3-25-13

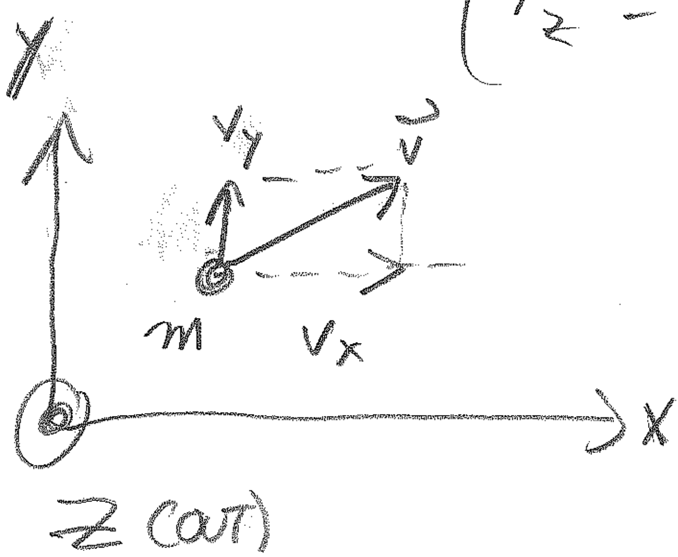
CH 8

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

Note: $p_x = mv_x$

$p_y = mv_y$

$(p_z = mv_z)$



Note: In 1-D:

$\longrightarrow x(\text{pos})$

$$F_x = ma_x = m\frac{dv_x}{dt}$$

$$F_x = \frac{d(mv_x)}{dt}$$

$$F_x = \frac{dP_x}{dt}$$

In general: $\vec{F} = \frac{d\vec{p}}{dt}$, 3D:

$\vec{F}$ = net force = $\sum \vec{F}$

consequences

(I.) Impulse

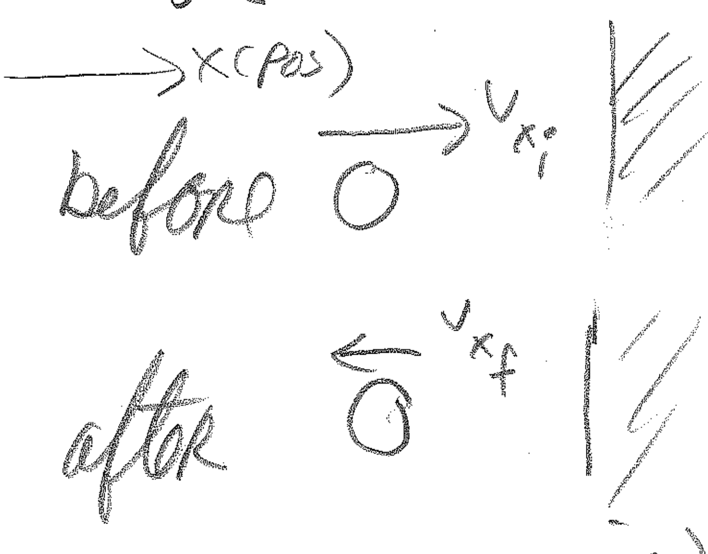
(II) conservation of momentum
(need the 3RD LAW)

(I) Impulse (0.8 lb) Higgs — Boson Experiment (CERN)

<u>Ball</u> mass = 0.80 kg

hit a brick wall

Example 8.2



(a) Find Impulse

$\vec{J}$ = Impulse $\equiv \overrightarrow{\Delta p}$

$$J_x = m v_{x_f} - m v_{x_i}$$

$$m v_{x_i} = +(0.40\,kg)(+30\,\tfrac{m}{s}) = +12\,kg\cdot\tfrac{m}{s}$$

$$m v_{x_f} = +(0.40\,kg)(-20\,\tfrac{m}{s}) = -8.0\,kg\cdot\tfrac{m}{s}$$

$v_{x_i} = 30\,\frac{m}{s}$ (given)

$v_{x_f} = -20\,\frac{m}{s}$ (Given)

