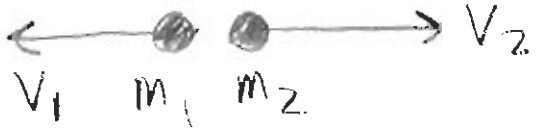
Collisions (1-d) ("elastic")

Initial

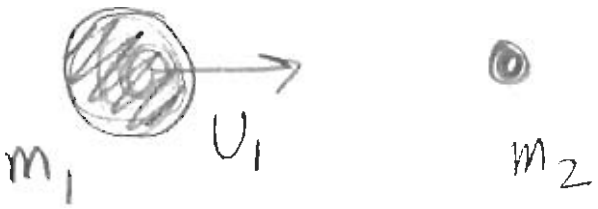
collision m_1 m_2 smack

Final



Big idea: Jumping between reference frames

To get the idea, choose a simple case: $m_1 >> m_2$, $v_2 = 0$

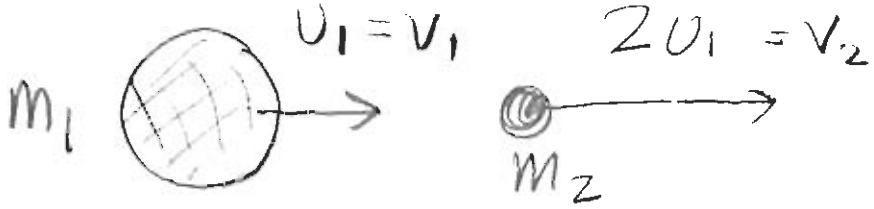


Trick: run along side m_1 at velocity v_1. m_1 will appear to be at rest.... subtract v_1 from all velocities; to go back to original "frame", add v_1 back

Initial 

Final

(as seen running along side)
now go back to original frame,
add v_1 back...



true as $\frac{m_1}{m_2} \to \infty$

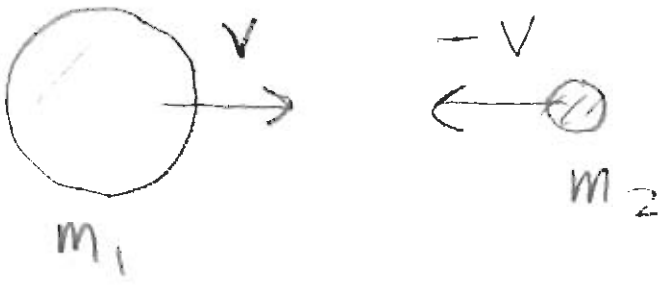
Little Ball/Big Ball Bounce

absolutely initial $m_1 >> m_2$

just after Big ball bounces

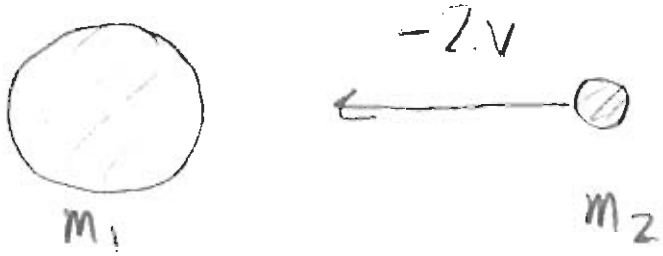
} magnify gap

initial



run alongside

running frame

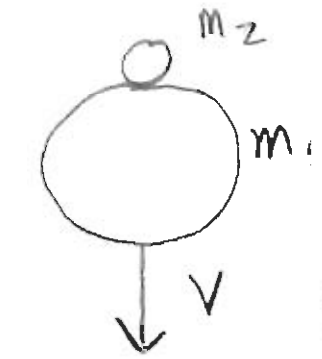


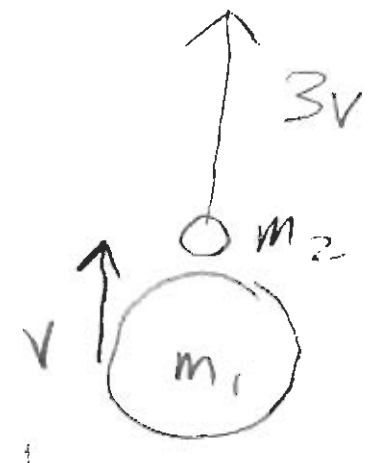
in this frame, initial

In this frame, final

Add v back to all masses

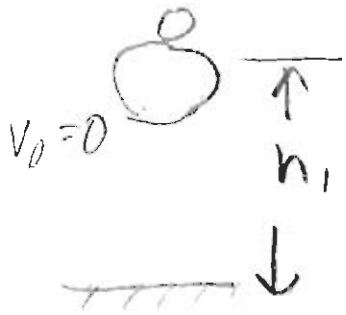
So:

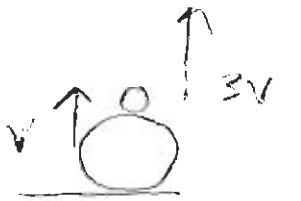




initial → final

how much higher than initial height?





$\frac{1}{2} m_1 v^2 = m g h_1$

$h_1 = \frac{1}{2} v^2$

$\frac{1}{2} m_2 (3v)^2 = m_2 g h_2$

$h_2 = 9 \times \frac{1}{2} v^2$

$h_2 = 9 \times h_1$