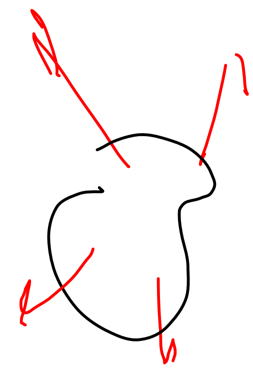
Phys 2110-4 3/18/13

Note Title 3/18/2013

Chap 9 Systems of particles



$$\vec{F} = m\vec{a}$$

$$\vec{F}_{\text{net } \underline{\text{ext}}} = \underset{\text{Total mass}}{M} \, \vec{a}_{cm}$$

$$\vec{p} = m\vec{v} \qquad \vec{P} = \sum \vec{p}_i$$

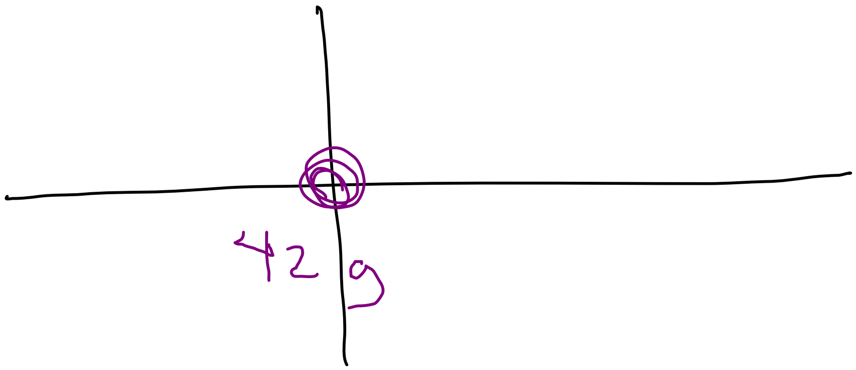
Isolated system — $\vec{P}$ is conserved (stays same)

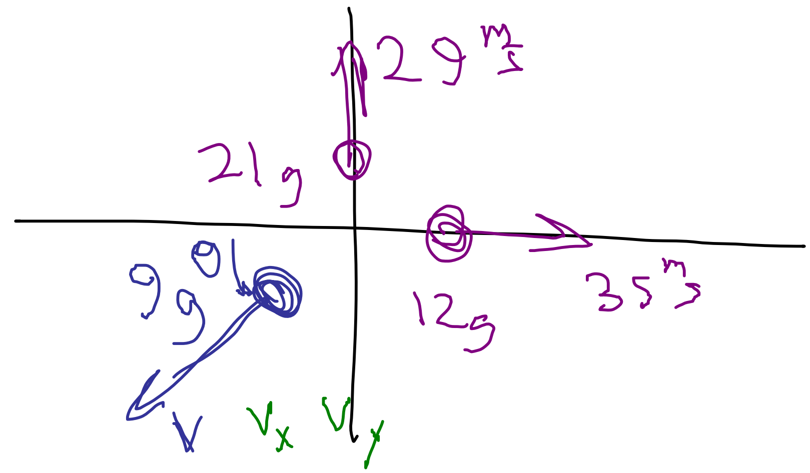
No net ext force

9.26

total momentum conserved

9.50 A 42g firecracker at rest at origin explodes into 3 pieces. Mass 12g moves along x axis at $35\,\frac{m}{s}$. 21 g piece moves along y axis at $29\,\frac{m}{s}$. Find velocity of 3rd piece.





Isolated

$\vec{P}$ is conserved.

