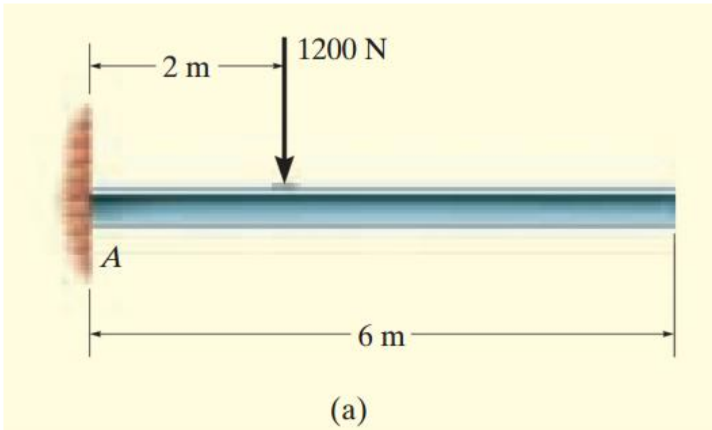
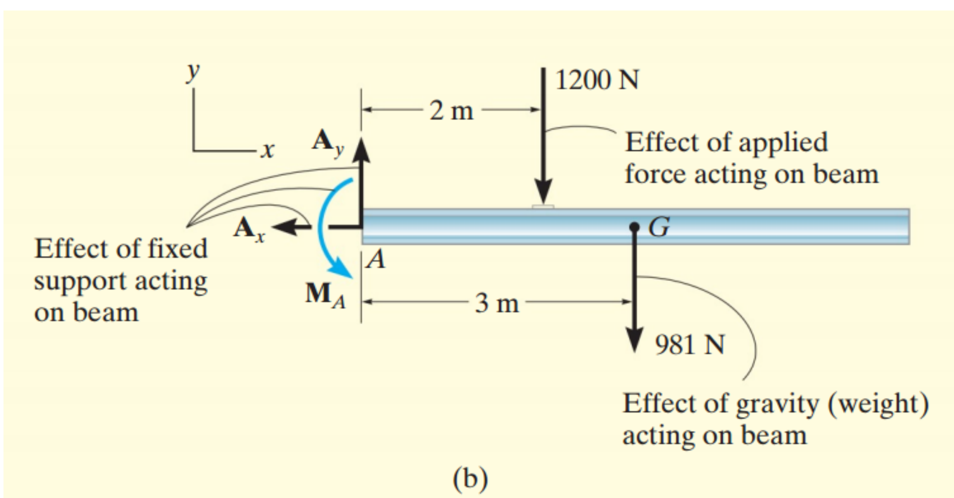
Example: Draw the free-body diagram of the uniform beam shown in Fig. below. The beam has a mass of 100 kg.



(a)

Solution:

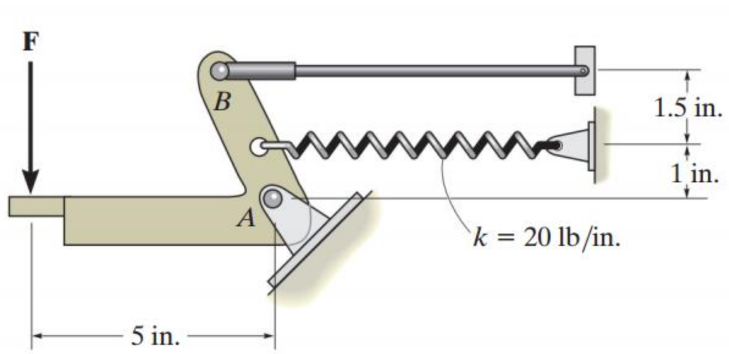
Since the support at A is fixed, the wall exerts three reactions on the beam, denoted as Ax, Ay, and MA. The magnitudes of these reactions are unknown, and their sense has been assumed. The weight of the beam, W = 100(9.81) N = 981 N, acts through the beam's center of gravity G, which is 3 m from A since the beam is uniform.



(b)

Example: Draw the free-body diagram of the foot lever shown in Fig. a and b below. The operator applies a vertical force to the pedal so that the spring is stretched 1.5 in. and the force on the link at B is 20 lb.

