The drawing shows a golf ball passing through a windmill at a miniature golf course. The windmill has 8 blades and rotates at an angular speed of 1.25 rad/s. The opening between successive blades is equal to the width of a blade. A golf ball of diameter $4.50 \times 10{-}2$ m is just passing by one of the rotating blades. What must be the minimum speed of the ball so that it will not be hit by the next blade?

Solution

The golf ball must travel a distance equal to its diameter in the time between blade arrivals to avoid being hit. If there are 8 blades and 8 blade openings and they have the same width, then each blade or opening is $\frac{1}{16}$ of a circle of is $2\frac{\pi}{16} = 0.39$ radians across. Therefore, the time between the edge of one blade moving out of the way and the next blade moving in the way is time = angular distance/angular velocity:

$t = \frac{0.39 rad}{1.25 \frac{rad}{s}} = 0.312\ s.$

The golf ball must get completely through the blade path in this time, so must move a distance equal to its diameter in 0.312s, therefore the speed of the golf ball is

$v = \frac{d}{t} = \frac{0.045 m}{0.312 s} = 0.144 \frac{m}{s}.$

Answer: $\mathbf{0.144 \frac{m}{s}}$.