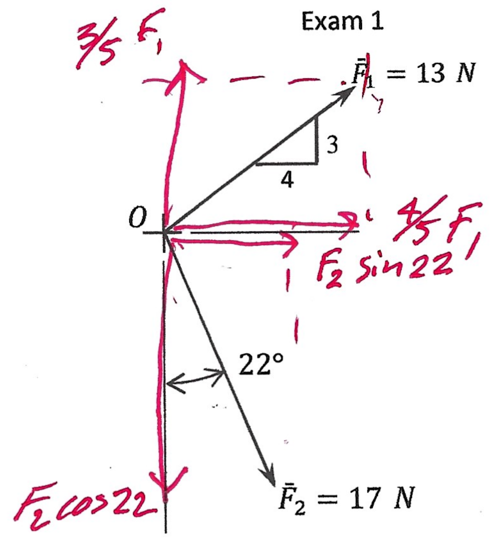
Vector Addition



1. For vectors $\bar{F}_1$ and $\bar{F}_2$, determine the magnitude of the resultant $\bar{R} = \bar{F}_1 + \bar{F}_2$.

A. 17.2 N B. 18.6 N

C. 19.2 N D. 17.9 N

$$F_1 = \overset{10.4}{\tfrac{4}{5}(13)}\,\hat{i} + \overset{7.8}{\tfrac{3}{5}(13)}\,\hat{j}$$

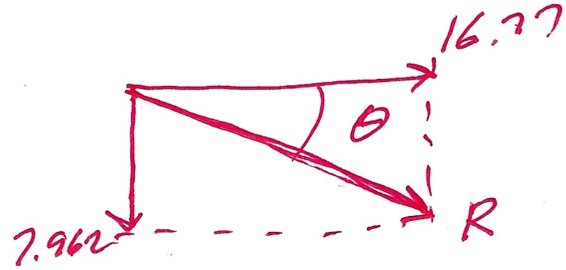
$$F_2 = \underset{6.37}{\cancel{17}\sin 22}\,\hat{i} - \underset{15.76}{17\cos 22}$$

$$R = (16.77\,\hat{i} - 7.962\,\hat{j})\ N = \sqrt{(\ )+(\ )} = \boxed{18.56\ N}$$

2. For vectors $\bar{F}_1$ and $\bar{F}_2$, determine the magnitude of the angle between the resultant $\bar{R} = \bar{F}_1 + \bar{F}_2$ and the horizontal reference line.

A. 25.4^o B. 27.2^o

C. 24.1^o D. 22.6^o



$$\theta = \tan^{-1}\frac{7.962}{16.77} = \boxed{25.39^\circ}$$

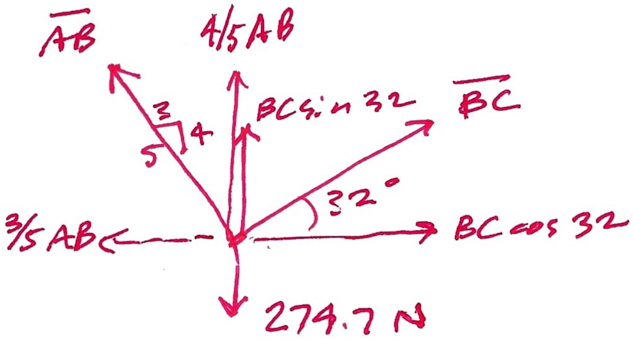
$$= \cos^{-1}\frac{16.77}{18.56} = \underline{25.39^\circ}$$

