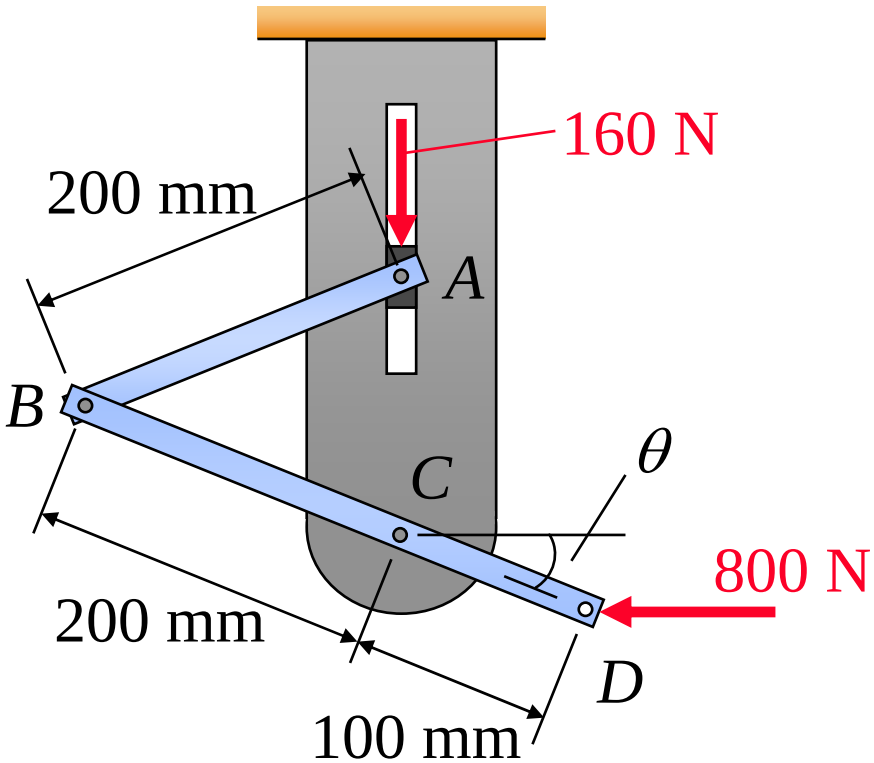
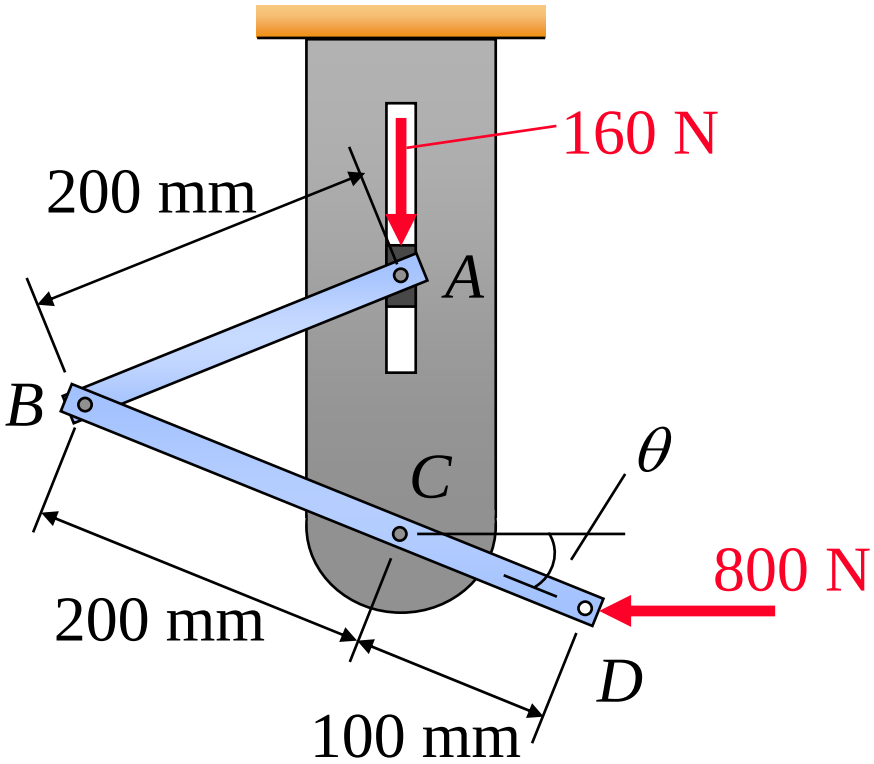
Problem 10.103