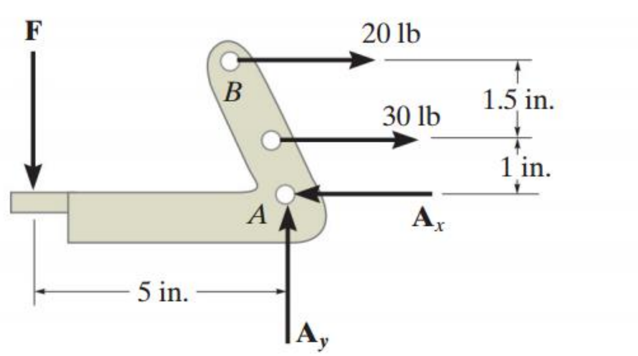
(a)



(b)

Solution:

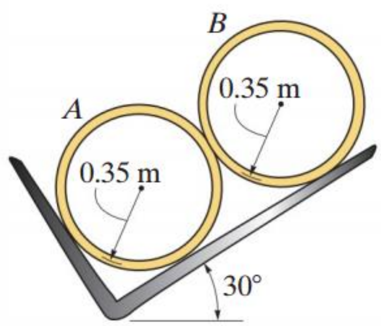
Since the pin at A is removed, it exerts force components A_x and A_y on the lever. The link exerts a force of **20 lb**, acting in the direction of the link. In addition the spring also exerts a horizontal force on the lever. If the stiffness is measured and found to be **k = 20 lb /in.**, then since the stretch **s = 1.5 in.**, using Eq. , $\mathbf{F_s = ks = 20\ lb/in.\ (1.5\ in.) = 30\ lb}$. Finally, the operator's shoe applies a vertical force of **F** on the pedal.



(c)

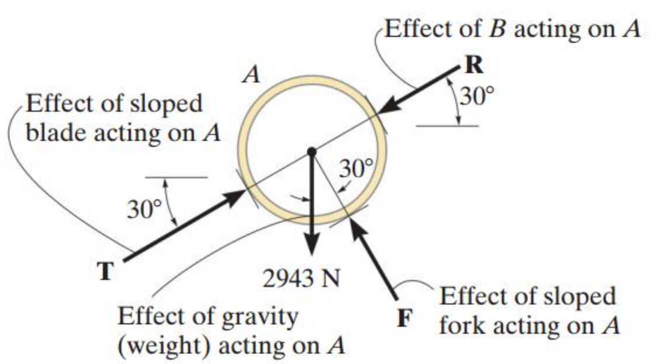
Example: Two smooth pipes, each having a mass of 300 kg, are supported by the forked tines of the tractor in Fig. a and b below. Draw the free-body diagrams for each pipe and both pipes together.

(a)

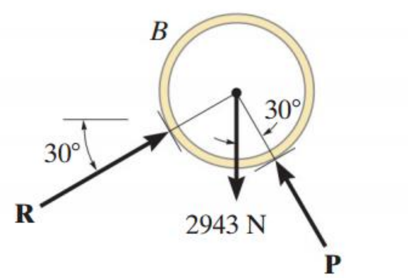


(b)

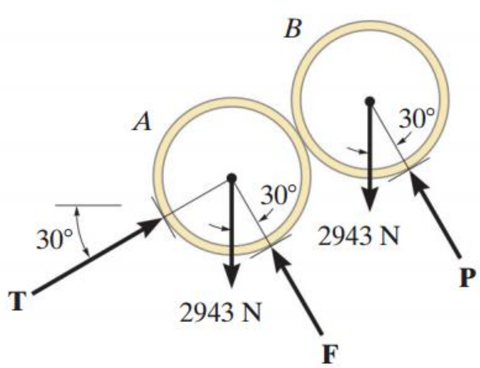
Solution: W = 300(9.81) N = 2943 N



(c)



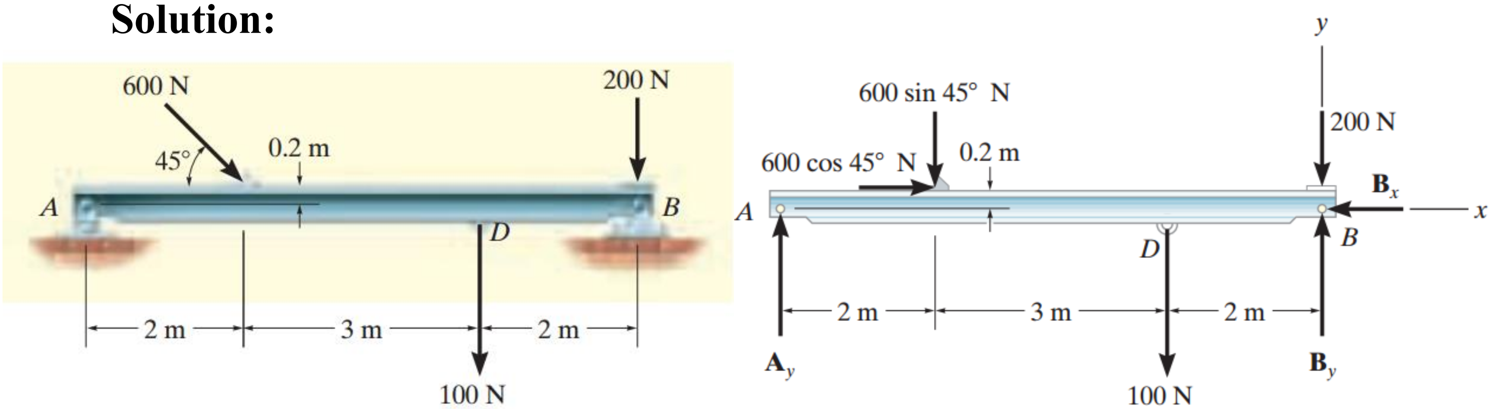
(d)



