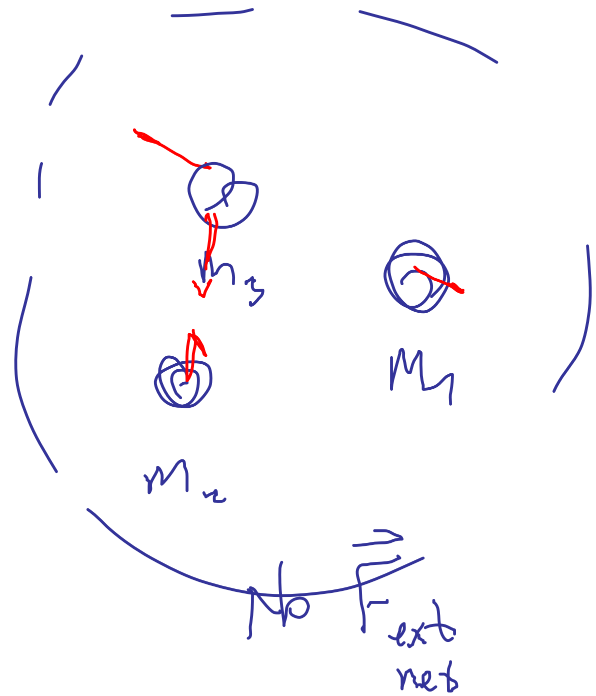
Phys 2110-5 10/22/12

Note Title 10/22/2012

Conservation of Motion

$\Longrightarrow$ Isolated System

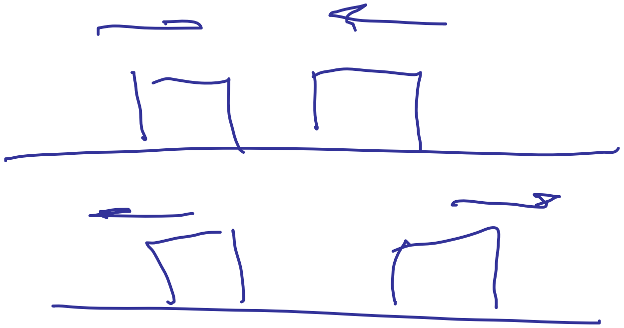


$\vec{P}$ is conserved!

$$\vec{P} = m_1 \vec{v}_1 + m_2 \vec{v}_2 + \dots$$

vectors, components!

Kleen up!



