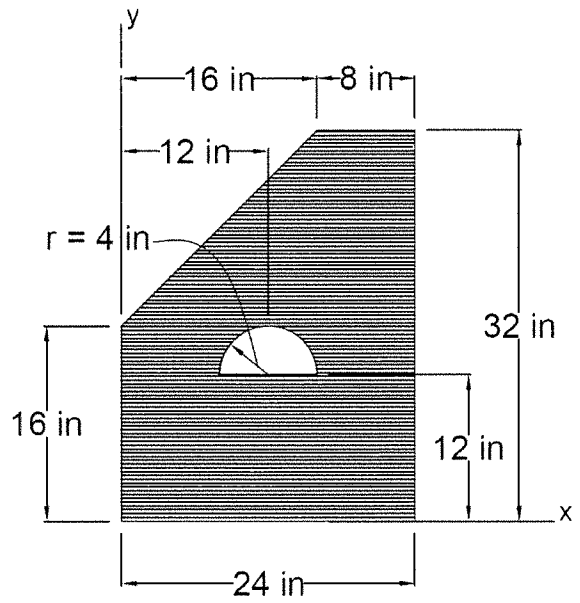
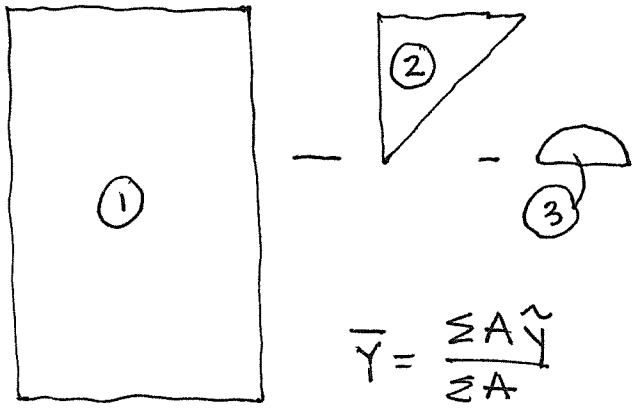
Name: _____ CWID #:_____ Section Number:_____

ENSC 2113 - FALL 2019 - EXAM #2

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) Using the tabular method of composite bodies, calculate the centroidal distance measured from the x-axis, y bar. Label all shapes utilized.



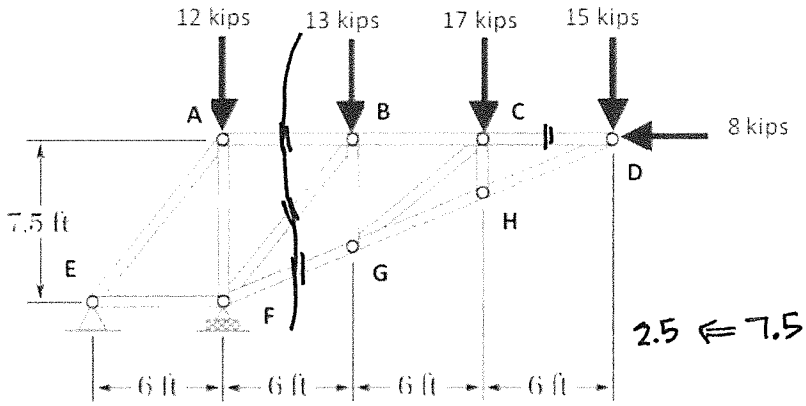


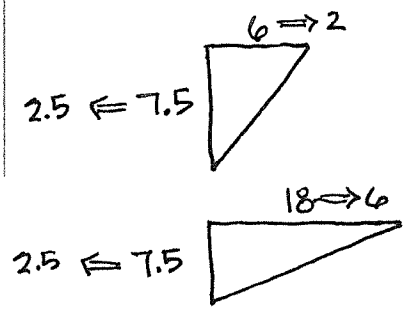
$$\bar{Y} = \frac{\Sigma A \tilde{y}}{\Sigma A}$$

