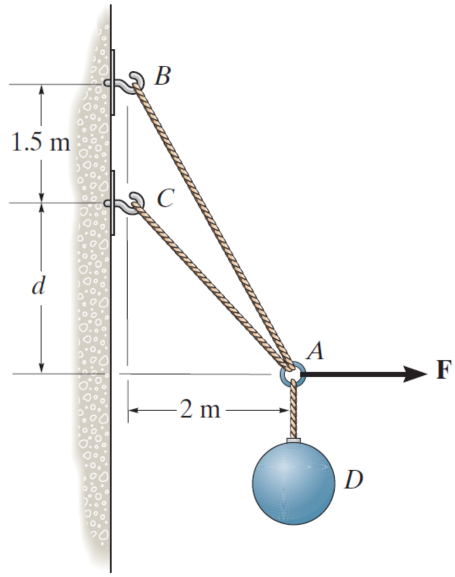
## Problem 3-38

Determine the forces in cables $AC$ and $AB$ needed to hold the 20-kg ball $D$ in equilibrium. Take $F = 300$ N and $d = 1$ m.




**Probs. 3–38/39**

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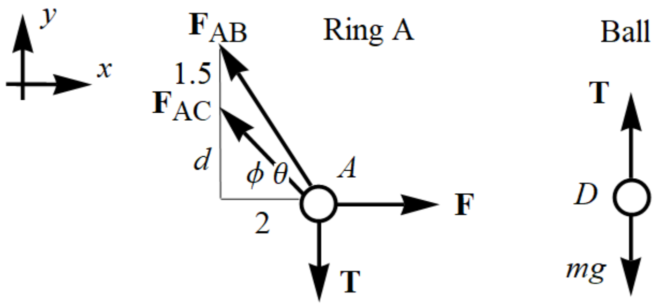
### Solution

Draw free-body diagrams for ring $A$ and the ball. Let $\phi$ and $\theta$ be the angles that $\mathbf{F}_{\text{AC}}$ and $\mathbf{F}_{\text{AB}}$ make with the horizontal, respectively.

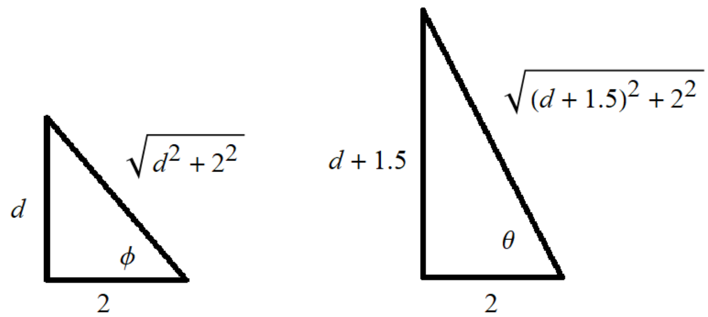



In order for the system to be in equilibrium, the sum of the forces in each direction must be zero.

$$\sum F_x = 0: \qquad F - F_{\text{AB}}\cos\theta - F_{\text{AC}}\cos\phi = 0 \qquad 0 = 0$$

$$\sum F_y = 0: \qquad F_{\text{AB}}\sin\theta + F_{\text{AC}}\sin\phi - T = 0 \qquad T - mg = 0$$

Use the Pythagorean theorem to find each triangle's hypotenuse.




As a result,

$$\cos\phi = \frac{2}{\sqrt{d^2+2^2}} \quad \text{and} \quad \sin\phi = \frac{d}{\sqrt{d^2+2^2}} \quad \text{and} \quad \cos\theta = \frac{2}{\sqrt{(d+1.5)^2+2^2}} \quad \text{and} \quad \sin\theta = \frac{d+1.5}{\sqrt{(d+1.5)^2+2^2}},$$

and the two middle equations become

$$F - F_{\text{AB}}\frac{2}{\sqrt{(d+1.5)^2+2^2}} - F_{\text{AC}}\frac{2}{\sqrt{d^2+2^2}} = 0$$

$$F_{\text{AB}}\frac{d+1.5}{\sqrt{(d+1.5)^2+2^2}} + F_{\text{AC}}\frac{d}{\sqrt{d^2+2^2}} - mg = 0.$$

Set $d = 1$ m, $F = 300$ N, $m = 20$ kg, and $g = 9.81$ m/s$^2$ and solve for $F_{\text{AB}}$ and $F_{\text{AC}}$.

$$F_{\text{AB}} \approx 98.6 \text{ N}$$

$$F_{\text{AC}} \approx 267 \text{ N}$$