

$$\begin{aligned}
e &= 1.60217733 \times 10^{-19} C \\
m_e &= 9.109 \times 10^{-31} kg \\
m_n &= 1.675 \times 10^{-27} kg \\
m_p &= 1.673 \times 10^{-27} kg \\
c &= 2.998 \times 10^8 m/s \\
h &= 6.626 \times 10^{-34} J \cdot s \\
\hbar &= 1.055 \times 10^{-34} J \cdot s \\
R &= 1.0973732 \times 10^7 m^{-1} \\
a_0 &= \frac{\hbar^2}{m_e k e^2} = 0.529 \text{Å} = 0.0529 nm \\
H_0 &= 23 \times 10^{-6} (km/s) / \text{lightyear} \\
E^2 &= p^2 c^2 + m^2 c^4 \\
e_{\text{total}} &= a \sigma T^4 \\
\lambda_{\text{max}} T &= 2.898 \times 10^{-3} m \cdot K \\
u(f, T) &= \frac{8\pi h f^3}{c^3} \left(\frac{1}{e^{hf/k_B T} - 1} \right) \\
E_{\text{resonator}} &= nhf \quad n = 1, 2, 3, \dots \\
u(f, T) &= \bar{E} N 9 f) df \\
K_{\text{max}} &= \frac{1}{2} m^e v_{\text{max}}^2 = eV_s \\
K_{\text{max}} &= hf - \phi \\
n\lambda &= 2d \sin \theta \quad n = 1, 2, 3, \dots \\
\lambda' - \lambda &= \frac{h}{m_e c} (1 - \cos \theta) \\
f' &= f \left(1 + \frac{gH}{c^2} \right) \\
f' &= f \left(1 + \frac{GM}{R_S c^2} \right) \\
\frac{e}{m_e} &= \frac{V\theta}{B^2 t d} \\
\frac{1}{\lambda} &= R \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \\
E_i - E_f &= hf \\
m_e v r &= n\hbar \\
r_n &= \frac{n^2 \hbar^2}{m_e k e^2} \quad n = 1, 2, 3, \dots \\
E_n = -\frac{ke^2}{2a_0} \left(\frac{1}{n^2} \right) &= -\frac{13.6 eV}{n^2} \quad n = 1, 2, 3, \dots \\
\frac{1}{\lambda} &= \frac{f}{c} = \frac{ke^2}{2a_0 hc} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \\
\lambda &= \frac{h}{p} \\
v_p &= \frac{\omega}{k} \\
v_g &= \left. \frac{d\omega}{dk} \right|_{k_0} \\
v_p &= c \sqrt{1 + \left(\frac{mc}{\hbar k} \right)^2} \\
f(x) &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} a(k) e^{ikx} dk \\
a(k) &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} f(x) e^{-ikx} dx \\
\Delta p_x \Delta x &\geq \frac{\hbar}{2} \\
\Delta E \Delta t &\geq \frac{\hbar}{2} \\
P(x) dx &= |\Psi(x, t)|^2 dx \\
1 &= \int_{-\infty}^{+\infty} |\Psi(x, t)|^2 dx \\
\Psi_k(x, t) &= A e^{i(kx - \omega t)} = A [\cos(kx - \omega t) + i \sin(kx - \omega t)] \\
i\hbar \frac{\partial \Psi}{\partial t} &= -\frac{\hbar^2}{2m} \frac{\partial^2 \Psi}{\partial x^2} + U(x) \Psi \\
E \psi(x) &= -\frac{\hbar^2}{2m} \frac{d^2 \psi}{dx^2} + U(x) \psi(x) \\
E_n &= \frac{\hbar^2 k^2}{2m} = \frac{n^2 \pi^2 \hbar^2}{2mL^2} \\
\psi_n(x) &= \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi x}{L}\right) \\
\delta &= \frac{1}{\alpha} = \frac{\hbar}{\sqrt{2m(U-E)}} \\
E_n &\approx \frac{n^2 \pi^2 \hbar^2}{2m(L+2\delta)^2} \quad n = 1, 2, 3, \dots \\
