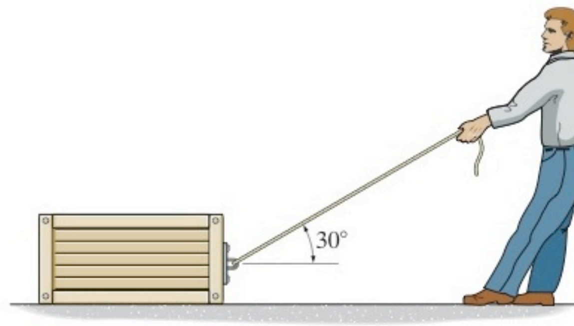
8–42. The coefficient of static friction between the 150-kg crate and the ground is $\mu_s = 0.3$, while the coefficient of static friction between the 80-kg man's shoes and the ground is $\mu_s' = 0.4$. Determine if the man can move the crate.



Free - Body Diagram. Since **P** tends to move the crate to the right, the frictional force $\mathbf{F}_C$ will act to the left as indicated on the free - body diagram shown in Fig. *a*. Since the crate is required to be on the verge of sliding the magnitude of $\mathbf{F}_C$ can be computed using the friction formula, i.e. $F_C = \mu_s N_C = 0.3\,N_C$. As indicated on the free - body diagram of the man shown in Fig. *b*, the frictional force $\mathbf{F}_m$ acts to the right since force **P** has the tendency to cause the man to slip to the left.

Equations of Equilibrium. Referring to Fig. *a*,

$+\uparrow \Sigma F_y = 0;$ $\quad N_C + P\sin 30° - 150(9.81) = 0$

$\overset{+}{\rightarrow} \Sigma F_x = 0;$ $\quad P\cos 30° - 0.3N_C = 0$

Solving,

$$P = 434.49\text{ N}$$
$$N_C = 1254.26\text{ N}$$

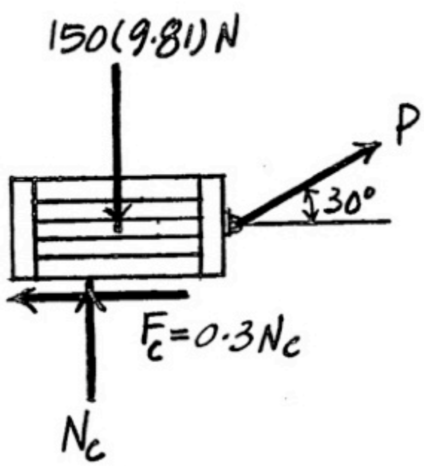
Using the result of P and referring to Fig. *a*, we have

$+\uparrow \Sigma F_y = 0;$ $\quad N_m - 434.49\sin 30° - 80(9.81) = 0$ $\quad N_m = 1002.04\text{ N}$

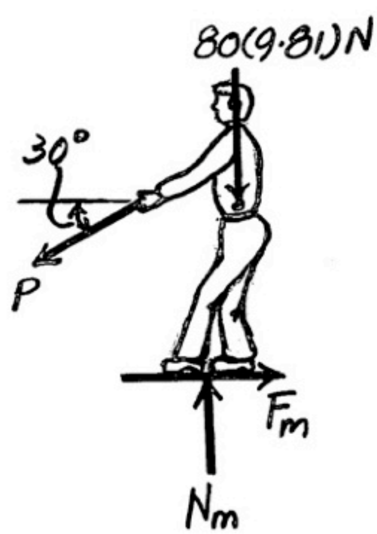
$\overset{+}{\rightarrow} \Sigma F_x = 0;$ $\quad F_m - 434.49\cos 30° = 0$ $\quad F_m = 376.28\text{ N}$