Terminology

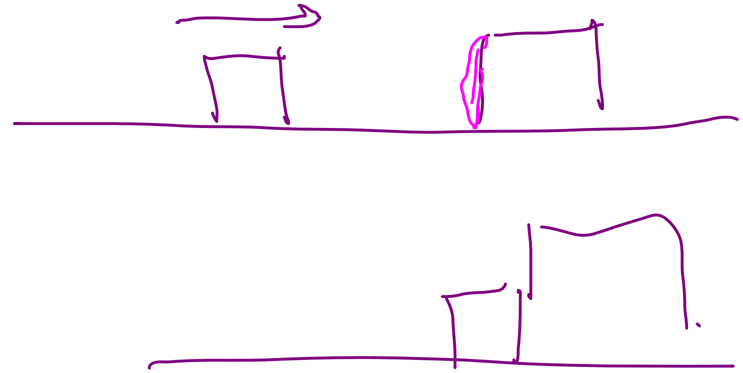
Generally, momentum is conserved

K_{tot} is in general not conserved

If it is: Elastic

If not Inelastic

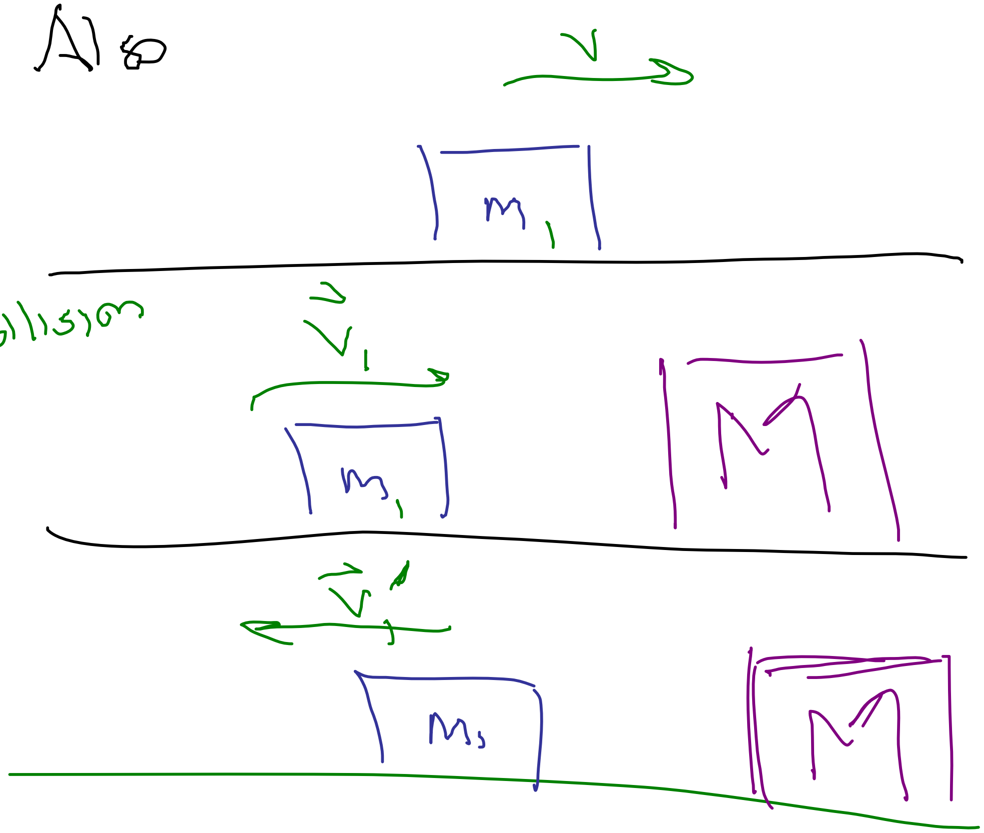
Special case:



stick together

Totally inelastic.

Also



collision

$$\vec p = m \vec v$$

$$\vec F_{net} = \frac{d\vec p}{dt} = m\vec a$$

Newton

$$\Delta \vec p = m_1 (\vec v_1' - \vec v_1)$$

$$dp_x = F_x \, dt$$

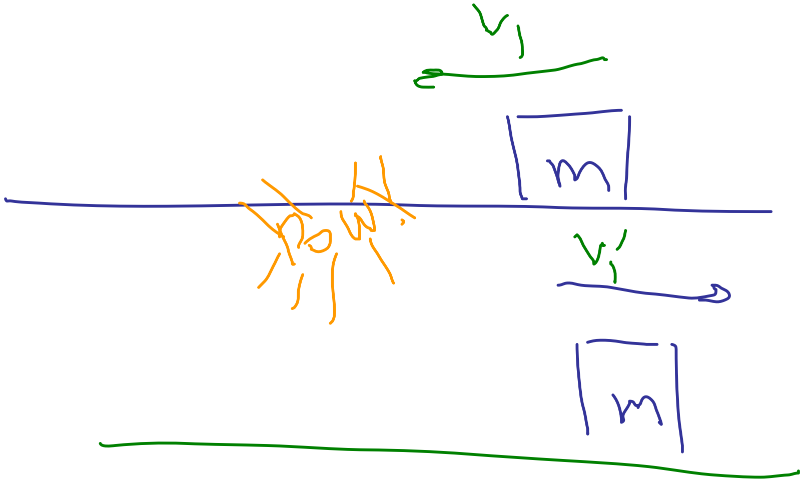
$$\Delta p_x = \int_{init}^{final} dp_x = \int F_x \, dt$$