$\swarrow$ impulse

$$J_x = -8.0\,kg\cdot\frac{m}{s} - 12\,kg\cdot\frac{m}{s}$$

$$\Delta P_x = -20.0\,kg\cdot\frac{m}{s}$$

$$\Delta P_x = -20.0\,N\cdot s$$

In general: $\vec{J} = \Delta\vec{p}$. $\left(N = \frac{kg\cdot m}{s^2}\right)$

Note: $$J_x = \Delta P_x = \int_i^f dP_x$$

$$dP_x = F_x\cdot dt \text{ since } F_x = \frac{dP_x}{dt}.$$

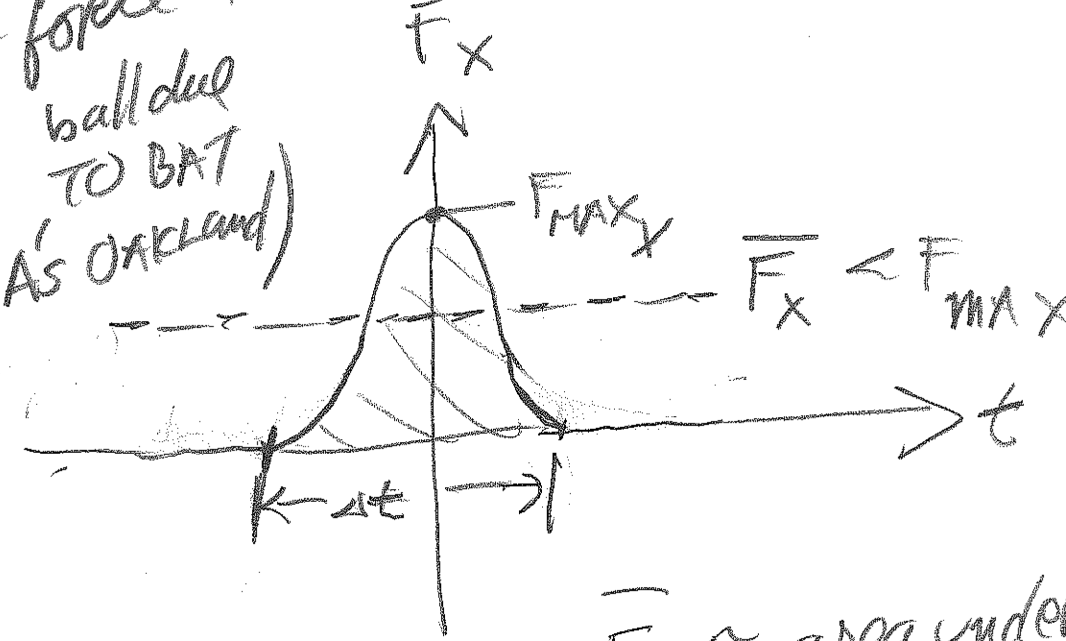
$$\Delta P_x = J_x = \int_i^f \left(\frac{dP_x}{dt}\right)dt$$

$$\Delta P_x = J_x = \bar{F}_x\cdot\Delta t$$

since $$\bar{F}_x \equiv \frac{1}{\Delta t}\int_i^f \frac{dP_x}{dt}dt$$

Average of function: Math 1 $$\bar{F}_x = \frac{1}{\Delta t}\int_i^f F_x dt$$

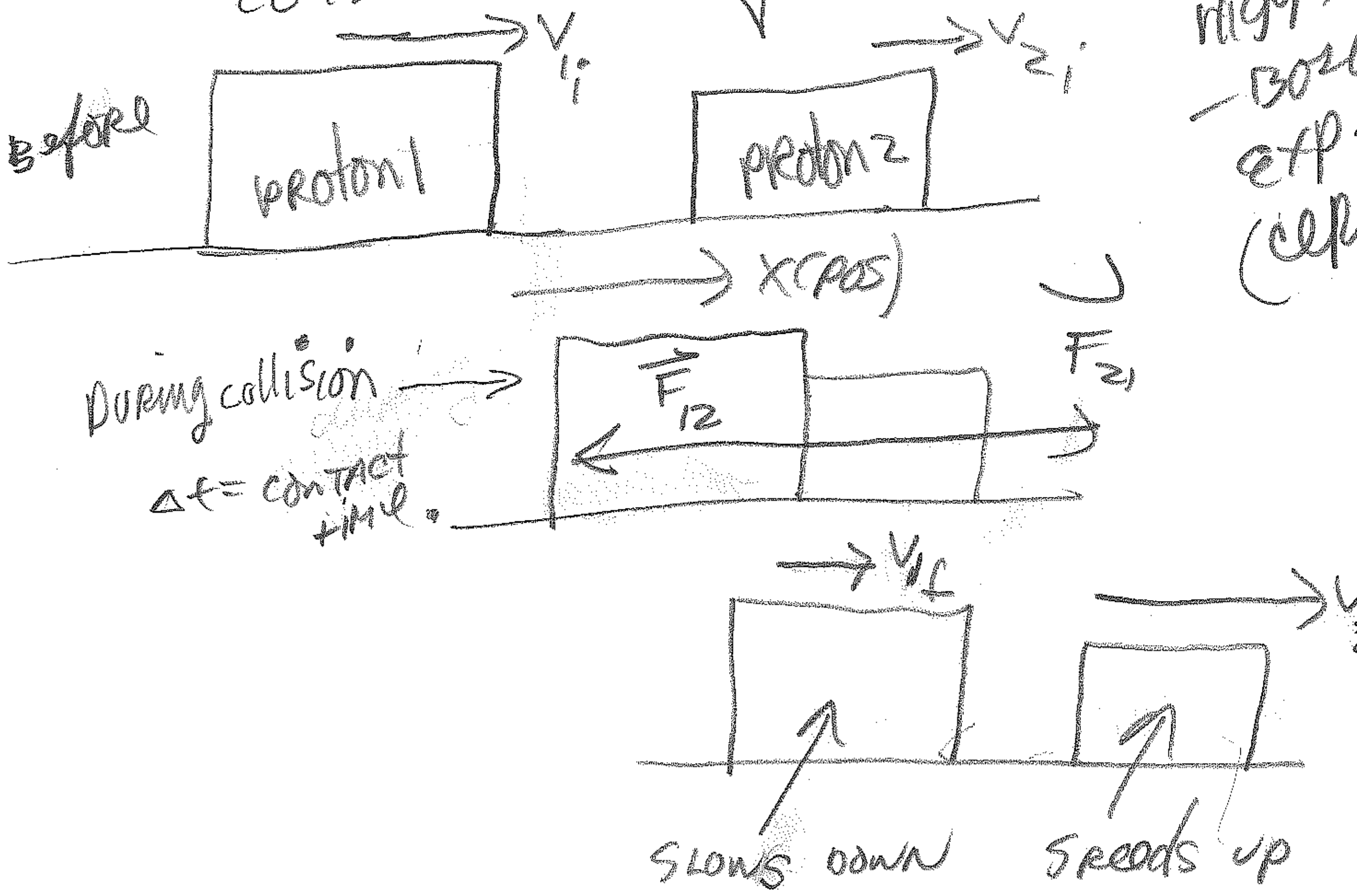
F_x = force on ball due TO BAT (A's OAKLAND)



$$\bar{F}_x \approx \frac{\text{area under curve}}{\Delta t}$$

conservation of momentum

Higgs - Boson exp. (CERN)



during: $\left|\vec{F}_{12}\right| = \left|\vec{F}_{21}\right|$

newton's 3RD LAW

$\longrightarrow$ X (POS)

$$\left|m_1 \frac{\Delta V_{1x}}{\Delta t}\right| = \left|m_2 \frac{\Delta V_{2x}}{\Delta t}\right|$$

$$\left|m_1 \Delta V_{1x}\right| = \left|m_2 \Delta V_{2x}\right|$$

Note:

$$m_1 \Delta V_{1x} = -m_2 \Delta V_{2x}$$

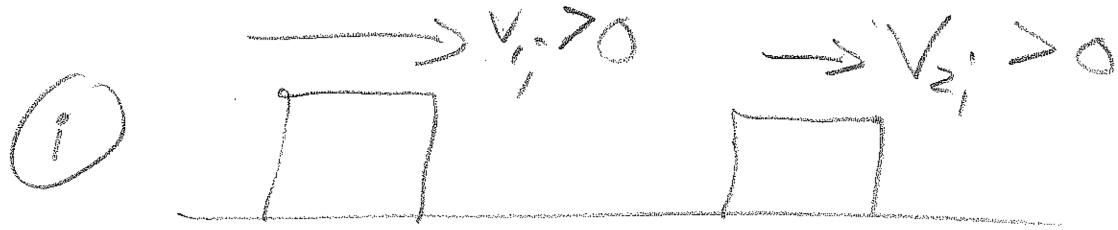
Negative sign from 3RD LAW.

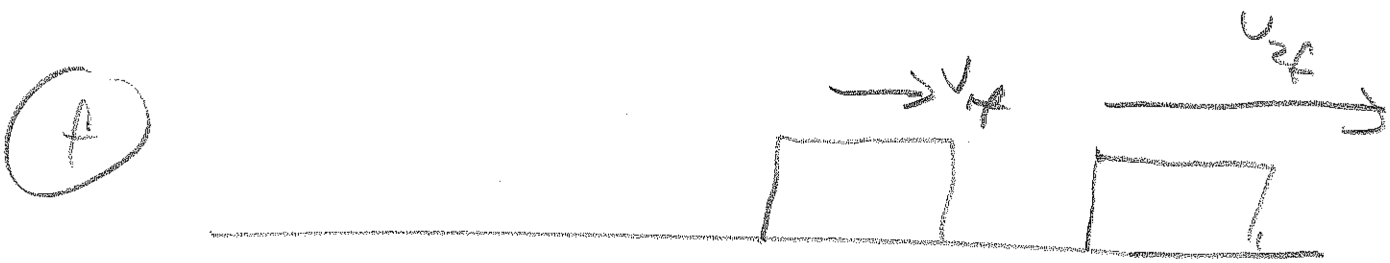
$$m_1(V_{1f} - V_{1i}) = -m_2(V_{2f} - V_{2i})$$

Re-arrange

$\longrightarrow x\,(\text{pos})$

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





See Example 8.5.

assume $m_1 v_{1_i} + m_2 v_{2_i} = m_1 v_{1_f} + m_2 v_{2_f}$

<u>In ELASTIC</u> and ELASTIC collisions

$\longrightarrow x$ (POS)

In ELASTIC: $\frac{1}{2} m_1 v_{1_i}^2 + \frac{1}{2} m_2 v_{2_i}^2 \neq \frac{1}{2} m_1 v_{1_f}^2 + \frac{1}{2} m_2 v_{2_f}^2$

$KE_i \neq KE_f$

OFTEN $KE_f \leq KE_i$ BUT

sometimes $KE_f \geq KE_i$

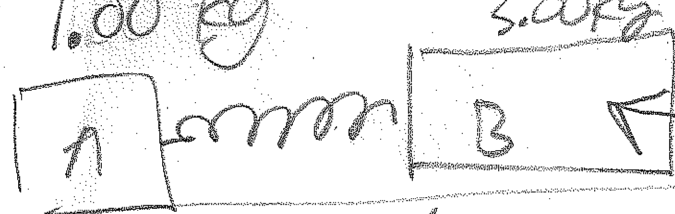
<u>Examples</u>: 8.7, 8.8 ($KE_f < KE_i$)

#24, CH8 ($KE_f > KE_i$)

<u>QUIZ</u> 10 (CH 8) due 4-17

#24 1.00 kg 3.00 kg

nuclear reaction between nuclei.



proton

Li nucleus

(H nucleus)

initially at REST

after

SMALL SCALE

spring has "DECAYED" w/o a TRACE.

#24 Insert CH8

FORMALISM.

$\longrightarrow x$ (POS)

$$\underset{\text{Before}}{\sum P_x} = \underset{\text{after}}{\sum P_x}$$

CH4,5 style: SUBTRACTING magnitudes.

$$\underset{\text{before}}{\text{POS} - \text{neg}} = \underset{\text{after}}{\text{POS} - \text{neg}}$$

FORMAL style: $V_x < 0$ means moving left

$$P_{Ax_i} + P_{Bx_i} = P_{Ax_f} + P_{Bx_f}$$

$$0 + 0 = m_A \cdot V_A + (3 \cdot m_A) \cdot V_B$$

$V_B = 1.20 \frac{m}{s}$

$$V_A = -\frac{3m_A}{m_A}\left(1.20\frac{m}{s}\right)$$

$V_A = -3.6$ m/s

6 What was initial U_s?

$$U_s = KE_f$$

$$= \frac{1}{2}m_A V_A^2 + \frac{1}{2}m_B V_B^2$$

$m_B = 3m_A$

$$= \frac{1}{2}m_A V_A^2 + \frac{3}{2}m_A \cdot \left(\frac{V_A}{3}\right)^2$$

$$= \frac{1}{2} m_A V_A^2 + \frac{3}{2} m_A \frac{V_A^2}{9}$$

$$= \frac{1}{2}(1.333) m_A V_A^2$$

$$= \frac{1}{2}(1.333)(3.6)^2 \text{ J}$$

$$= 8.6 \text{ J}$$

Note: $U_s = \frac{1}{2} K \Delta x^2$

Elastic collisions $\longrightarrow x$ (pos)

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

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

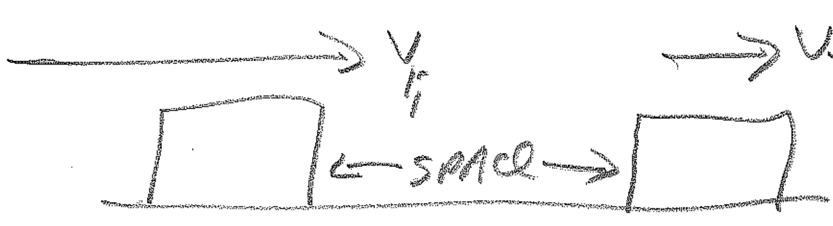
Leads to (algebra)

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

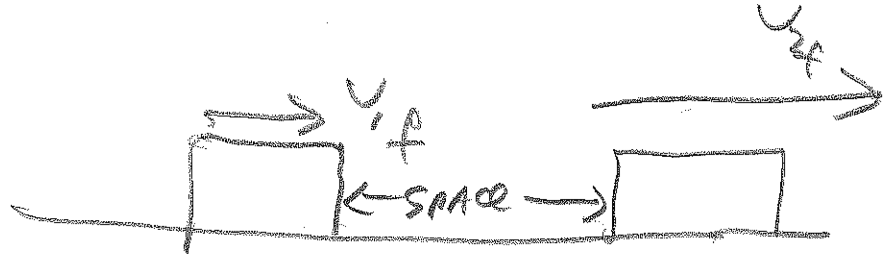
(B') $v_{1i} - v_{2i} = v_{2f} - v_{1f}$

