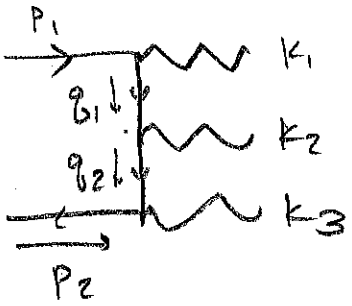
1.



MOMENTUM CONSERVATION @ EACH VERTEX

$P_1 = q_1 + K_1$ (I)

$q_1 = q_2 + K_2$ (II)

$q_2 + P_2 = K_3$ (III)

USE (I, II, III) TO GET $(P_1 + P_2)$ ON THE LHS:-

$P_1 + P_2 + q_2 = q_1 + K_1 + K_3$

$P_1 + P_2$: (I) + (III)

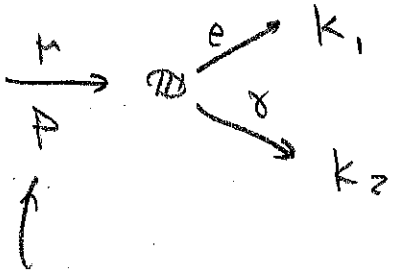
q_1: from (II)

$= q_2 + K_2$

$$P_1 + P_2 + \cancel{q_2} = \cancel{q_2} + K_1 + K_2 + K_3$$

$$\Rightarrow \boxed{P_1^\mu + P_2^\mu = K_1^\mu + K_2^\mu + K_3^\mu}$$ ← FOR EA. COMPONENT, μ

2.



cons. of momentum:

$P^\mu = K_1^\mu + K_2^\mu$

MUON FRAME: $P = (M_\mu, \vec{0})$

$K_1 = (E_e, \vec{K})$ ← $E_e = \sqrt{|\vec{K}|^2 + m_e^2}$

$K_2 = (E_\gamma, -\vec{K})$ ← $E_\gamma = |\vec{K}|$

$E_e + E_\gamma = M_\mu$

$$\Rightarrow E_e^2 = (M_\mu - E_\gamma)^2 = M_\mu^2 - 2|\vec{K}|M_\mu + |\vec{K}|^2$$

$E_e^2 = |\vec{K}|^2 + m_e^2$

$$\Rightarrow \boxed{|\vec{K}| = \frac{M_\mu^2 - m_e^2}{2M_\mu}}$$