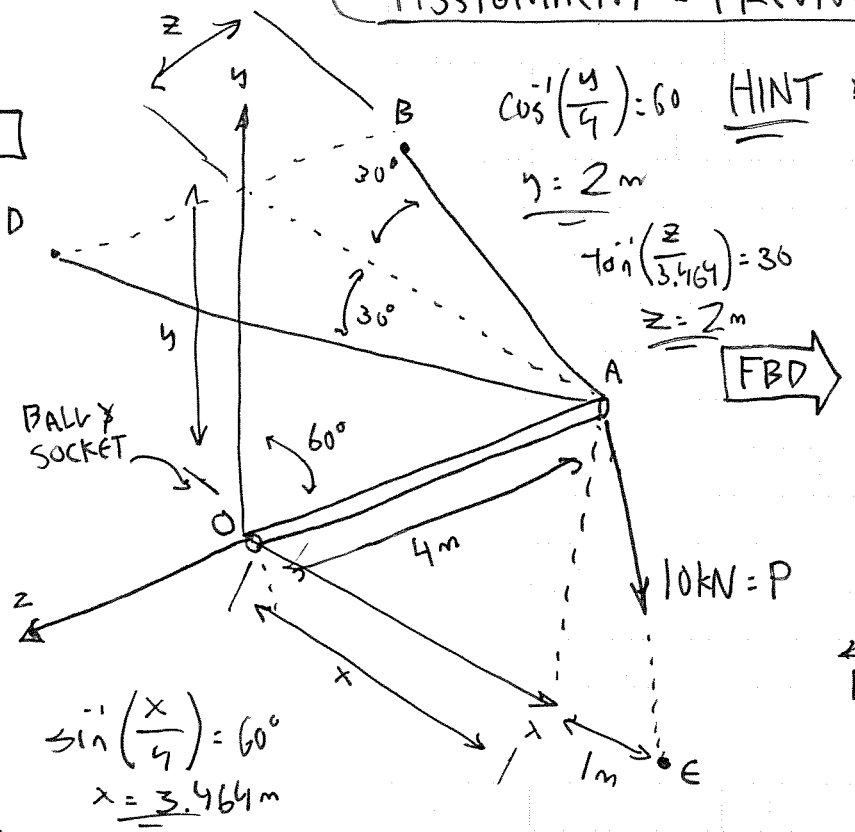
ASSIGNMENT - PREVIOUS FINAL

LUCAS WEST

1



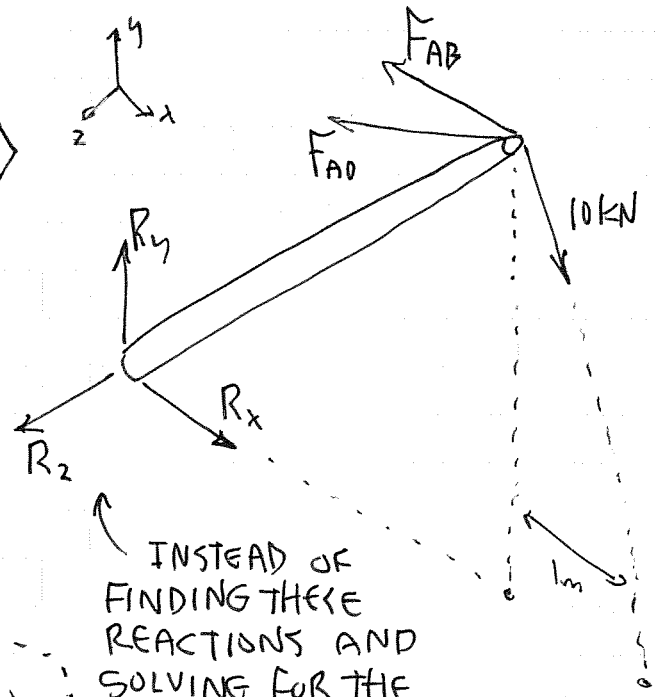
$\cos^{-1}\left(\frac{y}{4}\right) = 60$ HINT ▷ BAR OA IS A 2-FORCE MEMBER LIKE THE BARS IN A TRUSS, IT CAN ONLY BE TENSION OR COMPRESSION