Rod AB is attached to a block at A that can slide freely in the vertical slot shown. Neglecting the effect of friction and the weights of the rods, determine the value of θ corresponding to equilibrium.



Problem 10.103

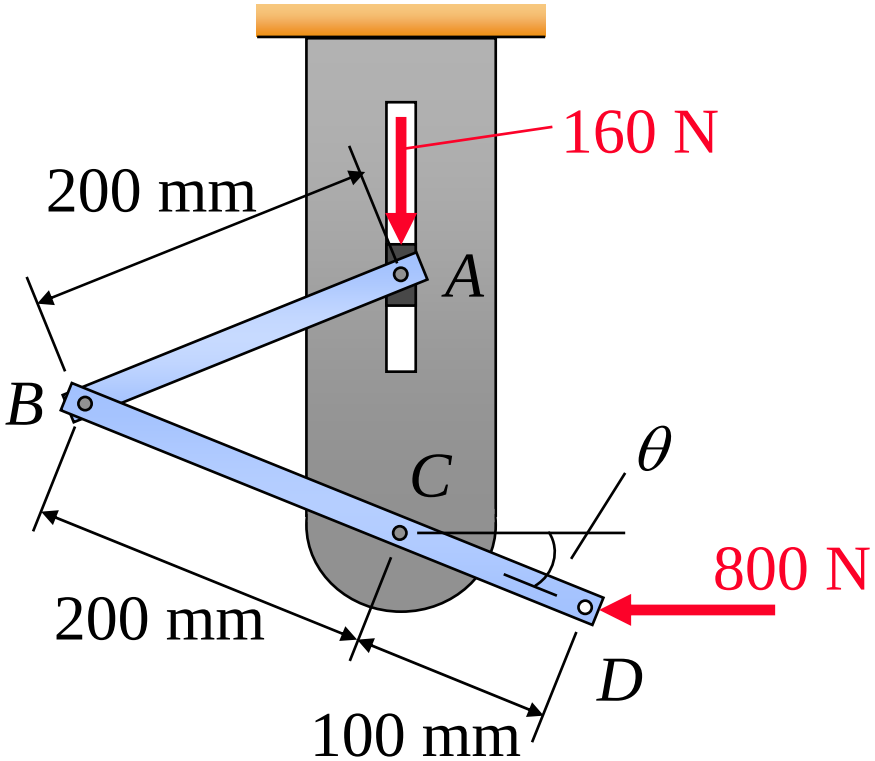
Solving Problems on Your Own

Rod AB is attached to a block at A that can slide freely in the vertical slot shown. Neglecting the effect of friction and the weights of the rods, determine the value of θ corresponding to equilibrium.

1. *Apply the principle of virtual work*. If a system of connected rigid bodies is in equilibrium, the total virtual work of the external forces applied to the system is zero for any virtual displacement of the system.

1a. Define a virtual displacement. By using a single variable, define a virtual displacement of all the forces that do work.

Problem 10.103



Solving Problems on Your Own

Rod AB is attached to a block at A that can slide freely in the vertical slot shown. Neglecting the effect of friction and the weights of the rods, determine the value of θ corresponding to equilibrium.