(e)

Example: Determine the horizontal and vertical components of reaction on the beam caused by the pin at B and the roller at A as shown in Fig. a. below. Neglect the weight of the beam.

Solution:



(a) (b)

Equations of Equilibrium. Summing forces in the x direction yields

$$\overset{+}{\rightarrow}\Sigma F_x = 0; \qquad 600 \cos 45° \text{ N} - B_x = 0$$

$$B_x = 424 \text{ N} \qquad \textit{Ans.}$$

A direct solution for $\mathbf{A}_y$ can be obtained by applying the moment equation $\Sigma M_B = 0$ about point B.

$$\circlearrowleft + \Sigma M_B = 0; \qquad 100 \text{ N}(2 \text{ m}) + (600 \sin 45° \text{ N})(5 \text{ m})$$

$$- (600 \cos 45° \text{ N})(0.2 \text{ m}) - A_y(7 \text{ m}) = 0$$

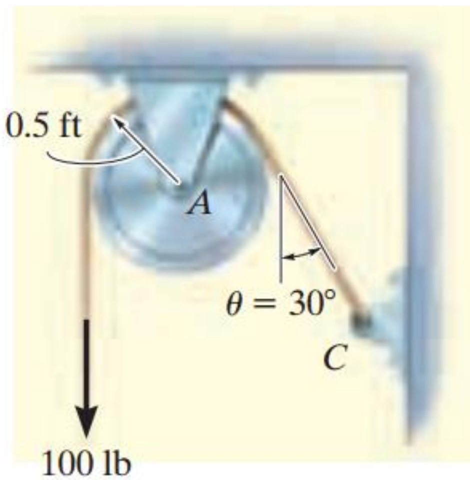
$$A_y = 319 \text{ N} \qquad \textit{Ans.}$$

Summing forces in the y direction, using this result, gives

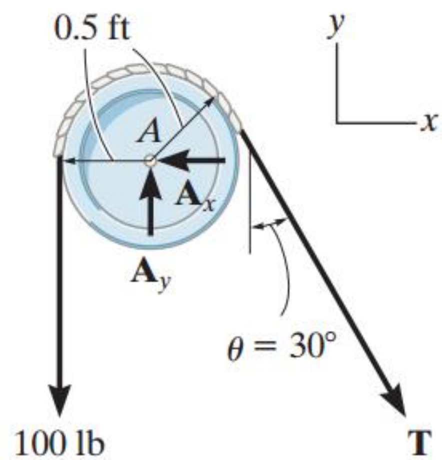
$$+\uparrow \Sigma F_y = 0; \qquad 319 \text{ N} - 600 \sin 45° \text{ N} - 100 \text{ N} - 200 \text{ N} + B_y = 0$$

$$B_y = 405 \text{ N} \qquad \textit{Ans.}$$

Example: The cord shown in Fig. a. below supports a force of 100 lb and wraps over the frictionless pulley. Determine the tension in the cord at C and the horizontal and vertical components of reaction at pin A.



(a)



Solution:

$\circlearrowleft + \Sigma M_A = 0; \qquad 100\text{ lb}(0.5\text{ ft}) - T(0.5\text{ ft}) = 0$

