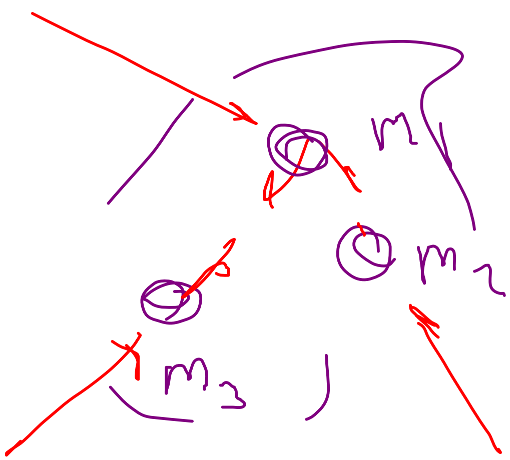
Phys 2110 - 4 3/12/12

Note Title 3/12/2012

Chap 9

Main results: Systems of particles



$$\vec{F}_{net\ ext} = M \vec{a}_{cm}$$

M = total mass

$\vec{a}_{cm}$ = accel of cm

$\xrightarrow{\text{If}}$ $\vec{F}_{\substack{net \\ ext}} = 0$

Isolated system

$\Longrightarrow$ $\vec{a}_{cm} = 0$

$\vec{p} = m\vec{v}$

Isolated system, total momentum is **conserved**.

$\vec{P}$ = total momentum

Momentum is a **vector**.

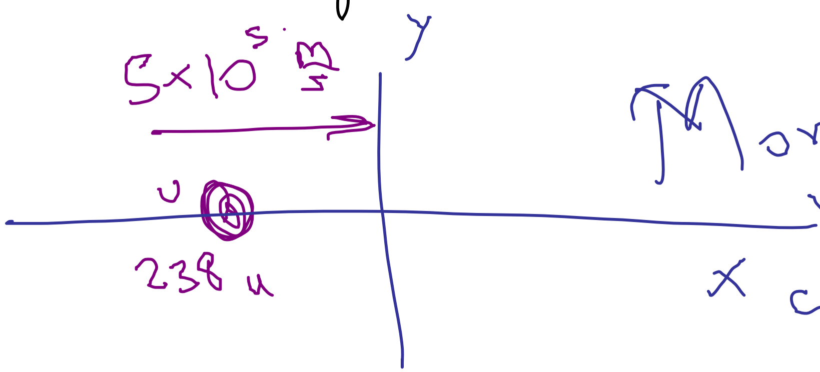
Collisions

$\vec{P}$ is conserved.

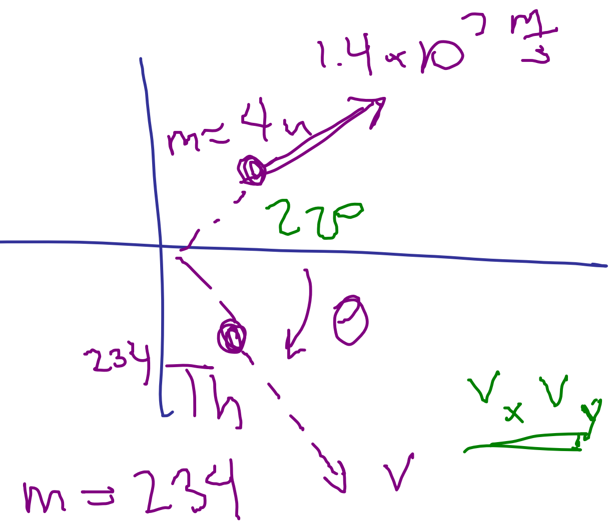
$\vec{V}_{cm}$ is same before & after.

$$\vec{V}_{cm} = \frac{m_1\vec{V}_1 + m_2\vec{V}_2}{(m_1 + m_2)}$$

9.48 A ^{238}U nucleus is moving in x-dir $5.0\times10^5 \frac{m}{s}$. Decays into α, ^{234}Th. The alpha moves at $1.4\times10^7 \frac{m}{s}$ at 22° above x-axis, find recoil velocity of thorium.