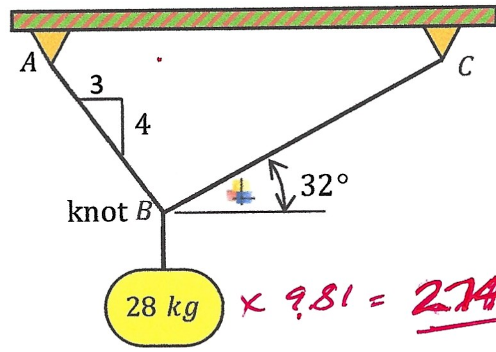
Statics Probs

1. FBD
2. Cartesians
3. Equilib Eqns
4. Solve

Particle Equilibrium in Two Dimensions – Part 1

11. Sketch a Free Body Diagram of knot B.





× 9.81 = 274.7 N

12. Determine the magnitude of the tension in cable segment AB.

A. 215 N B. 224 N

C. 243 N D. 234 N

$$\overset{+}{\rightarrow}\sum F_x = 0 = -\tfrac{3}{5}AB + BC\cos 32$$

$$BC = \frac{\frac{3AB}{5}}{(\cos 32)} = \underline{0.7075\ AB}$$

13. Determine the magnitude of the tension in cable segment BC.

A. 165 N B. 159 N

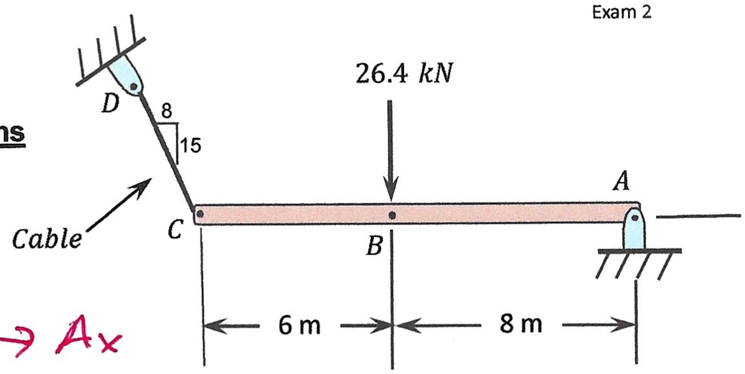
C. 171 N D. 152 N

$$+\uparrow\sum F_y = 0 = \tfrac{4}{5}AB + \underbrace{\cancel{BC}^{\,0.7075\,AB}\sin 32}_{0.3749} - 274.4$$

$$1.175\,AB = 274.4$$

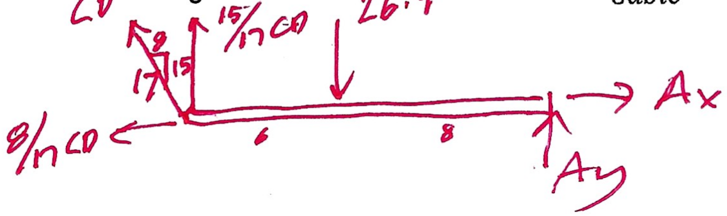
$$AB = 274.4 / 1.175 = \boxed{233.8\ N}$$

$$BC = 0.7075(233.8) = \boxed{165.4\ N}$$



Rigid Body Equilibrium in Two Dimensions

11. Sketch a Free Body Diagram of rigid bar ABC.



12. Determine the magnitude of the tension in cable CD.
   a. 15.8 kN b. 17.1 kN
   c. 15.2 kN d. 16.5 kN

$\circlearrowleft \sum M_A = 0 = -\frac{15}{17}CD(14) + 26.4(8)$

$CD = \boxed{17.10\ kN}$

13. Determine the horizontal component of reaction at hinge A.
   a. 8.05 $kN \rightarrow$ b. 8.68 $kN \leftarrow$
   c. 8.36 $kN \rightarrow$ d. 7.76 $kN \leftarrow$

$\xrightarrow{+} \sum F_x = 0 = -\frac{8}{17}(\;) + A_x$

$A_x = \boxed{8.05\ kN \rightarrow}$

14. Determine the vertical component of reaction at hinge A.
   a. 11.8 $kN \uparrow$ b. 10.9 $kN \uparrow$
   c. 11.3 $kN \uparrow$ d. 10.4 $kN \uparrow$

