Center of Mass:

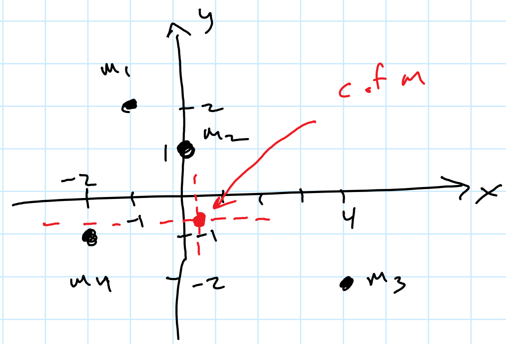
1) Find the com of the following point objects

$m_1 = 1$ kg

$m_2 = 2$ kg

$m_3 = 3$ kg

$m_4 = 4$ kg



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

$$= \frac{(1)(-1) + (2)(0) + (3)(4) + (4)(-2)}{1+2+3+4}$$

$$= \frac{3}{10} \text{ m}$$

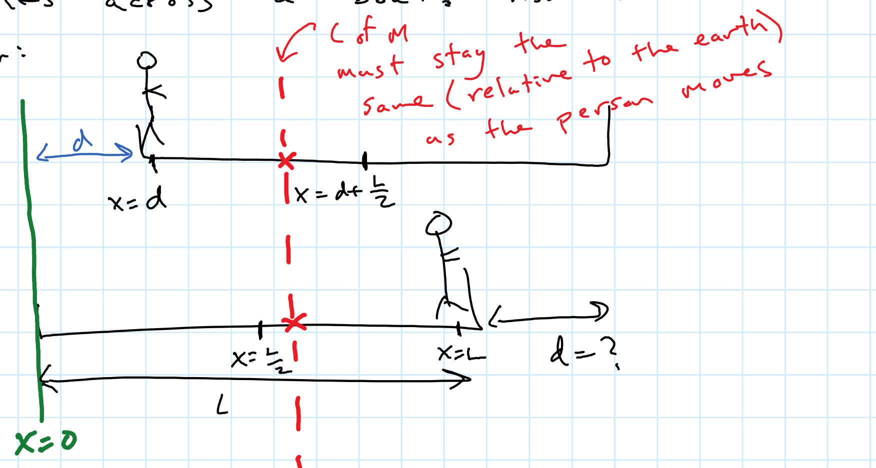
$$y_{cm} = \frac{\Sigma m_i y_i}{\Sigma m_i} = \frac{(1)(2) + (2)(1) + (3)(-2) + (4)(-1)}{1+2+3+4}$$

$$= \frac{-6}{10} = -\frac{3}{5} \text{ m}$$

2) A person walks across a boat. Assume No friction with the water:

initial:

final:



Find d the distance

given: $m_{boat} = 50$ kg

Find d
the distance
the boat moves
relative to the shore

given: $m_{boat} = 50$ kg

$m_{person} = 100$ kg

$L = 3$ m

$$(X_{cm})_i = \frac{m_p X_{pi} + m_b X_{bi}}{m_p + m_b}$$

$$= \frac{(100)\,d + (50)\left(d + \frac{3}{2}\right)}{100 + 50}$$

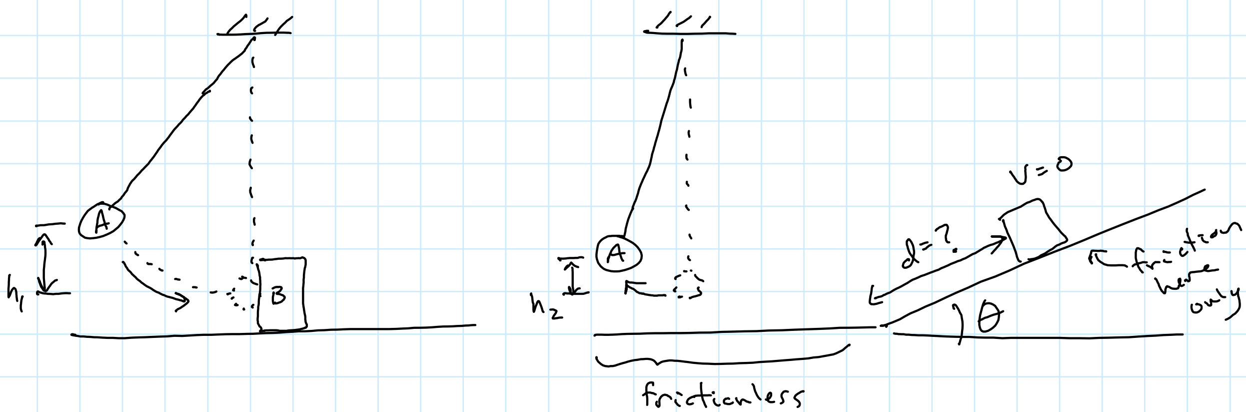
$$(X_{cm})_f = \frac{(100)(3) + (50)\left(\frac{3}{2}\right)}{100 + 50}$$

$$(X_{cm})_i = (X_{cm})_f$$

$$\frac{150\,d + 75}{\cancel{150}} = \frac{300 + 75}{\cancel{150}}$$

$$150\,d = 300$$

$$d = 2 \text{ m}$$



Mass A on a string, released from rest, strikes mass B and bounces back.

