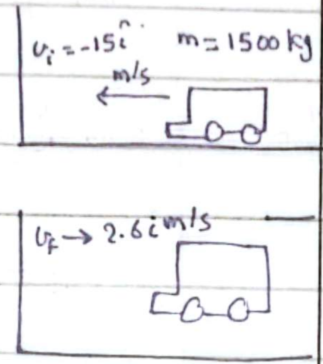
Ex 9.3



$t = 0.15$ s

$I = ??$

$F_{avg} = ??$

$$I = \Delta\vec{p}$$

$$= \vec{P}_f - \vec{P}_i = m\vec{v}_f - m\vec{v}_i$$

$$\Rightarrow I = m(\vec{v}_f - \vec{v}_i)$$

$$= (1500)(2.6\,i - (-15\hat{i}))$$

$$= 2.64 \times 10^4\ \hat{i}\ \text{kg m/s}$$

$$\Rightarrow I = F_{avg}\ \Delta t$$

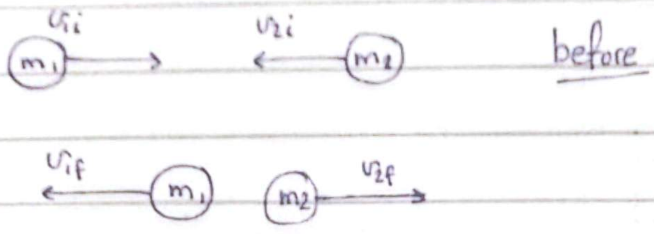
$$\vec{F}_{avg} = \frac{\vec{I}}{\Delta t} = \frac{2.64 \times 10^4\ \hat{i}}{0.15} = 1.76 \times 10^5\ \hat{i}\ \text{N}$$

Collision in 1D

Collision

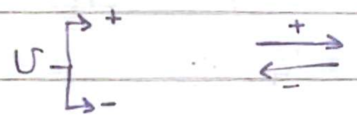
- elastic Collision
  - $\Delta\vec{p} = 0$, $\Delta k = 0$
  - billard balls
- inelastic Collision
  - $\Delta\vec{p} = 0$, $\Delta k \neq 0$, $k_f \neq k_i$
- Perfectly inelasti
  - isolated
    - $\Delta\vec{p} = 0$, $\Delta k \neq 0$
  - non-isolated
    - $\Delta\vec{p} = I$, $I = \Sigma F_{avg}\Delta t$, $\Delta k \neq 0$

Elastic Collision



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

$$\boxed{m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}} \quad (1)$$



$$\sum K_i = \sum K_f$$

$$\boxed{\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2} \quad (2)$$

from Eq. 1

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$m_1 v_{1i} - m_1 v_{1f} = m_2 v_{2f} - m_2 v_{2i}$$

$$\boxed{m_1 (v_{1i} - v_{1f}) = m_2 (v_{2f} - v_{2i})} \quad (3)$$

from Eq 2

$$\cancel{\tfrac{1}{2}} m_1 v_{1i}^2 + \cancel{\tfrac{1}{2}} m_2 v_{2i}^2 = \cancel{\tfrac{1}{2}} m_1 v_{1f}^2 + \cancel{\tfrac{1}{2}} m_2 v_{2f}^2$$

$$m_1 v_{1i}^2 - m_1 v_{1f}^2 = m_2 v_{2f}^2 - m_2 v_{2i}^2$$

$$\boxed{m_1 (v_{1i}^2 - v_{1f}^2) = m_2 (v_{2f}^2 - v_{2i}^2)} \quad (4)$$

* by devided (4) and (3)

$$\frac{\cancel{m_1} (v_{1i}^2 - v_{1f}^2)}{\cancel{m_1} (v_{1i} - v_{1f})} = \frac{\cancel{m_2} (v_{2f}^2 - v_{2i}^2)}{\cancel{m_2} (v_{2f} - v_{2i})}$$

$$\frac{\cancel{(v_{1i} - v_{1f})} (v_{1i} + v_{1f})}{\cancel{(v_{1i} - v_{1f})}} = \frac{\cancel{(v_{2f} - v_{2i})} (v_{2f} + v_{2i})}{\cancel{(v_{2f} - v_{2i})}}$$

$$\Rightarrow v_{1i} + v_{1f} = v_{2f} + v_{2i}$$

$$\boxed{v_{1i} - v_{2i} = v_{2f} - v_{1f}} \rightarrow (*)$$

from Eq (5) and (1)

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$v_{2f} = v_{1i} - v_{2i} + v_{1f}$$

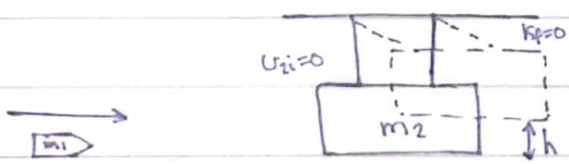
$$\Rightarrow \boxed{v_{1f} = \left(\frac{m_2 - m_1}{m_1 + m_2}\right) + \left(\frac{2m_2}{m_1 + m_2}\right)}$$

$$\Rightarrow \boxed{v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right) v_{1i} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) v_{2i}}$$

Ex 9.6 : Balistic Pendules

$v_{1i} = ??$

$m = m_1 + m_2$



$$\Sigma P_i = \Sigma P_f$$

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$$m_1 v_{1i} + \cancel{m_2 v_{2i}}^{\,0} = (m_1 + m_2)\, v_f$$

$$m_1 v_{1i} = (m_1 + m_2)\, v_f$$

$$\boxed{v_{1i} = \frac{m_1 + m_2}{m_1}\, v_f}$$

$\Rightarrow \Delta k \neq 0$

$$\Delta k + \Delta U_g + \cancel{\Delta U_s}^{\,0} = -\cancel{f_k d}^{\,0} + \cancel{W_{app}}^{\,0}$$

$$(\cancel{K_f}^{\,0} - K_i) + (U_f - \cancel{U_i}^{\,0}) = 0$$

$$-\frac{1}{2}\cancel{m} v^2 + \cancel{m} g h = 0$$

$$v_i = \sqrt{2gh}$$

↳ same as v_f for the System

$$\Rightarrow \boxed{v_{1i} = \frac{m_1 + m_2}{m_1}\sqrt{2gh}}$$