E_n &= \left(n + \frac{1}{2}\right) \hbar \omega \quad n = 0, 1, 2, 3, \dots \\
\langle x \rangle &= \int_{-\infty}^{+\infty} x |\Psi(x, t)|^2 dx \\
\langle f \rangle &= \int_{-\infty}^{+\infty} f(x) |\Psi(x, t)|^2 dx \\
\Delta x &= \sqrt{\langle x^2 \rangle - \langle x \rangle^2} \\
\langle p \rangle &= \int_{-\infty}^{+\infty} \Psi^* \left(\frac{\hbar}{i} \right) \frac{\partial}{\partial x} \Psi dx \\
\langle Q \rangle &= \int_{-\infty}^{+\infty} \Psi^* [Q] \Psi dx \\
[H] &= -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + U(x) \\
[E] &= i\hbar \frac{\partial}{\partial t} \\
i\hbar \frac{\partial \Psi}{\partial t} &= -\frac{\hbar^2}{2m} \nabla^2 \Psi + U(\vec{r}) \Psi \\
E \psi(\vec{r}) &= -\frac{\hbar^2}{2m} \nabla^2 \psi(\vec{r}) + U(\vec{r}) \psi(\vec{r}) \\
|p_x| &= \hbar k_1 = n_1 \frac{\pi \hbar}{L} \quad n_1 = 1, 2, \dots \\
E &= \frac{1}{2m} (|p_x|^2 + |p_y|^2 + |p_z|^2) \\
\psi(\vec{r}) &= \psi(r, \theta, \phi) = R(r) \Theta(\theta) \Phi(\phi) \\
x &= r \sin \theta \cos \phi \\
y &= r \sin \theta \sin \phi \\
z &= r \cos \theta \\
|\vec{L}| &= \sqrt{\ell(\ell+1)} \hbar \quad \ell = 0, 1, 2, \dots \\
L_z &= m_\ell \hbar \quad m_\ell = 0, \pm 1, \dots, \pm \ell
\end{aligned}$$

$$\begin{aligned}
\cos \theta &= \frac{L_z}{|\vec{L}|} \\
\Psi(r, \theta, \phi, t) &= R(r) Y_\ell^{m_\ell}(\theta, \phi) e^{-i\omega t} \\
E_n &= -\frac{\hbar^2 k^2}{2m_e} \left[\frac{Z^2}{n^2} \right] \quad n = 1, 2, \dots \\
P(r) &= r^2 |R(r)|^2 \\
\langle r \rangle &= \int_0^\infty r P(r) dr \\
\nabla^2 &= \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \\
\nabla^2 &= \frac{\partial^2}{\partial r^2} + \left(\frac{2}{r} \right) \frac{\partial}{\partial r} + \frac{1}{r^2} \left[\frac{\partial^2}{\partial \theta^2} + \cot \theta \frac{\partial}{\partial \theta} + \csc^2 \theta \frac{\partial^2}{\partial \phi^2} \right] \\
dV &= dx dy dz = r^2 \sin \theta d\phi d\theta dr \\
\vec{\mu} &= \frac{q}{2m_e} \vec{L} \\
\omega_L &= \frac{q}{2m_e} B \\
U &= -\vec{\mu} \cdot \vec{B} \\
E &= E_0 + \hbar \omega_L m_\ell \\
\vec{\mu}_s &= \frac{q}{2m_e} \vec{S} \\
S_z &= m_s \hbar \\
|\vec{S}| &= \sqrt{s(s+1)} \hbar = \frac{\sqrt{3}}{2} \hbar \\
\vec{\mu} &= \vec{\mu}_0 + \vec{\mu}_s = \frac{-e}{2m_e} \left[\vec{L} + g\vec{S} \right] \\
\psi(\vec{r}_1, \vec{r}_2) &= \pm \psi(\vec{r}_2, \vec{r}_1) \\
Z &\equiv \frac{\Delta \lambda}{\lambda} \\
Z &= \sqrt{\frac{c+v}{c-v}} - 1 \\
v &= \frac{H_0 R}{c} \\
H(t) &= \frac{\dot{a}(t)}{a(t)}
\end{aligned}$$