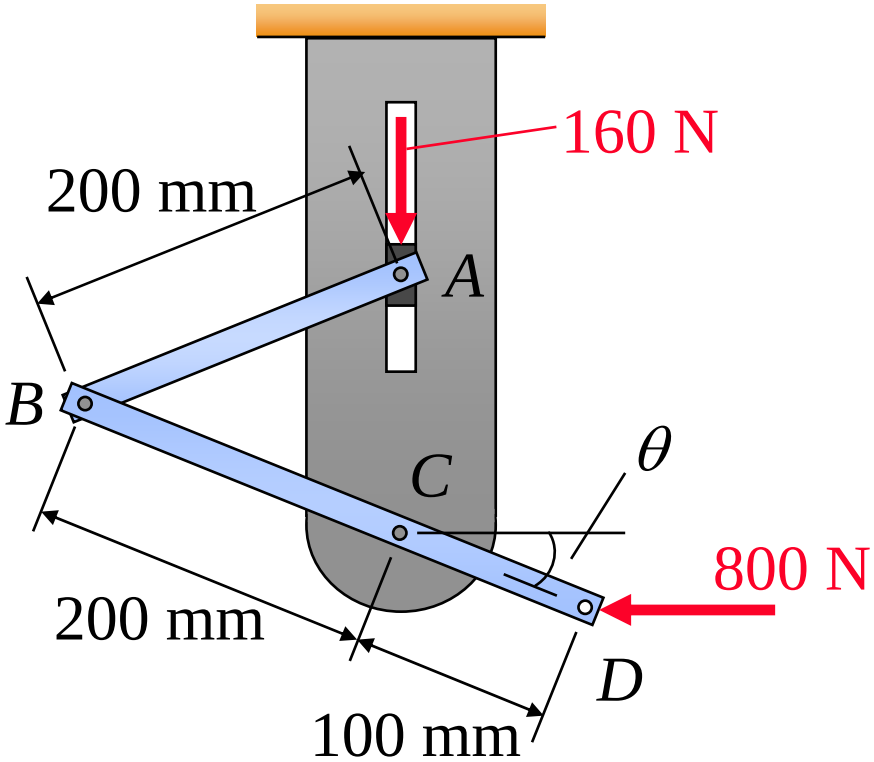
1b. Express the total virtual work done by the forces and couples during the virtual displacement.

$$\delta U = \mathbf{F} \cdot \delta \mathbf{r} \quad \text{and} \quad \delta U = M\,\delta\theta$$

where δU is the virtual work, $\mathbf{F}$ is a force undergoing a virtual displacement $\delta \mathbf{r}$, and M is a couple undergoing a virtual rotation $\delta\theta$.

1c. Set the virtual work to zero and solve for the variable.

Problem 10.103 Solution



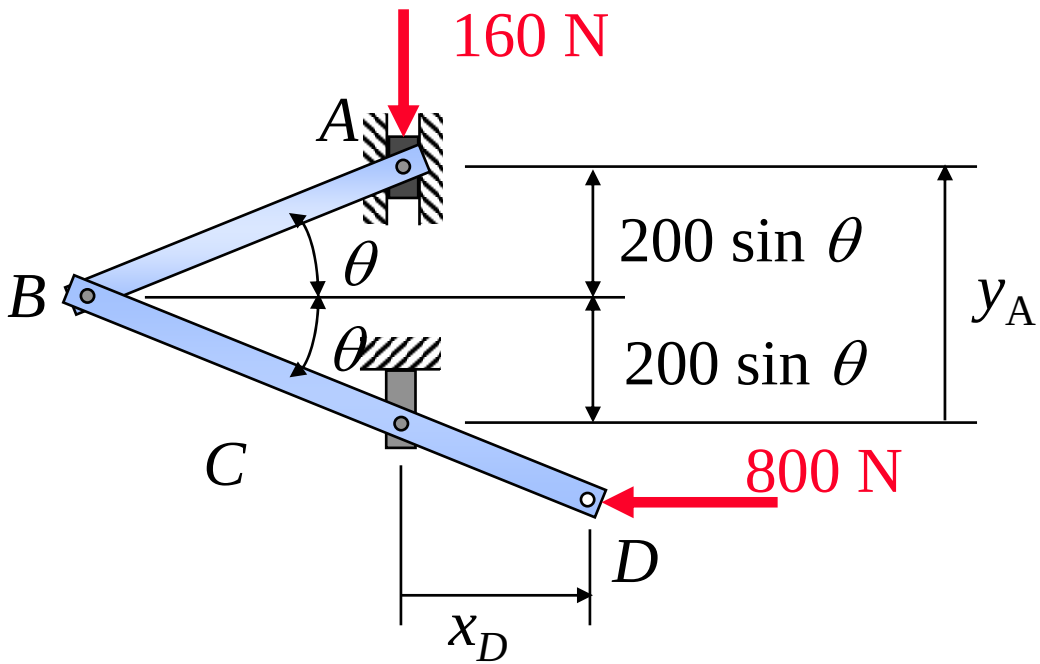
Define a virtual displacement.

