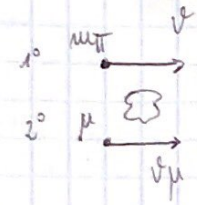
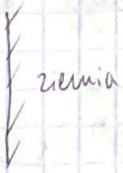
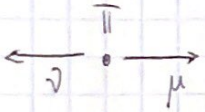
3.



LAB:



center of mass



$-p'_\nu = p_\mu \qquad p'_0 = p'_K = 0$

$p'_\mu = p'_\pi$

$$E_0 = m_\pi c^2 = E_K = \sqrt{p'^2_\mu c^2 + m_\mu^2 c^4} + p'_\nu c$$

$$m_\pi^2 c^4 - 2 m_\pi c^3 p'_\mu + p'^2_\mu c^2 = p'^2_\mu c^2 + m_\mu^2 c^4$$

$$m_\pi^2 c^4 - 2 m_\pi c\, p'_\mu = m_\mu^2 c^4$$

$$(m_\pi^2 - m_\mu^2) c = 2 m_\pi p'_\mu$$

$$p'_\mu = \frac{(m_\pi^2 - m_\mu^2)c}{2 m_\pi}$$

$$E'_\mu = \sqrt{\frac{c^2 (m_\pi^2 - m_\mu^2)^2}{4 m_\pi^2} c^2 + m_\mu^2 c^4} = \frac{c^2}{2 m_\pi} (m_\pi^2 + m_\mu^2)$$

$$E_\mu = \gamma (E'_\mu + v p'_\mu) = \gamma \frac{c^2}{2 m_\pi} (m_\pi^2 + m_\mu^2) + \gamma v \frac{(m_\pi^2 - m_\mu^2)c}{2 m_\pi}$$

$$p_\mu = \gamma \left(p'_\mu + \frac{E'_\mu}{c^2} v\right) = \gamma \frac{(m_\pi^2 - m_\mu^2)c}{2 m_\pi} + \gamma \frac{(m_\pi^2 + m_\mu^2)}{2 m_\pi} v$$

$$v_\mu = c^2 \frac{p_\mu}{E_\mu} = c \frac{m_\pi^2 c - m_\mu^2 c + m_\pi^2 v + m_\mu^2 v}{m_\pi^2 c + m_\mu^2 c + m_\pi^2 v + m_\mu^2 v}$$

$$v_\mu = \frac{h}{\gamma(v_\mu)\tau} \Rightarrow$$

$$v = \frac{m_\pi^2 c\, v_\mu + m_\mu^2 c\, v_\mu - c^2 m_\pi^2 + m_\mu^2 c^2}{m_\pi^2 c + m_\mu^2 c - m_\pi^2 v_\mu - m_\mu^2 v_\mu}$$

$$v = \frac{c^2 (m_\pi^2 \beta_\mu + m_\mu^2 \beta_\mu - m_\pi^2 + m_\mu^2)}{c (m_\pi^2 + m_\mu^2 - m_\pi^2 \beta_\mu - m_\mu^2 \beta_\mu)} \quad / : c$$

bo $v = v_\pi$

$$\beta_\pi = \beta = \frac{m_\pi^2 (\beta_\mu - 1) + m_\mu^2 (\beta_\mu + 1)}{m_\pi^2 (1 - \beta_\mu) + m_\mu^2 (1 - \beta_\mu)}$$

$$\gamma(v_\mu) = \frac{1}{\sqrt{1 - \beta_\mu^2}} \qquad v_\mu = \frac{h\sqrt{1-\beta_\mu^2}}{\tau} \quad / c$$

$$\beta_\mu = \frac{h\sqrt{1-\beta_\mu^2}}{\tau} \Rightarrow \beta_\mu = \frac{h}{\sqrt{\tau^2 c^2 + h^2}}$$