Phys 3250 Topics in Relativity
Formula Sheet for Exam 3

$\tau^2 = t^2 - s^2 \qquad d\tau^2 = dt^2 - ds^2 \qquad \sigma^2 = s^2 - t^2 \qquad d\sigma^2 = ds^2 - dt^2$

$\frac{E}{m} = \frac{dt}{d\tau} \qquad \frac{p}{m} = \frac{ds}{d\tau} \qquad m^2 = E^2 - p^2 \qquad (d\tau)^2 = (dt)^2 - (dr)^2 - (rd\phi)^2$

$(d\tau)^2 = \left(1 - \frac{2M}{r}\right)(dt)^2 - \frac{(dr)^2}{\left(1 - \frac{2M}{r}\right)} - (rd\phi)^2 \qquad (d\sigma)^2 = \frac{(dr)^2}{\left(1 - \frac{2M}{r}\right)} + (rd\varphi)^2 - \left(1 - \frac{2M}{r}\right)(dt)^2$

$d\tau = dt_{shell} = \left(1 - \frac{2M}{r}\right)^{1/2} dt \qquad d\sigma = dr_{shell} = \frac{dr}{\left(1 - \frac{2M}{r}\right)^{1/2}}$

$$\Delta r_{shell} = \int_{r_{inner}}^{r_{outer}} \frac{dr}{\left(1 - \frac{2M}{r}\right)^{1/2}} = \left(\sqrt{r(r-2M)} + 2M\ln\left(\sqrt{r} + \sqrt{r-2M}\right)\right]\Bigg|_{r_{inner}}^{r_{outer}}$$

$1kg = 7.424 \times 10^{-28} m \qquad 1m = 3.3356 \times 10^{-9} s \qquad M_{Sun} = 1.477 km$

The rest of the equations deal with special relativity from a conventional unit perspective

$x' = \frac{x - vt}{\sqrt{1 - v^2/c^2}} \qquad y' = y \qquad z' = z \qquad t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - v^2/c^2}} \qquad t'_B - t'_A = \frac{(t_B - t_A) - \frac{v}{c^2}(x_B - x_A)}{\sqrt{1 - v^2/c^2}}$

$x'_B - x'_A = \frac{x_B - x_A + v(t_B - t_A)}{\sqrt{1 - v^2/c^2}} \qquad L = L_0\sqrt{1 - v^2/c^2} \qquad t = \frac{t_0}{\sqrt{1 - v^2/c^2}}$

$u'_x = \frac{u_x - v}{1 - (u_x v)/c^2} \qquad u'_y = \frac{u_y\sqrt{1 - v^2/c^2}}{1 - (u_x v)/c^2} \qquad u'_z = \frac{u_z\sqrt{1 - v^2/c^2}}{1 - (u_x v)/c^2} \qquad \nu = \nu_0 \frac{\sqrt{1 - v^2/c^2}}{1 - \frac{v}{c}\cos\theta} \qquad \nu = \nu_0\sqrt{\frac{c \pm v}{c \mp v}}$

$m = \frac{m_0}{\sqrt{1 - v^2/c^2}} \qquad \vec{p} = m\vec{u} \qquad K = mc^2 - m_0c^2 \qquad E = mc^2 \qquad E^2 = (pc)^2 + E_0^2 = \left(K + m_0c^2\right)^2$

$q\vec{u} \times \vec{B} = \frac{mu^2}{R} \qquad R = \frac{\gamma m_0 u}{qB} \qquad 1eV = 1.602 \times 10^{-19} J \qquad 1\frac{MeV}{c} = 0.534 \times 10^{-21} \frac{kg \cdot m}{s}$