PHY131H1F Centre-screen notes
Wednesday, Oct. 3, 2012

θ = "theta"
ω = "omega"
α = "alpha"

arc length $s = r\theta$, if θ is in radians.

tangential speed $v_t = r\omega$, if ω is in rad/s.

tangential acceleration: $a_t = r\alpha$, if α is in rad/s^2

centripetal acceleration is toward the centre of circular path:

$$\boxed{a_c = \frac{v_t^2}{r}}$$

Bike wheel example.

Known: diameter = 1.0 m
$r = 0.5\,m$
$\Delta\theta = 20$ rev in
$\Delta t = 1$ sec.

Need: $a_c = \frac{v^2}{r}$

$$20\,\text{rev}\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right) = 40\pi\ \text{rad}.$$

constant ω $\rightarrow$ $\omega_{avg} = \omega = \frac{\Delta\theta}{\Delta t} = \frac{40\pi}{1} = 40\pi$ rad/s

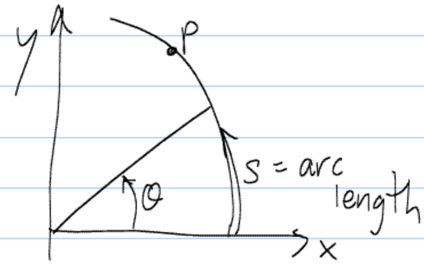
tangential speed $\rightarrow$ $v = \omega r = 40\pi(0.5) = 20\pi$ m/s

$$a_c = \frac{(20\pi\ m/s)^2}{0.5\,m} = 7897\ m/s^2$$

1 sig fig: $\boxed{a = 8000\ m/s^2}$

~ 800 gees! wow!

Example: Assume mag. of car's acceleration is constant.



Known: $r = 50\ m$

$\theta_0 = 0$

$s_0 = 0$

α, a_s are both contant & positive.

$t = 4.0\,s$, $v_f = 12\ m/s$

Need: a_t $(= a_s)$ ← tangential acceleration.

a_r $(= a_c)$ ← centripetal.

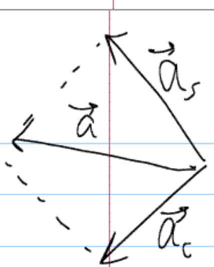
Along path s:

$$v_f = \cancel{v_0}^{\,0} + a_s t$$

$$a_s = \frac{v_f}{t} = \frac{12}{4} = 3\ m/s^2$$

$$\boxed{a_s = 3.0\,m/s^2}$$

At any moment.



$$a_c = \frac{v_f^2}{r} = \frac{12^2}{50} = 2.88\ m/s^2$$

$$\boxed{a_c = 2.9\ m/s^2}$$

$$a = \sqrt{a_s^2 + a_c^2} = \sqrt{3^2 + 2.88^2} = 4.159\ m/s^2$$

$$\boxed{a = 4.2\ m/s^2}$$

$\vec{a}$ is the <u>actual</u> acceleration of the car.

$\vec{a}_c$ and $\vec{a}_s$ are just components that we can compute easily.