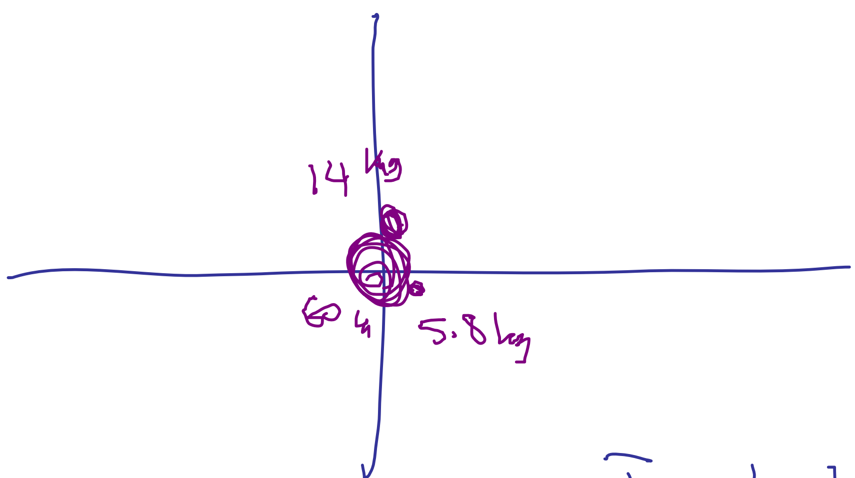
P_x: $P_x = 0 = (9g)(v_x) + (12g)(35\ \frac{m}{s})$

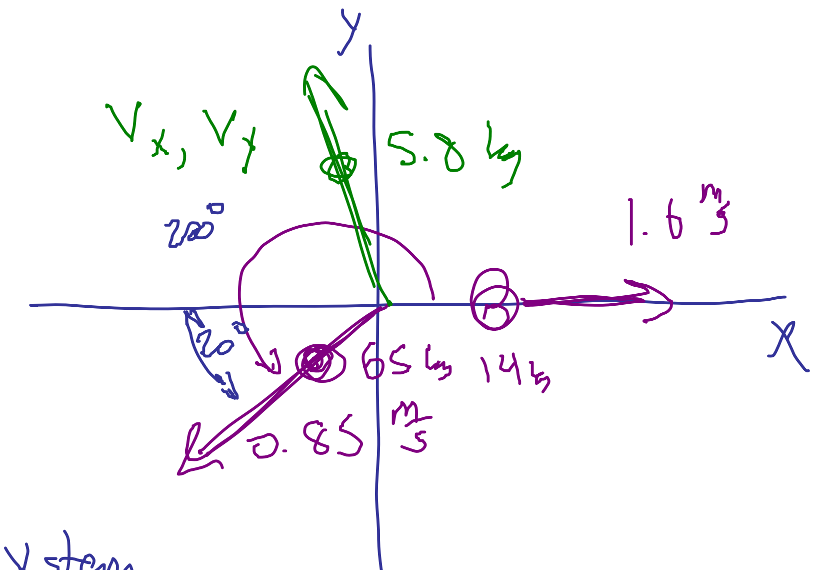
$v_x = -46.7\ \frac{m}{s}$

P_y: $P_y = 0 = (9g)(v_y) + (21g)(29\ \frac{m}{s})$

$v_y = -67.7\ \frac{m}{s}$

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





Isolated system, mom. cons.

P_x cons: $\quad 0 = (14\,kg)(1.6\,\frac{m}{s}) + (60\,kg)(0.85\,\frac{m}{s})(-1)\cos 20°$

$+ (5.8\,kg)\,V_x$

$\cos 200$

or whatever

$\Rightarrow V_x = 4.40\,\frac{m}{s}$

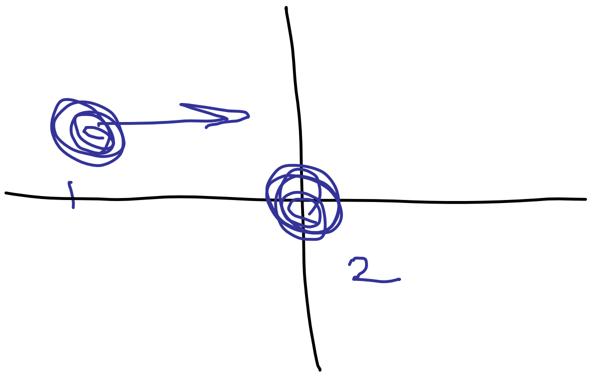
P_y cons: $\quad 0 = (0.85\,kg)\left(-0.85\,\frac{m}{s}\,\sin 20°\right)$

