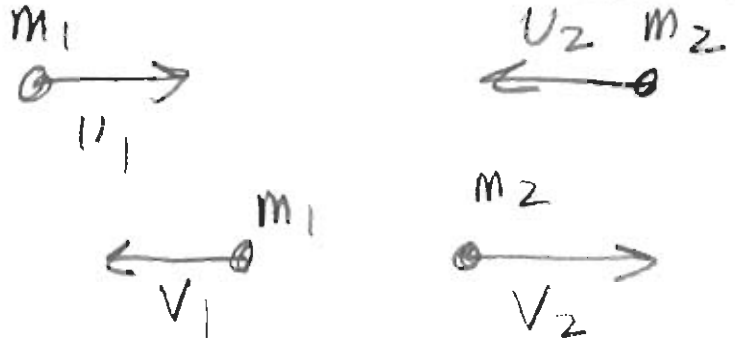
Inelastic

momentum still conserved



$$m_1 u_1 + m_2 u_2 = m_1 V_1 + m_2 V_2$$

→ why? center of mass unmoved by

given → ? ← unknowns

now inelastic

$$\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 V_1^2 + \frac{1}{2} m V_2^2 + Q$$

lost energy

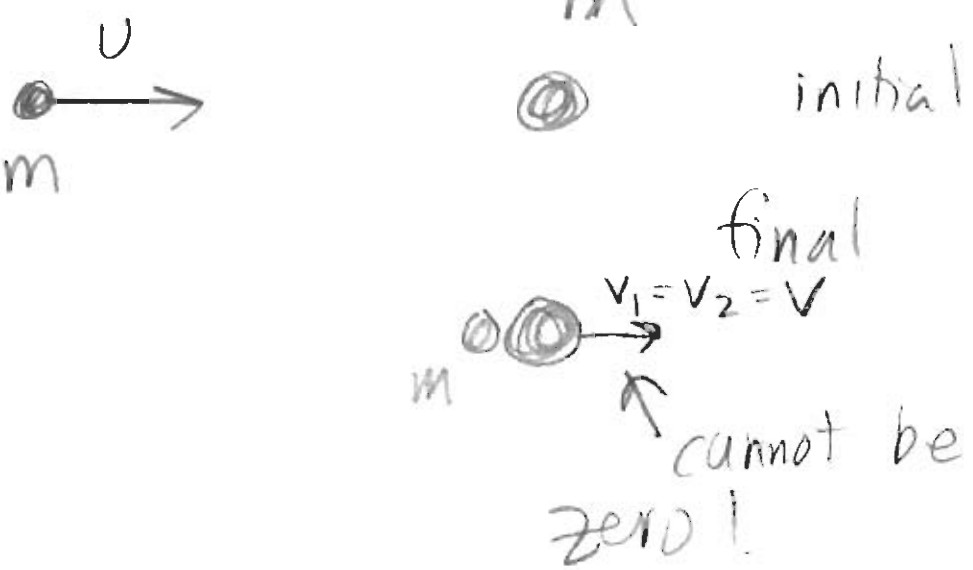
How big can Q be?

Can all initial energy of m_1, m_2 disappear?

NO → center of mass motion cannot stop..

