2. 

## Problem 11.41P (HRW)

A wheel $A$ of radius $r_{a}=10.0 \mathrm{~cm}$ is coupled by belt $B$ to wheel $C$ of radius $r_{c}=25.0 \mathrm{~cm}$. Wheel $A$ increases its angular speed from rest at a uniform rate of 1.6 $\mathrm{rad} / \mathrm{s}^{2}$. We have to find the time for wheel $C$ to reach a rotational speed of $100 \mathrm{rev} / \mathrm{min}$, assuming that belt does not slip.


## Solution:

Let at time $t$ the angular speed of wheel $A$ be $\omega_{a}$ and the angular speed of wheel $C$ be $\omega_{c}$. As the two wheels are connected by a belt which does not slip, the linear speeds at the rims of the two wheels has to be equal. This requirement gives the condition

$$
r_{a} \omega_{a}=r_{c} \omega_{c}
$$

Also, the angular acceleration $\alpha_{a}$ of wheel $A$ and the angular acceleration $\alpha_{c}$ of wheel $C$ will be similarly related, that is
$r_{a} \alpha_{a}=r_{c} \alpha_{c}$.
We are given that
$r_{a}=10.0 \mathrm{~cm}, r_{c}=25.0 \mathrm{~cm}$, and $\alpha_{a}=1.6 \mathrm{rad} / \mathrm{s}^{2}$.
Therefore,
$\alpha_{c}=\frac{1.6 \times 10}{25} \mathrm{rad} \mathrm{s}^{-2}=0.64 \mathrm{rad} \mathrm{s}^{-2}$.
We will now calculate the time in which the wheel $C$ will acquire the angular speed

$$
\omega_{c}=\frac{100 \times 2 \pi}{60} \mathrm{rad} \mathrm{~s}^{-1}=10.47 \mathrm{rad} \mathrm{~s}^{-1} .
$$

As the wheel $C$ is speeding up with constant acceleration the time in which it will attain this angular speed will be $t=\frac{\omega_{c}}{\alpha_{c}}=\frac{10.47}{0.64} \mathrm{~s}=16.4 \mathrm{~s}$.

