In an automatic clothes drier, a hollow cylinder moves the clothes on a vertical circle (radius r = 0.412 m), as the drawing shows. The appliance is designed so that the clothes tumble gently as they dry. This means that when a piece of clothing reaches an angle of θ above the horizontal, it loses contact with the wall of the cylinder and falls onto the clothes below. How many revolutions per second should the cylinder make in order that the clothes lose contact with the wall when θ = 76.0°?

Solution

From Newton's 2nd law, write an equation for the net centripetal force acting on a single piece of cloth in the dryer:

$$F_c = ma_c.$$

$$mg\sin\theta - N = ma_c.$$

Note that the normal force is negative because it is directed downward in response to the centripetal force. At the point where the cloth falls from the dryer wall, the normal force becomes zero, so:

$$mg\sin\theta = ma_c.$$

Centripetal acceleration is equal to $\omega^2 r$, and the cloth comes off at an angle of 76.0°, therefore:

$$mg\sin\theta = mr\omega^2.$$

$$\omega^2 = \frac{g\sin\theta}{r} \to \omega = \sqrt{\frac{9.81\frac{m}{s^2} * \sin 76.0°}{0.412\text{ m}}} = 4.81\frac{\text{rad}}{\text{s}}.$$

To convert this to rev/s, divide it by 2π:

$$\omega = \frac{4.81}{2\pi}\frac{\text{rev}}{\text{s}} = 0.766\frac{\text{rev}}{\text{s}}.$$

Answer: $\mathbf{0.766\frac{rev}{s}}$.