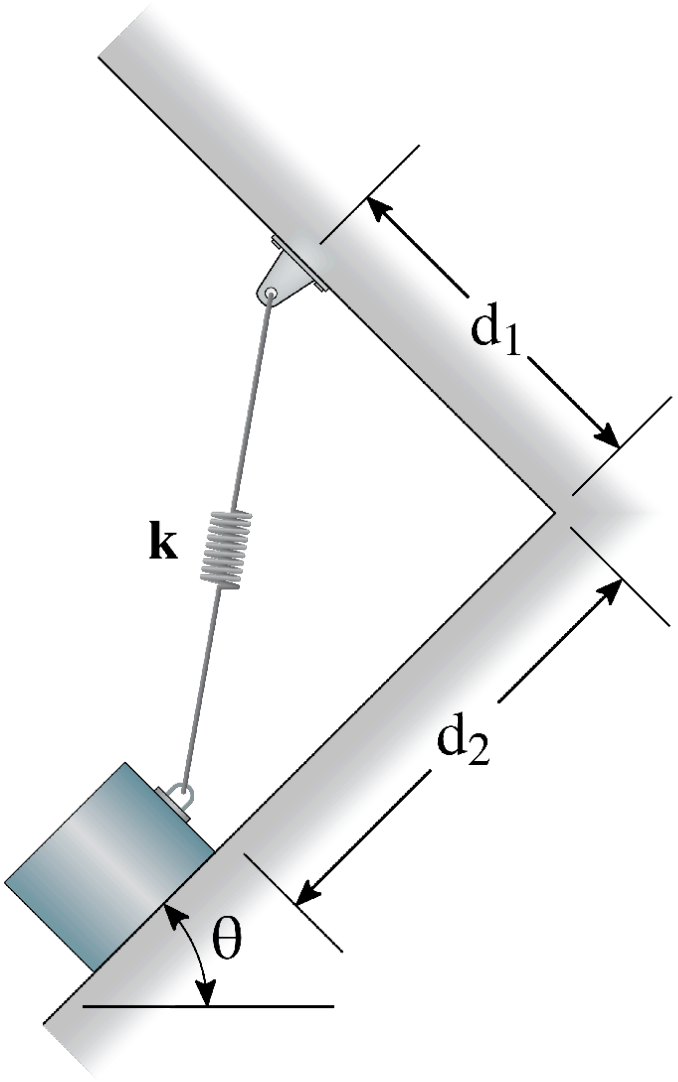

A block with mass m is in equilibrium and is attached to a spring that is firmly stuck on a wall. Assuming that the surfaces are frictionless, determine the unstretched length of the spring.

Draw a FBD to simplify the system.

How many external forces act on the block?

3

What is the smallest angle ϕ (in DEGREES) between the spring and the horizontal?

$\phi = \theta + \arctan(\frac{d_1}{d_2})$ (Assume it will be $< 90°$)

Find the magnitude of the elastic tension T along the spring.

$$\Sigma F_x = 0 \rightarrow T\cos(\phi) - N\sin(\theta) = 0 \rightarrow N = \frac{\cos(\phi)}{\sin(\theta)}T$$

$$\Sigma F_y = 0 \rightarrow N\cos(\theta) + T\sin(\phi) - mg = 0 \rightarrow \frac{\cos(\theta)\cos(\phi) + \sin(\theta)\sin(\phi)}{\sin(\theta)}T = mg$$

$$\rightarrow T = \frac{mg\sin(\theta)}{\cos(\theta)\cos(\phi) + \sin(\theta)\sin(\phi)}$$

Finally, determine the unstretched length of the spring.

$$T = k(x_f - x_0)$$

$$x_f = \sqrt{{d_1}^2 + {d_2}^2}$$

$$x_0 = \sqrt{{d_1}^2 + {d_2}^2} - \frac{T}{k}$$