$+\uparrow \sum F_y = 0 = \frac{15}{17}CD - 26.4 + A_y$

$A_y = \boxed{11.31\ kN \uparrow}$

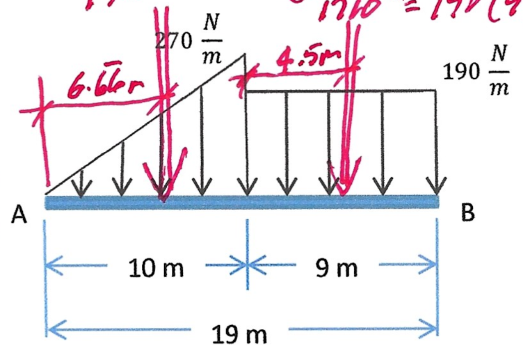
Distributed Loadings

15. Determine the magnitude of the resultant force, F_R, equivalent to the distributed loading acting on bar AB.

   a. 3.29 kN b. 3.17 kN
   c. 2.94 kN d. 3.06 kN

$1350\ N = 270\left(\frac{10}{2}\right)$

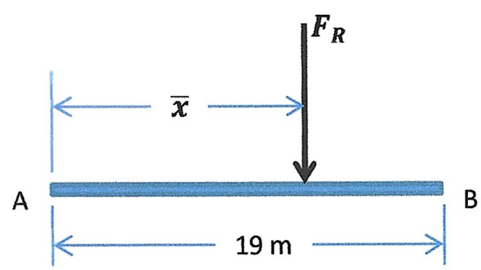
$1710\ N = 190(9)$



$\sum F = 1350 + 1710 = \boxed{3060\ N}$

16. Determine the location, $\bar{x}$, where the resultant force acts to have the same effect on bar AB as the distributed loading.

   a. 11.4 m b. 10.6 m
   c. 11.0 m d. 10.2 m

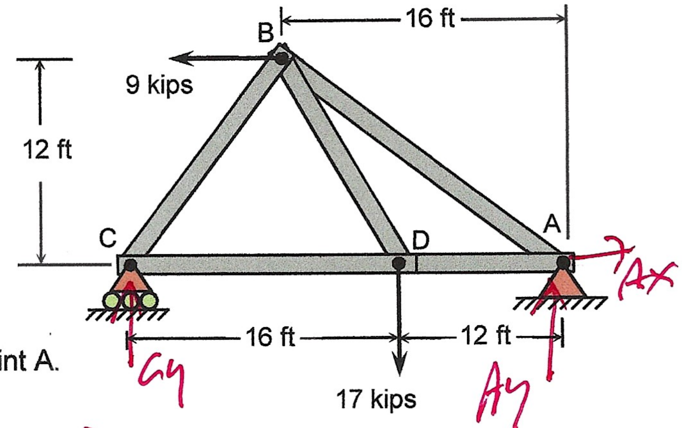


$\sum M_A = 1350\left(\frac{10}{3}(2)\right) + 1710(10+4.5)$

$= \frac{33795}{3060} = \boxed{11.04\ m}$

Trusses – Method of Joints

Truss ABCD is pin connected at all joints and is simply supported with a pin at A and a roller at C.



1. Determine the horizontal reaction at the pin at point A.

 a. 9.65 kip ← b. 8.68 kip ←
 c. 9.00 kip → d. 9.32 kip →

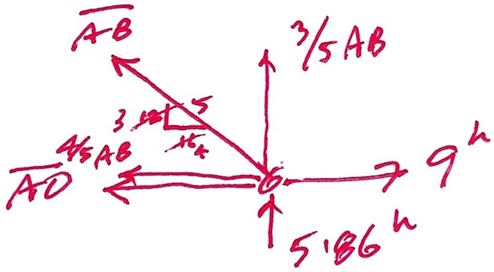
$$\overrightarrow{\Sigma F_x} = 0 = -9 + A_x$$
$$A_x = \boxed{9.0^k \rightarrow}$$

