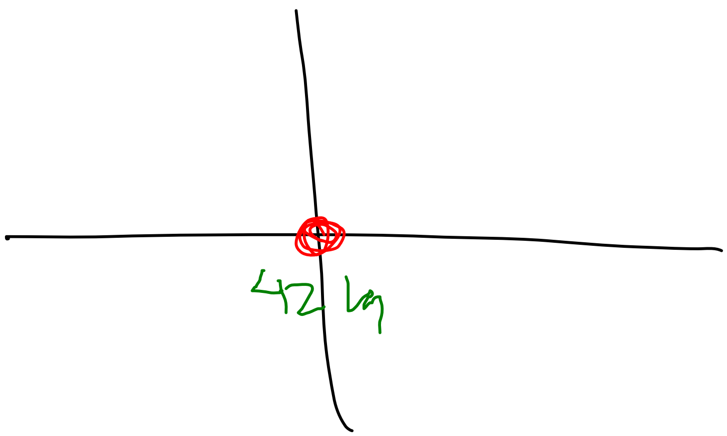
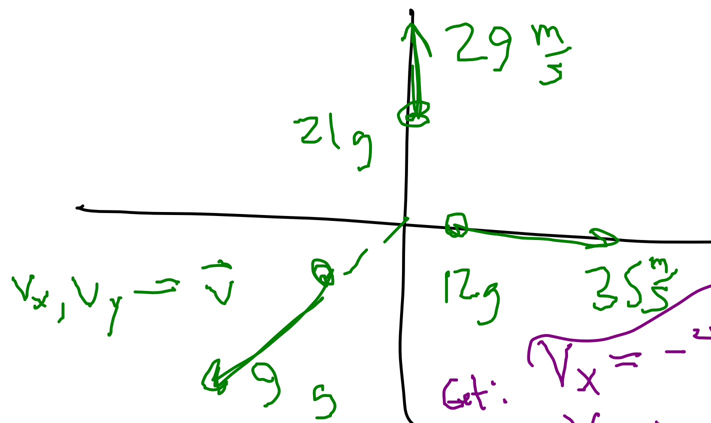
Phys 2110-4 10/24/11

Note Title 10/24/2011

Isolated systems $\vec{F}_{ext} = 0$ $\vec{P}$ is conserved

9.20



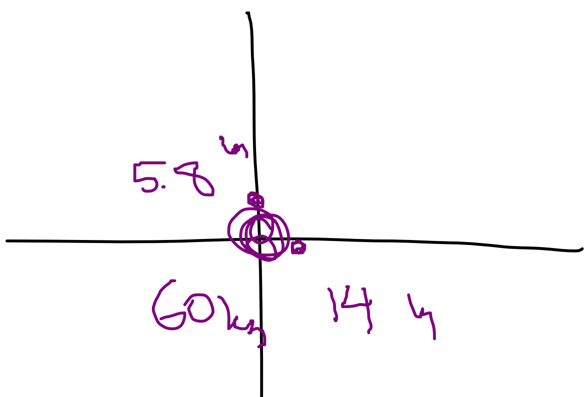


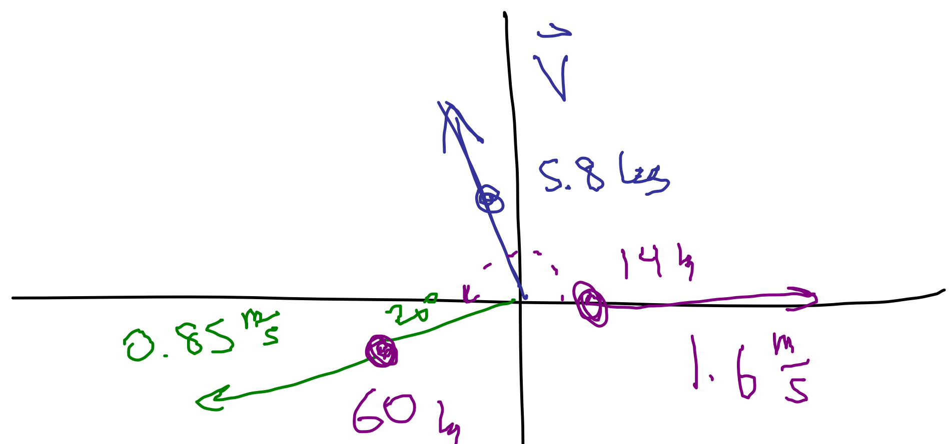
Get: $v_x = -46.7\ \frac{m}{s}$
$v_y = -67.7\ \frac{m}{s}$

x momentum $0 = (9\,g)(v_x) + (12\,g)(35\ \frac{m}{s})$

y momentum $0 = (9\,g)(v_y) + (21\,g)(29\ \frac{m}{s})$

9.51 60 kg astronaut tosses 14 kg oxygen tank and 5.8 kg camera. Tank moves in x-dir at 1.6 $\frac{m}{s}$, astronaut recoils at 0.85 $\frac{m}{s}$ in dir 200° ccw from +x. Find camera's velocity.





