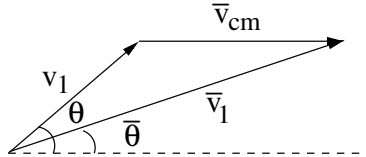


**[mex57] Loss of kinetic energy in elastic collision**

Consider a particle of mass  $m_1$  and incident velocity  $\bar{v}_0$  undergoing an elastic collision via central force with a target of mass  $m_2$  that is initially at rest. The particle emerges with velocity  $\bar{v}_1$  from the collision as viewed in the laboratory frame. The figure shows this velocity in relation to the center-of-mass velocity  $\bar{v}_{cm}$  and the final velocity  $\mathbf{v}_1$  of the particle in the center-of-mass frame. Also shown are the scattering angles  $\theta$  (center-of mass frame) and  $\bar{\theta}$  (laboratory frame). Show that the ratio of the final and initial kinetic energies in the laboratory frame is

$$\frac{T_1}{T_0} = \frac{1 + 2\rho \cos \theta + \rho^2}{(1 + \rho)^2}, \quad \rho = \frac{m_1}{m_2}.$$



**Solution:**