Since $F_m < F_{max} = \mu_s' N_m = 0.4(1002.04) = 400.82\text{ N}$, the man does not slip. Thus,

he can move the crate. **Ans.**

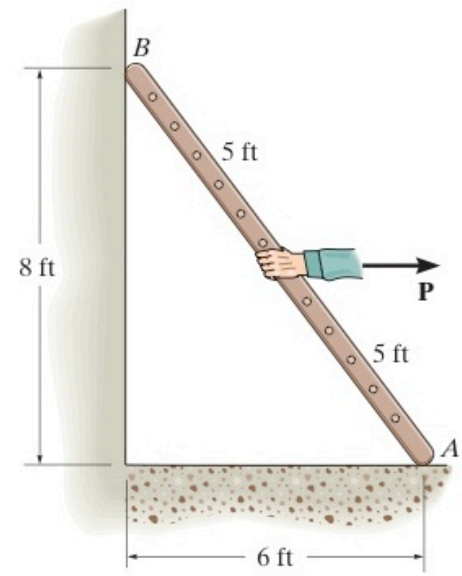


(a)



(b)

8–11. The uniform 20-lb ladder rests on the rough floor for which the coefficient of static friction is $\mu_s = 0.4$ and against the smooth wall at B. Determine the horizontal force P the man must exert on the ladder in order to cause it to move.



Assume that the ladder slips at A :

$F_A = 0.4 N_A$

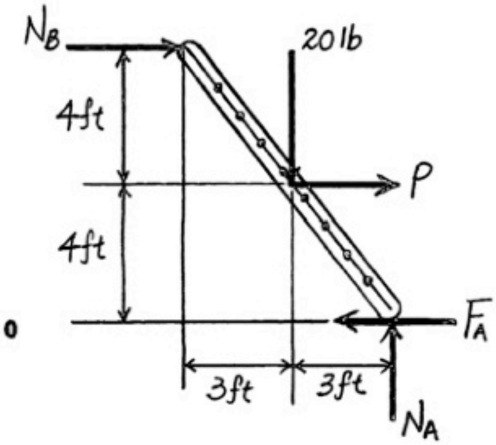
$+\uparrow \Sigma F_y = 0;\quad N_A - 20 = 0$

$N_A = 20 \text{ lb}$

$F_A = 0.4(20) = 8 \text{ lb}$

$\circlearrowleft + \Sigma M_B = 0;\quad P(4) - 20(3) + 20(6) - 8(8) = 0$

$P = 1 \text{ lb}$ **Ans**

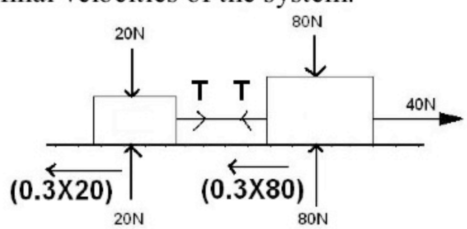


$\xrightarrow{+} \Sigma F_x = 0;\quad N_B + 1 - 8 = 0$

$N_B = 7 \text{ lb} > 0$ OK

The ladder will remain in contact with the wall.

4. Two weights 80N and 20N are connected by by a thread and move along a rough horizontal plane under the action of a force 40N, applied to the first weight of 80N as shown in figure below. The co efficient of friction between the sliding surfaces of the weights and the plane is 0.3. Determine the acceleration of the weights and the tension in the thread using work energy equation. Let ‘s’ be the distance moved by the system ‘u’ and ‘v’ be the initial and final velocities of the system.

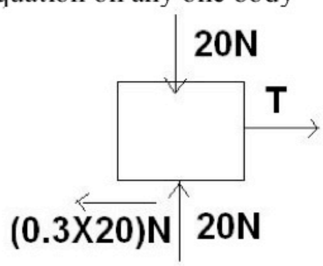


With the action of 40N force, the system will move horizontally and towards right. Let the net force along the direction is sum up the Horizontal force ..
= 40 – (0.3X20) – (0.3 X 80) = 10 N , now applying the work energy equation

= (W1+W2) / 2g . (v^2-u^2) … ie, 10Xs = (20+800) / 2X9.81. (v^2-0) (u = 0, because the system starts moving from rest)