2. Determine the vertical reaction at the pin at point A.

 a. 5.86 kip ↑ b. 5.64 kip ↑
 c. 5.42 kip ↑ d. 6.00 kip ↑

$$\circlearrowleft + \Sigma M_C = 0 = 9(12) - 17(16) + A_y(28)$$
$$A_y = \frac{164}{28} = \boxed{5.857^k \uparrow}$$

3. Draw a Free Body Diagram of joint A.



4. Determine the force in member AB.

 a. 10.1 kip (T) b. 9.05 kip (T)
 c. 9.39 kip (C) d. 9.76 kip (C)

$$+\uparrow \Sigma F_y = 0 = \tfrac{3}{5}AB + 5.86$$
$$AB = \boxed{-9.762^k\ (C)}$$

$$\overset{+}{\rightarrow} \Sigma F_x = 0 = -AD + \tfrac{4}{5}AB + 9$$
$$AD = \boxed{16.81^k\ (T)}$$

5. Determine the force in member AD.

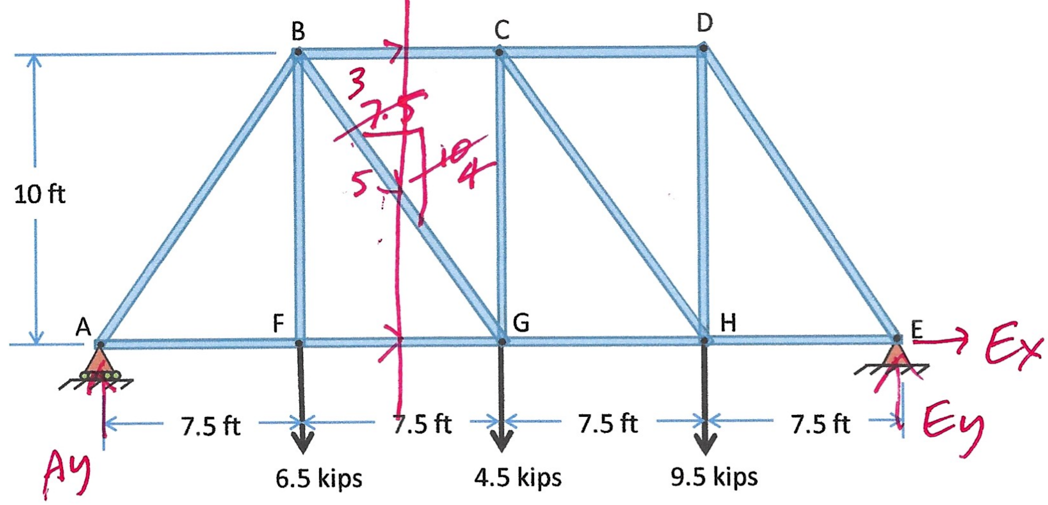
 a. 16.8 kip (T) b. 15.5 kip (C)
 c. 14.9 kip (C) d. 16.2 kip (T)

Entire Truss $\circlearrowleft \Sigma M_E = 0 = -A_y(30) + 6.5(22.5) + 4.5(15) + 9.5(7.5)$

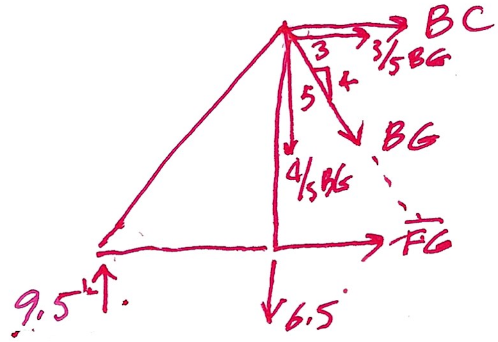
$A_y = \frac{285}{30} = \underline{9.50^k}$

Trusses – Method of Sections

The truss shown consists of members pinned at the joints, supported by a roller at A and a pin at E.