makes sense

Elastic



$$\boxed{v_{rel} = \left| \frac{d\,\text{space}}{dt} \right|}$$

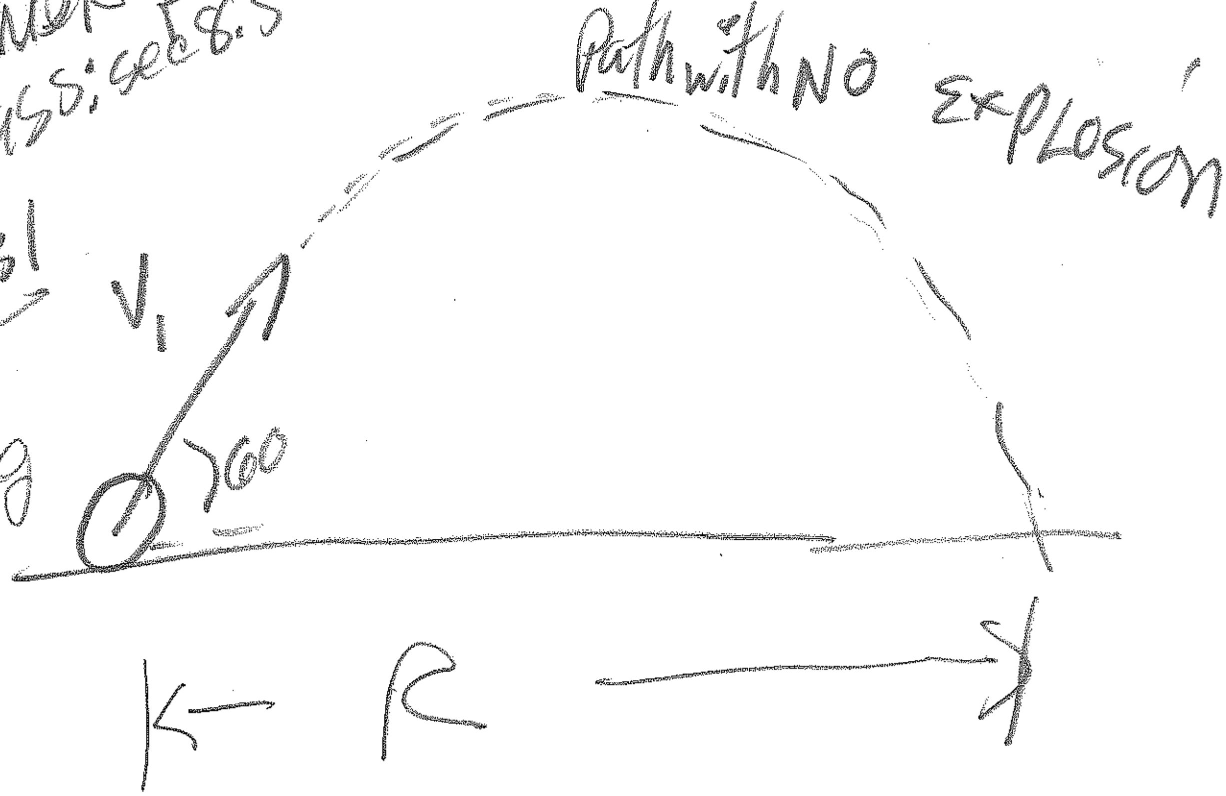


$v_{rel} = v_{1i} - v_{2i} = v_{2f} - v_{1f}$ = constant!