Therefore 10s = 100 X v^2 / 2X9.81 or v^2 = 1.962s
Substitute v^2 = 1.9628 in the equation, $v^2 = u^2+2as$,, ie, 1.962s = 0+ 2as ,
a = 1.962/2 = 0.981m/sec^2

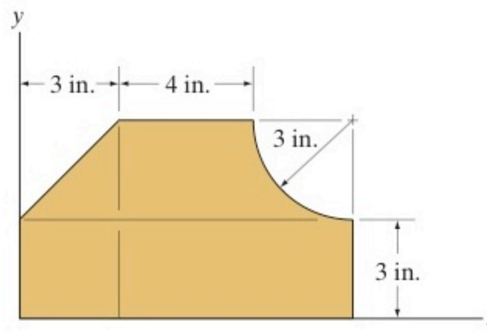
To find T apply work energy equation on any one body



Consider 20 N block, Frree diagram of 20N weight is shown …
Workdone = Netforce X Distance = [T-(0.3X20)]s , = **(T-6)s -----(1)**
Change in kinetic energy = W/2g (v^2-u^2),, (u=0; v^2 = 1.962s)
20/2X9 .81 . (1.962s-0) ----(2) , from this we get T -6 = 2,

Therefore T = 8N

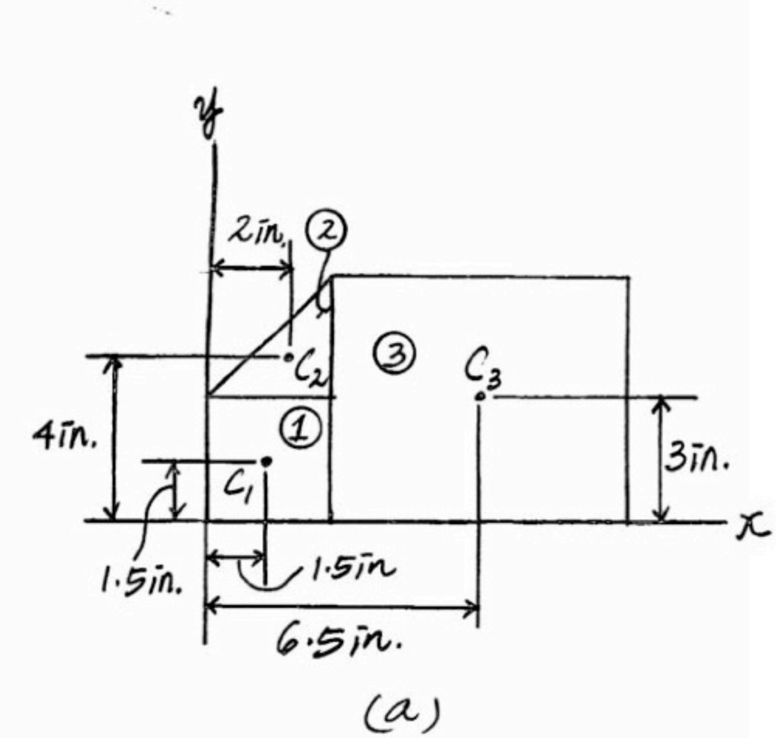
9–59. Locate the centroid $(\bar{x}, \bar{y})$ of the composite area.



Centroid: The centroid of each composite segment is shown in Figs. *a* and *b*. since segment (4) is a hole, its area should be considered negative.