6. Sketch a free body diagram of a section of the truss that will allow you to find the member forces in members BC, FG and BG.



$\circlearrowleft \Sigma M_G = 0 = -9.5(15) + 6.5(7.5) - BC(10)$

$BC = -\frac{93.75}{10} = \boxed{-9.375^k (C)}$

7. Determine the force in member BC.

   a. 9.36 kips (C) b. 9.73 kips (T)

   c. 9.00 kips (C) d. 8.66 kips (C)

$\circlearrowleft \Sigma M_B = 0 = -9.5(7.5) + FG(10)$

$FG = \frac{71.25}{10} = \boxed{7.125^k (T)}$

8. Determine the force in member FG.

   a. 7.13 kips (T) b. 7.67 kips (C)

   c. 7.40 kips (T) d. 7.96 kips (T)

$\rightarrow \Sigma F_x = 0 = -9.375 + \frac{3}{5} BG + 7.125$

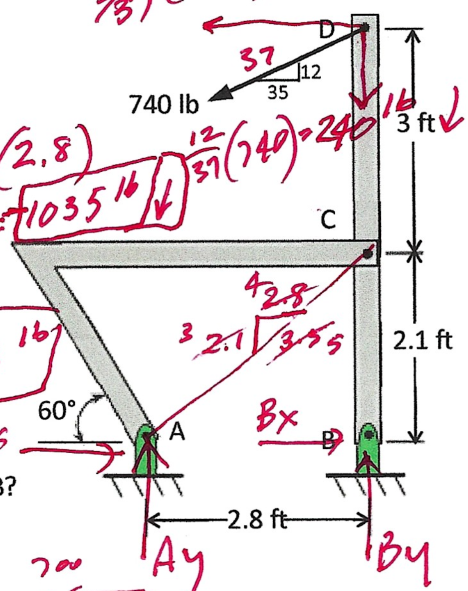
$BG = \frac{5}{3}(\ ) = \boxed{+3.75^k (T)}$

9. Determine the force in member BG.

   a. 4.06 kips (C) b. 3.75 kips (T)

   c. 3.60 kips (T) d. 3.90 kips (C)

Frames & Simple Machines



15. What is the vertical component of the reaction at B?

a. 1.04 kip ↓ b. 1.28 kip ↑

c. 240 lb ↑ d. 1.52 kip ↓

$\circlearrowleft + \Sigma M_A = 0 = 700(5.1) - 240(2.8) + B_y(2.8)$

$B_y = \frac{2898}{2.8} = \boxed{-1035^{lb} \downarrow}$

16. What is the magnitude of the force acting on member BCD at pin C?

a. 1.59 kips b. 2.83 kips

c. 1.70 kips d. 2.13 kips

$C = \boxed{2125^{lb}}$

$\circlearrowleft + \Sigma M_B = 0 = 700(5.1) - \frac{4}{5}C(2.1)$

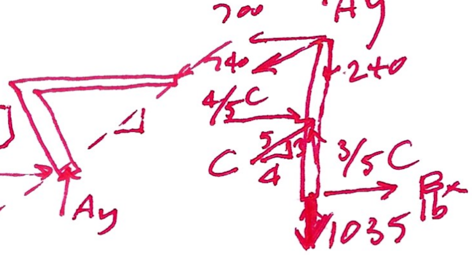
17. What is the horizontal component of the reaction at B?