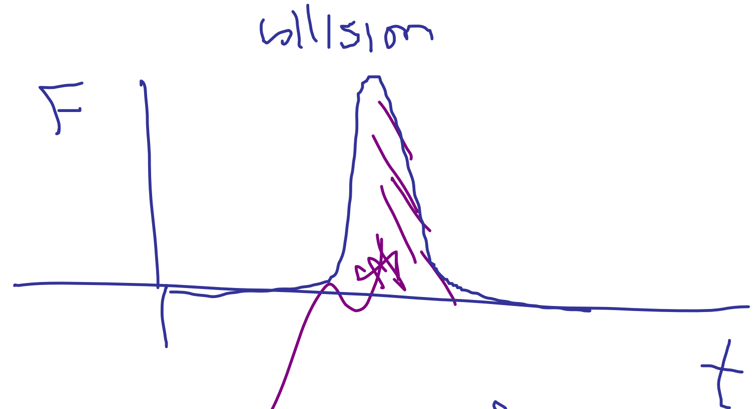
$\int F \, dx$ = Work

$\int F \, dt = \Delta \vec p$

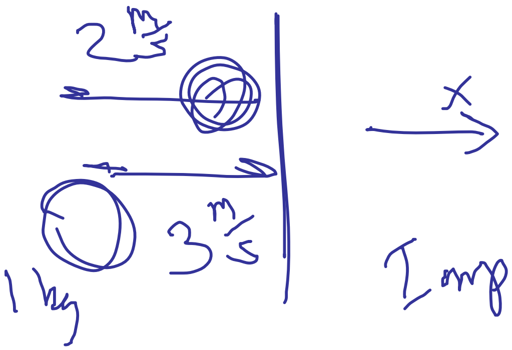
"Impulse" is $\Delta \vec p = \vec J = \int F_x \, dt$

$$\Delta p_x = \int F\,dt$$





$$\Delta p_x = J_x$$



Impulse

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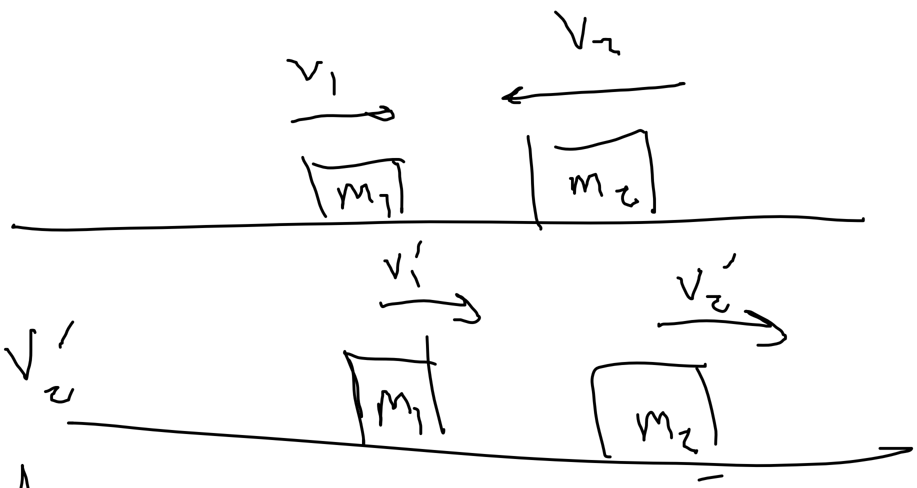
$$J_x = m\,(v_x' - v_x)$$

$$= (1\,\text{kg})\left(-2\,\tfrac{m}{s} - 3\,\tfrac{m}{s}\right) = -5\,\text{kg}\,\tfrac{m}{s}$$

Elastic collisions



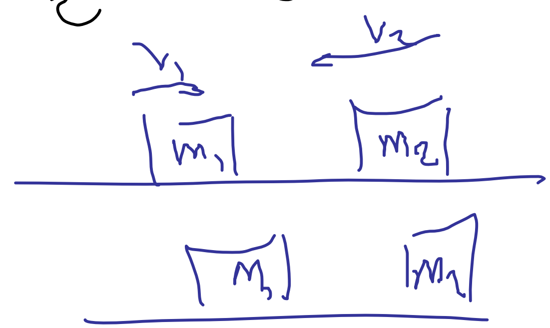
Mom. conserved

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

If elastic, K conserved

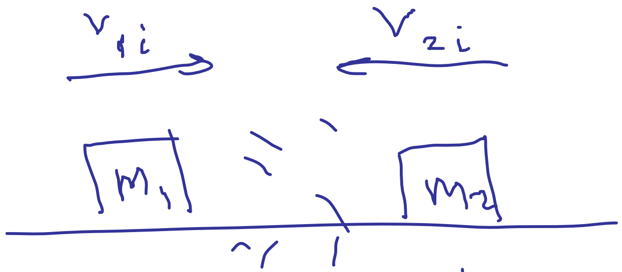
$$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$$