Momentum is conserved



Mom in x-dir:

$$(283)(5\times10^5 \tfrac{m}{s}) = 4(1.4\times10^7 \tfrac{m}{s})\underline{\cos 22^\circ} + (234)\,V_x$$

Find V_x

Mom in y-dir

$$0 = 4(1.4\times10^7 \tfrac{m}{s})\underline{\sin 22^\circ} + (234)\,V_y$$

Solve for V_x, V_y $\Longrightarrow$ V, θ

In general for processes in an isolated system, E is not conserved

If E is conserved in a collision; **elastic**

If E not cons'd **inelastic**

Another term used is:

$$\vec{F}_{net} = \frac{d\vec{p}}{dt}$$

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

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

$$\int \frac{d\vec{p}}{dt}\,dt = \int \vec{F}_{net}\,dt$$

$$\Delta\vec{p} = \int \vec{F}_{net}\,dt$$

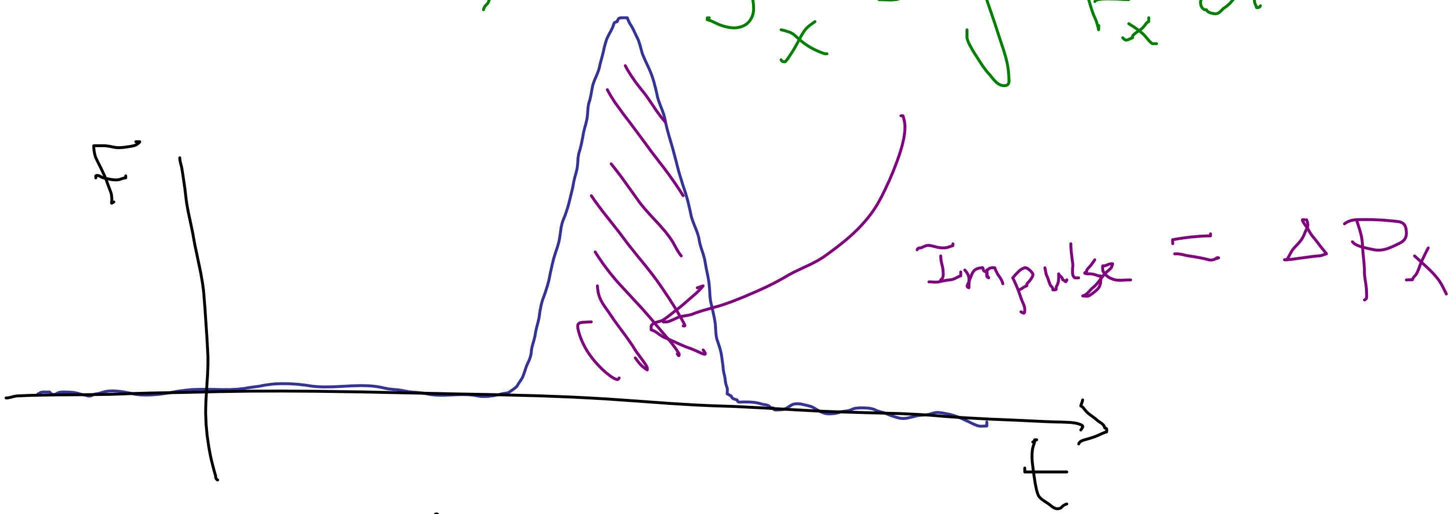
= impulse
(del'd to particle) $= \vec{J}$

$$W = \int \vec{F}\cdot d\vec{r}$$
scalar

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

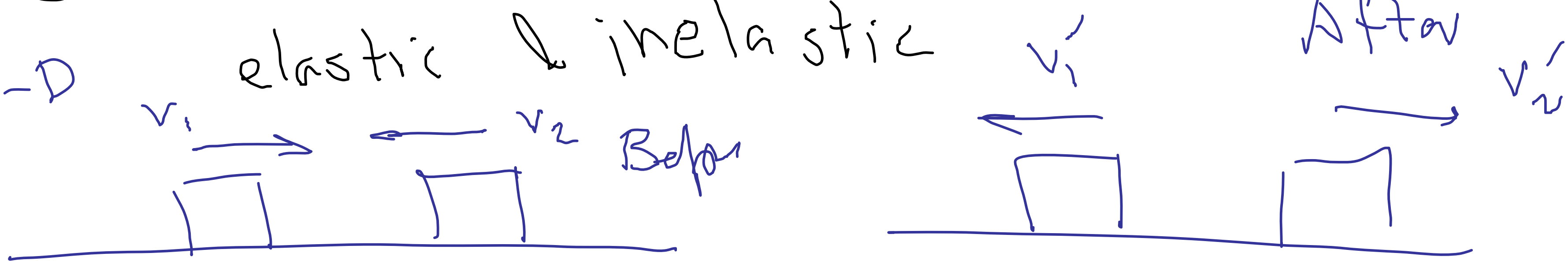
p. 143

In one dim, $J_x = \int F_x\, dt$



Go back to elastic & inelastic

1-D



$$\rightarrow \quad m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2' \tag{9.12}$$

If energy is also conserved.