$y = 2\,m$

$\tan^{-1}\left(\frac{z}{3.464}\right) = 30$

$z = 2\,m$

FBD



$\sin^{-1}\left(\frac{x}{4}\right) = 60°$

$x = 3.464\,m$

INSTEAD OF FINDING THESE REACTIONS AND SOLVING FOR THE BAR WE WILL DO A FBD AT POINT A

A) ALL FORCES IN VECTOR FORM

$\vec{OA} = (3.464\hat{i} + 2\hat{j}) \rightarrow \vec{\lambda}_{OA} = (0.866\hat{i} + 0.5\hat{j})$

$\vec{F}_{OA} = F_{OA}\vec{\lambda}_{OA} = F_{OA}(0.866\hat{i} + 0.5\hat{j})$

$\vec{AB} = (-3.464\hat{i} - 2\hat{k}) \rightarrow \vec{\lambda}_{AB} = (-0.866\hat{i} - 0.5\hat{k})$

$\vec{F}_{AB} = F_{AB}(-0.866\hat{i} - 0.5\hat{k})$

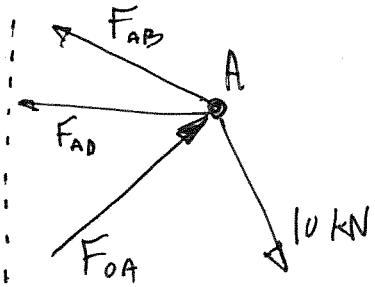
$\vec{AD} = (-3.464\hat{i} + 2\hat{k}) \rightarrow \vec{\lambda}_{AD} = (-0.866\hat{i} + 0.5\hat{k})$

$\vec{F}_{AD} = F_{AD}(-0.866\hat{i} + 0.5\hat{k})$

$\vec{AE} = (1\hat{i} - 2\hat{j}) \rightarrow \vec{\lambda}_{AE} = (0.447\hat{i} - 0.894\hat{j})$

$\vec{P} = 10\vec{\lambda}_{AE} = (4.47\hat{i} - 8.94\hat{j})\,kN$

FBD AT POINT A



1 CONTINUED. EQUILIBRIUM $\Sigma F = 0$

$\Sigma F_x = 0 = 0.866 F_{OA} - F_{AB}(0.866) - F_{AD}(0.866) + 4.47$

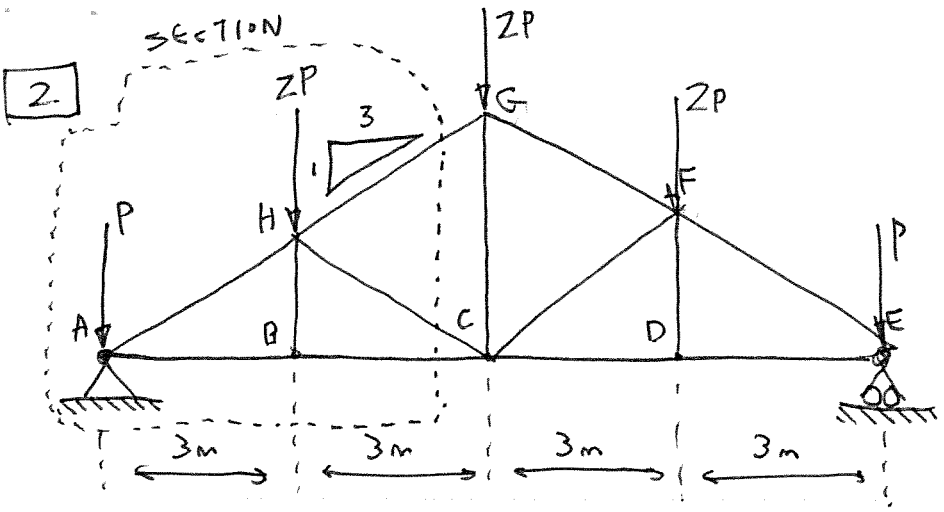
$\Sigma F_y = 0 = 0.5 F_{OA} - 8.94 \longrightarrow \boxed{F_{OA} = 17.9 \text{ kN}}$