$$y_A = 400 \sin \theta$$

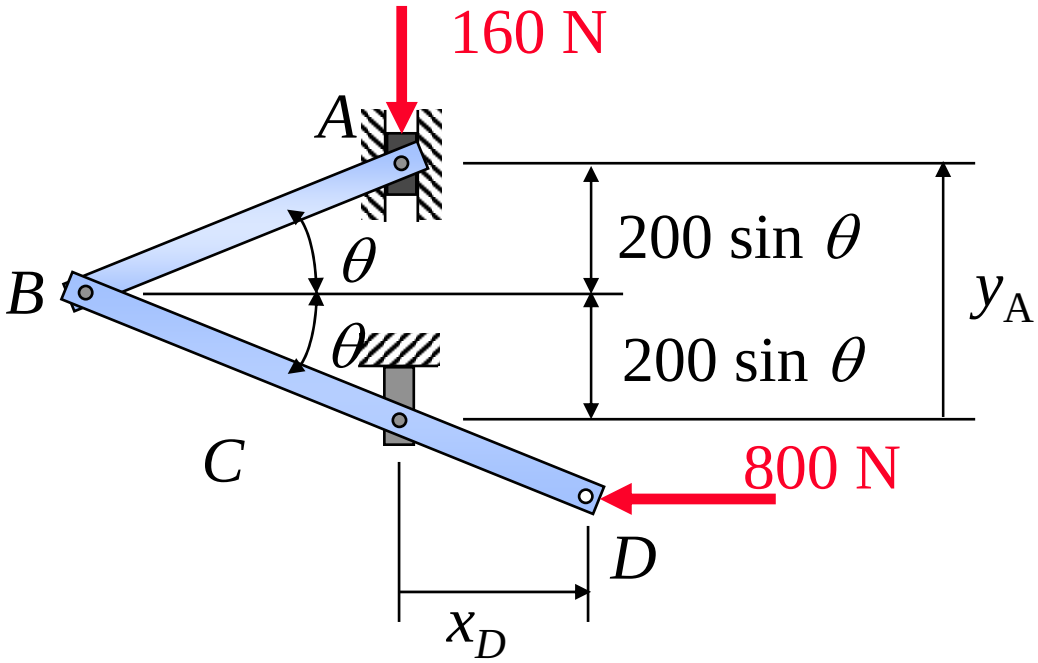
$$\delta y_A = 400 \cos \theta \, \delta\theta$$

$$x_D = 100 \cos \theta$$

$$\delta x_D = -100 \sin \theta \, \delta\theta$$



Problem 10.103 Solution



Express the total virtual work done by the forces.

Set the virtual work to zero and solve for the variable.

Virtual work: $\delta U = -(160\text{ N})\,\delta y_A - (800\text{ N})\,\delta x_D = 0$

$$-(160)(400\cos\theta\,\delta\theta) - (800)(-100\sin\theta\,\delta\theta) = 0$$

$$\frac{\sin\theta}{\cos\theta} = 0.8\,; \qquad \tan\theta = 0.8$$

$$\theta = 38.7^{\circ}$$