(Cancel $\frac{1}{2}$'s ~)

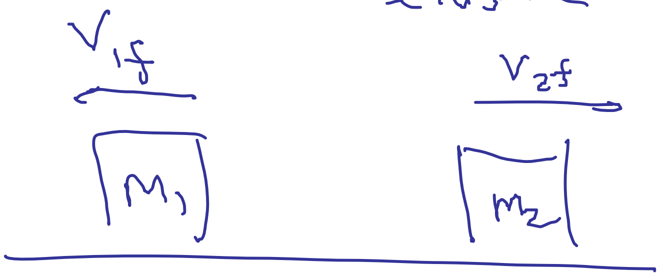


Example: Tell v_1', v_2'

Can do it if 2 eqns, elastic.



elastic



Algebra!

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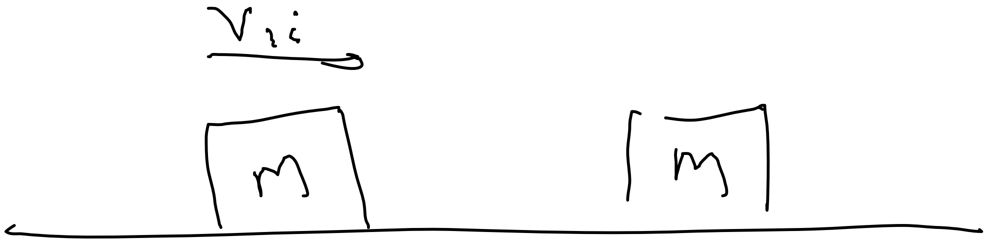
$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i} + \frac{2m_2}{m_1 + m_2} v_{2i}$$

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

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

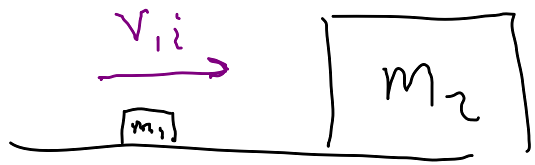
Special case $m_1 = m_2 = m$



$V_{1f} = 0$

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

$m_1 << m_2$

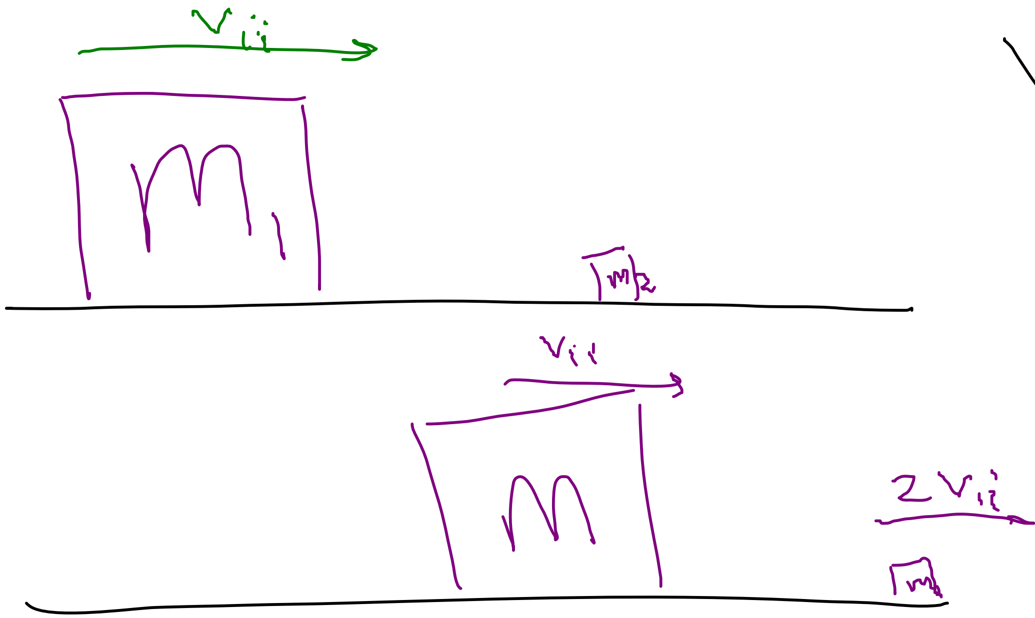


$$V_{1i} = \frac{-m_2}{m_2} V_{1i}$$

$$= -V_{1i}$$

$$V_{2f} = \frac{2m_1}{m_2} V_{1f} \quad \text{(small)}$$

$m_1 >> m_2$



$$v_{1f} = \frac{m_1}{m_1} v_{1i} = v_{1i}$$

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

9.31 Playing in street child tosses ball at $18\frac{m}{s}$ toward front of car moving toward him at $14\frac{m}{s}$. What's ball's speed after it rebounds elastically from front of car?