a. 1.70 kips → b. 1.00 kip ←

c. 575 lb ← d. 700 lb →

$\xrightarrow{+} \Sigma F_x = 0 = B_x - 700 + \frac{4}{5}(2125)$

$B_x = \boxed{-1000 \text{ lb} \leftarrow}$

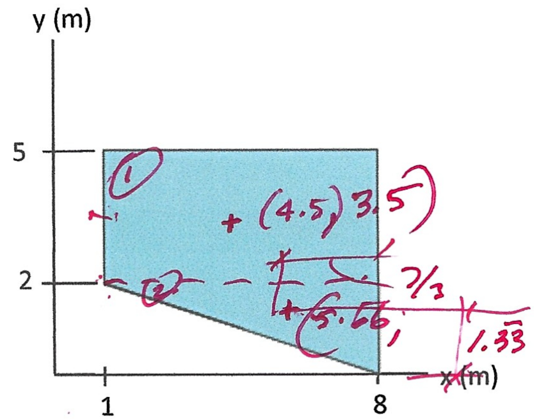


Centroids by Integration

18. What is area of the shaded region?

a. 40.0 m^2 b. 56.0 m^2

c. 37.3 m^2 d. 28.0 m^2



19. What is the x-coordinate of the centroid of the shaded region?

a. 4.50 m b. 4.79 m

c. 3.50 m d. 4.00 m

20. What is the y-coordinate of the centroid of the shaded region?

a. 2.04 m b. 2.50 m

c. 3.19 m d. 2.96 m

	A	$\tilde{x}$	$\tilde{y}$	$\tilde{x}A$	$\tilde{y}A$
1	21	3.5+1 4.5	1.5+2 3.5	94.5	73.5
2	7	8−2/3 5.66	2(2/3) 1.33	39.66	9.33
	28			134.16	82.83

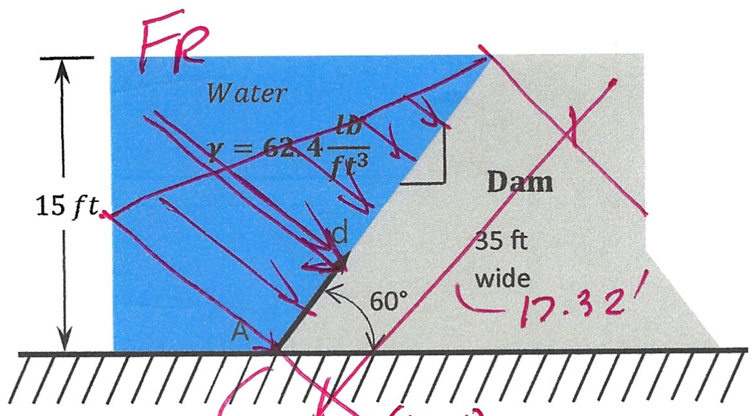
$\bar{x} = \frac{134.16}{28} = \boxed{4.792 \text{ m}}$

$\bar{y} = \frac{82.83}{28} = \boxed{2.959 \text{ m}}$

Fluid Pressure

1. Determine the pressure the water exerts on point A at the bottom of the sloping upstream face of the dam .

   A $974 \frac{lb}{ft^2}$ B $863 \frac{lb}{ft^2}$
   C $899 \frac{lb}{ft^2}$ D $936 \frac{lb}{ft^2}$



