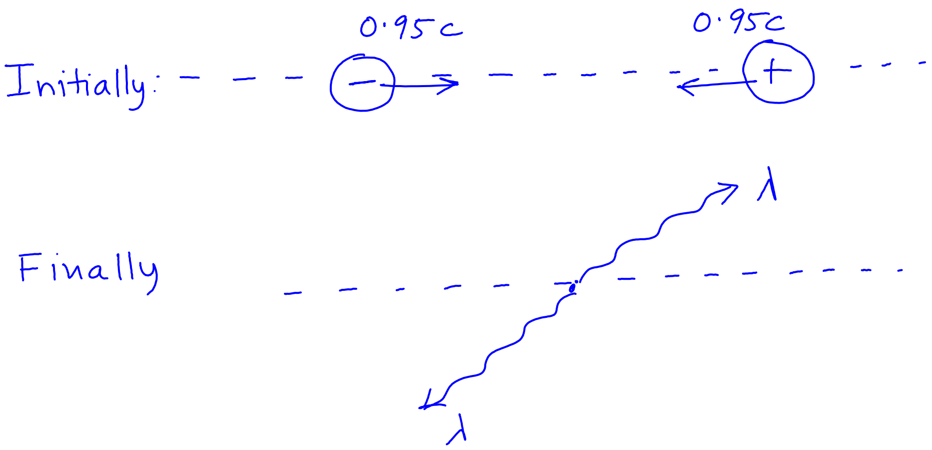
Wednesday, November 11, 2009
10:36 AM

Solution to Quiz 8



We are given that the two photons are identical, so, both have the same wavelength, λ

From Energy conservation, before and after collision,

$$\gamma_e m_e c^2 + \gamma_p m_p c^2 = \frac{hc}{\lambda} + \frac{hc}{\lambda} \quad \text{—— (1)}$$

where, e: electron, p: proton $\Rightarrow m_e = m_p$ [They are particle-anti-particle pair, and have the same mass.]

also, $v_e = v_p$ (velocities) $= 0.95c$

$$\Rightarrow \gamma_e = \gamma_p = \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{1}{\sqrt{1-(0.95)^2}} \quad \text{—— (2)}$$

Hence (1) & (2) give

$$\cancel{2}\frac{hc}{\lambda} = \cancel{2}\gamma_e m_e c^2 \qquad \left[\text{Using } m_e = m_p,\ v_e = v_p,\ \gamma_e = \gamma_p\right]$$

$$\Rightarrow \lambda = \frac{hc}{\gamma_e m_e c^2} = \frac{h}{\gamma_e m_e c} = 0.75 \text{ pm}$$