PHYSICS 4D EQUATION SHEET

$\vec{u}' = \vec{u} - \vec{v}$

$\Delta t = \gamma \Delta t'$

$L = \dfrac{L'}{\gamma}$

$\gamma = \dfrac{1}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

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

$y' = y$

$z' = z$

$t' = \gamma\left(t - \dfrac{vx}{c^2}\right)$

$u_x' = \dfrac{u_x - v}{1 - \left(u_x v / c^2\right)}$

$u_y' = \dfrac{u_y}{\gamma\left[1 - \left(u_x v / c^2\right)\right]}$

$u_z' = \dfrac{u_z}{\gamma\left[1 - \left(u_x v / c^2\right)\right]}$

$\vec{p} = \gamma m \vec{u}$

$\vec{F} = \dfrac{d\vec{p}}{dt}$

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

$E = \gamma mc^2 = K + mc^2$

$E^2 = (pc)^2 + (mc^2)^2$

$E_i = \dfrac{m_i c^2}{\sqrt{1 - \left(\dfrac{u_i}{c}\right)^2}}$

$E_{res} = nhf$

$\Delta E = hf$

$K_{\max} = \dfrac{1}{2} m_e v_{\max}^2 = eV_s$

$K_{\max} = hf - \phi$

$2d \sin\theta = n\lambda$

$\Delta\lambda = \dfrac{h}{m_e c}(1 - \cos\theta)$

$\left|E_f - E_i\right| = hf$

$r_n = \dfrac{n^2 \hbar^2}{m_e k e^2}$

$m_e v r = n\hbar$

$E_n = -\dfrac{ke^2}{2a_o}\left(\dfrac{1}{n^2}\right)$

$E_n = -13.6eV\left(\dfrac{z}{n}\right)^2$ n =1,2,3, ...

$r_n = a_o \dfrac{n^2}{Z}$

$\lambda = h / p$

$f = E / h$

$v_p = \omega / k$

$v_g = \dfrac{d\omega}{dk}$

$\Delta p_x \Delta x \geq \dfrac{\hbar}{2}$

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

$P(x)dx = \left|\Psi(x,t)\right|^2 dx$

$\int_{-\infty}^{+\infty} \left|\Psi(x,t)\right|^2 dx$

$p_{ab} = \int_a^b \left|\Psi(x,t)\right|^2 dx$

$\Psi(x,t) = Ae^{i(kx - \omega t)}$

$\Psi(x,0)=\int_{-\infty}^{+\infty} a(k)e^{ikx}dk$	$\int_{0}^{+\infty} P(r)dr=1$
$\Psi(x,t)=\int_{-\infty}^{+\infty} a(k)e^{i(kx-\omega t)}dk$	$<r>=\int_{0}^{+\infty} rP(r)dr$
$\frac{-\hbar^2}{2m}\frac{\partial^2\Psi(x,t)}{\partial x^2}+U(x)\Psi(x,t)=i\hbar\frac{\partial\Psi(x,t)}{\partial t}$	$<f>=\int_{0}^{+\infty} f(r)P(r)dr$
$\Psi(x,t)=\psi(x)\phi(t)=\psi(x)e^{-i\omega t}$	$\vec{\mu}=i\vec{A}$
$\frac{-\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2}+U(x)\psi(x)=E\psi(x)$	$\vec{\mu}=g\frac{q}{2m}\vec{L}$
$E_n=\frac{n^2\pi^2\hbar^2}{2mL^2}$	$\mu_B=\frac{e\hbar}{2m_e}$
$\psi(x)=\sqrt{\frac{2}{L}}\sin\left(\frac{n\pi x}{L}\right)$	$\mu_z=g\frac{q}{2m_e}L_z$
$E_n=(n+1/2)\hbar\omega$	$\vec{\tau}=\vec{\mu}\times\vec{B}$
$<x>=\int_{-\infty}^{+\infty} x\left\|\Psi(x,t)\right\|^2 dx$	$\omega_L=\frac{eB}{2m_e}$
$<f>=\int_{-\infty}^{+\infty} f(x)\left\|\Psi\right\|^2 dx$	$U=-\vec{\mu}\bullet\vec{B}$
$\Delta x=\sqrt{<x^2>-<x>^2}$	$\mu_s=g\frac{q}{2m_e}\vec{S}$
$R=\frac{(\Psi\Psi^*)_{reflected}}{(\Psi\Psi^*)_{incident}}$	$S_z=m_s\hbar\ (m_s=\pm 1/2)$
$T=\frac{(\Psi\Psi^*)_{transmitted}}{(\Psi\Psi^*)_{incident}}$	$\left\|\vec{S}\right\|=\sqrt{s(s+1)}\hbar$
$R+T=1$	$s=1/2$ (for an electron)
$\frac{-\hbar^2}{2m}\nabla^2\Psi(\vec{r},t)+U(\vec{r})\Psi(\vec{r},t)=i\hbar\frac{\partial\Psi(\vec{r},t)}{\partial x}$	$\vec{\mu}=\vec{\mu}_o+\vec{\mu}_s=\frac{-e}{2m_e}(\vec{L}+g\vec{S})$
$\frac{-\hbar^2}{2m}\nabla^2\psi(\vec{r})+U(\vec{r})\psi(\vec{r})=E\psi(\vec{r})$	$\vec{J}=\vec{L}+\vec{S}$
$\psi(r,\theta,\phi)=R_{nl}(r)Y_l^{m_l}(\theta,\phi)$	$\left\|\vec{J}\right\|=\sqrt{j(j+1)}\hbar$ (j = ℓ+s , ℓ+s-1,... , $\left\|\ell-s\right\|$)
$L=\sqrt{l(l+1)}\hbar$	$J_z=m_j\hbar$ (m_j= j, j-1, ..., -j)
$L_z=m_l\hbar$	
$P(r)=r^2\left\|R_{nl}(r)\right\|^2$	