10.31

$r = 1.5\,m$

a. $s = r\theta$, so

$$\theta = \frac{s}{r} = \frac{3.0\,m}{1.5\,m} = \boxed{2.0\text{ rads}}$$

b. $$\omega = \frac{\theta}{t} = \frac{2\text{ rads}}{1\text{ sec}} = \boxed{2.0\text{ rads/s}}$$
$$= \boxed{2.0\,s^{-1}}$$

"angular velocity"

c. acceleration? Well, it's not accelerating "angularly", so its only acceleration is centripetal.

$$a_c = \frac{v^2}{r} = \frac{(r\omega)^2}{r} = r\omega^2$$
$$= (1.5\,m)(2\text{ rad/s})^2$$
$$= \boxed{6.0\,m/s^2}$$

10.33 Propellar spinning at 10 rev/s = ω_i

$\alpha = 2.0\ \text{rad/s}^2$ for $t = 40\,\text{s}$

What is rotation at that time?

Is it reasonable?

$$\omega_i = 10\,\frac{\text{rev}}{\text{s}} \times \frac{2\pi\ \text{rad}}{1\ \text{rev}} = 20\pi\,\frac{\text{rad}}{\text{s}} = 62.8\ \text{rad/s}$$

$$\omega_f = \omega_i + \alpha t$$

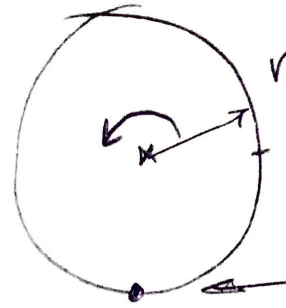
$$= 62.8\ \text{rad/s} + \left(-2\,\frac{\text{rad}}{\text{s}^2}\right)(40\,\text{s})$$

$$= 62.8 - 80 = \boxed{-17.2\ \text{rad/s}}$$

No, it's not reasonable. This result suggests that the propeller slowed to 0 & then started spinning in the opposite direction.

Ridiculous!

10.42. Vertical wheel



$r = \frac{d}{2} = \frac{0.50\,m}{2} = 0.25\,m$

$\alpha = 5\ rad/s^2$

Where is this point at 10s?

a. $\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$= \frac{3}{2}\pi + 0t + \frac{1}{2}\left(5\frac{rad}{s^2}\right)(10s)^2$

$= \frac{3}{2}\pi + 250\ rad$

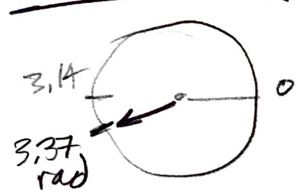
$= \underline{254.71\ rad}$ But where is $\underline{\text{that}}$?

Take remainder after dividing out all the 2π revolutions:

$254.71 \ / \ 2\pi = 40.\underline{54}\ rev$

remainder

$\underline{0.54}\ rev \times \frac{2\pi}{1\ rev} = \boxed{3.37\ rad}$



b. Linear acceleration at this point?

$a_{tan} = r\alpha = (0.25)(5) = \boxed{1.25\ m/s^2}$

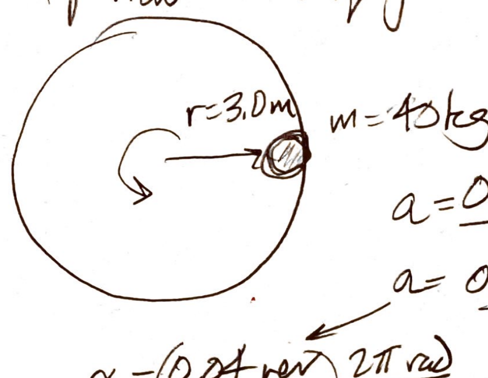
$a_{radial} = a_c = \frac{v^2}{r} = \frac{(r\omega)^2}{r}$

$\omega = \omega_i + \alpha t = 0 + (5)(10) = 50\ rad/s$

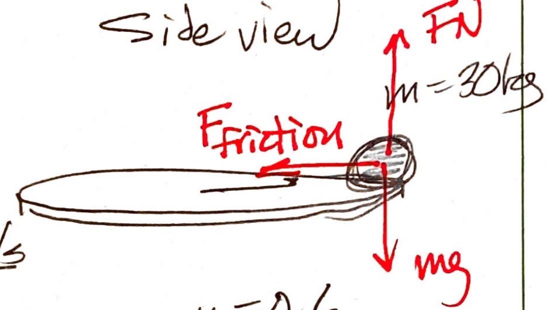
$a_c = r\omega^2 = (0.25)\left(50\frac{rad}{s}\right)^2 = \underline{625\ m/s^2}$

The key indicates that this is the correct answer. They should have asked for the $\underline{\text{tangential}}$ acceleration.

10.51 Top view of merry-go-round



Side view



$a = \dfrac{0.4 \text{ rev/s}}{10s}$

$a = 0.04 \dfrac{\text{rev}}{s^2}$

$\alpha = \left(0.04 \dfrac{\text{rev}}{s^2}\right) \dfrac{2\pi \text{ rad}}{1 \text{ rev}}$

$= \boxed{0.251 \dfrac{\text{rad}}{s^2}}$

$\mu = 0.6$

After $t = 5.0s$ have passed, is child still on merry-go-round, or have they fallen off?

Several strategies are possible. Here's one:

1) How much friction (static) is available?

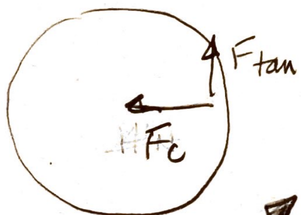
$F_f = \mu F_N = \mu mg = (0.6)(40)(9.8) = \boxed{235N}$

2) How much is needed to keep child accelerating (tangentially & radially)?!

$F_c = \dfrac{mv^2}{r}$, $\omega_f = \omega_i + \alpha t = 0 + (0.251)(5s) = 1.26$ rad/s

$v = r\omega = (3 \text{ m})(1.26 \text{ rad/s}) = 3.78$ m/s

$F_c = \dfrac{(40)(3.78)^2}{3} = 190N$ (centripetally)

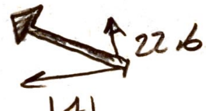


$F_{tangential} = ma$

$= (40kg)(r\alpha)$

$= (40)(3)\left(0.251 \dfrac{\text{rad}}{s^2}\right)$

$= \underline{30.1} N$



F_{net} required $= \sqrt{F_c^2 + F_{tan}^2} = \sqrt{(190)^2 + (30.1)^2}$

$= \boxed{191N}$ needed

3) Because maximum F_{static} available (235N) is more than the 191 N needed for the child to not slide, the child stays on the merry-go-round.

whew!