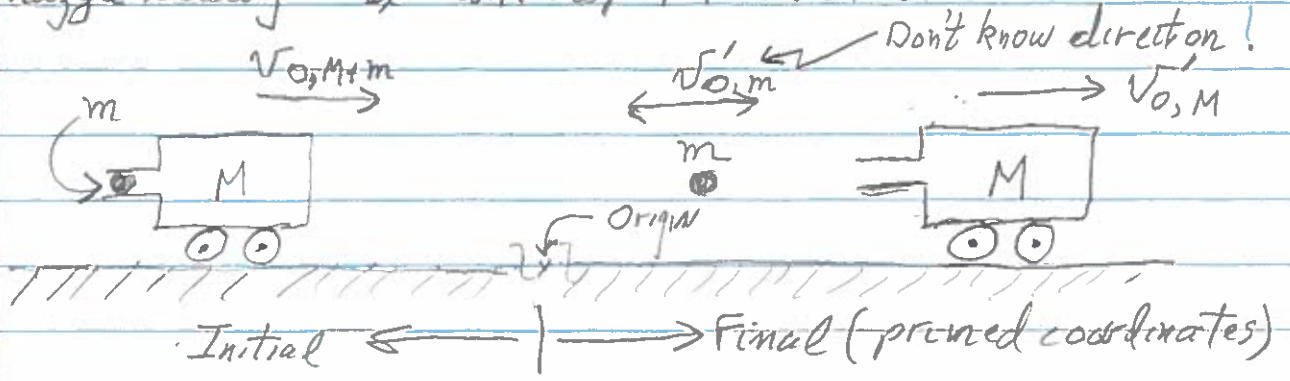


↓ VG

• Momentum Problem - Cannon on wheels.

Cannon of mass M & cannon ball of mass m initially moving together at $v_{0, M+m} \hat{x}$ fires m in $-\hat{x}$ direction at muzzle velocity v_{ex} with respect to cannon



$$\left. \begin{aligned} P_i &= (m+M)v_{0, M+m} \\ P_f &= Mv'_{0, M} + mv'_{0, m} \end{aligned} \right\} P_i = P_f \text{ for } F_{ext} = 0$$

muzzle velocity $v'_{M, m}$

where $v'_{0, m} = v'_{0, M} + v'_{M, m}$

∴ $P_i = P_f \Rightarrow$

$$\begin{aligned} (m+M)v_{0, M+m} &= Mv'_{0, M} + mv'_{0, m} \\ &= Mv'_{0, M} + m(v'_{0, M} + v'_{M, m}) \\ &= (m+M)v'_{0, M} + mv'_{M, m} \end{aligned}$$

\Rightarrow

$$v'_{0, M} = v_{0, M+m} - \frac{mv'_{M, m}}{m+M} = v_{0, M+m} + \frac{mv_{ex}}{m+M}$$

where $v_{ex} = v'_{m, M} = -v'_{M, m}$

\Rightarrow $(m+M)v_{0, M+m} = Mv'_{0, M} + m(v'_{0, M} - v_{ex})$