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2$$

Two equations, two unknowns: v_1' v_2'

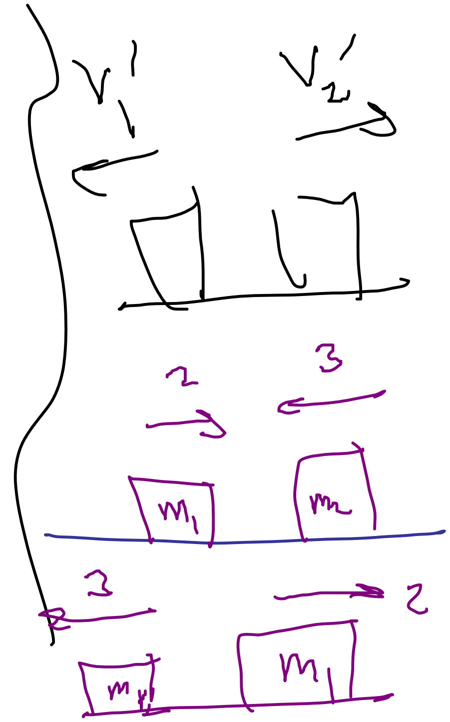
given m's
initial velocities

Solution p.146

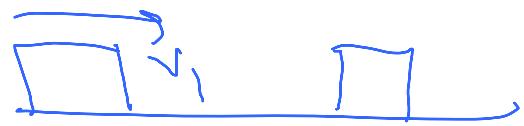
(9.15

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

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



Suppose $v_2 = 0$



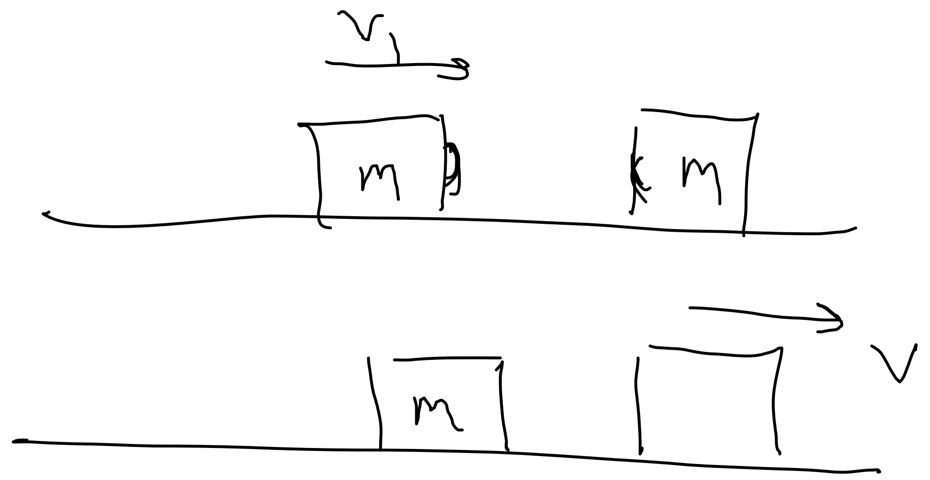
$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1$$

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

Can't have this!

