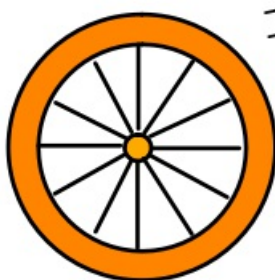


1. Determine the rotational inertia of a wagon wheel made of: a 5.0kg cast iron band, wrapped around a 3.0kg wooden rim with a 1.0m outer diameter and 0.95m inner diameter, connected to 12 wooden spokes that are each 0.39m long and 0.20kg stick out radially from a 2.0kg brass cylinder that is 0.17m in diameter.

2. What percentage does the rotational inertia of the wheel increase if a 0.50kg "road apple" becomes stuck to the rim?

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$$\begin{aligned} I &= I_{\text{band}} \quad (a) \\ &+ I_{\text{rim}} \quad (b) \\ &+ 12(I_{\text{spoke}}) \quad (c) \\ &+ I_{\text{hub}} \quad (d) \end{aligned}$$

$$I_{\text{hoop}} = mr^2 = (5)(0.5)^2 = 1.25$$

$$I_{\text{rim}} = \frac{1}{2}m(r_1^2 + r_2^2) = \frac{1}{2}(3)(0.475^2 + 0.5^2)$$

$$= 0.7134$$

$$I_{\text{spokes}} = 12 \left[\frac{1}{12} ML^2 + Mh^2 \right] = 12 \left[\frac{1}{12}(0.2)(0.39)^2 + 0.2(0.28)^2 \right]$$

$$= 0.2186$$

$$I_{\text{hub}} = \frac{1}{2}mr^2 = \frac{1}{2}(2)(0.085)^2$$

$$= 0.007225$$

$$I_{\text{total}} = 2.189 \text{ kg m}^2$$

2. add 0.5kg at rim
% increase in I = ?

$$\begin{aligned} I &= mr^2 \quad (\text{particle}) \\ &= (0.5)(0.5)^2 = 0.125 \end{aligned}$$

$$\frac{0.125}{2.189} = 5.7\%$$

$$I = I_{\text{hoop}} + I_{\text{rim}} + I_{\text{spokes}} + I_{\text{hub}}$$

$$= mR^2 + \frac{1}{2}m(R_1^2 + R_2^2) + 24\left[\frac{1}{12}mL^2 + mh^2\right] + \frac{1}{2}mR_{\text{hub}}^2$$

$$= (5)(0.5)^2 + \frac{1}{2}(3)(0.475^2 + 0.5^2) + 24\left[\frac{1}{12}(0.2)(.39)^2 + (.2)(.28)^2\right] + \frac{1}{2}(2)(.08)^2$$

$$= 1.25 + 0.7134 + 0.43716 + 0.007225$$

$$I = 2.41 \text{ kgm}^2$$

add "road apple"

$$I_{\text{RA}} = mr^2 = (0.5)(0.5)^2 = 0.125 \text{ kgm}^2$$

$$\% \text{ increase} = \frac{\Delta I}{I_i} \times 100$$

$$= \frac{.125}{2.41} \times 100 = 5.2\%$$