SHAPE	AREA	$\tilde{y}$	$A\tilde{y}$
1	$bh = 24(32) = 768$	$\frac{h}{2} = 16$	12288
2 VOID	$-\frac{1}{2}bh = -\frac{1}{2}(16)(16) = -128$	$16 + \frac{2}{3}h = 16 + \frac{2}{3}(16) = 26.67$	-3413.3
3 VOID	$-\frac{\pi r^2}{2}$ $-\frac{\pi(4)^2}{2} = -25.13$	$12 + \frac{4r}{3\pi}$ $12 + \frac{4(4)}{3\pi} = 13.7$	-344.2
Σ	614.87		8530.5

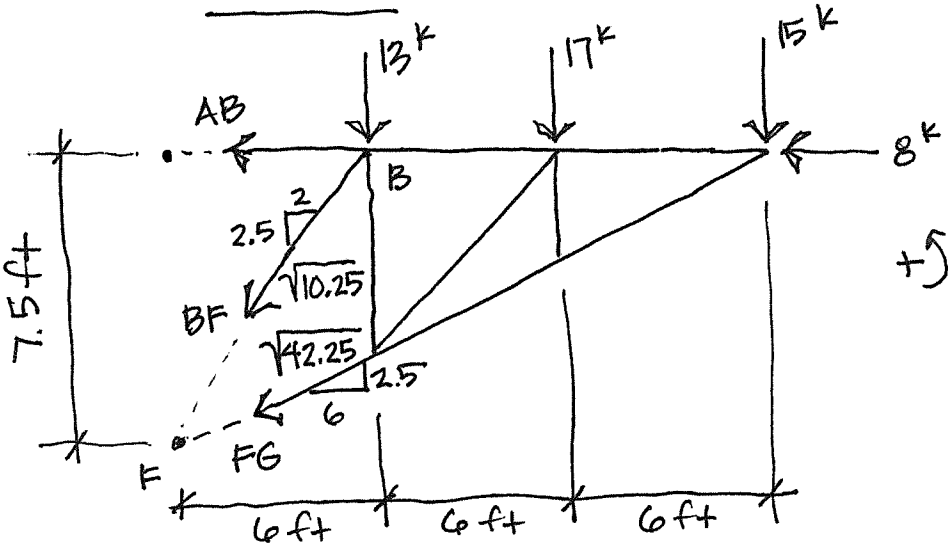
$$\bar{Y} = \frac{8530.5}{614.87} = \boxed{13.87 \text{ in}}$$

2) The truss below is supported by a pin at E and a roller at F. Determine the force in members AB, BF, and FG using the method of sections and member CD using the method of joints. Indicate tension or compression in your answer and draw all pertinent free-body diagrams.





CUT FBD:



$+\circlearrowleft \Sigma M_F = 0 = -13(6) - 17(12) - 15(18) + 8(7.5) + AB(7.5)$

$\boxed{AB = 65.6^K (T)}$

$+\circlearrowleft \Sigma M_B = 0 = -17(6) - 15(12) - \frac{6}{\sqrt{42.25}} FG(5)$

$FG = -61.1$

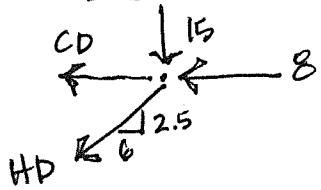
$\boxed{FG = 61.1^K (C)}$

$\uparrow \Sigma F_y = 0 = -13 - 17 - 15 - \frac{2.5}{\sqrt{10.25}} BF - \frac{2.5}{\sqrt{42.25}}(-61.1)$

$BF = -27.53$

$\boxed{BF = 27.53^K (C)}$

JOINT D:



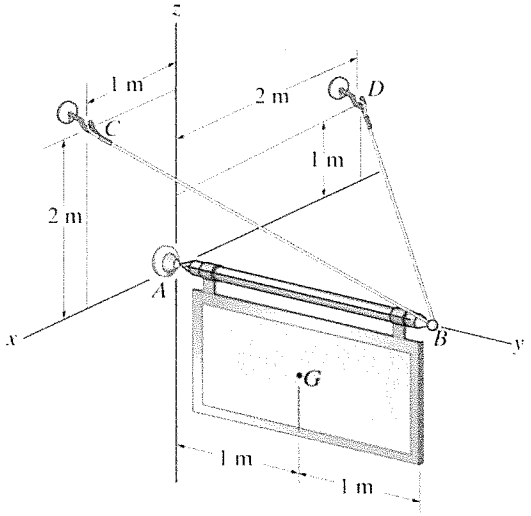
$\uparrow \Sigma F_y = 0 = -15 - \frac{2.5}{\sqrt{42.25}} HD$

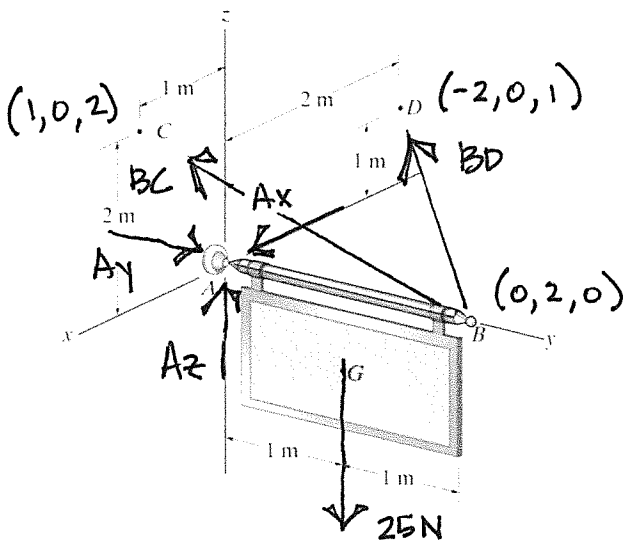
$HD = -39^K$

$\rightarrow \Sigma F_x = 0 = -CD - 8 - \frac{6}{\sqrt{42.25}}(-39)$

$\boxed{CD = 28^K (T)}$

3) A 25N sign hangs from rod AB as shown. A ball and socket at A and tension cables BC and BD support rod AB. Draw the free-body diagram (on the image provided on the right). Assume all support reactions positive in your FBD using right hand rule sign convention. Calculate the support reactions utilizing equilibrium equations.





CARTESIAN FORM:

$$\vec{BD} = BD\,\vec{u}_{BD}$$

$$= BD\,\frac{\vec{r}_{BD}}{|r_{BD}|}$$

$$= BD\,\frac{\{-2\hat{i} - 2\hat{j} + 1\hat{k}\}}{\sqrt{(-2)^2 + (-2)^2 + (1)^2}}$$

$$= \left\{-\tfrac{2}{3}BD\,\hat{i} - \tfrac{2}{3}BD\,\hat{j} + \tfrac{1}{3}BD\,\hat{k}\right\}$$

$$\vec{BC} = BC\,\vec{u}_{BC}$$

$$= BC\,\frac{\vec{r}_{BC}}{|r_{BC}|}$$

$$= BC\,\frac{\{1\hat{i} - 2\hat{j} + 2\hat{k}\}}{\sqrt{(1)^2 + (-2)^2 + (2)^2}}$$

$$= \left\{\tfrac{1}{3}BC\,\hat{i} - \tfrac{2}{3}BC\,\hat{j} + \tfrac{2}{3}BC\,\hat{k}\right\}$$

EQUILIBRIUM:

① $\Sigma F_x = 0 = A_x - \frac{2}{3}BD + \frac{1}{3}BC$

② $\Sigma F_y = 0 = A_y - \frac{2}{3}BD - \frac{2}{3}BC$

③ $\Sigma F_z = 0 = A_z - 25 + \frac{1}{3}BD + \frac{2}{3}BC$

④ $\Sigma M_x = 0 = \frac{1}{3}BD(2) + \frac{2}{3}BC(2) - 25(1)$

⑤ $\Sigma M_y = 0 = 0$

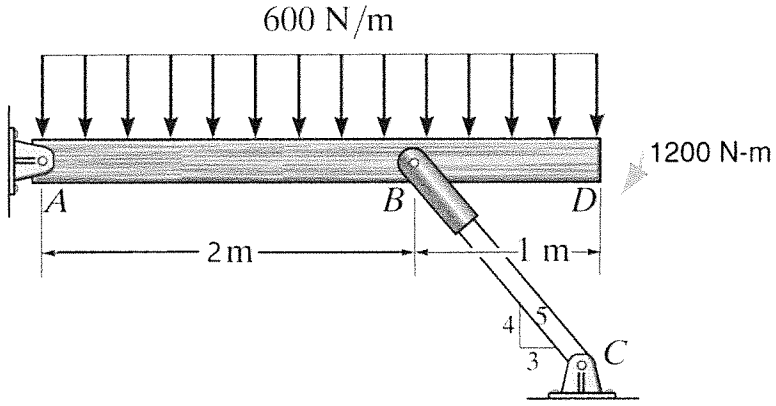
⑥ $\Sigma M_z = 0 = -\frac{1}{3}BC(2) + \frac{2}{3}BD(2)$

$BC = 2\,BD$

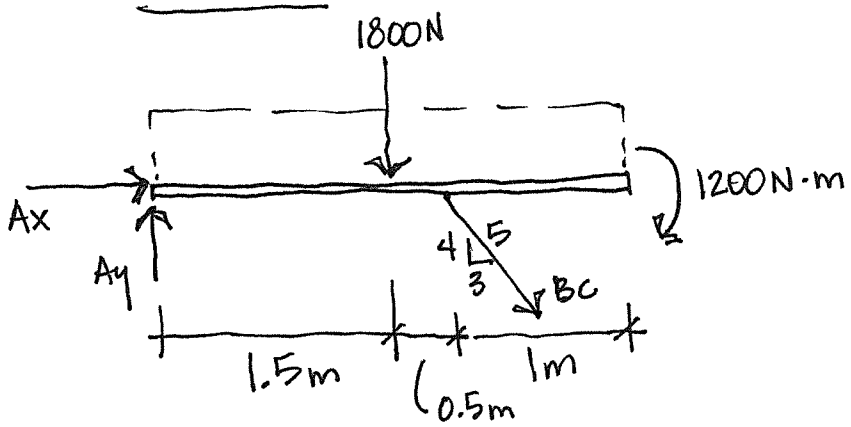
SOLVING:

$BD = 7.5\,N$	$A_x = 0\,N$
$BC = 15\,N$	$A_y = 15\,N$
	$A_z = 12.5\,N$

4) Calculate the support reactions at pins A and C due to the loading shown. Indicate direction in the answer with directional arrows and draw all pertinent free-body diagrams. Member BC is pinned to member ABD at point B.



FBD ABD:



$+\circlearrowleft \Sigma M_A = 0 = -1800(1.5) - \frac{4}{5}BC(2) - 1200$

$BC = -2437.5$

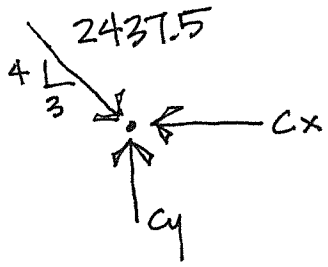
$+\uparrow \Sigma F_y = 0 = A_y - 1800 - \frac{4}{5}(-2437.5)$

$A_y = -150$ $\boxed{A_y = 150\,N \downarrow}$

$+\rightarrow \Sigma F_x = 0 = A_x + \frac{3}{5}(-2437.5)$

$\boxed{A_x = 1462.5\,N \rightarrow}$

FBD C:



$+\rightarrow \Sigma F_x = 0 = \frac{3}{5}(2437.5) - C_x$

$\boxed{C_x = 1462.5\,N \leftarrow}$

$+\uparrow \Sigma F_y = 0 = -\frac{4}{5}(2437.5) + C_y$

$\boxed{C_y = 1950\,N \uparrow}$