$m_1 = m_2 = m$

$v_1' = 0$



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

$$= v_1$$

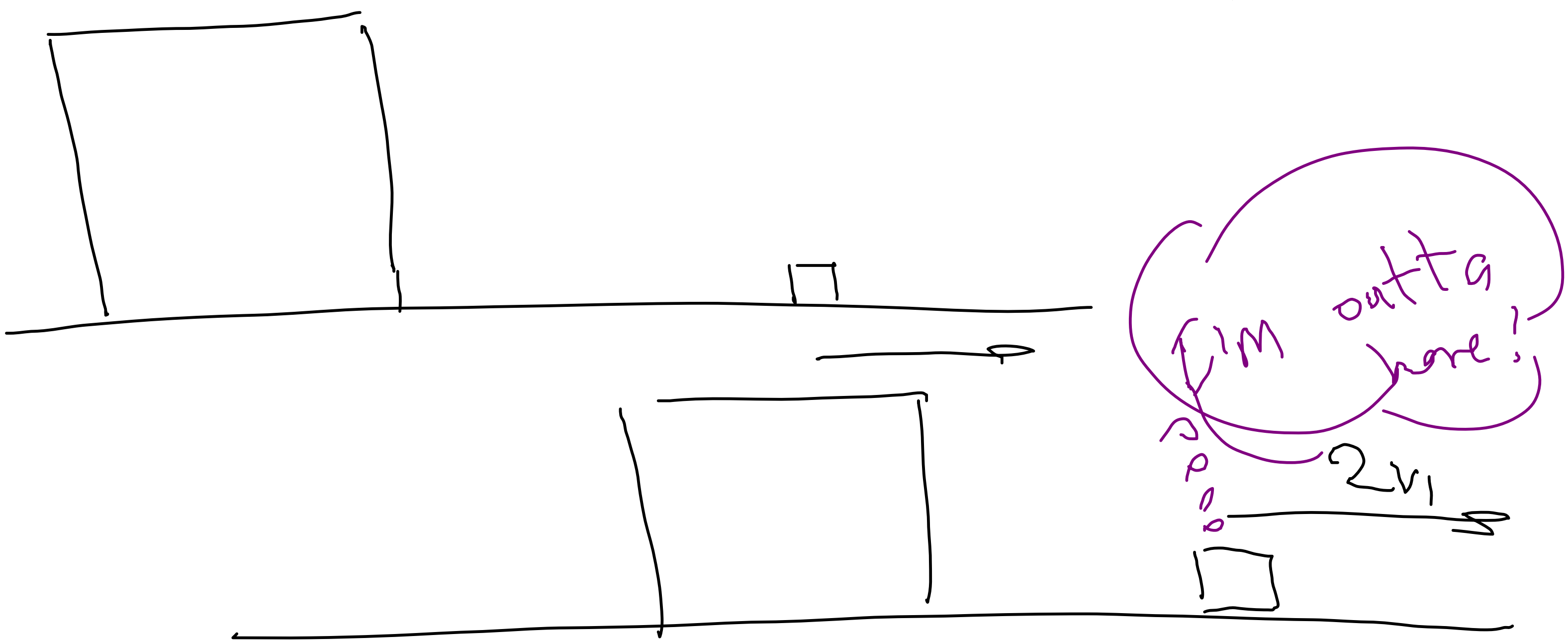
$m_1 \ll m$

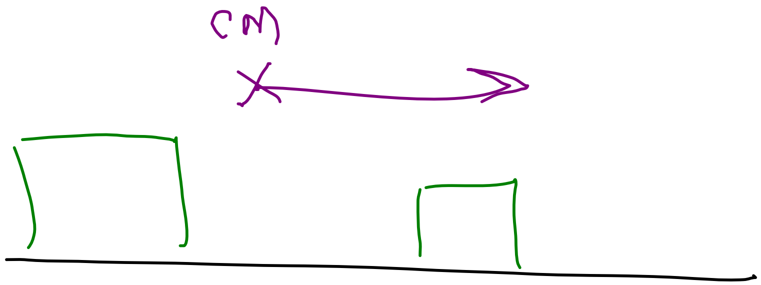
$$v_1' = \frac{0 - m_2}{0 + m_2} v_1 = -v_1$$

