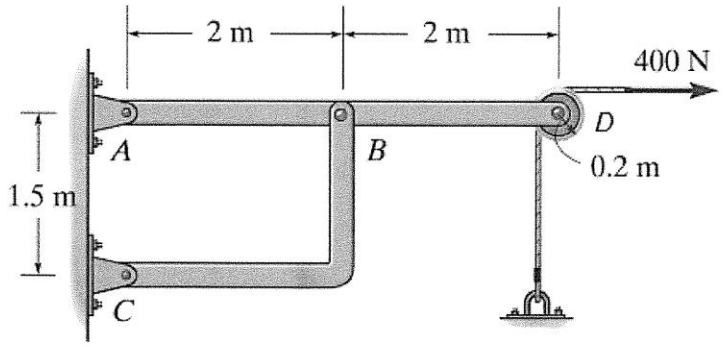
Name: _____ **CWID #:**_____ **Section Number:**_____

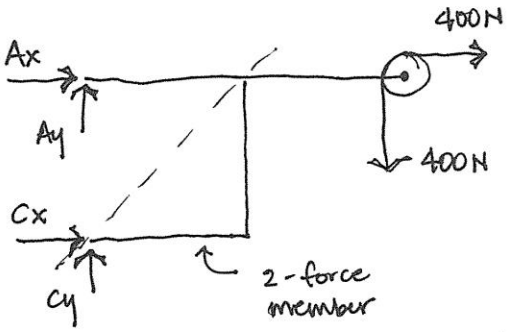
ENSC 2113 – FALL 17 – EXAM #3

EACH PROBLEM IS WORTH 25 POINTS. BOX YOUR ANSWERS AND PROVIDE PROPER UNITS, WHERE APPLICABLE. CALCULATIONS AND FREE BODY DIAGRAMS MUST BE SHOWN THAT SUPPORT THE ANSWER TO RECEIVE CREDIT.

1) The frame below consists of two members, AB and CB. Determine the external support reactions at the pins A and C. Indicate direction in your answer with directional arrows and draw any pertinent free-body diagrams.



OVERALL FBD:



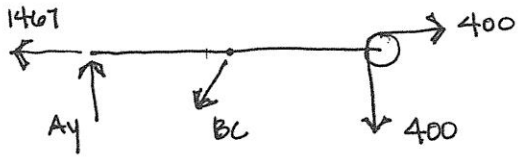
$+\circlearrowleft \Sigma M_A = 0 = -400(0.2) - 400(3.8) + C_x(1.5)$

$C_x = 1067\ N \rightarrow$

$+\rightarrow \Sigma F_x = 0 = A_x + 1067 + 400$

$A_x = 1467\ N \leftarrow$

FBD ABD:



$+\circlearrowleft \Sigma M_B = 0 = -A_y(2) - 400(0.2) - 400(1.8)$

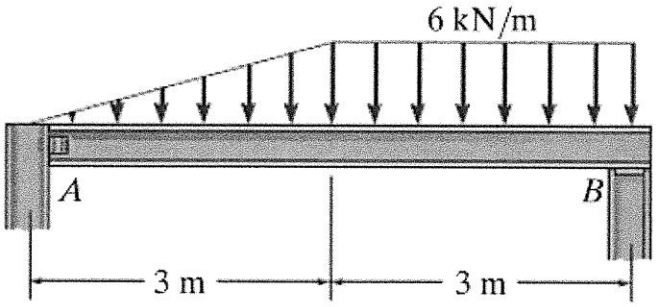
$A_y = 400\ N \downarrow$

FROM OVERALL:

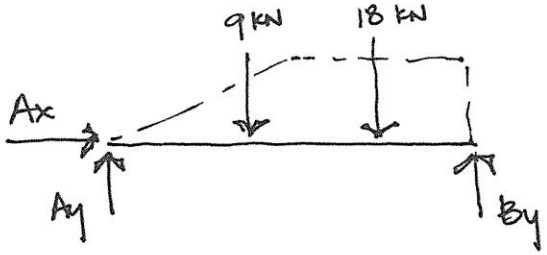
$+\uparrow \Sigma F_y = 0 = -400 - 400 + C_y$

$C_y = 800\ N \uparrow$

2) Determine the shear and bending moment equations for the beam below for the load region 0 m<x<3 m utilizing equilibrium equations. Point A is a pin and B is a roller. Draw any pertinent free-body diagrams.