$m_1 >> m_2$

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

$M_1 >> m_2$

$$= 2V_{1i} - V_{2i}.$$

$V_{2i} = -18\frac{m}{s}$

$V_{1i} = 14\frac{m}{s}$

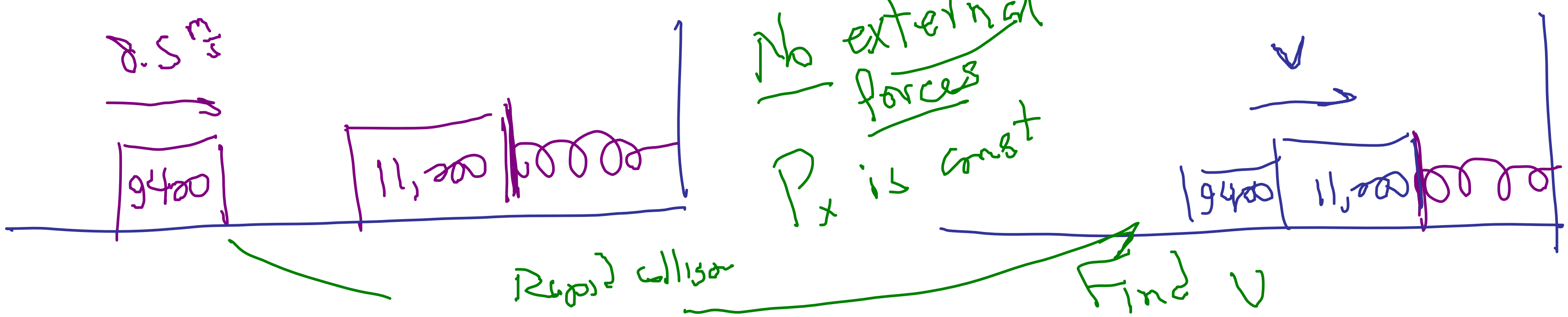
$$= 2\left(14\frac{m}{s}\right) - \left(-18\frac{m}{s}\right)$$

$$= 28 + 18$$

$$= 46\frac{m}{s}$$

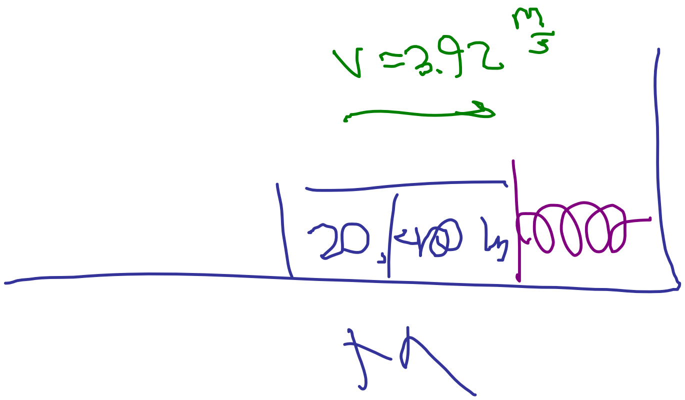
9.43 An 11,000 kg freight car rests against a spring bumper ... $k = 0.32\ MN/m$. Car is hit by second car of mass 9400 kg moving at $8.5\ \frac{m}{s}$. Couple together. Find a) Max compr. of spring b) Speed at which they rebound.