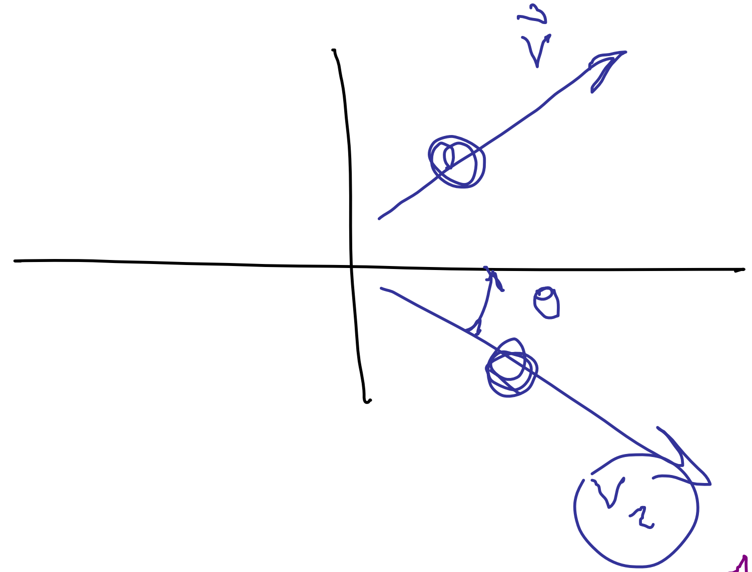
$+ (5.8\,kg)\,V_y$

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

20 on figure or

V_j θ

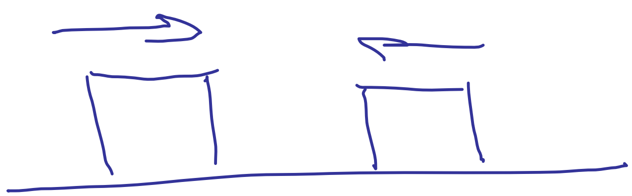




Momentum is cons'd.

Find unknown things.

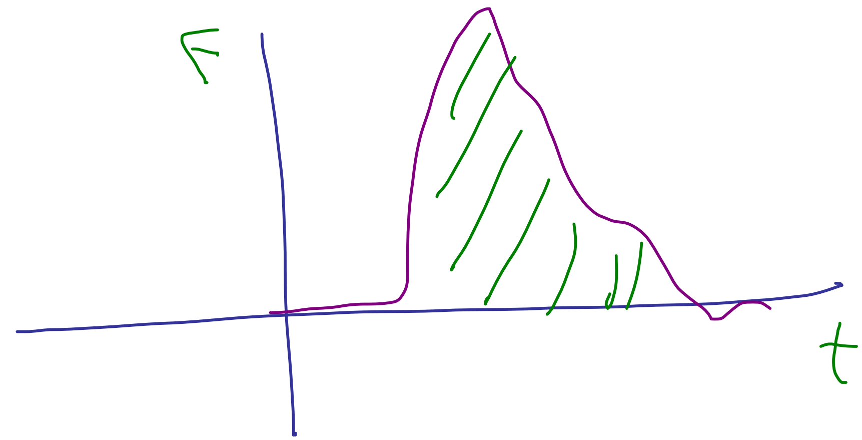
More about collisions.



Mom is conserved

Δp_x

$\frac{dp}{dt} = F$



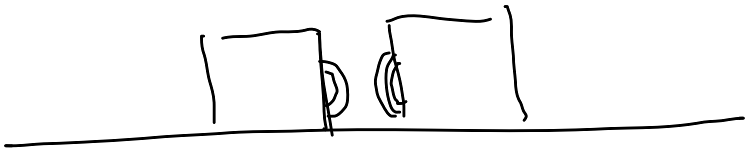
$\int_{\text{collis}} dp = \int_{\text{collision}} F(t)\, dt$

$\Delta p_x = \int_{\text{collision}} F(t)\, dt = \text{Impulse} = J_x$

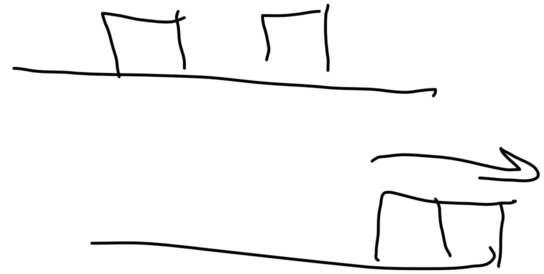
Change in momentum

$J_x = \int F(t)\, dt = \Delta p_x$

Area under F vs. t curve.



