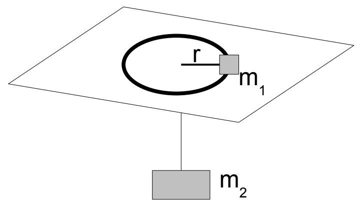
Chapter 5 Problem 37 †



Given

Solution

a) Find the tension in the string.

Since m_1 is moving in a circle with constant speed, it is experiencing centripetal acceleration. The only force acting on m_1 is the tension in the string. Therefore,

$$T = m_1 a = m_1 \frac{v^2}{r} \tag{1}$$

Likewise the hanging mass, m_2, is stationary and the tension must offset the weight of the mass. Therefore,

$$T = m_2 g \tag{2}$$

b) Find the period of circular motion.

Substitute equation 2 into equation 1 and solve for speed

$$m_2 g = m_1 \frac{v^2}{r}$$

$$v^2 = \frac{m_2 g r}{m_1}$$

$$v = \sqrt{\frac{m_2 g r}{m_1}}$$

The period of circular motion is the time it takes for m_1 to make one full rotation on the table top. When this happens, the mass has travelled the circumference of a circle.

$$C = 2\pi r$$

Speed is defined to be the distance travelled per time period, T. Therefore,

$$v = \frac{C}{T}$$

Solving for the time period gives

$$T = \frac{C}{v}$$

Substitute in the values for speed and circumference

$$T = \frac{2\pi r}{\sqrt{\frac{m_2 g r}{m_1}}}$$

†Problem from Essential University Physics, Wolfson

Simplify the complex fraction

$$T = 2\pi r \sqrt{\frac{m_1}{m_2 g r}}$$

Bring r into the square root sign and simplify

$$T = 2\pi \sqrt{\frac{m_1 r}{m_2 g}}$$