$$P_x: \quad 0 = (60\,kg)\left(-0.85\,\tfrac{m}{s}\cos 20\right) + (14\,kg)\left(1.6\,\tfrac{m}{s}\right) + (5.8\,kg)\,V_x$$

V_x

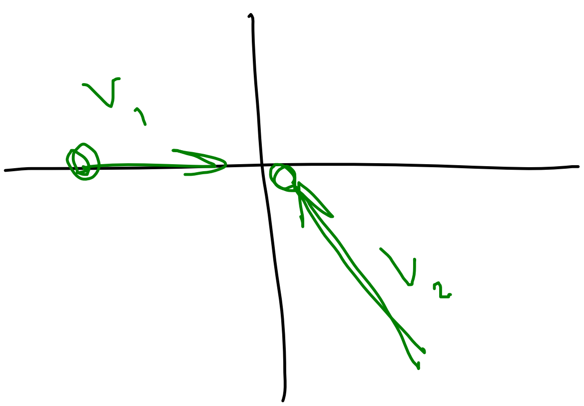
P_y: $0 = (60\,kg)(-0.85\,\frac{m}{s}\sin 70) + (5.8\,kg)\,v_y$

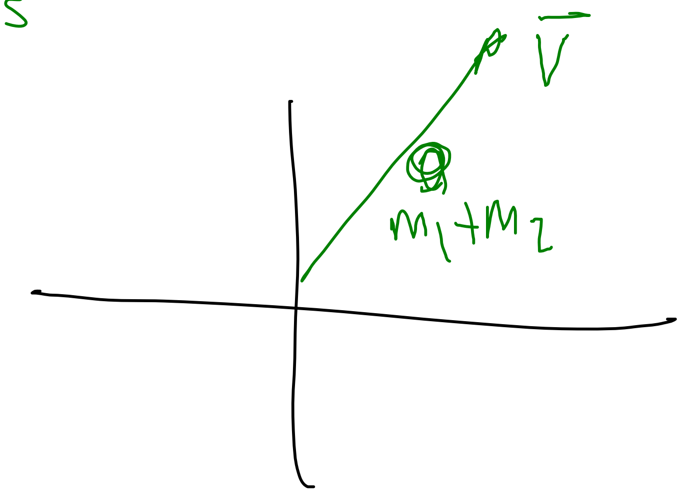
$\Longrightarrow v_y$

$\Longrightarrow$ $v_x = 4.40\,\frac{m}{s}$

$v_y = 3.01\,\frac{m}{s}$

?





$$\Delta \vec{P} = 0$$

$$\Delta(\vec{p}_1 + \Delta p_2) = 0$$
$$\Delta \vec{p}_1 = -\Delta \vec{p}_2$$

Change of momentum of a mass:

Collisions Force acts for a short amount of time.

$$\vec{F}_{net} = \frac{d\vec{p}}{dt} \qquad dp_x = F_x \, dt$$

$$\int_{t_1}^{t_2} dp_x = \int_{t_1}^{t_2} F_x \, dt$$

$$p(t_2) - p(t_1) = \int_{t_1}^{t_2} F_x \, dt$$

$$= \Delta P$$

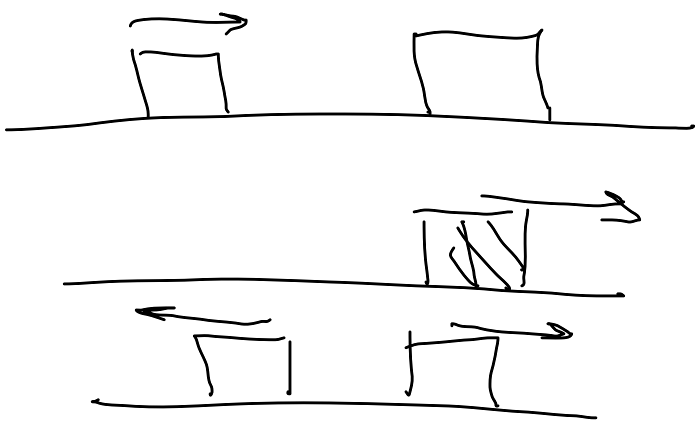
$= J$, Impulse = Change in momentum

$\Delta P = J$ $\int F dt$ = Area under curve

$$\Delta p = \int F\,dt = F_{avg}\,\Delta t$$ for a particular interval

$$F_{avg} = \frac{\Delta p}{\Delta t}$$

Collisions:



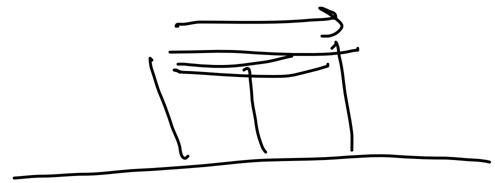
Momentum is cons'd

E is not necessarily conserved.

