PHY 3305 Spring 2011 Quiz #2 Name:

1) Assuming a constant acceleration over 1 second, how much force is required to accelerate one proton from 0.99 times the speed of light to 0.999999 times the speed of light?

Soln

$$F = \frac{dp}{dt} = \frac{\Delta p}{\Delta t}$$

$$\Delta t = 1\,sec$$

$$p_1 = \gamma(\beta=0.99)\, m_p\, (0.99c)$$

$$= 7.09\,(1.67\times10^{-27}\,kg)\; 2.97\times10^{8}\,m/s$$

$$= 3.51\times10^{-18}\,kg\,m/s$$

$$p_2 = 707\,(1.67\times10^{-27}\,kg)\; 3.0\times10^{8}\,m/s$$

$$= 3.54\times10^{-16}\,kg\,m/s$$

$$\boxed{F = 3.51\times10^{-16}\,N}$$

Quiz #3 PHY 3305 Feb 15, 2011 Name:

1) An inch is 2.54 cm. What is the velocity of a ruler when its inch marks line up with centimeter marks of a stationary blue (wavelength = 400 nm) metric ruler?

$L = L_p/\gamma \qquad \gamma = L_p/L = 2.54$

$\frac{1}{\sqrt{1-\beta^2}} = 2.54 \Rightarrow \qquad 0.155 = 1-\beta^2$

$+\beta^2 = +0.845$

$\boxed{\beta = 0.92}$

What color would the metric ruler appear to be (calculate the wavelength) to a person approaching with the moving ruler?

$f = f_0 \frac{\sqrt{1+\beta}}{\sqrt{1-\beta}}$ ($\beta > 0$ since approaching)

$c = \lambda\nu \Rightarrow \frac{c}{\lambda} = \frac{c}{\lambda_0}\frac{\sqrt{1+\beta}}{\sqrt{1-\beta}}$ ($c = \lambda f$)

$\lambda_0 = \lambda \frac{\sqrt{1+\beta}}{\sqrt{1-\beta}} = \lambda \frac{\sqrt{1.92}}{\sqrt{0.08}} = \lambda\left(\frac{1.39}{0.28}\right)$

$= 4.96\lambda$

$\boxed{\lambda = 80.6\text{ nm}}$