

PHY 251 equation sheet for exam 1

$\nu = \frac{\nu_0}{\gamma[1 + (v/c) \cos \theta]}$ with $\theta = 0$ for emitter moving directly away.

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

$$p = \gamma m_0 v, F_{\perp} = \gamma m_0 a, F_{\parallel} = \gamma^3 m_0 a.$$

$$x_2 = \gamma(x_1 - vt_1)$$

$$y_2 = y_1$$

$$z_2 = z_1$$

$$t_2 = \gamma\left(t_1 - \frac{v}{c}x_1\right)$$

and

$$v_{2,x} = \frac{v_{1,x} - v}{1 - \frac{v v_{1,x}}{c^2}}$$

$$v_{2,y} = \frac{v_{1,y}}{\gamma\left[1 - \frac{v v_{1,x}}{c^2}\right]}$$

$$v_{2,z} = \frac{v_{1,z}}{\gamma\left[1 - \frac{v v_{1,x}}{c^2}\right]}$$

$$E = E_0 + E_k = m_0 c^2 + (\gamma - 1)m_0 c^2,$$

$$E^2 = E_0^2 + p^2 c^2.$$

$$p_{x,2} = \gamma(p_{x,1} - v(E/c^2))$$

$$p_{y,2} = p_{y,1}$$

$$p_{z,2} = p_{z,1}$$

$$E_2 = \gamma(E - vp_x).$$

$$E = h\nu = hc/\lambda, 1 \text{ eV} = 1.602 \times 10^{-19} \text{ Joule},$$

$$h = 6.62 \times 10^{-34} \text{ J}\cdot\text{sec}, \hbar = 4.14 \times 10^{-15}$$

$$\text{eV}\cdot\text{sec}. hc = 1239.8 \text{ eV}\cdot\text{nm}.$$

$$k_B = 1.38 \times 10^{-23} \text{ J/K}, k_B = 8.62 \times 10^{-5}$$

$$\text{eV/K}, c = 3.00 \times 10^8 \text{ m/sec}.$$

$$u_{\nu} d\nu = \frac{8\pi h\nu^3}{c^3} \frac{1}{\exp[h\nu/kT] - 1} d\nu$$

$$\lambda_{\text{peak}} = hc/(2.821 k_B T)$$

$$E_k = h\nu - \phi.$$

$$\lambda = h/p, \lambda_s - \lambda_0 = \frac{h}{m_e c}(1 - \cos \theta).$$

Centripetal force to maintain circular motion:

$$\gamma m v^2 / r.$$

Lorentz force: $q\vec{v} \times \vec{B}$.

Masses:

| | kg | MeV/c ² | amu |
|-------|-------------------------|--------------------|----------|
| m_e | 9.11×10^{-31} | 0.510999 | 0.000549 |
| m_p | 1.673×10^{-27} | 938.272 | 1.007276 |
| m_n | 1.675×10^{-27} | 939.566 | 1.008665 |
| amu | 1.660×10^{-27} | 931.494 | 1 |

$$p = h/\lambda$$

$$r_n = \frac{n^2}{Z} a_0 \text{ with } a_0 = \frac{\epsilon_0 h^2}{m\pi e^2} = 0.053 \text{ nm}.$$

$$E_n = -\frac{Z^2}{n^2} E_0 \text{ with } E_0 = \frac{me^4}{8\epsilon_0^2 h^2} = 13.60 \text{ eV}.$$

$$m_r = \frac{m_1 m_2}{m_1 + m_2}.$$

$$\frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r^2} = m \frac{v^2}{r}.$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ in mks units}.$$