Answer on Question #47771, Physics, Computational Physics

A mass m of 400g hangs from the rim of a wheel of radius = 15cm when released from rest the mass falls 2m in 6.5 sec. Find the moment of inertia of the wheel.

Solution:

In 6.5 seconds, potential energy loss is

$$PE = mgh = 0.4\ \text{kg} * 2.0\ \text{m} * 9.81\ \text{m/s}^2 = 7.848\ \text{J}$$

Final velocity of mass (twice the average velocity):

$$v_f = 2 * \frac{2\ \text{m}}{6.5\ \text{s}} = 0.6154\ \text{m/s}$$

Final angular velocity of wheel:

$$\omega_f = \frac{v_f}{R} = \frac{0.6154}{0.15} = 4.10\ \text{rad/s}$$

$$K.E.gain = P.E.loss$$

$$\frac{mv_f^2}{2} + \frac{I\omega_f^2}{2} = PE$$

Solve for moment of inertia, I.

$$I = \frac{2PE - mv_f^2}{\omega_f^2}$$

$$I = \frac{2 * 7.848 - 0.4 * 0.6154^2}{4.10^2} = 0.925\ \text{kg} \cdot \text{m}^2$$

Answer: $I = 0.925\ \text{kg} \cdot \text{m}^2$.