

Chapter 9 Problems

1. An electric drill starts from rest and rotates with a constant angular acceleration. After the drill has rotated through a certain angle, the magnitude of the centripetal acceleration of a point on the drill is twice the magnitude of the tangential acceleration. What is the angle?

Answer: The tangential and centripetal acceleration of a point at a distance r from the rotation axis are given by $a_T = r\alpha$ and $a_c = r\omega^2$, respectively. After the drill has rotated through the angle in question, $a_c = 2a_T$, or

$$r\omega^2 = 2r\alpha.$$

This expression can be used to find the angular acceleration α ,

$$\alpha = \frac{\omega^2}{2}.$$

We can obtain the angle θ by making use of $\omega^2 = \omega_0^2 + 2\alpha\theta$,

$$\theta = \frac{\omega^2}{2\alpha} = \left(\frac{\omega^2}{2}\right) \left(\frac{2}{\omega^2}\right) = 1.00\text{rad}.$$

2. A ball of radius 0.200 m rolls along a horizontal table top with a constant linear speed of 3.60 m/s. The ball rolls off the edge and falls a vertical distance of 2.10 m before hitting the floor. What is the angular displacement of the ball while the ball is in the air?

Answer: The angular speed of the ball can be found from

$$\omega = \frac{v}{r} = 18.0\text{rad/s}.$$

The time it takes for the ball to fall through the vertical distance y can be found from

$$y = v_{0y}t - \frac{1}{2}gt^2$$

which gives

$$t = \sqrt{\frac{2y}{g}} = 0.655\text{sec}.$$

Since the angular speed of the ball remains constant while it is falling,

$$\theta = \omega t = 11.8\text{rad.}$$