$$\bar{x} = \frac{\Sigma \tilde{x} A}{\Sigma A} = \frac{1.5(3(3)) + 2\left(\frac{1}{2}(3)(3)\right) + 6.5(7(6)) + \left(10 - \frac{4(3)}{3\pi}\right)\left(-\frac{\pi(3^2)}{4}\right)}{3(3) + \frac{1}{2}(3)(3) + 7(6) + \left(-\frac{\pi(3^2)}{4}\right)} = \frac{233.81}{48.43} = 4.83 \text{ in.} \qquad \textbf{Ans.}$$

$$\bar{y} = \frac{\Sigma \tilde{y} A}{\Sigma A} = \frac{1.5(3(3)) + 4\left(\frac{1}{2}(3)(3)\right) + 3(7(6)) + \left(6 - \frac{4(3)}{3\pi}\right)\left(-\frac{\pi(3^2)}{4}\right)}{3(3) + \frac{1}{2}(3)(3) + 7(6) + \left(-\frac{\pi(3^2)}{4}\right)} = \frac{124.09}{48.43} = 2.56 \text{ in.} \qquad \textbf{Ans.}$$



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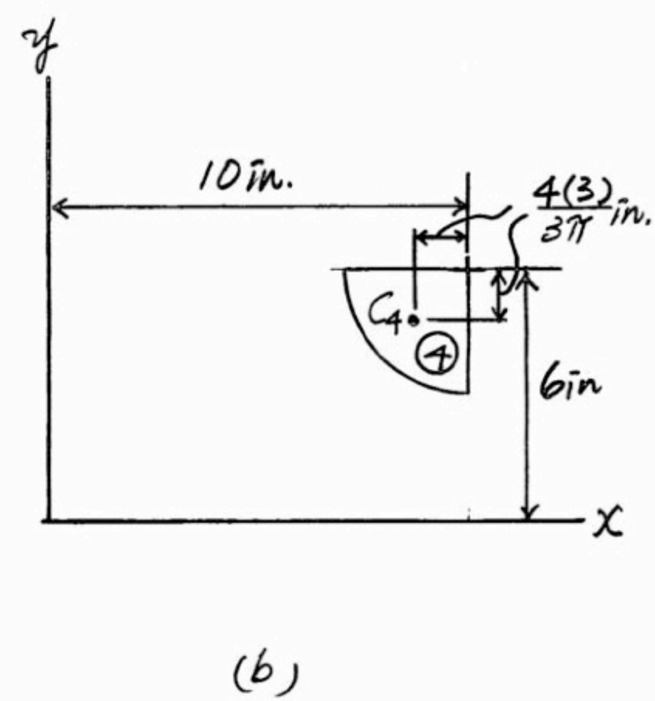


7. Two blocks of weight 150N and 50 N are connected by a string and passing over a frictionless pulley. Determine the acceleration of blocks A and B and the tension in the string.

Given, Weight of blocks : 150N and 50N. Here , acceleration of these two blocks will not be equal, because the 50N block is supported by a single string.

But, 150 N block is supported by two strings (ie: string on either side); hence acceleration of block 50N is twice the acceleration of block 150N.
Let a = acceleration of block 50N weight, and T= Tension in the string
150N block is moving downwards and hence 50N block is moving upwards.

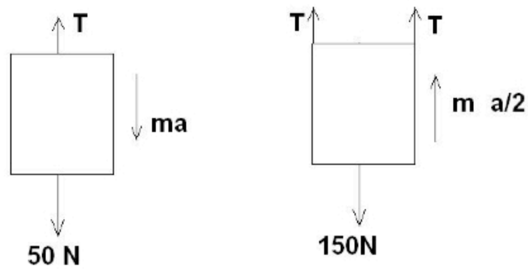


figure (a) figure (b)

Consider 50N block (moving upwards)
The forces acting on the block along with the inertia force are shown in figure (a)
Applying $\sum$ V = 0
T-50-ma=0

$$T-50-\left(\frac{50}{9.81}a\right)=0$$

Or **T-5.09a=50--------(1)**
Consider 150N block (moving downwards)
The forces acting on the block along with the inertia force are shown in figure (b)
Note that a= a/2 and Tension = 2T

