Phys 242
hmk #1

#1

(1) the electric field flux through a surface enclosing charge q is q/ϵ_0

(2) there are no magnetic monopoles

(3) a changing magnetic field induces an electric field

(4) a changing electric field induces a magnetic field

a steady current also gives rise to a magnetic field

(1) $\oint \vec{E}\cdot d\vec{a} = q/\epsilon_0$

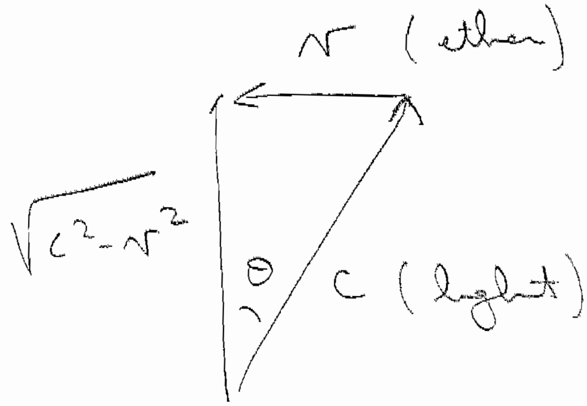
(2) $\oint \vec{B}\cdot d\vec{a} = 0$

(3) $\oint \vec{E}\cdot d\vec{s} = -d\Phi_B/dt$

(4) $\oint \vec{B}\cdot d\vec{s} = \mu_0\epsilon_0 \dfrac{d\Phi_E}{dt} + \mu_0 I$

#2

2.3



so time between mirrors $A - M_2 - A$ =

$$\frac{d}{v} = \frac{2 l_2}{\sqrt{c^2 - v^2}}$$

from above, $\boxed{\sin\theta = \frac{v}{c}}$

#3

2.21

lab frame

muon frame

$$t = \gamma t'$$

$$t' = 2.2\,\mu s$$

$$l = 9.5 \text{ cm}$$

$$\therefore\ l = v t = v \gamma t'$$

$$= \beta c \gamma t'$$

$$= \beta c \frac{1}{\sqrt{1-\beta^2}} t'$$

$$\sqrt{1-\beta^2}\, l = \beta c t'$$

$$1-\beta^2 = \beta^2 \frac{c^2 t'^2}{l^2}$$

$$\boxed{\beta = 1.4\times10^{-4}}$$

$$\beta^2\left(1 + \frac{c^2 t'^2}{l^2}\right) = 1$$

$$\beta = \frac{1}{\left(1 + \frac{c^2 t'^2}{l^2}\right)^{1/2}} = \frac{1}{\left(1 + \frac{(3\times10^8)^2 (2.2\times10^{-6})^2}{(.095)^2}\right)^{1/2}}$$

#4

2.28

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

$$v = \frac{120 \times 10^3}{60 \times 60} = 33\,3 \text{ m/s}$$

$$\beta = 0.333 \qquad \gamma = 1.061$$

$$\Delta t = \gamma \, \Delta t' \quad \Rightarrow$$ moving person ages $\boxed{1.06}$ slower

$$\Delta l = \frac{\Delta l'}{\gamma} = \frac{1}{1.06} = \boxed{0.94 \text{ m}}$$

#5

a) end of train sees flash first since it is moving towards flash

front of train sees flash later since it is moving away from flash

b) let train have proper length L_0

$$L = \frac{L_0}{\gamma} =$$

$$\Delta t_1 = \frac{d}{v} = \frac{\frac{L}{2} + v\Delta t_1}{c}$$ <u>front</u>

$$(c - v)\Delta t_1 = \frac{L}{2}$$

$$\Delta t_1 = \frac{L}{2(c-v)} = \frac{L_0}{2\gamma}\frac{1}{c-v}$$

c)

$$\Delta t_2 = \frac{\frac{L}{2} - v\,\Delta t_2}{c}$$

$$(c+v)\,\Delta t_2 = \frac{L}{2} \qquad \underline{\text{back}}$$

$$\Delta t_2 = \frac{L}{c+v} = \frac{L_0}{2\gamma}\,\frac{1}{c+v}$$

$\Delta t_2 < \Delta t_1$ — back sees flash first

d)

$$\Delta t = \Delta t_1 - \Delta t_2 = \frac{L_0}{2\gamma}\left(\frac{1}{c-v} - \frac{1}{c+v}\right)$$

$$= \frac{L_0}{2}\sqrt{1-\frac{v^2}{c^2}}\;\frac{c+v-c+v}{c^2-v^2}$$

$$= \frac{L_0}{2}\sqrt{1-\frac{v^2}{c^2}}\;\frac{2v}{c^2\left(1-\frac{v^2}{c^2}\right)}$$

$$= \frac{v L_0}{c^2} \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$ ✓

as seen from K, the train clocks are running slower by $\Delta t = \gamma \Delta t'$, a factor of $\frac{1}{\gamma}$. so clocks on train appear unsynchronized by $\boxed{\frac{v L_0}{c^2}}$ —