$T = 100\text{ lb}$ *Ans.*

Using this result,

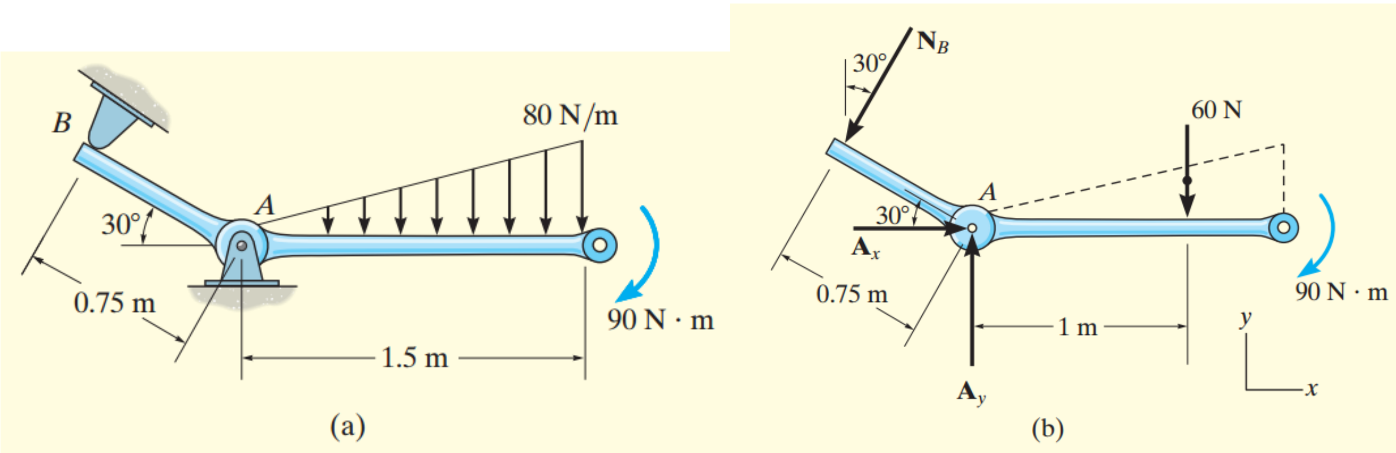
$\overset{+}{\rightarrow} \Sigma F_x = 0; \qquad -A_x + 100 \sin 30^\circ\text{ lb} = 0$

$A_x = 50.0\text{ lb}$ *Ans.*

$+\uparrow \Sigma F_y = 0; \qquad A_y - 100\text{ lb} - 100 \cos 30^\circ\text{ lb} = 0$

$A_y = 187\text{ lb}$ *Ans.*

Example: The member shown in Fig. a. below is pin connected at A and rests against a smooth support at B. Determine the horizontal and vertical components of reaction at the pin A.



(a) (b)

Solution:

Free-Body Diagram. As shown in Fig. **(b)**, the supports are removed and the reaction $\mathbf{N}_B$ is perpendicular to the member at B. Also, horizontal and vertical components of reaction are represented at A. The resultant of the distributed loading is $\frac{1}{2}(1.5\text{ m})(80\text{ N/m}) = 60\text{ N}$. It acts through the centroid of the triangle, 1 m from A as shown.

Equations of Equilibrium. Summing moments about A, we obtain a direct solution for N_B,

$$\circlearrowleft + \Sigma M_A = 0; \quad -90\text{ N}\cdot\text{m} - 60\text{ N}(1\text{ m}) + N_B(0.75\text{ m}) = 0$$

$$N_B = 200\text{ N}$$

Using this result,

$$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad A_x - 200\sin 30^\circ\text{ N} = 0$$

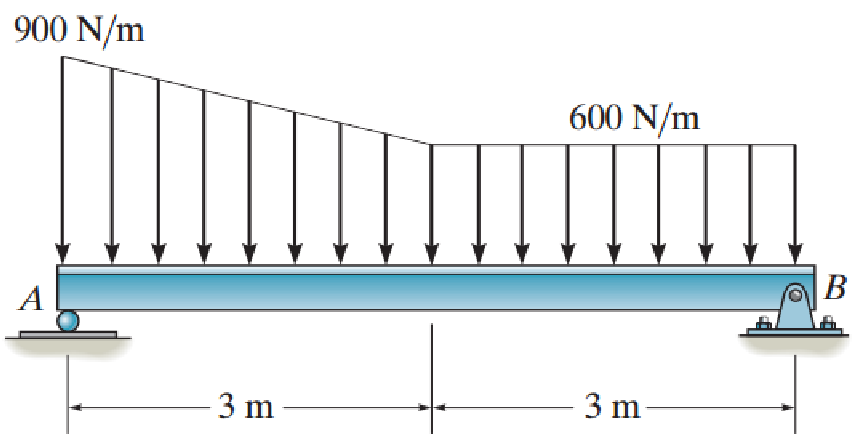
$$A_x = 100\text{ N} \qquad \textit{Ans.}$$

$$+\uparrow \Sigma F_y = 0; \quad A_y - 200\cos 30^\circ\text{ N} - 60\text{ N} = 0$$

$$A_y = 233\text{ N} \qquad \textit{Ans.}$$

HW:

1. Determine the reactions at the supports:



2. Determine the reactions at the supports: