Answer on Question #48830, Physics, Mechanics | Kinematics | Dynamics

A gyroscope has a radius of 3 cm. Using a string wrapped around its central axis, you apply a constant torque for 3 seconds, which results in an angular acceleration of 5 rad/s^2 during that time. Assuming it started at rest, what is the gyroscope's instantaneous angular velocity after 3 seconds?

Solution:

Rotation is described in terms of angular displacement, time, angular velocity, and angular acceleration. Angular velocity is the rate of change of angular displacement and angular acceleration is the rate of change of angular velocity.

Average angular acceleration:

$$\overline{\alpha} = \frac{\Delta\omega}{\Delta t}$$

where $\Delta\omega$ is the rate of change of angular velocity in time Δt.

$$\Delta\omega = \omega_f - \omega_i$$

Given:

$\omega_i = 0$

$\Delta t = 10\ s,$

$\overline{\alpha} = ?$

$\omega_f = 5\ \text{rad/s}^2$

$$\overline{\alpha} = \frac{\omega_f - \omega_i}{\Delta t}$$

Thus,

$$\omega_f = \alpha t = 5 * 3 = 15\ \text{rad/s}$$

Answer: $\omega_f = 15\ \text{rad/s}.$