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

$m_1 >> m_2 \longrightarrow v_1' = v_1$

$\xrightarrow{v_1}$ $\qquad\qquad v_2' = 2v_1$





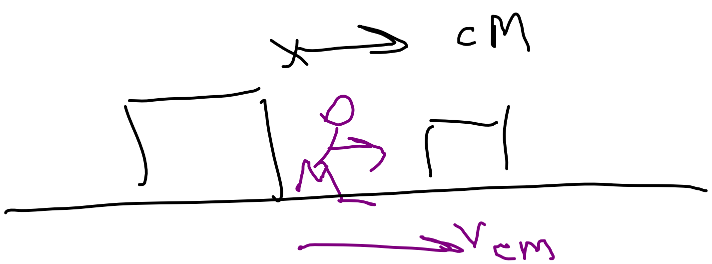
p. 142

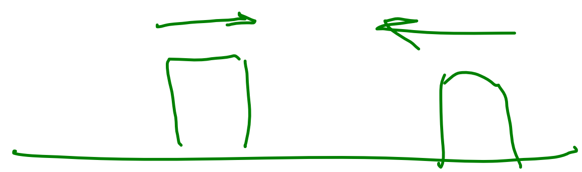
Total kinetic energy

$$K = K_{cm} + K_{int}$$

$$= \frac{1}{2} M v_{cm}^2 + \frac{1}{2} \sum m_i v_{rel}^2$$

$$\vec{v}_i = \vec{v}_{cm} + \vec{v}_{i\,rel}$$

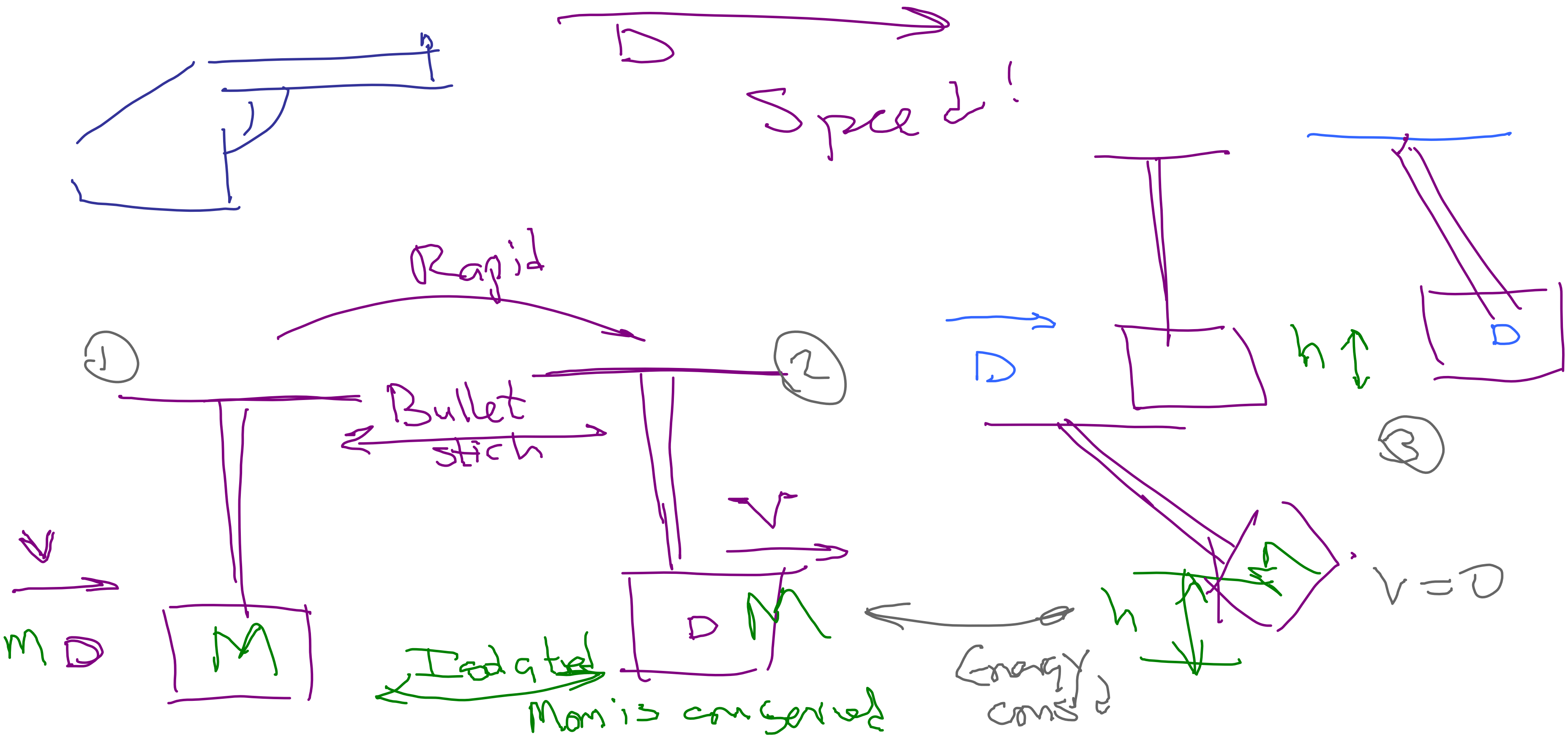




If you move along with cm, then total mom is zero p.149

Example: Ballistical pendulum

p. 145



Energy:

② – ③

$$\frac{1}{2}(M+m)V^2 = (M+m)gh$$

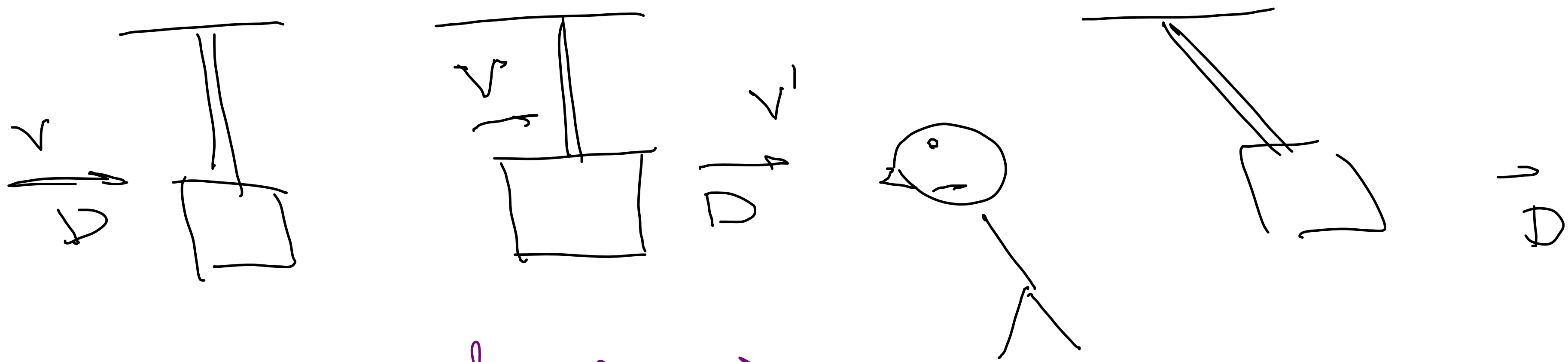
$$V = \sqrt{2gh}$$

Momentum cons. ① – ②

$$mv = (M+m)V$$

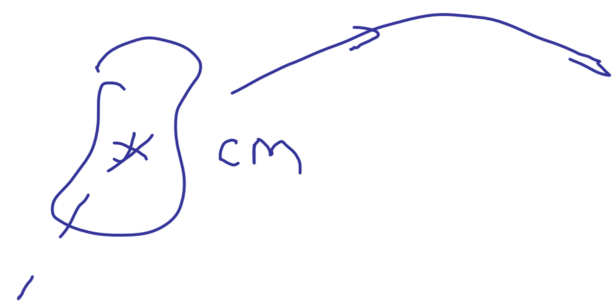
$$mv = (M+m)\sqrt{2gh}$$

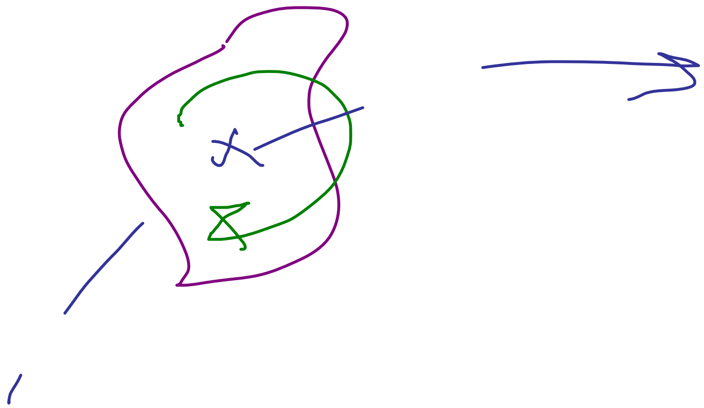
$$v = \frac{(M+m)}{m}\sqrt{2gh}$$



Rotational Motion

Objects have size.




x