Spring contact.

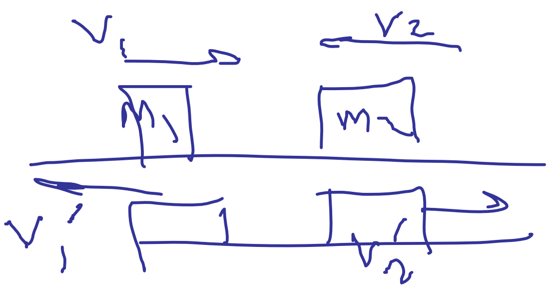


In that case. Mom. cons'd

Energy cons'd also

In general, K. energy is lost — inelastic

K.E. is cons'd — elastic collision.



$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

If it's elast then

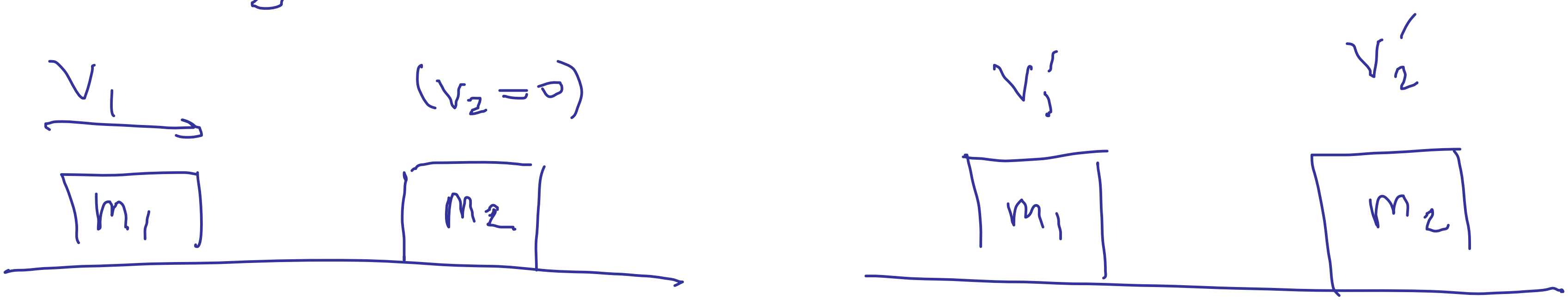
1-D $$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$$

p. 145-146

Gives answer on p. 146

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1+m_2} v_2$$

$v_2' =$ ——



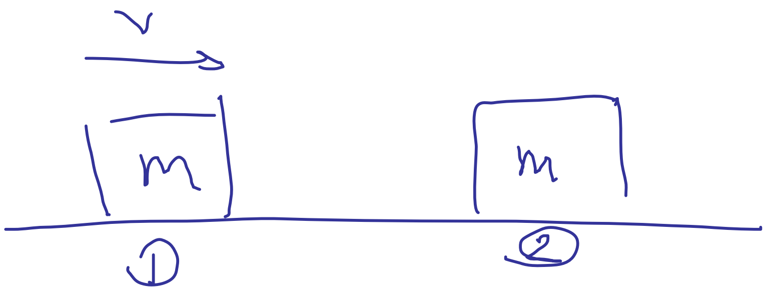
elastic collision.