$\Sigma F_z = 0 = -F_{AB}(0.5) + F_{AD}(0.5) \longrightarrow F_{AB} = F_{AD}$

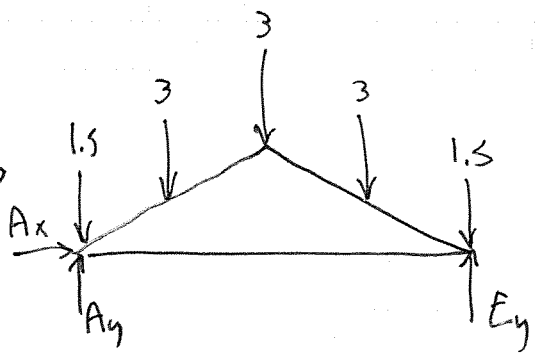
$0 = 0.866(17.9) - F_{AB}(0.866) - (F_{AB})(0.866) + 4.47$

$\boxed{F_{AB} = 11.5 \text{ kN} = F_{AD}}$

2.



FBD



A) REACTIONS

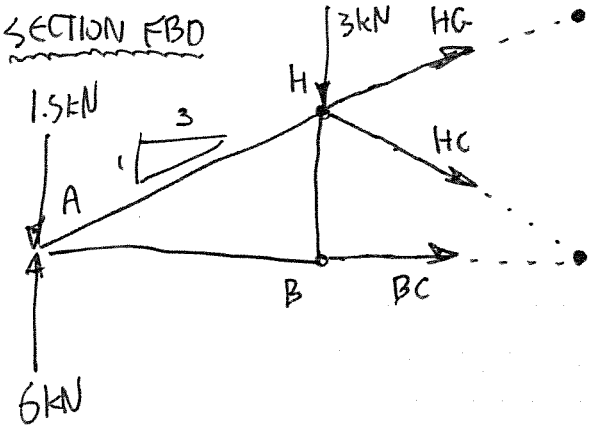
$\Sigma F_x = \boxed{0 = A_x}$ $\quad \Sigma F_y = 0 = A_y + E_y - 1.5 - 1.5 - 3 - 3 - 3$

$A_y + E_y = 12 \longrightarrow \boxed{A_y = 6\ kN}$

$\Sigma M_A = 0 : -3(3m) - 3(6m) - 3(9m) - 1.5(12m) + E_y(12m) \longrightarrow \boxed{E_y = 6\ kN}$

B) METHOD OF SECTIONS: BC, HC, HG

SECTION FBD



$\Sigma M_H = 0 = (1)(BC) + (3)(1.5) - (3)(6)$

$\boxed{BC = 13.5\ kN}$ TENSION

$\Sigma F_x = 0 = BC + \frac{3}{3.162}(HC) + \frac{3}{3.162}(HG)$

$\Sigma F_y = 0 = -1.5 - 3 + 6 + \frac{1}{3.162}(HG) - \frac{1}{3.162}(HC)$

$HC = -(13.5)\left(\frac{3.162}{3}\right) - HG$

$-1.5 = \left(\frac{1}{3.162}\right)HG - \left(\frac{1}{3.162}\right)\left(-13\left(\frac{3.162}{3}\right) - HG\right)$

