{pot}/2 = -E_n$

$hf = E_i - E_f \; ; \; r_n = r_0 n^2 \; ; \; r_0 = \dfrac{a_0}{Z} \; ; \; a_0 = \dfrac{\hbar^2}{mke^2} = 0.529 A \; ; \; L = mvr = n\hbar$ angular momentum

X - ray spectra : $\; f^{1/2} = A_n (Z - b) \; ; \;$ K : $b = 1$, L : $b = 7.4$

de Broglie : $\; \lambda = \dfrac{h}{p} \; ; f = \dfrac{E}{h} \; ; \; \omega = 2\pi f \; ; \; k = \dfrac{2\pi}{\lambda} \; ; \; E = \hbar\omega \; ; \; p = \hbar k \; ; \; E = \dfrac{p^2}{2m}$

group and phase velocity : $\; v_g = \dfrac{d\omega}{dk} \quad ; \quad v_p = \dfrac{\omega}{k} \quad ; \quad$ Heisenberg $\; : \; \Delta x \Delta p \sim \hbar \quad ; \quad \Delta t \Delta E \sim \hbar$

Wave function $\qquad \Psi(x,t) = |\Psi(x,t)| e^{i\theta(x,t)} \quad ; \qquad P(x,t) \, dx = |\Psi(x,t)|^2 \, dx =$ probability

Schrodinger equation : $\quad -\dfrac{\hbar^2}{2m} \dfrac{\partial^2 \Psi}{\partial x^2} + V(x)\Psi(x,t) = i\hbar \dfrac{\partial \Psi}{\partial t} \quad ; \qquad \Psi(x,t) = \psi(x) e^{-i\frac{E}{\hbar}t}$

Time - independent Schrodinger equation : $\quad -\dfrac{\hbar^2}{2m} \dfrac{\partial^2 \psi}{\partial x^2} + V(x)\psi(x) = E\psi(x) \; ; \quad \displaystyle\int_{-\infty}^\infty dx \, \psi^* \psi = 1$

∞ square well : $\; \psi_n(x) = \sqrt{\dfrac{2}{L}} \sin(\dfrac{n\pi x}{L}) \; ; \; E_n = \dfrac{\pi^2 \hbar^2 n^2}{2mL^2}$