Mass B goes up incline and comes to rest.

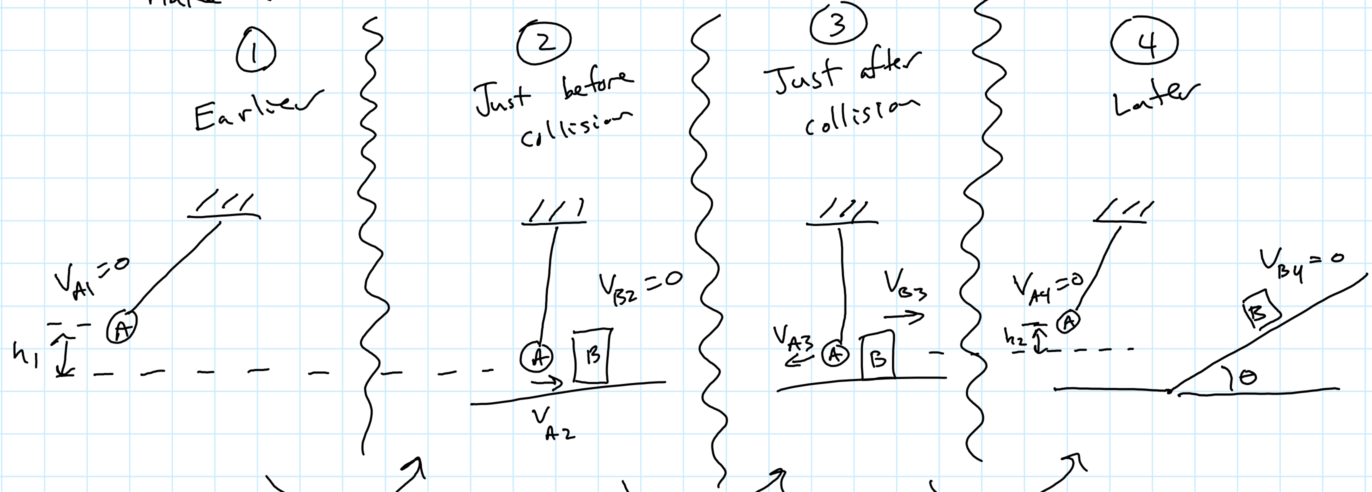
Only the incline has friction

Find d (the distance mass B goes up incline)

given: $M_A = 0.5$ kg $h_1 = 1.4$ m $\theta = 30°$

$M_B = 0.6$ kg $h_2 = 0.7$ m $\mu_k = 0.2$

Make a timeline:



use energy

$E_1 = E_2$

use momentum

$\vec{p}_2 = \vec{p}_3$

use energy

For A

$E_3 = E_4$

For B

$E_3 + W_{friction} = E_4$

$$\vec{P}_2 = \vec{P}_3 \quad \rightarrow +$$

$$M_A \underbrace{V_{A2}}_{\text{Unknown ✓}} + M_B(0) = M_A \underbrace{V_{A3}}_{\text{Unknown ✓}} + M_B \underbrace{V_{B3}}_{\text{Unknown}}$$

1st) use $E_1 = E_2$ to find V_{A2}

$E_1 = E_2$ for mass A

$$m_A g h_1 = \frac{1}{2} m_A V_{A2}^2$$

$$V_{A2} = \sqrt{2 g h_1}$$

$$= \sqrt{2(9.8)(1.4)}$$

$$= 5.24 \ \frac{m}{s}$$

2nd) Use $E_3 = E_4$ for mass A to find V_{A3}

$$\frac{1}{2} m_A V_{A3}^2 = m_A g h_2$$

$$V_{A3} = \sqrt{2 g h_2}$$

$$= \sqrt{2(9.8)(0.7)}$$

$$= 3.70 \ \frac{m}{s}$$

3rd) use $\vec{P}_2 = \vec{P}_3 \ \longrightarrow +$ to find V_{B3}

$$m_A V_{A2} + m_B(0) = m_A V_{A3} + m_B V_{B3}$$

$$(0.5)(5.24) + 0 = (0.5)(-3.70) + (0.6) V_{B3}$$

bounces back must be Negative

$$V_{B3} = 7.45 \ \frac{m}{s}$$

4th) use $E_3 + W_{friction} = E_4$ for Mass B to find d

$$K_3 + W_{friction} = (U_g)_4$$

$$\frac{1}{2} m_B V_{B3}^2 - \mu_k \underbrace{m_B g \cos\theta}_{N} d = m_B g \underbrace{d \sin\theta}_{h}$$

$$\frac{1}{2}(0.6)(7.45)^2 - (0.2)(0.6)(9.8)(\cos 30^\circ) d = (0.6)(9.8)(\sin 30^\circ) d$$

$$16.7 - 1.02 d = 2.94 d$$

$$16.7 = 3.96 d$$

$$d = 4.21 \ m$$

$$\sin\theta = \frac{h}{d}$$

$$d \sin\theta = h$$