Some Useful Numbers, Equations, and Identities:

Speed of light, $c = 2.998 \times 10^8$ m/s

Planck's constant, $h = 6.626 \times 10^{-34}\,\mathrm{J \cdot s}$

$\hbar = \frac{h}{2\pi}$ $\qquad$ $1\ \mathrm{eV} = 1.602 \times 10^{-19}\,\mathrm{J}$

Coulomb's constant, $k = 8.99 \times 10^9\,\mathrm{N\,m^2\,C^{-2}}$

Electron Charge, $e = 1.602 \times 10^{-19}\,\mathrm{C}$

Electron Mass, $m_e = 9.11 \times 10^{-31}\,\mathrm{kg} = 0.511\,\mathrm{MeV/c^2}$

Rydberg Constant: $\mathrm{R} = 1.097 \times 10^7\,\mathrm{m^{-1}}$

Atomic Mass Unit: $\mathrm{u} = 1.6606 \times 10^{-27}\,\mathrm{kg} = 931.5\,\mathrm{MeV/c^2}$

Proton Mass, $m_p = 1.673 \times 10^{-27}\,\mathrm{kg} = 938.3\,\mathrm{MeV/c^2} = 1.0073\,\mathrm{u}$

Neutron Mass, $m_n = 1.675 \times 10^{-27}\,\mathrm{kg} = 939.6\,\mathrm{MeV/c^2} = 1.0087\,\mathrm{u}$

Compton wavelength for an electron: $\frac{h}{m_e c} = 0.00243\,\mathrm{nm}$

Compton-Scattering formula: $\lambda' - \lambda_o = \frac{h}{m_e c}(1 - cos\theta)$

Photo-Electric Equation: $eV_s = hf - \phi = h(f - f_o)$

For a Relativisitic Particle: $p = \gamma m_o u, \qquad \gamma = \frac{1}{\sqrt{1-(\frac{v}{c})^2}}$

Energy for a particle: $E = K + m_o c^2 = \gamma m_o c^2$

Energy-momentum relation for a particle: $p = \frac{1}{c}\sqrt{E^2 - m_o^2 c^4} = \frac{1}{c}\sqrt{2m_o c^2 K + K^2}$

Energy-momentum relation for a photon: $E = pc$

Relative Velocity: $u' = \frac{u-v}{1-\frac{uv}{c^2}}$

Doppler Effect for a light source approaching the observer: $f_{obs} = f_o \frac{\sqrt{1+\frac{v}{c}}}{\sqrt{1-\frac{v}{c}}}$

$sin^2\theta = \frac{1}{2}[1 - cos(2\theta)]$

$cos^2\theta = \frac{1}{2}[1 + cos(2\theta)]$

$\int_0^\infty e^{-\alpha x^2} dx = \frac{1}{2}\sqrt{\frac{\pi}{\alpha}}, \quad \alpha > 0$

$\int_0^\infty x^2 e^{-\alpha x^2} dx = \frac{1}{4}\sqrt{\frac{\pi}{\alpha^3}}, \alpha > 0$

$\int_a^b x^n e^{-x} dx = -(x^n + nx^{n-1} + n(n-1)x^{n-2} + n(n-1)(n-2)x^{n-3} + ... + n!)e^{-x}|_a^b$

$\int_0^\infty x^n e^{-x} dx = n!$

De Broglie Wavelength: $\lambda = h/p$

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

1-Dimensional Normalization Condition: $\int_{-\infty}^{+\infty} \psi^* \psi \, dx = 1$

Harmonic Oscillator Potential: $U = \frac{1}{2}m\omega^2 x^2$

For a Hydrogenic atom,
Energy $E_n = -\frac{ke^2}{2a_o}\frac{Z^2}{n^2}, \ n = 1, 2, 3, 4, ...$

Bohr Radius: $a_o = \frac{h^2}{4\pi^2 m_e k e^2} = 0.529 \times 10^{-10}\,\mathrm{m}$

Volume element in spherical coordinates, $dV = r^2 sin\theta dr d\theta d\phi$, *or* $4\pi r^2 dr$

Ground state Wavefunction for Hydrogen: $\Psi(r, \theta, \phi) = \frac{1}{\cancel{Z}\sqrt{\pi}}(\frac{1}{a_o})^{3/2} \cancel{Z} e^{-r/a_o}$

Root-Mean-Square deviation: $\Delta r = \sqrt{\overline{r^2} - \overline{r}^2}$

Expectation value for an operator Q: $\overline{Q} = \int_{\text{allspace}} dV \Psi^* [Q] \Psi$
