PHY 251 equation sheet for exam 1 (September 22, 2009 version)

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

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

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

$$\begin{aligned} x_2 &= \gamma\,(x_1 - v t_1) \\ y_2 &= y_1 \\ z_2 &= z_1 \\ t_2 &= \gamma\left(t_1 - \frac{v}{c^2} x_1\right) \end{aligned}$$

and

$$\begin{aligned} v_{2,x} &= \frac{v_{1,x} - v}{1 - \dfrac{v\, v_{1,x}}{c^2}} \\ v_{2,y} &= \frac{v_{1,y}}{\gamma\left[1 - \dfrac{v\, v_{1,x}}{c^2}\right]} \\ v_{2,z} &= \frac{v_{1,z}}{\gamma\left[1 - \dfrac{v\, v_{1,x}}{c^2}\right]} \end{aligned}$$

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

$$\begin{aligned} p_{x,2} &= \gamma\left(p_{x,1} - v(E/c^2)\right) \\ p_{y,2} &= p_{y,1} \\ p_{z,2} &= p_{z,1} \\ E_2 &= \gamma(E - v p_x). \end{aligned}$$

$E = h\nu = hc/\lambda$, 1 eV=1.602×10^{-19} Joule,
$h = 6.62 \times 10^{-34}$ J·sec, $h = 4.14 \times 10^{-15}$ eV·sec. $hc = 1239.8$ eV·nm.
$k_B = 1.38 \times 10^{-23}$ J/K, $k_B = 8.62 \times 10^{-5}$ eV/K, $c = 3.00 \times 10^8$ m/sec.

$$\begin{aligned} u_\nu\, d\nu &= \frac{8\pi h\nu^3}{c^3} \frac{1}{\exp[h\nu/kT] - 1}\, d\nu \\ \lambda_{\text{peak}} &= hc/(4.965\, k_B T) \end{aligned}$$

$E_k = h\nu - \phi$.

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

$p = h/\lambda$
$r_n = \dfrac{n^2}{Z} a_0$ with $a_0 = \dfrac{\epsilon_0 h^2}{m\pi e^2} = 0.053$ nm.
$E_n = -\dfrac{Z^2}{n^2} E_0$ with $E_0 = \dfrac{me^4}{8\epsilon_0^2 h^2} = 13.60$ eV.
$m_r = \dfrac{m_1 m_2}{m_1 + m_2}$.
$\dfrac{1}{4\pi\epsilon_0} \dfrac{Ze^2}{r^2} = m\dfrac{v^2}{r}$.
$\epsilon_0 = 8.85 \times 10^{-12}$ in mks units.
$(1 + x)^n \simeq 1 + nx$ for $x \ll 1$.