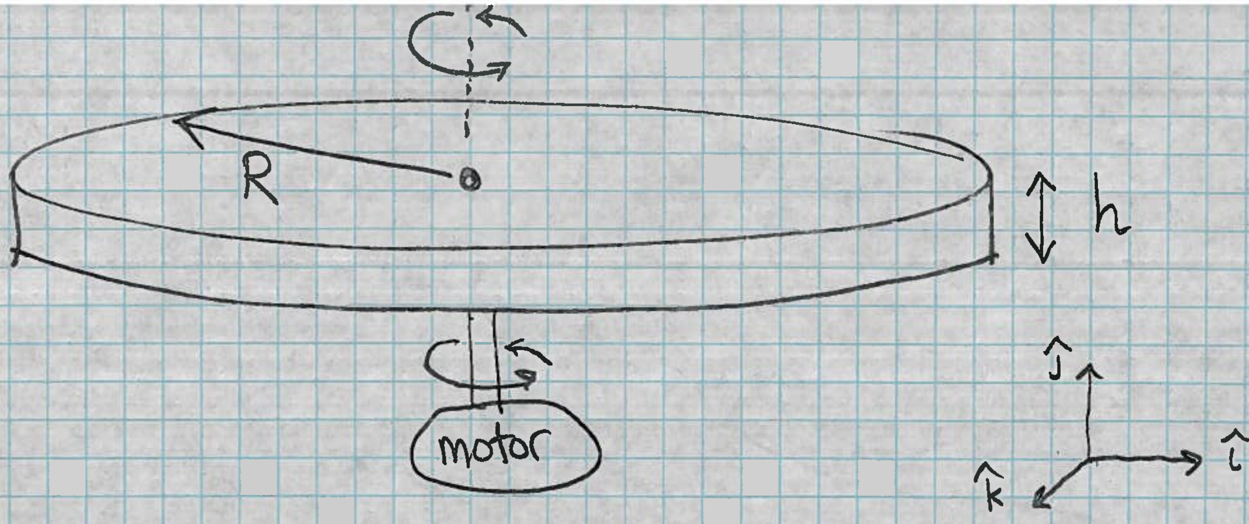


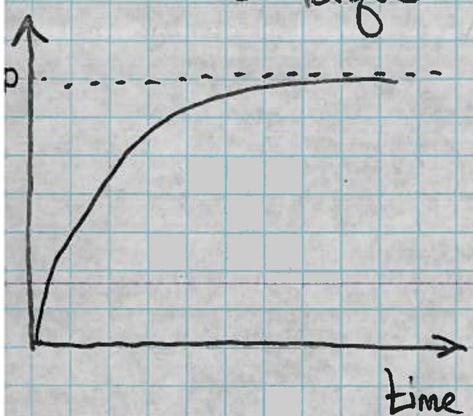
Potter's wheel has $R = 0.4\,m$, $h = 0.05\,m$, $\rho = 7780\,\frac{kg}{m^3}$.

Thus

$$\text{mass} \quad M = \pi R^2 h \rho = 196\ kg$$

$$\text{mom of Inertia} \quad I = \tfrac{1}{2} M R^2 = 15.6\ kg \cdot m^2$$

Wheel is at rest. Potter then turns on motor, which applies a torque



$$\vec{\tau}(t) = 20\ N.m \left(1 - e^{-t}\right) \hat{j} \qquad t \text{ in seconds}$$

So, at time $t = 2$ sec,

$$\vec{\tau} = 20\ N \cdot m \left(1 - e^{-2}\right) \hat{j}$$

$$= 17.29\ N \cdot m \quad \hat{j}$$

$$\vec{\alpha} = \frac{\vec{\tau}}{I} = \frac{17.29\ N.m\ \hat{j}}{15.6\ kg \cdot m^2} = 1.11\ \frac{rad}{s^2}\ \hat{j}$$

To find the angular velocity at $t = 2$ sec, $\omega(2)$, we need to integrate the angular acceleration from $t = 0$ to $t = 2$. We can't use the simple kinematic formulae because the <u>acceleration is not constant</u>!

$$\vec{\omega}(2) - \vec{\omega}(0) = \int_{t=0}^{t=2} \vec{\alpha}(t)\,dt = \int_{t=0}^{t=2} \frac{\vec{\tau}(t)}{I}\,dt$$

But $\omega(0) = 0$, so

$$\vec{\omega}(2) = \int_{t=0}^{t=2} \frac{20\ \text{N}\cdot\text{m}}{15.6\ \text{kg}\cdot\text{m}^2}\left(1 - e^{-t}\right) dt\ \hat{j}$$

$$= 1.282\ \frac{\text{rad}}{\text{s}^2}\left[\int_0^2 1\,dt - \int_0^2 e^{-t}\,dt\right]\hat{j}$$

$$= 1.282\ \frac{\text{rad}}{\text{s}^2}\left[(2-0)\text{s} - \left(-e^{-2} - (-e^{-0})\right)\text{s}\right]$$

$$= 1.282\ \frac{\text{rad}}{\text{s}^2}\left[2\text{s} - (-0.1353 + 1)\text{s}\right]\hat{j}$$

$$= 1.282\ \frac{\text{rad}}{\text{s}^2}\left[2\text{s} - 0.8647\text{s}\right]\hat{j}$$

$$\boxed{\vec{\omega}(t=2\text{s}) = 1.46\ \frac{\text{rad}}{\text{s}}\ \hat{j}}$$

The instantaneous power delivered by the motor is

$$\text{instantaneous } \underline{P} = \vec{\tau}(t)\cdot\vec{\omega}$$

Here, $\vec{\tau}$ and $\vec{\omega}$ are in same direction, so

$$\underline{P}(t=2\text{s}) = \tau(t=2\text{s})\cdot\omega(t=2\text{s})$$

$$= 17.29\ \text{N}\cdot\text{m}\cdot 1.46\ \frac{\text{rad}}{\text{s}}$$

$$\boxed{\underline{P} = 26.1\ \text{Watts}}$$