Simplify with 2nd picture

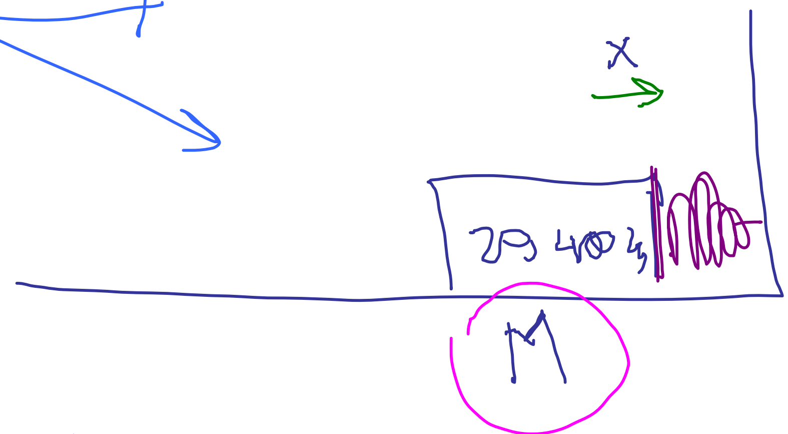


$$(9400\ \text{kg})(8.5\ \tfrac{m}{s}) = (9400 + 11{,}000)\ \text{kg}\ V$$

Get $V = 3.92\ \frac{m}{s}$ (before spring squished)



Energy cons'd



$$\frac{1}{2} M v^2 = \frac{1}{2} k x^2 \Longrightarrow x = 0.99\ m$$

(a)

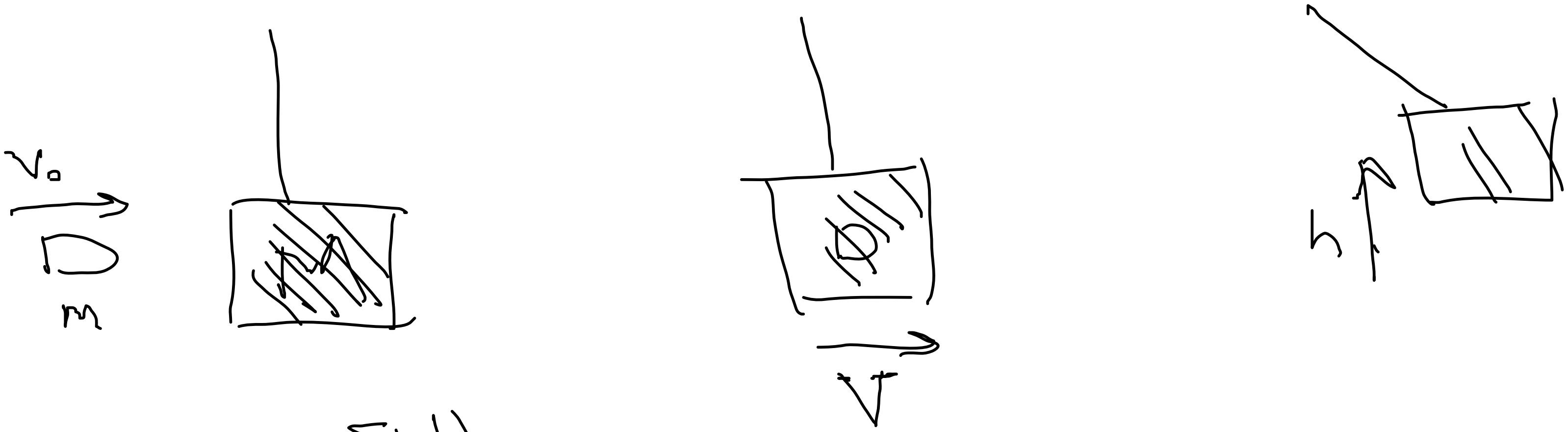
(b)

p. 145

Ballistic Pendulum

Bullet fired into wooden block, rises to height

h $\longrightarrow$ from h initial speed.



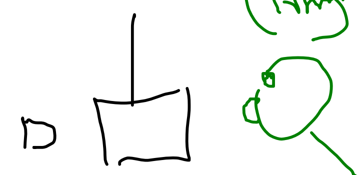
Sudden collision

$\xrightarrow{\text{P is cons'd}}$ $\xrightarrow{\text{E is cons'd.}}$

P: $$m v_0 = (M+m) V \quad (1)$$

E: $$\frac{1}{2}(M+m) V^2 = (M+m) g h \quad (2)$$

h known $\Rightarrow V \longrightarrow v_0$



Chap 10