

Answer on Question #66741-Physics-Mechanics-Relativity

A proton undergoes a head on elastic collision with a particle of unknown mass which is initially at rest and rebounds with $16/25$ of its initial kinetic energy. Calculate the ratio of the unknown mass with respect to the mass of the proton.

Solution

From the conservation of energy:

$$E_p = E'_p + E$$

$$\frac{16}{25}E_p = E'_p$$

$$\left(\frac{v'}{v}\right)^2 = \frac{16}{25} \rightarrow \frac{v'}{v} = \frac{4}{5}$$

$$\frac{25 - 16}{25}E_p = E$$

$$\frac{mV^2}{m_p v^2} = \frac{9}{25} \rightarrow \frac{m}{m_p} = \frac{9}{25} \frac{v^2}{V^2}$$

From the conservation of momentum:

$$m_p v = mV - m_p v'$$

$$V = \frac{m_p}{m}(v + v') = \frac{m_p}{m}\left(v + \frac{4}{5}v\right) = \frac{9}{5}v \frac{m_p}{m}$$

Thus,

$$\frac{m}{m_p} = \frac{9}{25} \left(\frac{m}{m_p}\right)^2 \frac{25}{81} = 9 \left(\frac{m}{m_p}\right)^2$$

$$\frac{m}{m_p} = \frac{1}{9}$$

Answer: $\frac{1}{9}$.