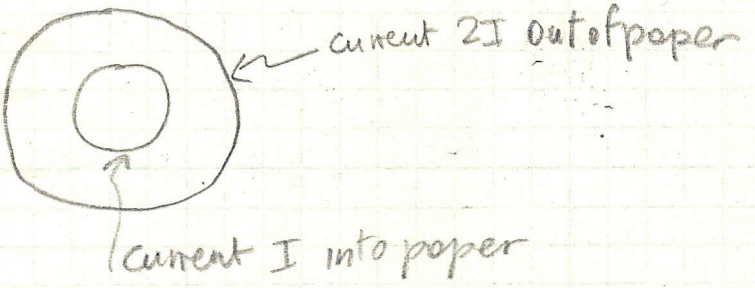
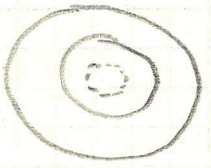
PHYSICS 24 MIDTERM

(1)



By symmetry field will be tangential. Use following paths for Ampere law (r = radius of path) $\oint \vec{B} \cdot d\vec{\ell} = 2\pi r B = \frac{4\pi}{c} I_{enclosed}$

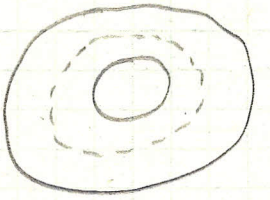
(a)



$I_{enclosed} = 0$

$\boxed{B = 0}$

(b)

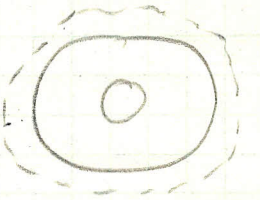


$I_{enclosed} = I$

$\boxed{B = \frac{2I}{rc}}$

Field lines

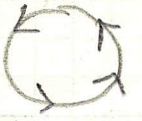
(c)



$I_{enclosed} = I$ (but in opposite direction)

$\boxed{B = \frac{2I}{rc}}$

Field Lines



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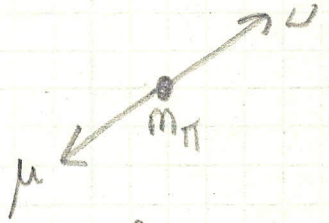
(2)



Conservation of momentum

$|\vec{P}_\nu| = |\vec{P}_\mu| = P$

Cons of energy ($c = 1$)

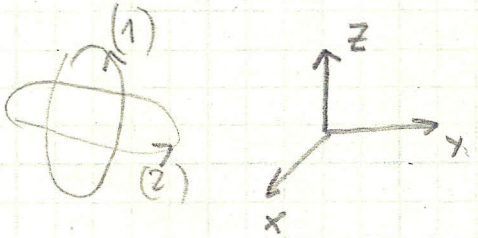
$m_\pi = P + \sqrt{m_\mu^2 + P^2}$

(Note $m_\nu = 0 \Rightarrow E_\nu = P_\nu = P$)

$$(m_\pi - p)^2 = m_\mu^2 + p^2$$

$$m_\pi^2 + p^2 - 2m_\pi p = m_\mu^2 + p^2 \Rightarrow \boxed{p = \frac{m_\pi^2 - m_\mu^2}{2m_\pi}}$$

(3)

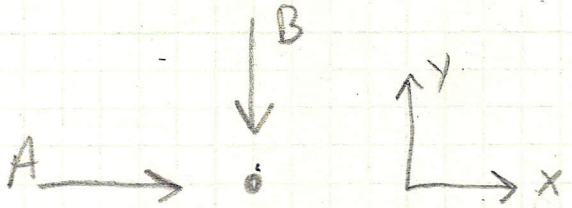


$$\vec{B}_1 = \frac{2\pi I}{cr}\hat{x}$$

$$\vec{B}_2 = \frac{2\pi I}{cr}\hat{z}$$

$$\Rightarrow \vec{B} = \frac{2\pi I}{cr}(\hat{x} + \hat{z}) \qquad |\vec{B}| = \frac{2\pi\sqrt{2} I}{cr}$$

(4)



S = earth $\quad \vec{V}_B = (0, -0.9c) \quad \vec{V}_A = (0.9c\ 0)$

S' = frame of A. Moving with velocity 0.9c in x-direction wrt to frame S $\quad \gamma = \frac{1}{\sqrt{1 - \frac{81}{100}}} = \frac{10}{\sqrt{19}}$

$$V'_{Bx} = \frac{V_{Bx} - 0.9c}{1 - \frac{0.9c\,V_{Bx}}{c^2}} = -0.9c$$

$$V'_{By} = \frac{V_{By}}{\gamma\left(1 - \frac{0.9c\,V_{By}}{c^2}\right)} = \frac{-0.9c}{\gamma} = \frac{\sqrt{19}}{10}\frac{9}{10}c = \frac{9\sqrt{19}}{100}c$$

$$\Rightarrow V'_B = \sqrt{(0.9)^2 + \left(\frac{9\sqrt{19}}{100}\right)^2}\,c$$

$$\boxed{V'_B = 0.98c}$$