Example: A computer hard disk starts from rest, then speed up with an angular acceleration of 190 rad/s² until it reaches is final angular speed of 7200 rpm. How many revolutions has the disk made 10.0 s after it starts up. (Answer 6043 rad = 962 rev)

\[ \Delta \theta = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{7200^2 - 0^2}{2 \times 190} = 150,000 \text{ rad/s}^2 \]

\[ \theta = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{7200^2}{2 \times 190} = 962 \text{ rev} \]

The plot to the right describes the angular velocity versus time for an object moving around a 2-m-radius circle. Four time segments, A, B, C, and D have been labeled. Assume the initial angle is zero. (a) What is the object’s angular acceleration during time segment B (5 s < t < 10 s)? (b) How many radians does the object subtend (go through) during time segment A (0 s < t < 5 s)? (Answers: (a) -3 rev/s², (b) 157 rad)

(a) \[ \alpha = \frac{\Delta \omega}{\Delta t} \]

(b) \[ \Delta \theta = \int \omega \, dt \]

\[ \Delta \theta (0 s < t < 5 s) = \int \omega \, dt = \frac{\omega_0^2 - \omega_0^2}{2} = \frac{157\pi \text{ rad}}{} \]

Linear Vector Description of Rotational Motion

Ex: Pendulum Swinging

Vector op: \( \Delta \vec{V} \) (scale up)

\[ \vec{a} = \left< a_r, a_t, a_z \right> = \frac{\Delta \vec{V}}{\Delta t} \]

Speeding up \((a \rightarrow b)\)

Slowing down \((b \rightarrow c)\)
A small piece of clay is stuck near the edge of a phonograph turntable. Let \( \alpha \) represent the angular acceleration of the clay and \( \alpha_r \) represent the centripetal acceleration of the clay.

a. For each situation described below, describe a possible motion of the turntable. (Some parts have more than one correct answer.) Explain your reasoning in each case.

i. \( \ddot{r} = 0 \text{ and } \ddot{\alpha}_r = 0 \)

ii. \( \ddot{r} = 0 \text{ and } \ddot{\alpha}_r \neq 0 \)

iii. \( \ddot{r} 
eq 0 \text{ and } \ddot{\alpha}_r = 0 \)
Example: A 40-cm-radius disk begins rotating from rest and spins up uniformly to an angular speed of 4500 rev/min in 5 seconds. (a) What is the angular acceleration of the disk? (Answer: 94.2 rad/s²) (b) What is the linear acceleration vector of a point on the edge of the disk at 3 s? (Answer: <31.972, 37.7> m/s²) (c) How far does a point on the edge travel in 3 s? (Answer: 170 m)

The plot to the right describes the angular velocity versus time for an object moving around a 2-m-radius circle. Four time segments, A, B, C, and D, have been labeled. Assume the initial angle is zero. (c) What is the linear speed of the object during the time segment in which the object is undergoing uniform circular motion? Extra credit: at what time, other than t = 0 s, is the object’s net displacement equal to zero? (Answers: (c) 63 m/s, e.c. 17.5 s)