Kinds of Collissions

Elastic Collission ⇒ hard objects

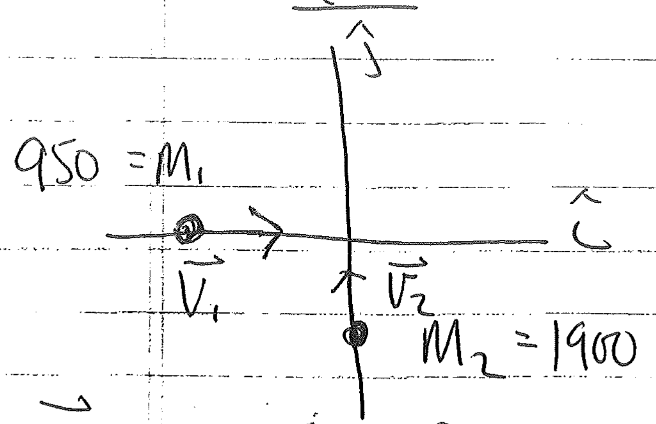
$$KE_{\substack{system\\BEFORE}} = KE_{\substack{system\\AFTER}}$$

Inelastic Collission ⇒ ☺ $\vec{P}_{before} = \vec{P}_{after}$

Perfectly Inelastic ⇒ objects stick together

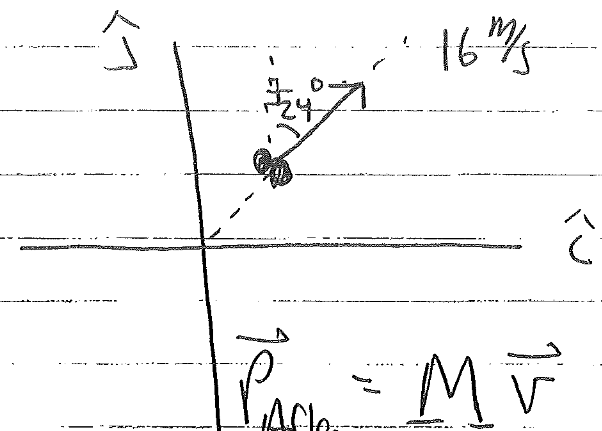
8.41) pg 266 "Perfectly Inelastic"

Before



$$\vec{P}_{before} = \vec{P}_1 + \vec{P}_2$$
$$= m_1\vec{V}_1 + M_2\vec{V}_2$$
$$= 950(V_1\hat{i}) + 1900(V_2\hat{j})$$

After



$$\vec{P}_{After} = \underline{M}\,\vec{V}$$
$$= (m_1 + m_2)\left(16\sin(24)\hat{i} + 16\cos(24)\hat{j}\right)$$

$$\vec{P}_{before} = \vec{P}_{After}$$

$\boxed{\hat{i}}$

$$P_{x_{before}} = P_{x_{After}}$$

$$950 v_1 = (950+1900)16\sin(24)$$

$$\therefore v_1 = 19.52 \text{ m/s}$$

$\boxed{\hat{j}}$

$$P_{y_{before}} = P_{y_{after}}$$

$$1900 v_2 = (950+1900)16\cos(24)$$

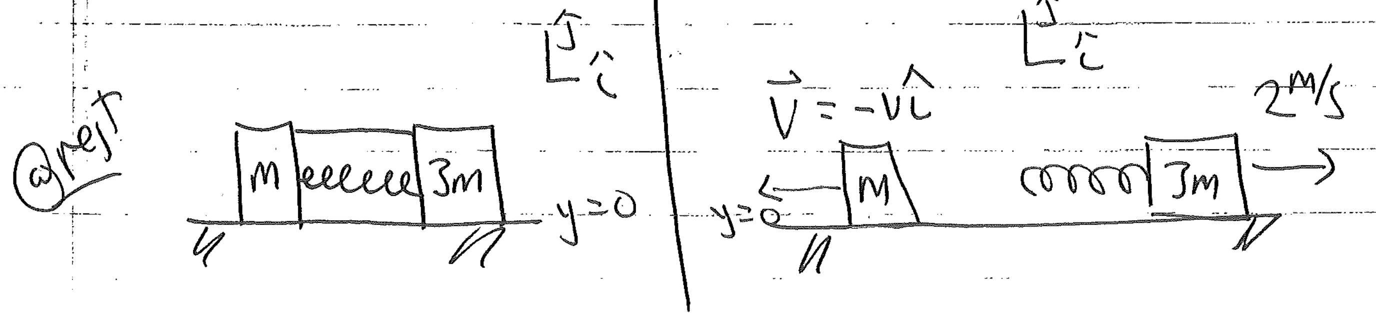
$$\therefore v_2 = 21.93 \text{ m/s}$$

Aside: $KE_{before} = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = 637.9\times10^3$ joules

$KE_{after} = \frac{1}{2}(m_1+m_2)(16)^2 = 364.8\times10^3$ joules

?  ?