OVERALL FBD:

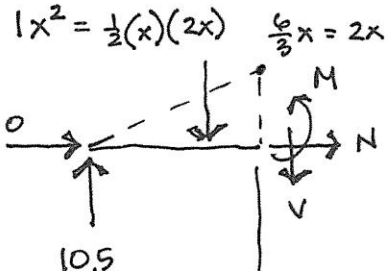


$+\circlearrowleft \Sigma M_B = 0 = 18(1.5) + 9(4) - A_y(6)$

$A_y = 10.5 \text{ kN} \uparrow$

$A_x = 0$

FBD OF CUT:



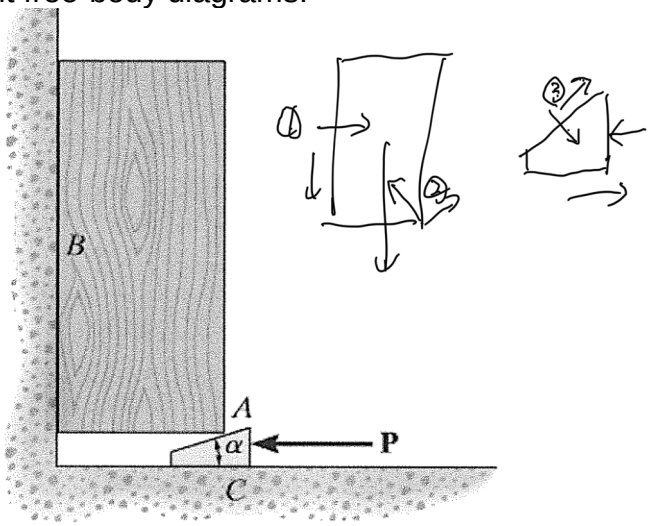
$+\uparrow \Sigma F_y = 0 = -\frac{1}{2}x^2 + 10.5 - V$

$\boxed{V = -x^2 + 10.5 \text{ kN}}$

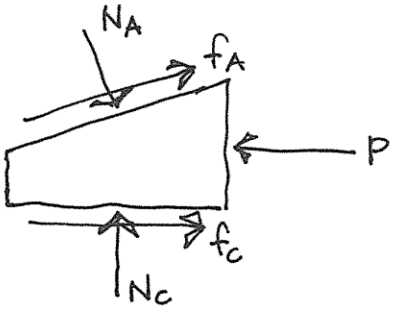
$+\circlearrowleft \Sigma M_x = 0 = -10.5x + x^2\left(\frac{x}{3}\right) + M$

$\boxed{M = 10.5x - \frac{x^3}{3} \text{ kN-m}}$

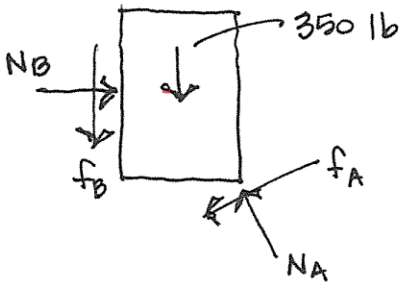
3) Determine the force required to move the wedge to the left. The wooden box has a weight of 350 lb and the static coefficient of friction at all surfaces is 0.25. The angle, alpha, is 15 degrees. Neglect the size and weight of the wedge. Draw all pertinent free-body diagrams.



FBD WEDGE:



FBD BLOCK:



FROM BLOCK:

$\rightarrow \Sigma F_x = 0 = N_B - 0.25 N_A \cos 15 - N_A \sin 15$

$N_B = 0.5 N_A$

$\uparrow \Sigma F_y = 0 = -0.25 N_B - 350 - 0.25 N_A \sin 15 + N_A \cos 15$

$350 = 0.776 N_A \qquad N_A = 450.9$

FROM WEDGE:

$\uparrow \Sigma F_y = 0 = -450.9 \cos 15 + 0.25(450.9)\sin 15 + N_C$

$N_C = 406.4$

$\rightarrow \Sigma F_x = 0 = -P + 450.9 \sin 15 + 0.25(450.9)\cos 15 + 0.25(406.4)$

$\boxed{P = 327.2 \text{ LB}}$

4) Draw the shear and bending moment diagrams for the loading condition below. Label all diagrams appropriately.