If E (K) is conserved

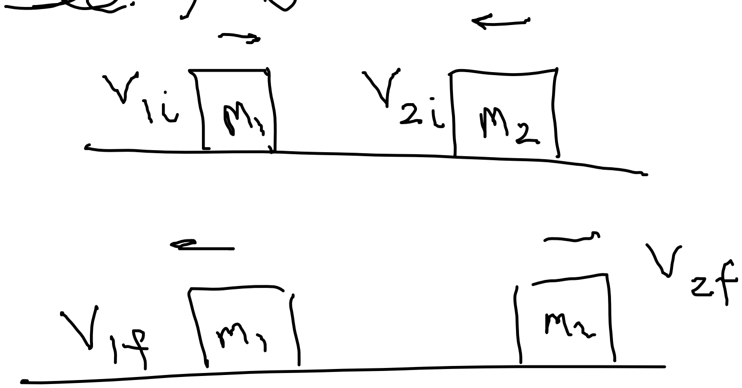
$\boxed{\text{elastic collision}}$

If energy is lost, inelastic collision.



$\Longrightarrow$ Totally inelastic collision.

Sec. 9.6



2 eqns

Momentum is cons'd

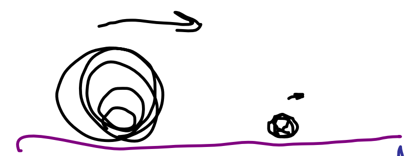
$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

If E is cons'd

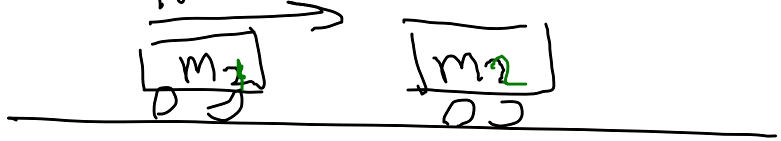
$$\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_1 v_{2i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

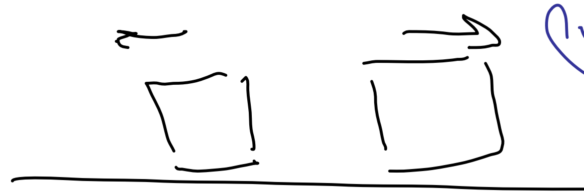
Then given v_{1i} v_{2i} can find v_{1f} v_{2f}

Algebra!



Simple case





m_1 small

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

(v_{2f} small)

Algebra gives

$$\boxed{v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i} \qquad v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i}}$$

$m_1 = m_2$ $\quad v_{1f} = 0 \quad v_{2f} = \frac{2m}{2m} v_{1i} = v_{1i}$

m_2 is small

$v_{1f} = v_{1i}$

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

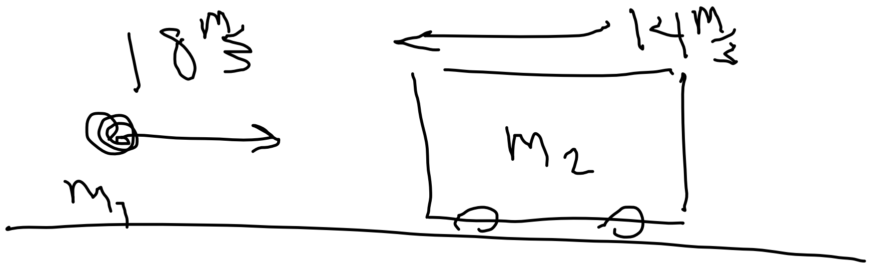
Most gen. case v_{1i} v_{2i} (both moving initially)

(9.15a)

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

$$v_{2f} = \_\_\_$$

9.31 Playing in the street child tosses ball at $18 \frac{m}{s}$ toward front of car moving toward him at $14 \frac{m}{s}$. Find ball's final speed if it rebounds elastically.



What are the masses?

$$m_2 >> m_1$$

1 = ball

2 = car

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

etc $m_1 \ll m_2$

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

$$= -18 + 2(-14) = -46 \ \frac{m}{s}$$

9.33 Proton moving at $6.9 \frac{Mm}{s}$ collides elastically with a second proton moving in opp. dir. at $11 \frac{Mm}{s}$.

Find subsequent velocities.

Use the 1-D elastic eqns with $m_1 = m_2 = M$

(Exchange v's)

Ref frames

Often we go to a particular ref. frame to make math easier.

CM ref frame