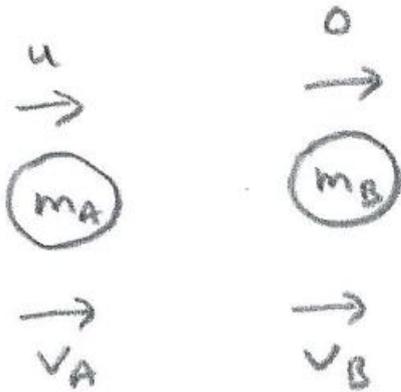# STEP/Collisions – Q3 (11/6/23)

Particle A of mass m_A is travelling with speed u on a smooth surface and collides with particle B of mass m_B, which is at rest. If the coefficient of restitution between the particles is e, find a condition involving e, m_A & m_B for A to reverse its direction after the collision.

Solution

Conservation of momentum $\Rightarrow m_A u = m_A v_A + m_B v_B$,

By Newton's Law of Restitution, $v_B - v_A = eu$

Substituting for v_B in the 1st eq'n,

$m_A u = m_A v_A + m_B(eu + v_A)$,

so that $v_A(m_A + m_B) = u(m_A - em_B)$

and $v_A = \frac{u(m_A - em_B)}{m_A + m_B}$

Then $v_A < 0 \Rightarrow m_A - em_B < 0 \Rightarrow e > \frac{m_A}{m_B}$

[Thus if $m_A \geq m_B$, a change of direction isn't possible.

If $m_A < m_B$, a change of direction will be possible provided e is sufficiently big. Note that a bigger e means that A and B bounce off each other more.]