5.5 Angular Acceleration

Accelerate This!

Angular Acceleration

The analogue to linear acceleration is angular acceleration (symbol = \( \alpha \) (units: rad/s\(^2\))): speeding up or slowing down the rotation of a body in uniform circular motion.

\[
\alpha = \frac{\Delta \omega}{\Delta t}
\]

\( \omega \) = angular speed (rad/s)
\( t \) = time (s)

CD Examples

1. A CD accelerates uniformly from rest to its operational speed of 500. rpm in 3.50 s.
   What is the angular acceleration during this time?
   Convert \( \omega \) in rpm to rad/s:
   \[
   \omega = 500. \text{rpm} \times \frac{0.105 \text{ rad/s}}{1 \text{ rpm}} = 52.5 \text{ rad/s}
   \]
   Then plug values into the definition of \( \alpha \):
   \[
   \alpha = \frac{\Delta \omega}{\Delta t} = \frac{52.5 \text{ rad/s}}{3.50 \text{ s}} = 15.0 \text{ rad/s}^2
   \]

2. What is the angular acceleration at operational speed?
   Since the CD player reached its operational speed after 3.50 s (and goes at a constant rate), it now has no more angular acceleration.

3. If it stops uniformly in 4.50 s, what's \( \alpha \) then?
   \[
   \alpha = \frac{\Delta \omega}{\Delta t} = \frac{0 \text{ rad/s} - 52.5 \text{ rad/s}}{4.50 \text{ s}} = -11.7 \text{ rad/s}^2
   \]

Tangential Acceleration (\( a_t \))

As a body rotates faster, the tangential speed of a measuring point increases.

Units = m/s\(^2\).

Tangential acceleration (\( a_t \)) math:

\[
a_t = r \cdot \alpha
\]

\( r \) = radius (m)
\( \alpha \) = angular acceleration (rad/s\(^2\))
4. \( a_t \) Example

What is the tangential acceleration of a 0.40 m radius object that starts from rest, and reaches an angular speed of 15 rad/s in 10 seconds?

First, find \( \alpha \):

\[
\alpha = \frac{\Delta \omega}{\Delta t} = \frac{15 \text{ rad/s}}{10 \text{ s}} = 1.5 \text{ rad/s}^2
\]

Then, find \( a_t \):

\[
a_t = r \cdot \alpha = 0.40 \text{ m} \cdot 1.5 \text{ rad/s}^2 = 0.6 \text{ m/s}^2
\]

Homework 5.5

Preview 5.6

Problems 5.5 in your Booklet
Due: Next Class