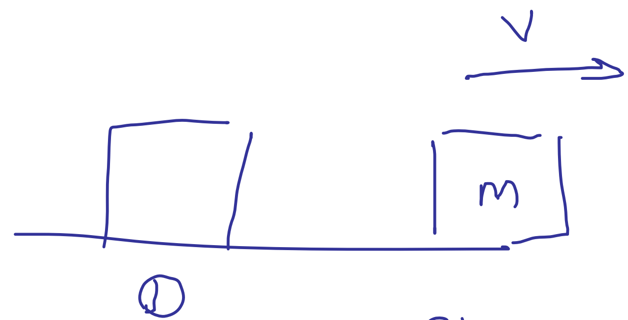
Get:

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1$$

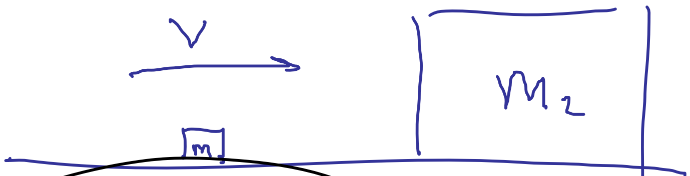
$$v_2' = \frac{2m_1}{m_1 + m_2} v_1$$

Both masses are same

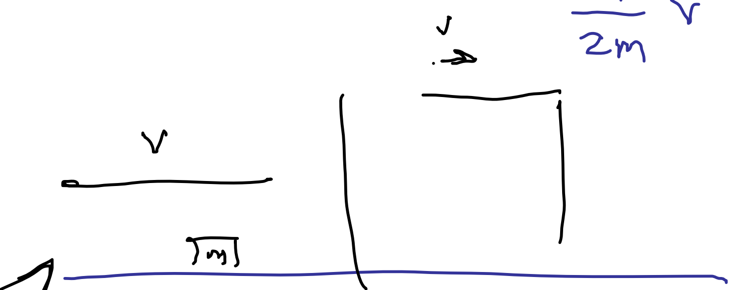




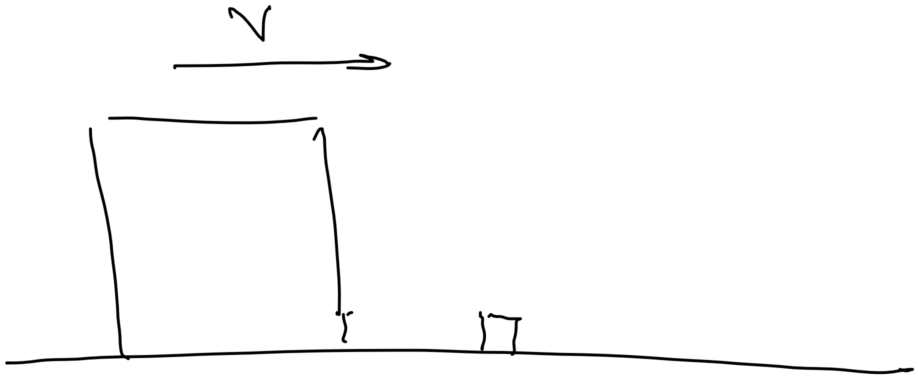
$$\frac{2m}{2m} v = v$$

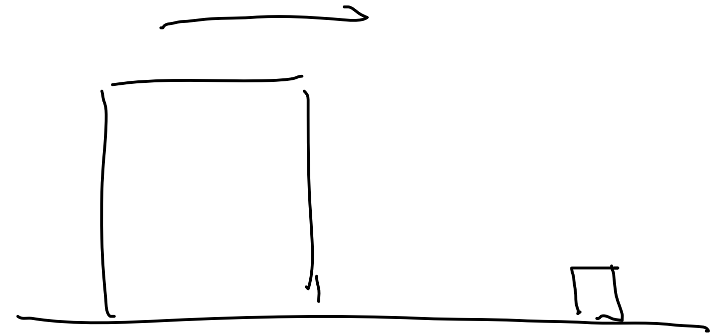


$$v_1' = \frac{0 - m_2}{0 + m_2} v_1$$
$$= -v_1$$



$$v_2' = \frac{2\,\text{small}}{\text{big}} \cdot v$$





$$\frac{m_1 - \cancel{m_2}}{m_1 + \cancel{m_2}}$$

$$v_1' = v_1$$

$$v_2 = \frac{2\cancel{M}}{\cancel{M}} v$$

$$= 2v$$