relative speed

Center of mass: sec 8.5

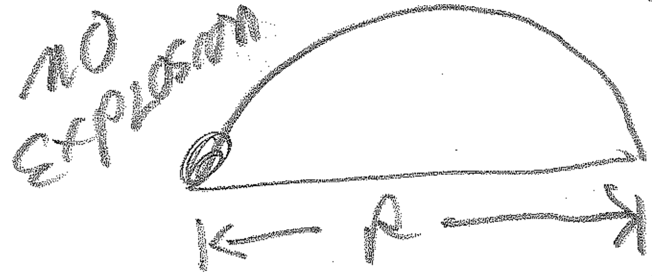
Fig 8.31



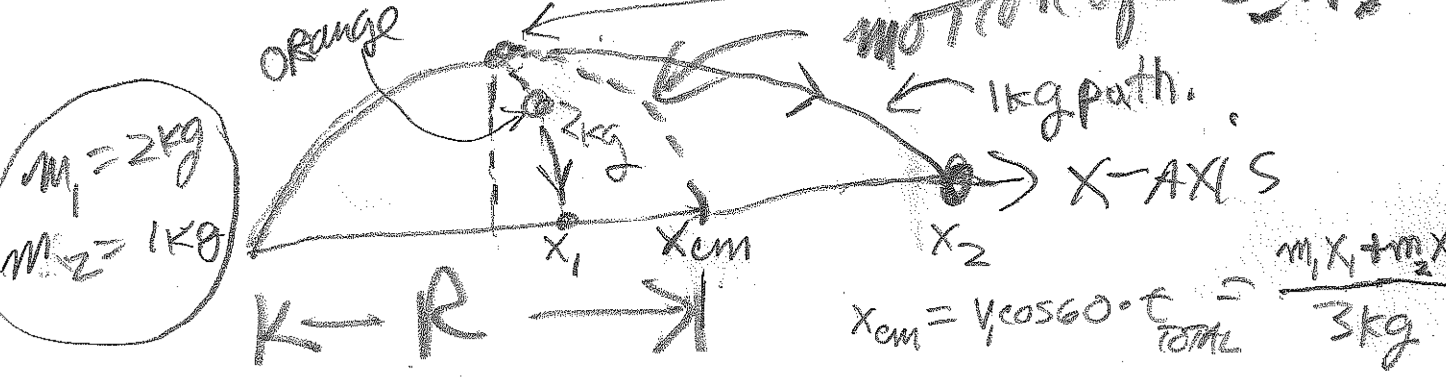
$$R = V_1 \cos 60^\circ \cdot t_{TOTAL}$$

activphysics:

* c.m. = center of mass

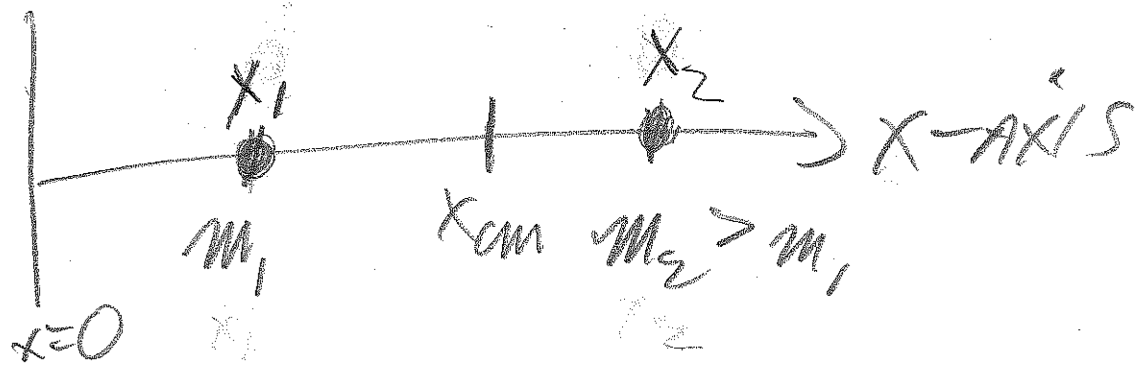


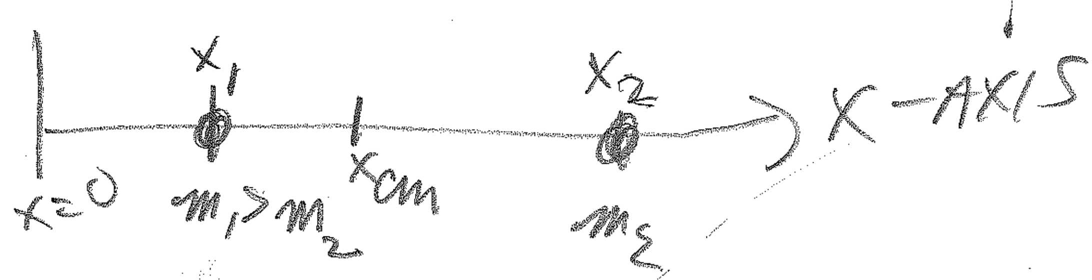
motion of CM. *



$$x_{cm} = V_1 \cos 60 \cdot t_{TOTAL} = \frac{m_1 x_1 + m_2 x_2}{3kg}$$

Definition x_{cm} (1D)





$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$$x_{cm} = \frac{\sum_{i=1}^{N} m_i x_i}{\sum m_i}$$ in general.