Angular Kinematics For each of the following linear kinematics variables write:

A the corresponding angular variable

B the equation that relates the linear and angular versions

C the defining equation of that angular variable

D the units of each angular variable

1. Position A) θ B) $s = \Delta\theta r$ C) isn't one D) radians (or degrees - but convert to radians!)
2. Velocity A) ω B) $V = \omega r$ C) $\omega = \frac{\Delta\theta}{\Delta t}$ D) $\frac{rad}{sec}$
3. Acceleration A) α B) $\vec{a} = \langle a_r, a_T \rangle = \langle \frac{v^2}{r}, \alpha r \rangle = \langle \omega^2 r, \alpha r \rangle$ C) $\alpha = \frac{\Delta\omega}{\Delta t}$ D) $\frac{rad}{sec^2}$

1 revolution $= 2\pi$ radians $= 360°$

If We Could Turn Back Time In an attempt to turn back time Superman ran around the Earth at 7,200,000 mph. After Superman runs around the Earth 10,000 times he stops and realizes he succeeded at turning back time since it is currently the same time he started at. How much did he turn back time? (aka: how long did it take him to run around the Earth 10,000 times?)

$r_E = 3{,}959$ mi

$V = 7{,}200{,}000$ mph

$t = ?$

$V = \omega r$

$\frac{7{,}200{,}000 \text{ mph}}{3{,}959 \text{ mi}} = \omega$

$\omega = 1{,}818.6 \frac{rad}{hr}$

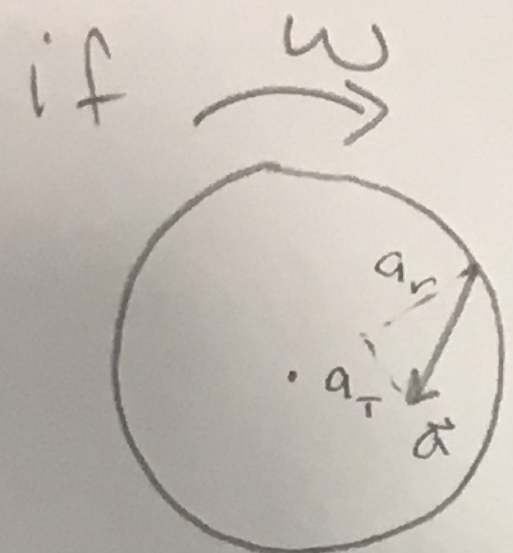
$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi(10{,}000 \text{ rev})}{\Delta t}$

$\Delta t = \frac{2\pi(10{,}000 \text{ rev})}{1{,}818.6 \frac{rad}{hr}}$

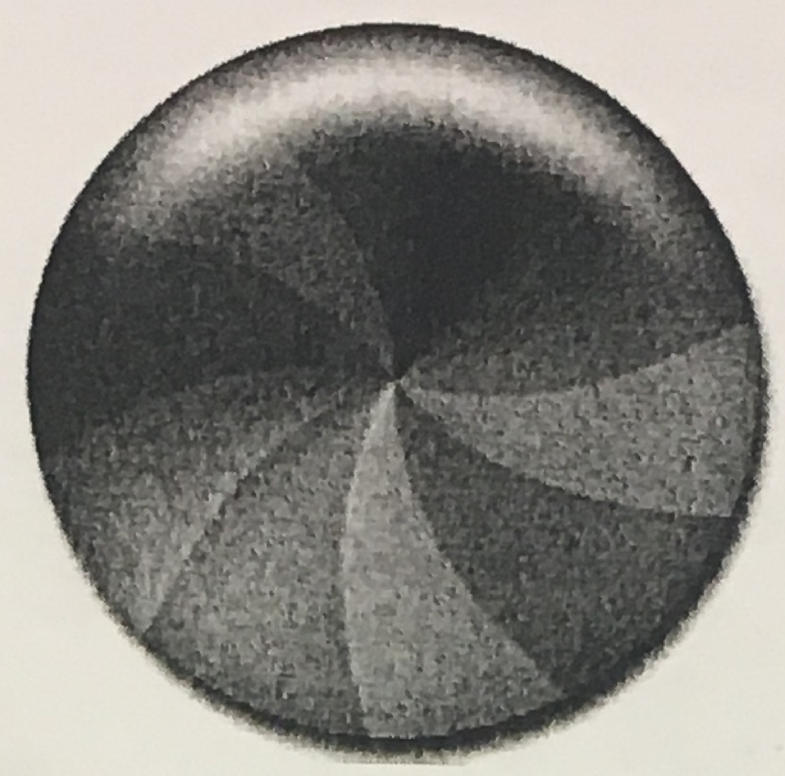
$\Delta t = 34.5$ hrs

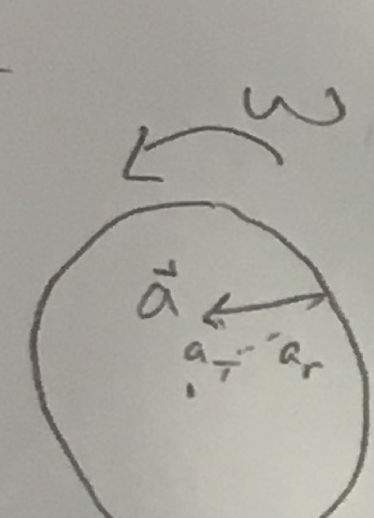
[0]Select problems may be modified from Walsh, Harrison, or the Internet.

Spinning Circle of Death Your computer gets the spinning ring of death that keeps speeding up as you slowly watch your computer fall apart. On the picture below draw the acceleration vector, then draw and label its components.



$\vec{a} = \langle a_r, a_T \rangle$





Merry-Go-Round A 3 meter radius merry-go-round begins rotating from rest and spins up uniformly to an angular speed of 100 rev/min in 10 seconds.

A What is the angular acceleration (in $\frac{rad}{s^2}$) of the disk?

B How far (in meters) does a point on the edge travel in the first $\boxed{3\ s?}$

C What is the linear acceleration vector of a point on the edge of the disk at 10 s? (in vector notation)

A)

$$\omega = \frac{100\ rev}{min}\left(\frac{1\ min}{60\ sec}\right)\left(\frac{360°}{1\ rev}\right)\left(\frac{2\pi\ rad}{360°}\right) = \frac{10}{3}\pi\ \frac{rad}{sec} \simeq 10.47\ \frac{rad}{sec}$$

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{\omega_f - \cancel{\omega_i}^{\,0}}{\Delta t} = \frac{10.47\ \frac{rad}{sec} - 0}{10\ sec} = 1.047\ \frac{rad}{sec^2}$$

B)

$$\Delta\theta = \cancel{\omega_i}^{\,0}\Delta t + \frac{1}{2}\alpha\Delta t^2$$

$$\Delta\theta = \frac{1}{2}\alpha\Delta t^2 = \frac{1}{2}\left(1.047\ \frac{rad}{sec^2}\right)(3s)^2 = 4.71\ rad$$

$$s = \Delta\theta \cdot r = (4.71\ rad)(3\ m) = 14.13\ m$$

c)

$$\vec{a} = \langle a_r, a_T \rangle = \langle \omega^2 r, \alpha r \rangle = \left\langle \left(10.47\ \frac{rad}{sec}\right)^2(3m), \left(1.047\ \frac{rad}{sec^2}\right)(3m) \right\rangle$$

$$\vec{a} = \left\langle 328.86\ \frac{m}{sec^2}, 3.14\ \frac{m}{sec^2} \right\rangle$$