$-6.149 = 0.633\,HG \longrightarrow \boxed{HG = -9.72\ kN}$

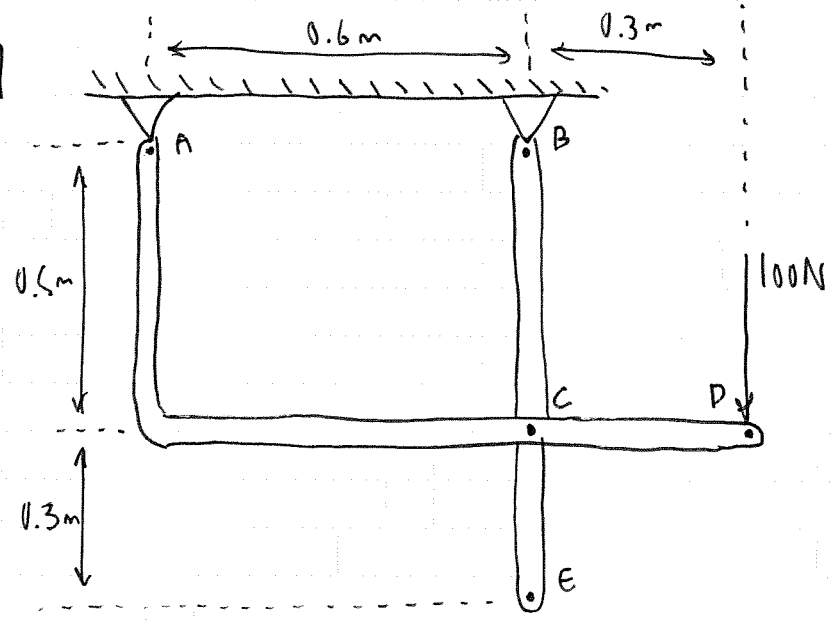
COMPRESSION

$HC = -(13.5)\left(\frac{3.162}{3}\right) - (-9.72)$

$\boxed{HC = -4.5\ kN}$

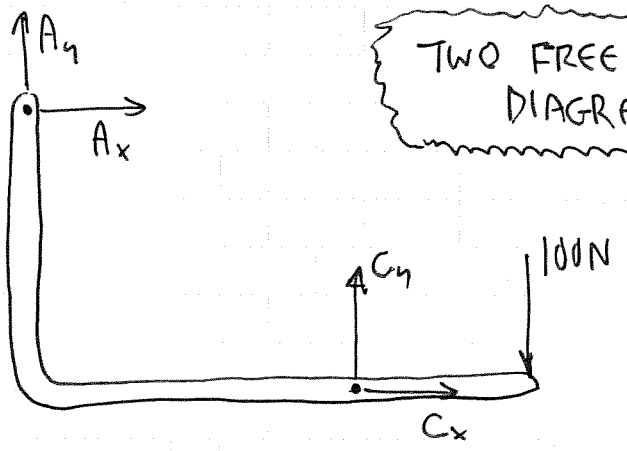
COMPRESSION

3

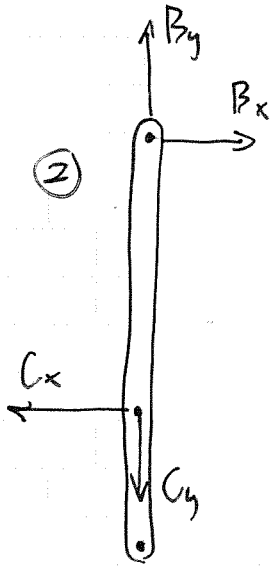


TWO FREE BODY DIAGRAMS

(1)



(2)



