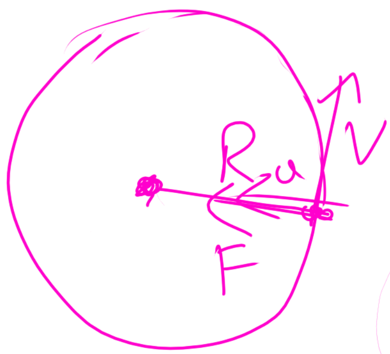
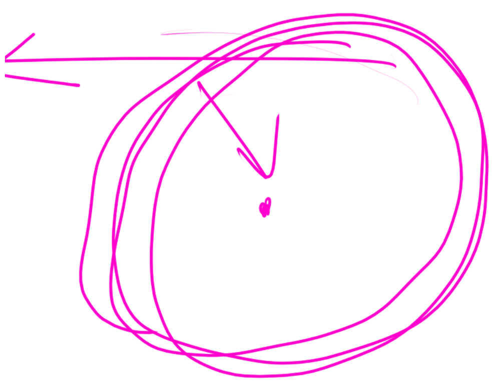


$$\text{Acceleration} = \frac{v^2}{R} = a$$

$$V = \frac{2\pi R}{T},$$



$$F = ma = \frac{mv^2}{R}$$

$$\omega = \frac{V}{R}, \quad \omega = \frac{2\pi}{T} = 2\pi f$$

f (frequen) $= \frac{1}{T}$

T

(1) A typical wind turbine at the Smoky Hills Wind Farm in Lincoln and Ellsworth counties in Kansas generates 1 MW when the wind is blowing. During calm periods, however, no power is generated. Thus, to ensure a steady supply of power a mechanism must be created by which the energy generated by the turbine can be easily stored and retrieved. One option is to use batteries, but another and perhaps simpler approach would be to store the energy in a spinning flywheel. One percent of a day's maximum output from the turbine would correspond to 860 MJ of energy. With what angular speed (in rad/s) would a 5000 kg flywheel with a radius of 4 m spin in order to store 860 MJ of energy? You can model the flywheel as a uniform disk spinning about an axis perpendicular to the disk passing through its center.

1 The rotational kinetic energy stored in the flywheel is

$$\boxed{K_{rot} = \frac{1}{2} I \omega^2} \qquad (1)$$

To find the moment of inertia, given

$$I = \frac{1}{2} MR^2 = \frac{1}{2} \cdot (5000\,kg) \cdot (4m)^2$$

$$= 40000\ kg\,m^2$$

2 Rewrite (1) $\Rightarrow$ $\omega = \sqrt{\dfrac{K_{rot}}{\frac{1}{2} I}}$

$$\sqrt{\frac{K_{rot}}{\frac{I}{2}}} = 2$$

$$860 \cdot 10^6 J = \frac{1}{2} \cdot (400000 \, kgm^2) \omega^2$$

$$\omega^2 = \frac{860 \cdot 10^6 J \cdot 2}{400000 \, kgm^2}$$

$$= 43000 \frac{1}{s^2}$$

$$\omega \approx 207.36 \frac{rad}{s} = 207.4 \frac{rad}{s}$$

3)

(2) A merry-go-round is spinning with an angular velocity of 1.5 rad/s. The merry-go-round then slows down with constant angular acceleration and comes to a rest in 20 s. Through how many revolutions will it move from the time it starts slowing down to the time it comes to a stop?

(2) We have:

- $\omega_i = 1{,}5\ rad\ s^{-1}$
- $\omega_f = 0$
- $\Delta t = 20s$

constant acceleration

$$\boxed{\begin{gathered}\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta \\ \Delta\omega = \alpha\cdot\Delta t \Rightarrow \alpha = \frac{\Delta\omega}{\Delta t}\end{gathered}}$$

We need:

- $\Delta\theta$ (angle travelled, can find #revolutions by dividing by 360°)

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② Given: $\omega_i = 1.5\,\text{rad s}^{-1}$, $\Delta t = 20\,s$, $\Delta\theta$?

cont.

Solution: $\Delta\omega = \alpha\Delta t \Rightarrow \alpha = \frac{\Delta\omega}{\Delta t} = \frac{-\omega_i}{\Delta t}$

Since acceleration α is constant.

$$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta \Rightarrow \Delta\theta = \frac{\omega_f^2 - \omega_i^2}{2\alpha}$$

$$\boxed{\begin{aligned}\Delta\omega &= \omega_f - \omega_i \\ &= 0 - \omega_i \\ &= -\omega_i\end{aligned}}$$

$$= \frac{\omega_f^2 - \omega_i^2}{2\cdot\left(\frac{-\omega_i}{\Delta t}\right)}$$

$$= 15\,\text{rad} \simeq 2.39\ \text{rev.}$$

$$\boxed{b}\quad \#\text{rev} = \frac{15}{2\pi} = \frac{15}{6.28} \simeq 2.39.$$