

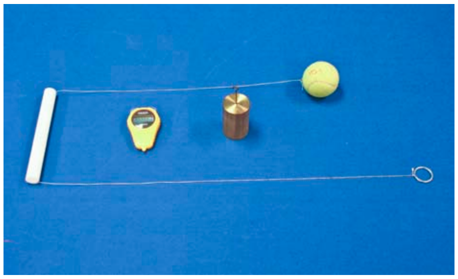

Concept:

This demonstration provides an excellent opportunity for the instructor to quantitatively verify the dynamics of uniform circular motion. Application of Newton's Second Law to the ball's motion in the horizontal plane gives:

$$m_w g = m_b \frac{v^2}{R} = m_b \frac{\left(2\pi R/T\right)^2}{R} = m_b \frac{4\pi^2 R}{T^2} \text{ or}$$

$$g = 4\pi^2 \left(\frac{m_b}{m_w}\right)\left(\frac{R}{T^2}\right)$$

where m_w = mass of weight, m_b = mass of ball, R = radius, and T = period. Note that the weight of the mass, $m_w g$, provides the tension in the string, and it is actually this tension that exerts the centripetal force on the ball. Here, we also assume the contribution to the tension arising from friction between the string and support tube is negligible.

Equipment:

- Whirligig with 115 g Ball
- Weight (1 kg)
- Stopwatch

Procedure:

Qualitative:

1. Hang the 1 kg weight from the ring at the end of the string.
2. Notice that the weight falls, pulling the smaller mass ball to the top of the cylinder.
3. Swing the ball in a horizontal circle at a high enough angular velocity to provide enough tension in the string to lift the 1 kg weight. Different angular velocities will raise or lower the weight.

Quantitative:

1. Hang the 1 kg weight from the ring at the end of the string.
2. Swing the 115 g ball in a horizontal circle over your head keeping the red mark on the string in line with the bottom of the tube. This will make the ball travel in a circle with a radius of 1 m.
3. Have someone else use the stopwatch to measure the time it takes for the ball to complete 10 revolutions. Calculate the balls orbital period.
4. Using the equation above, calculate the gravitational acceleration on Earth's surface (g).