$\Sigma F_x = 0 = A_x + C_x = 0$

$\Sigma F_y = 0 = A_y + C_y - 100$

$\Sigma M_C = 0 = -100(0.3) - A_x(0.5) - A_y(0.6)$

$A_x + (0) = 0 \rightarrow \underline{A_x = 0}$

$0 = -100(0.3) - (0)(0.5) - A_y(0.6)$

$A_y = -50N$

$(-50) + C_y - 100 = 0$

$C_y = 150N$

$\Sigma F_x = 0 = B_x - C_x = 0$

$\Sigma F_y = 0 = B_y - C_y = 0$

$\Sigma M_c = 0 = B_x(0.5) \rightarrow \underline{B_x = 0}$

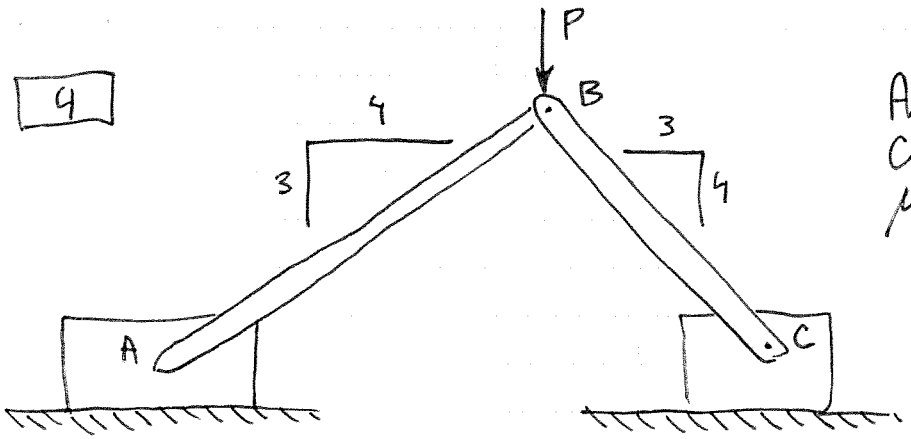
$(0) - C_x = 0$

$\underline{C_x = 0}$

$B_y = C_y$

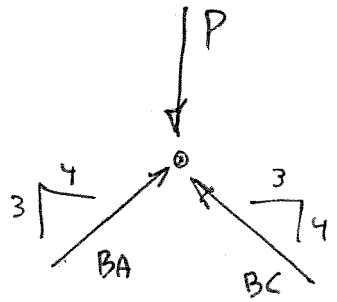
$B_y = 150N$

4



$A = 200N$
$C = 120N$
$\mu_s = 0.30$

A) FREE BODY DIAGRAM OF B



$\Sigma F_x = 0 = \left(\frac{4}{5}\right)BA - \left(\frac{3}{5}\right)BC \rightarrow BA = \left(\frac{3}{4}\right)BC$

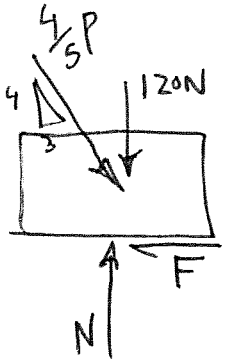
$\Sigma F_y = 0 = \left(\frac{3}{5}\right)BA + \left(\frac{4}{5}\right)BC - P$

$\left(\frac{3}{5}\right)\left(\frac{3}{4}\right)BC + \left(\frac{4}{5}\right)BC = P \rightarrow \boxed{BC = \frac{4}{5}P}$

$\boxed{BA = \frac{3}{5}P}$

B) P FOR IMPENDING MOTION (ASSUME MOTION IMPENDS AT C)

FREE BODY DIAGRAM OF BLOCK C



$\Sigma F_x = 0 = \left(\frac{3}{5}\right)\left(\frac{4}{5}\right)P - F$

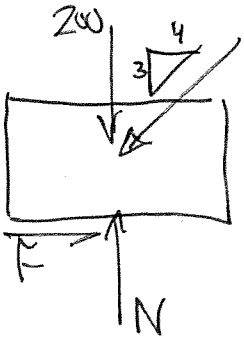
$\Sigma F_y = 0 = N - \left(\frac{4}{5}\right)\left(\frac{4}{5}\right)P - 120 \rightarrow N = \left(\frac{16}{25}\right)P + 120$

IMPENDING MOTION $F = \mu_s N$

$0 = \left(\frac{3}{5}\right)\left(\frac{4}{5}\right)P - \mu_s\left[\left(\frac{16}{25}\right)P + 120\right]$

