$\vec{J} = \vec{F}_{avg}\,\Delta t \qquad \vec{p} = m\vec{v}$

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

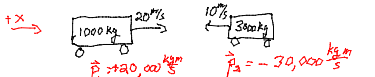
if there is no net force on an object.

$\vec{J} = 0 \rightarrow \Delta\vec{p} = 0 \rightarrow \vec{p}_f = \vec{p}_i$

Momentum is conserved if no net force

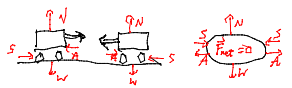
Total momentum of a set of objects

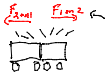
$\vec{P} = \vec{p}_1 + \vec{p}_2 + \vec{p}_3 + \ldots$



$\vec{p}_1 = +20{,}000\ \frac{kg\,m}{s} \qquad \vec{p}_2 = -30{,}000\ \frac{kg\,m}{s}$

$\vec{P} = -10{,}000\ \frac{kg\,m}{s}\ \hat{x}$



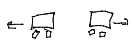


When they collide

← System feels both of these forces & they cancel $\vec{F}_{net} = 0$ still for system

Therefore, momentum is conserved during the collision.

$\vec{P} = -10{,}000\ \frac{kg\,m}{s}$



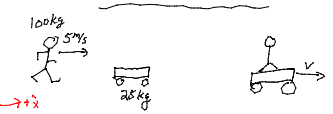
e.g. suppose cars stick together

$\vec{P} = M\vec{v} \Rightarrow (4000)v = -10000$

$v = \frac{-10000}{4000}$

$v_x = -2.5\ m/s$

maximally inelastic collision
- when two objects collide & stick together



from right before the collision to right after the collision, no net horizontal force on both combined

What is v?

A) 1 m/s B) 2 m/s C) 3 m/s
D) 4 m/s E) 5 m/s F) 6 m/s

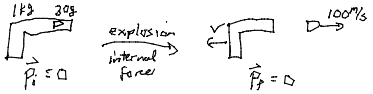
$p_{ix} = 500\ \frac{kg\,m}{s} + 0\ \frac{kg\,m}{s}$

$p_{fx} = 125v$

$500 = 125v$

$\frac{500}{125} = v$

$v = 4\ m/s$



recoil

$\vec{p}_f = 0 = (0.03)(100) - (1)(v)$

$= 3 - v = 0$

$\rightarrow v = 3\ m/s$

Rocket Propulsion

rocket shoots gas backward and it moves forward so $\vec{p}$ is conserved

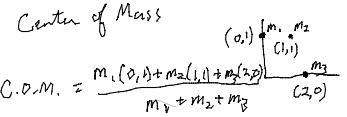
$m_{gas} << m_{rocket}$

want $\rightarrow v_{gas} >> v_{rocket}$

Total Momentum

$\vec{P}_{tot} = M_{tot}\ \vec{V}_{com}$

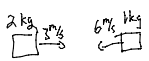
Center of Mass



$C.O.M. = \dfrac{m_1(0,1) + m_2(1,1) + m_3(2,0)}{m_1 + m_2 + m_3}$

$= \dfrac{\sum \text{mass} \times \text{position}}{\sum \text{mass}}$

2kg com $x = 0$ 1kg $x = 1$ $\quad x_{com} = \dfrac{2 \cdot 0 + 1 \cdot 1}{2 + 1} = \dfrac{1}{3}$



$\vec{p}_{tot} = 2(3) + 1(-6) = 0 = M_{tot} \cdot \vec{V}_{com}$

$V_{com} = 0$