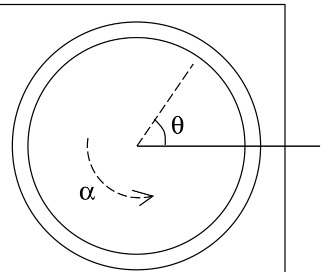
Problem 10.18



A car accelerates from rest to 22.0 m/s in 9.00 seconds. The diameter of the car's wheels is .580 meters.

a.) Assuming no slippage, determine the number of revolutions the tires make during this period.

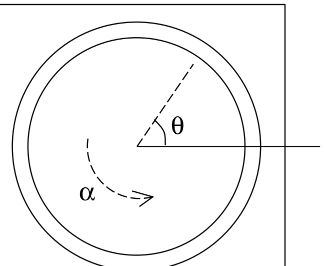
This is not a very exciting problem, but this time we need to use translational kinematics to determine the speed of a point on the tire's diameter. To that end, we need to begin by determining the distance the car travels.

There are two ways to do this. The first requires the use of *average velocity*, a quantity I don't generally like to use because there are too many ways you can get yourself messed up using it. The second required two kinematics equation. To get the acceleration, we need:

$$a = \frac{v_2 - \cancelto{0}{v_1}}{\Delta t} = \frac{v_2}{\Delta t}$$

To get distance, we need:

$$(v_2)^2 = (\cancelto{0}{v_1})^2 + 2a\Delta x = 2a\Delta x$$



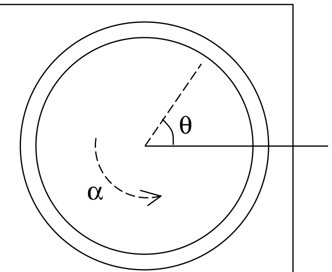
Using the latter equation, we can write:

$$(v_2)^2 = (\cancelto{0}{v_1})^2 + 2a\Delta x$$

$$\Rightarrow \quad \Delta x = \frac{(v_2)^2}{2a} = \frac{(v_2)^2}{2\left(\frac{v_2}{\Delta t}\right)} = \frac{(v_2)\Delta t}{2} = \frac{(22.0 \text{ m/s})(9.00 \text{ s})}{2} = 99.0 \text{ m}$$

Note: For constant acceleration, the *average velocity* is the *half the sum* of the initial and final velocities. With that, the latter approach comes out to be:

$$\Delta x = v_{avg}\Delta t = \left(\frac{v_2}{2}\right)\Delta t = (11.0 \text{ m/s})(9.00 \text{ s}) = 99.0 \text{ m.}$$



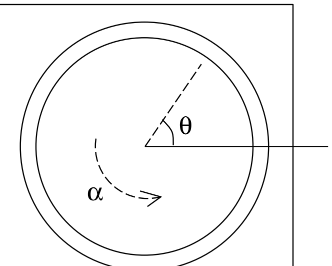
Knowing how far the car traveled, all we need to do is determine how many circumferences that is, and we'll have the number of revolutions turned through during the 9.00 seconds. That is:

$$\#\text{ revolutions} = \frac{(99.0 \text{ m})}{2\pi(.290 \text{ m})} = 54.3$$

b.) What is the final angular speed in revolutions/second?

To get the angular speed in "radians/second," we can write:

$$\omega_2 = \frac{v_2}{R} = \frac{(22.0 \text{ m/s})}{(.290 \text{ m/rad})} = 75.9 \text{ rad/s}$$



To convert the "radians/second" angular speed to "revolutions/second," we write:

$$\omega_2 = \frac{v_2}{R} = \frac{(22.0 \text{ m/s})}{(.290 \text{ m/rad})} = 75.9 \text{ rad/s}$$