C) VERIFY MOTION WASN'T IMPENDING AT A

$\boxed{P = 125N}$



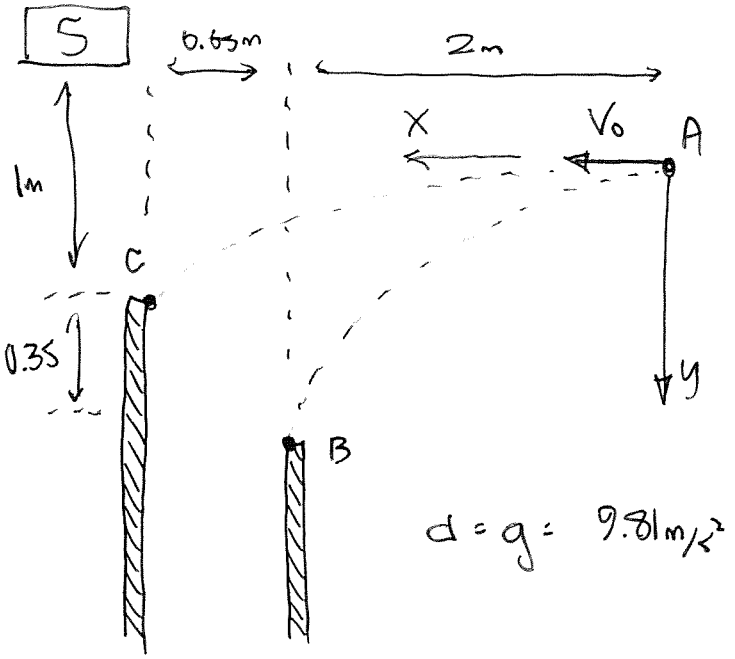
$\left(\frac{3}{5}\right)(125)$

$\Sigma F_x = 0 = F - \left(\frac{4}{5}\right)\left(\frac{3}{5}\right)125 \rightarrow F = 60N$

$\Sigma F_y = 0 = N - 200 - \left(\frac{3}{5}\right)\left(\frac{3}{5}\right)(125) \rightarrow N = 245N$

$\mu = \frac{F}{N} = \frac{60}{245} \rightarrow 0.245$ LESS THAN TRUE COEFFICIENT

5



ASSUME: CONSTANT SPEED IN X
CONSTANT ACCELERATION IN Y

CONSTANT SPEED

$$V = \frac{dx}{dt} \rightarrow dx = v\,dt$$

INTEGRATE BOTH SIDES

$$\boxed{x = x_0 + vt}$$

$a = g = 9.81\ m/s^2$

CONSTANT ACCELERATION

$$a = \frac{dv}{dt} \rightarrow dv = a\,dt$$

$$\boxed{v = v_0 + at}$$

$$\boxed{x = x_0 + v_0 t + \frac{1}{2}at^2}$$

$$\boxed{v^2 = v_0^2 + 2a(x - x_0)}$$

C = (2.65, 1)
B = (2, 1.35)

POINT B & C

$$x = \cancel{x_0}^{0} + v_0 t \rightarrow x = v_0 t \quad (1)$$

$$y = \cancel{y_0}^{0} + \cancel{v_0}^{0} t + \frac{1}{2}at^2 \rightarrow y = \frac{1}{2}at^2 \quad (2)$$

B) (2) $1.35 = \frac{1}{2}(9.81)t^2 \rightarrow t = \sqrt{\frac{1.35(2)}{9.81}} = 0.525\ s$

(1) $2 = v_0(0.525) \rightarrow \boxed{v_0 = 3.81\ m/s}$

C) (2) $1 = \frac{1}{2}(9.81)t^2 \rightarrow t = \sqrt{\frac{1\cdot(2)}{9.81}} = 0.452\ s$

(1) $2.65 = v_0(0.452) \rightarrow \boxed{v_0 = 5.87\ m/s}$

- SAND WILL ENTER THE CHUTE AS LONG AS THE INITIAL VELOCITY FALLS BETWEEN $3.81\ m/s \leq v_0 \leq 5.87\ m/s$