**Example 2**

A bicycle wheel and tire are supported so that they are free to rotate about their centroidal axis through the hub of the wheel. A small weight \( W \) is taped to the tire as shown in the accompanying figure at a distance \( R \) from the axis of rotation. When this weight is displaced slightly from the vertical axis shown, the wheel is observed to oscillate 3 cycles every 10 s. If \( R = 0.28 \) m, and \( W = 3.34 \) N, determine the centroidal mass moment of inertia \( I \) of the wheel and tire.

Ax: \( F = 0.237 \) N·m·s^2

We will treat the weight \( W \) as a small particle and assume small oscillations.

\[
3 \cdot \text{cycles in 10 s} \Rightarrow \frac{3}{10} \text{cycles/s} = 0.3 \text{cycles/s}
\]

\[
\omega^2 = \frac{WR}{I + \frac{WR^2}{R^2}} \quad \text{and} \quad \omega^2 = \left( \frac{2 \pi}{\text{cycles/s}} \right)^2 \frac{I + \frac{WR^2}{R^2}}{WR}
\]

**Rewrite as:**

\[
I = \left( \frac{\text{cycles/s}}{2 \pi} \right)^2 \frac{WR - \frac{WR^2}{R^2}}{\frac{1}{3}}
\]

From experimental data - \( \tau = \frac{10 \text{sec}}{3 \text{cycles}} = \frac{10}{3} \text{ sec} \)

Finally,

\[
I = \left( \frac{10}{3} \right)^2 \frac{1}{2 \pi} \left( 3.34 \right) \left( 0.28 \right)^2 = \frac{3.34 \times 0.28}{9.81}
\]

\[
I = 0.237 \text{ N·m·s}^2
\]