Equations Test 1 – PHYS 3313

$c = 3.0\times10^{8}\ m/s$

$m_{electron} = 0.511\ MeV/c^2 = 9.11\times10^{-31}\ kg$

$m_{proton} = 938\ MeV/c^2 = 1.67\times10^{-27}\ kg \approx m_{neutron}$

$e = 1.6\times10^{-19}\ Coulomb$

$h = 6.63\times10^{-34}\ J.s = 4.14\times10^{-15}\ eV.s$

$R = 1.097\times10^{7}\ m^{-1}$

$\phi_{(Work\ function)}$:

$Platinum = 6.4\,eV$
$Silver = 4.6\,eV$
$Potassium = 2.2\,eV$

$a_0 = r_1 = 0.529\times10^{-10}\ m$

$E_1 = \text{-}13.6\,eV$

$\frac{1}{4\pi\varepsilon_0} = 9\times10^{9}\ N.m^2/C^2$

$$\gamma = \left(1-\frac{v^2}{c^2}\right)^{-1/2}$$

Lorentz Transform S' moving relative to S

$$x' = \gamma(x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = \gamma\left(t - \frac{vx}{c^2}\right)$$

Velocity addition

$$v_x = \frac{v_{x'} + v}{1+\frac{v.v_{x'}}{c^2}}$$

$$p = \gamma mv$$

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

$$v = \frac{pc^2}{E}$$

$$KE = \frac{mv^2}{2} = \frac{p^2}{2m}\ (non-relativistic)$$

$$W = qV = -\int Fdx \qquad P = Energy/Time$$

$$E_{particle} = \sqrt{(mc^2)^2 + (pc)^2}$$

$$E = pc \quad if\ m = 0$$

$$E = hf\ \ (photons)$$

$$\hbar = h/2\pi$$

$$v = f\lambda \quad v = c\ for\ EM\ waves$$

$$KE_{\max} = hf - hf_0 = hf - \phi = eV_0\ \ (photoelectric)$$

$$x-rays \quad \lambda_{\min} = \frac{hc}{eV_0}$$

$$Compton \quad \lambda' - \lambda = \lambda_c(1-\cos\theta);\ \lambda_c = \frac{h}{mc}$$

$$\lambda = \frac{h}{p} \qquad \Delta x\Delta p = \geq \frac{\hbar}{2} \qquad \Delta E\Delta t = \geq \frac{\hbar}{2}$$

$$v_p = \frac{\omega}{k} \quad v_g = \frac{\partial\omega}{\partial k} \quad \omega = 2\pi\upsilon \quad k = \frac{2\pi}{\lambda}$$

$$F_e = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$$

$$E_n = \frac{E_1}{n^2} \qquad r_n = r_1 n^2$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^{\,2}} - \frac{1}{n_i^{\,2}}\right)\ \ (emitted\ photon)$$

$$\hat{p} = \frac{\hbar}{i}\frac{\partial}{\partial x} \qquad \hat{E} = i\hbar\frac{\partial}{\partial t}$$

Schrodinger's Equation:

$$i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2} + U\Psi$$

Time-independent Schrodinger's Equation:

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{2m}{\hbar^2}(E-U)\psi = 0$$

$$\hat{G}\psi_n = G_n\psi_n$$

$$\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + U \qquad \int_{-\infty}^{\infty}|\psi|^2 dx = 1$$

$$\langle G(x)\rangle = \int \psi^* G(x)\psi\ dx$$

$$Particle\ in\ a\ box \quad E_n = \frac{n^2\pi^2\hbar^2}{2mL^2}$$

Harmonic oscillator:

$$E_n = \left(n + \tfrac{1}{2}\right)hf \qquad n = 0,\ 1,\ 2,\ 3,\ ....$$

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

$$\sin\alpha\sin\beta = \frac{1}{2}\left[\cos(\alpha-\beta) - \cos(\alpha+\beta)\right]$$