$$V = \frac{m_1 u_1 + m_2 u_2}{m_1 + m_2}$$

example Inelastic Collisions



Why? center of mass motion cannot be stopped by internal forces

$$\frac{mU + M \cdot 0}{m+M} = \frac{m}{m+M} U$$ initial velocity of COM

$$= V \quad \text{(Total momentum)}$$

final

$$\frac{1}{2}(m+M)V^2 = \frac{1}{2}(m+M)\left(\frac{m}{m+M}\right)^2 U^2$$

$$= \frac{1}{2}\frac{m^2}{m+M}U^2$$

lost energy: $\frac{1}{2}mU^2 - \frac{1}{2}\frac{m^2}{m+M}U^2$

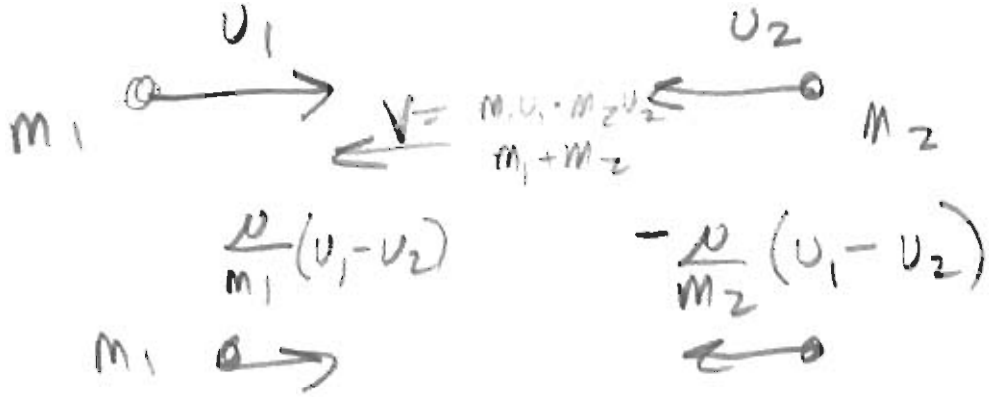
$$= \frac{1}{2}m\left(\frac{m+M-m}{m+M}\right)U^2 = \frac{1}{2}m\left(\frac{M}{m+M}\right)U^2$$

$$\frac{\text{lost}}{\text{initial}} = \frac{\frac{1}{2} m \left(\frac{M}{m+M}\right) v^2}{\frac{1}{2} m v^2} \qquad \frac{M}{m+M}$$

do problem

2-d

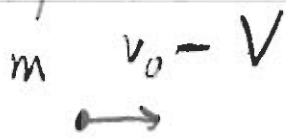
θ^* is varia

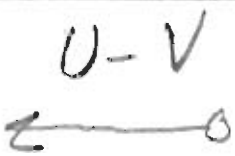


add V back

$$\tan\theta_1 = \frac{\frac{v}{m_1}(v_1 - v_2)\sin\theta^*}{V + \frac{v}{m_1}(v_1 - v_2)\cos\theta^*}$$

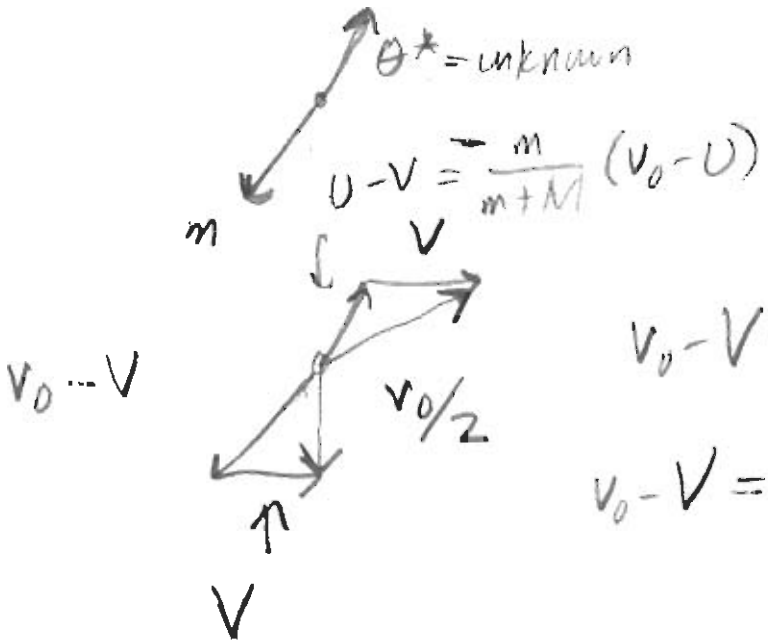
what is largest θ_1?





$$V = \frac{m v_0 + M U}{m + M}$$

M



$$v_0 - V = \frac{(m+M)v_0 - m v_0 - M U}{m + M}$$

$$v_0 - V = \frac{M}{m+M}(v_0 - U)$$

$$\tan\theta_1 = \frac{\sin\theta^*}{\frac{V}{\frac{M}{m_1}(v_1 - v_2)} + \cos\theta^*}$$

when $v_2 = 0$

$$\frac{V}{\frac{M}{m_1} v_1} = \frac{\frac{m_1 v_1}{m_1 + m_2}}{\frac{m_1 m_2}{m_1(m_1 + m_2)} v_1} = \frac{m_1}{m_2}$$

$$\tan\theta_1 = \frac{\sin\theta^*}{\frac{m_1}{m_2} + \cos\theta^*}$$

note:

$\theta_1 \leq \frac{\pi}{2}$ when $\frac{m_1}{m_2} > 0$