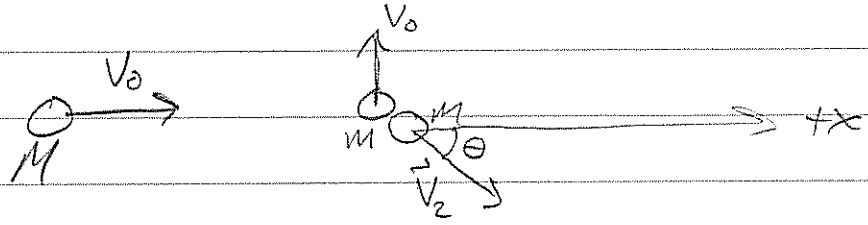
Example – Conservation of Momentum

Taylor 3.2

$m = \frac{1}{2} M$



$P_{ix} = MV_0$

$P_{iy} = 0$

$P_{fx} = mV_{2x} = mV_2 \cos\theta$

$P_{fy} = mV_0 - mV_{2y}$

$= mV_0 - mV_2 \sin\theta$

$\vec{P}_i = \vec{P}_f$

x: $MV_0 = mV_2 \cos\theta$

y: $0 = mV_0 - mV_2 \sin\theta$

And V_2 and θ

$MV_0 = mV_2 \cos\theta$

$V_2 = \frac{M}{m} \frac{V_0}{\cos\theta}$

$mV_0 = MV_2 \sin\theta$

$V_0 = \frac{M}{m} \frac{V_0}{\cos\theta} \sin\theta$

$V_2 = \frac{M}{\frac{1}{2}M} \frac{V_0}{\cos(26.6°)}$

$= 2 \frac{V_0}{\cos(26.6°)}$

$V_2 = 2.24 V_0$

$1 = \frac{M}{m} \tan\theta$

$\tan\theta = \frac{m}{M} = \frac{1}{2}$

$\theta = 26.6°$

Calc $\vec{v}_{cm,f}$

$\vec{v}_1 = \langle 0, v_0, 0 \rangle$

$\vec{v}_2 = \langle v_2 \cos\theta, -v_2 \sin\theta, 0 \rangle \quad v_2 = 2.14 v_0, \theta = 26.6°$

$= \langle 2v_0, -1v_0, 0 \rangle$

$\vec{v}_{cm,f} = \frac{m\vec{v}_1 + m\vec{v}_2}{2m} = \frac{m\langle 0, v_0, 0 \rangle + m\langle 2v_0, -1v_0, 0 \rangle}{2m}$

$= \frac{\langle 2mv_0, 0, 0 \rangle}{2m}$

$\vec{v}_{cm,f} = \langle v_0, 0, 0 \rangle$ which is the same as $\vec{v}_{cm}$ before the explosion.