Ex.) Before | After



Find v.

If $m = 0.35$ kg, find PE_{spring} before.

System: m, 3m, Spring(no mass), Earth

$$\vec{P}_{before} = \vec{P}_m + \vec{P}_{3m} = 0$$

$$\vec{P}_{After} = \vec{P}_{3m} + \vec{P}_m = 3m(2\hat{i}) + m(-v\hat{i})$$

$$\vec{P}_{before} = \vec{P}_{after}$$

$$\boxed{\hat{i}} \quad 0 = 6m - vm$$

$$v = 6 \text{ meters/second}$$

ANSWER

$$TE_{Before} = \underbrace{KE_{Before}}_{\to 0 \text{ "rest"}} + \underbrace{PE_{g_{Before}}}_{\to 0} + PE_{s_{before}} = \left[\tfrac{1}{2}kx^2\right]$$

$$TE_{After} = KE_{After} + \underbrace{PE_{g_{After}}}_{\to 0} + \underbrace{PE_{s_{After}}}_{\to 0} = \tfrac{1}{2}(m)\underset{\substack{\uparrow \\ 6}}{v}^2 + \tfrac{1}{2}(3m)(2)^2$$

Cons. Energy

$$TE_{Before} = TE_{After}$$

$$\left[\tfrac{1}{2}kx^2\right] = m\left[18 + 6\right]$$

if $m = 0.35\text{ kg}$, ... ☺

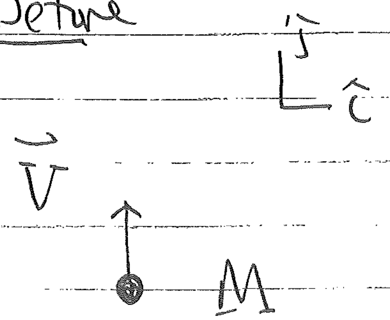
Q] How would this be different if we had friction?

$$TE_{before} + \underbrace{(\text{Work by friction})}_{\text{NEGATIVE!!}} = TE_{After}$$

Ex.) A firework is shot straight up into the air. $M = 8\,kg$. At the instant when it is moving $100\,m/s$, it breaks into two parts. $M_1 = 5\,kg$ and moves off @ an angle of 35° with a speed of $150\,m/s$.

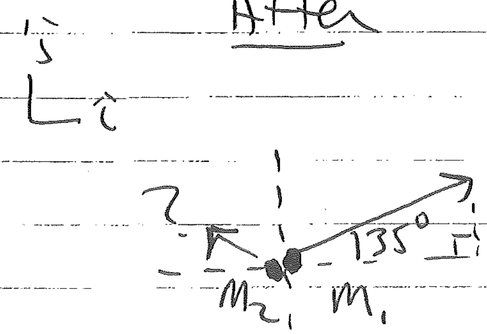
Assume that $M_2 = 3\,kg$. Find the speed + direction for M_2.

Before



$\vec{P}_{before} = M\vec{V} = 800\,\hat{j}$

After



$\vec{P}_{m_1} = m_1\vec{v}_1 = 5\left(150\cos(35)\hat{i} + 150\sin(35)\hat{j}\right)$

$\vec{P}_{m_2} = m_2\vec{v}_2 = 3\left(V_x\hat{i} + V_y\hat{j}\right)$

$\vec{P}_{After} = \vec{P}_{m_1} + \vec{P}_{m_2}$

$$\vec{P}_{before} = \vec{P}_{after}$$

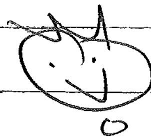
$\boxed{\hat{i}}$ $\quad 0 = 5\left(150\cos(35)\right) + 3V_x$

$\therefore V_x = -204.8\,m/s$

$\boxed{\hat{j}}$ $\quad 800 = 5\left(150\sin(35)\right) + 3V_y$

$$\therefore V_y = 123.3 \, m/s$$

$$\therefore \vec{V_2} = V_x \hat{i} + V_y \hat{j} = -204.8\hat{i} + 123.3\hat{j}$$



$$|\vec{V_2}| \; @ \; \ldots^\circ$$

BUT $\vec{F}_{gravity}$ is an external force!!

Is momentum conserved? $\approx$ YES

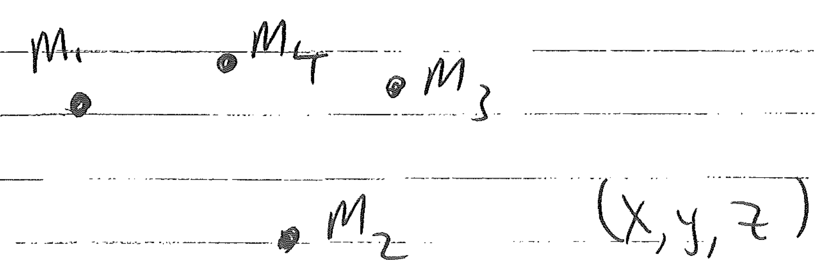
- "Impulse Approximation": during the event, internal (collission) forces are much greater than external forces.

- Short collision times (don't allow ext. force to affect motion)

Center of Mass (NOT ON THIS EXAM)

If we were to take an "extended object" and replace it w/ a point mass, that point mass should be placed @ the "center of mass" (COM, CM)

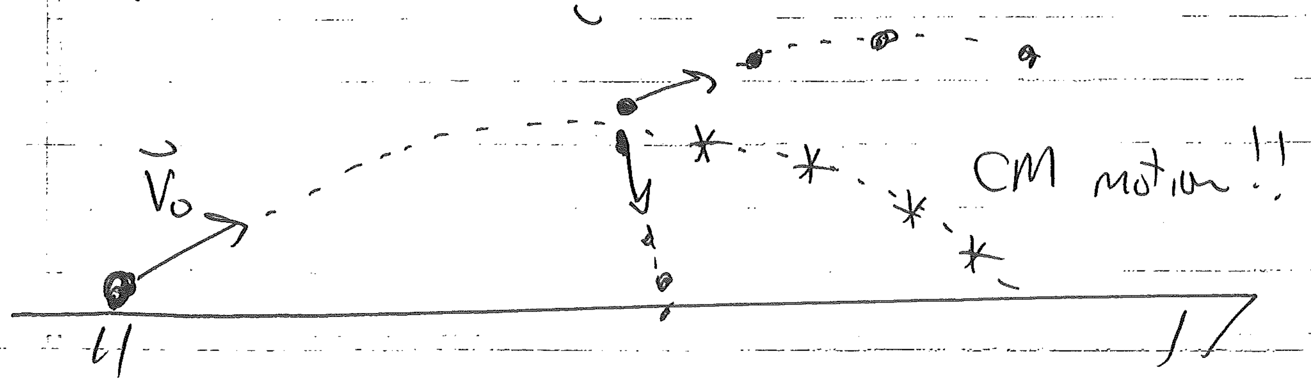
Definition :



$$X_{cm} = \frac{\sum_i m_i x_i}{\sum_i m_i} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + m_4 x_4}{(m_1 + m_2 + m_3 + m_4)}$$

$$y_{cm} = \frac{\sum_i m_i y_i}{\sum_i m_i}$$

$$z_{cm} = \frac{\sum_i m_i z_i}{\sum_i m_i}$$



EX:

$$X_{cm} = \frac{\int x\,dm}{\int dm}$$

$dM \Rightarrow$ a little piece of mass

$\int dM =$ Total mass

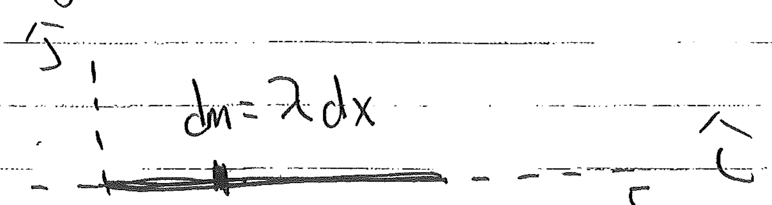
Mass density: 3-d $\rho =$ Mass/volume

2-d $\sigma =$ Mass/area

1-d $\lambda =$ Mass/length

A rod 5 meters long has a mass of 10 kg. Find the location of its CM.

$$\lambda = \frac{10\,kg}{5\,m} = 2\,\frac{kg}{m}$$



$$\int x\,dm = \int_0^5 x\lambda\,dx = \lambda\int_0^5 x\,dx$$

$$= \lambda \frac{x^2}{2}\Big|_0^5 = 25 \text{ meters} \cdot kg$$

$$X_{cm} = \frac{25}{10} = 2.5 \text{ meters}$$