## Quiz 8

## April 30, 2003

In the Earth frame, the speed of the muon is measured to be v, and the distance that it travels is measured to be d. The time required for this trip, as measured in the Earth's frame is

$$t = \frac{d}{v}.$$

Because of time dialation, this corresponds to a time

$$\tau_{\mu} = \frac{t}{\gamma}$$

in the muon frame, the proper time. As usual,

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

This is the answer for part a.

For part b, you could proceed either of two ways. Either note that d' (the distance that the Earth travels in the muon frame) is equal to

$$d' = v\tau_{\mu} = \frac{vt}{\gamma} = \frac{d}{\gamma},$$

or use the length contraction formula to go directly to the result  $d' = d/\gamma$ .

Note that I varied the numbers in the problem at will. The actual lifetime of a muon is 2.2  $\mu$ s. I suggest that you remember this problem and the associated figure 39.10 in the text to help you remember where the factors of  $\gamma$  go when solving these problems.

	Sec 0101	Sec 0104	Sec 0105
v	0.999c	0.800c	0.950c
d	4.60 km	4.60 km	4.60  km
t	$15.3 \ \mu s$	$19.2 \ \mu s$	$16.1 \ \mu s$
$ au_{\mu}$	$0.68 \ \mu s$	$11.5 \ \mu s$	$5.03~\mu { m s}$
d'	206 m	2.76  km	1.44 km

Table 1: Numbers for the problem by section.