2. Determine the fluid force the water exerts on a $1\ ft$ width of the dam.

   A $8.43\ kips$ B $8.77\ kips$
   C $8.11\ kips$ D $7.78\ kips$

3. Determine the total fluid force the water exerts on the dam.

   A $307\ kips$ B $284\ kips$
   C $295\ kips$ D $273\ kips$

4. Determine the distance, d, from point A at which the force acts, measured along the sloping upstream face of the dam.

   A $5.77\ ft$ B $5.00\ ft$
   C $5.53\ ft$ D $5.26\ ft$

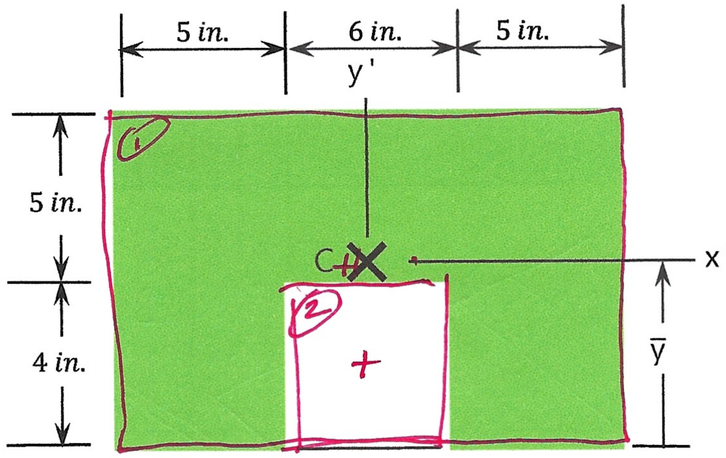
$p = 15(62.4) = \boxed{936\ psf}$

$F_R = \frac{1}{2}(936\ \frac{lb}{ft})(17.32\ ft) = \boxed{8106\ lb}$

$\text{Total } F = 35(\ )/1000 = \boxed{283.7^k}$

$d = \frac{17.32}{3} = \boxed{5.774\ ft}$

Moments and Products of Inertia for Composite Areas



14. The vertical distance from the base to the centroidal x-axis, $\bar{y}$, for the shaded area is:

$\bar{y} = \frac{600}{120} = \boxed{5.0}$

A 4.80 *in.* B 5.20 *in.*

C 5.00 *in.* D 5.40 *in.*

15. The second moment of area about the centroidal x-axis, $\bar{I}_{x'}$, for the shaded area is:

$= 940 - 180 = \boxed{760 \text{ in}^4}$

A 760 $in.^4$ B 790 $in.^4$

C 730 $in.^4$ D 820 $in.^4$

16. The radius of gyration with respect to the centroidal x-axis, $\bar{k}_{x'}$, for the shaded area is:

$\bar{k}_{x'} = \sqrt{I_{x'}/A} = \sqrt{760/120} = \boxed{2.51\bar{6}}$

A 2.32 *in.* B 2.42 *in.*

C 2.22 *in.* D 2.52 *in.*

17. The second moment of area about the y-axis, $\bar{I}_{y'}$, for the shaded area is:

A 3120 $in.^4$ B 3000 $in.^4$

C 3250 $in.^4$ D 3380 $in.^4$

18. The product of inertia, $\bar{I}_{x'y'}$, for the shaded area with respect to the centroidal axes is:

A 4600 $in.^4$ B ~~0~~ — Symmetric about y'

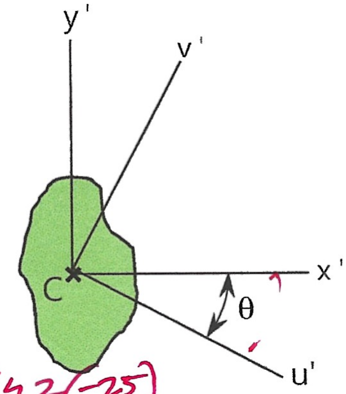
C 4800 $in.^4$ D 5000 $in.^4$

	A	$\tilde{y}$	$\tilde{y}A$	$\bar{I}_x$	$\bar{I}_y$	d_y ($\tilde{y}-\bar{y}$)	Ad_y^2
1 (16 × 9)	144	4.5	648	$16(9)^3/12$ = 972	$(16)^3 9/12$ = 3072	5−4.5 = 0.5	36
2 (6 × 4)	−24	2	−48	$6(4)^3/12$ = −32	$(6)^3 4/12$ = −72	5−2 = 3.0	−216
Σ	120		600	940	3000		−180

760

Rotation of Axes for Moment of Inertia

The shaded area has the following properties with respect to the centroidal x' and y' axes, $\bar{I}_{x'} = 830 in.^4$, $\bar{I}_{y'} = 270 in.^4$, $\bar{I}_{x'y'} = -150\ in.^4$ and $\theta = 25°$.