Applying $\sum$ V = 0

$$2T-150+\left(\frac{150}{9.81}X\frac{a}{2}\right)=0$$

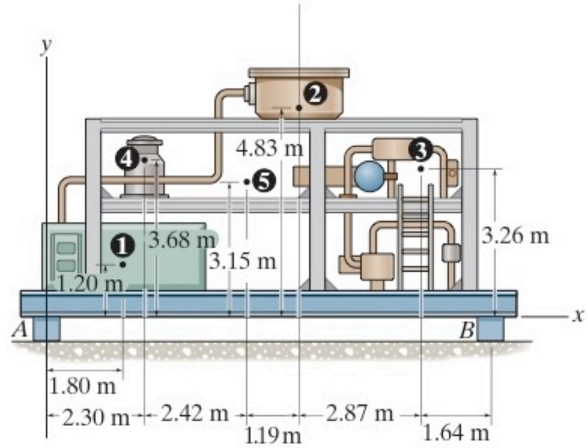
$$2T+\left(15.29X\frac{a}{2}\right)=150$$

2T=7.645a=150--------(2)
Solving the equation (1) and (2) we get 'a' and 'T' ;, . a= 2.0805m/sec2 and T = 64.278N

Acceleration of 50 N block (a) = 2.805m/sec^2 , Acceleration of 150 N block $\left(\frac{a}{2}\right)$**= 1.402m/sec^2 and**

Tension in the spring (T) = 64.278N

9–70. Locate the center of mass for the compressor assembly. The locations of the centers of mass of the various components and their masses are indicated and tabulated in the figure. What are the vertical reactions at blocks A and B needed to support the platform?



1	Instrument panel	230 kg
2	Filter system	183 kg
3	Piping assembly	120 kg
4	Liquid storage	85 kg
5	Structural framework	468 kg

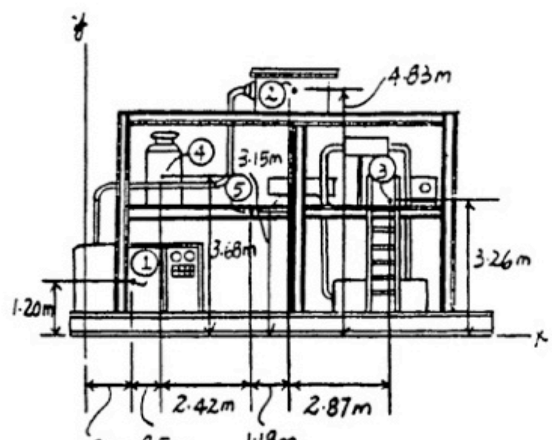
Centroid : The mass of each component of the compressor and its respective centroid are tabulated below.

Component	m (kg)	$\tilde{x}$ (m)	$\tilde{y}$ (m)	$\tilde{x}m$ (kg · m)	$\tilde{y}m$ (kg · m)
1	230	1.80	1.20	414.00	276.00
2	183	5.91	4.83	1081.53	883.89
3	120	8.78	3.26	1053.60	391.20
4	85	2.30	3.68	195.50	312.80
5	468	4.72	3.15	2208.96	1474.20
Σ	1086			4953.59	3338.09

Thus,

$$\bar{x} = \frac{\Sigma \tilde{x}m}{\Sigma m} = \frac{4953.59}{1086} = 4.561 \text{ m} = 4.56 \text{ m} \qquad \textbf{Ans}$$

$$\bar{y} = \frac{\Sigma \tilde{y}m}{\Sigma m} = \frac{3338.09}{1086} = 3.074 \text{ m} = 3.07 \text{ m} \qquad \textbf{Ans}$$



Equations of Equilibrium :

$$+\Sigma M_A = 0; \quad B_y(10.42) - 1086(9.81)(4.561) = 0$$

$$B_y = 4663.60 \text{ N} = 4.66 \text{ kN} \qquad \textbf{Ans}$$

$$+\uparrow \Sigma F_y = 0; \quad A_y + 4663.60 - 1086(9.81) = 0$$

$$A_y = 5990.06 \text{ N} = 5.99 \text{ kN} \qquad \textbf{Ans}$$