19. Determine the centroidal moment of inertia, $\bar{I}_{u'}$, with respect to the u' axis.

A $615\ in.^4$ B $575\ in.^4$

C $635\ in.^4$ D $595\ in.^4$

$$I_u = \frac{830+270}{2} + \frac{830-270}{2}\cos 2(-25) - (-150)\sin 2(-25)$$

$$= 550 + 180 - 114.9$$

$$= \boxed{615.1\ in^4}$$

20. Determine the centroidal moment of inertia, $\bar{I}_{v'}$, with respect to the v' axis.

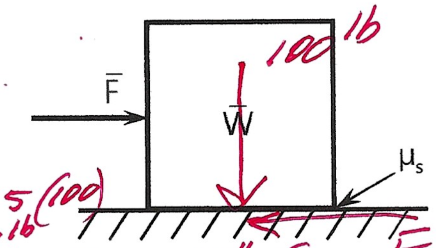
A $465\ in.^4$ B $505\ in.^4$

C $525\ in.^4$ D $485\ in.^4$

$$I_v = 550 - 180 + 114.9$$

$$= \boxed{484.9\ in^4}$$

Dry Friction



$\Sigma F_x = 0 = 40 - F$

$F = 40$

46. Determine the magnitude of the friction force the rough plane exerts on the block if $\bar{W} = 100\ lb$, $\mu_s = 0.5$, and $\bar{F} = 40\ lb$.

   a. $50.0\ lb$ b. $40.0\ lb$
   c. $45.0\ lb$ d. $35.0\ lb$

$F_{max} = \mu W = 0.5(100) = 50\ lb$

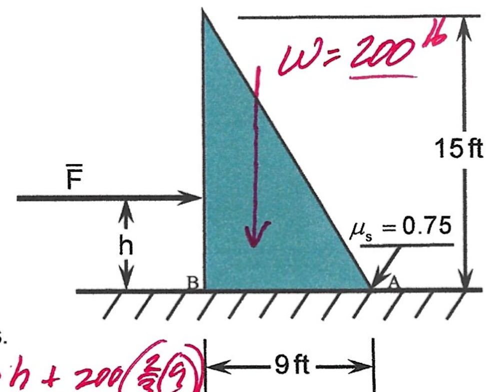
Frict = 40 lb (Equilibrium) Frict

47. Determine the smallest magnitude of force $\bar{F}$ for which motion of the block impends if $\bar{W} = 150\ lb$ and $\mu_s = 0.3$.

   a. $45.0\ lb$ b. $40.0\ lb$
   c. $50.0\ lb$ d. $60.0\ lb$

$F = \mu W = 0.3(150) = \boxed{45\ lb}$

Slipping or Tipping: The uniform triangular object weighs 200 lb .



48. Determine the magnitude of the force $\bar{F}$ for which slipping impends provided it acts at height h sufficiently small so that tipping does not occur.

   a. 180 lb b. 75.0 lb
   c. 200 lb d. 150 lb

$F = \mu W = 0.75(200) = \boxed{150\ lb}$

49. If force $\bar{F} = 120$ lb determine the height h at which tipping impends.

   a. $8.00\ ft$ b. $13.3\ ft$
   c. $10.0\ ft$ d. $15.0\ ft$

$\Sigma M_{A} = 0 = -120h + 200(\tfrac{2}{3}(9))$

$h = \frac{1200}{120} = \boxed{10.0\ ft}$

50. Determine the height h at which the force $\bar{F}$ acts to create slipping AND tipping at the same time.

   a. $8.00\ ft$ b. $13.3\ ft$
   c. $10.0\ ft$ d. $15.0\ ft$

to slip $F = 150\ lb$

to Tip @ $h = \frac{1200}{150} = \boxed{8.0\ ft}$