8.46. **Model:** Masses m_1 and m_2 are considered particles. The string is assumed to be massless.
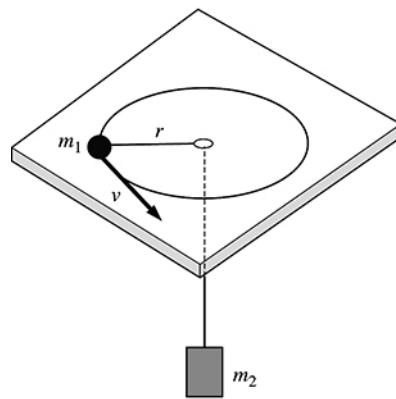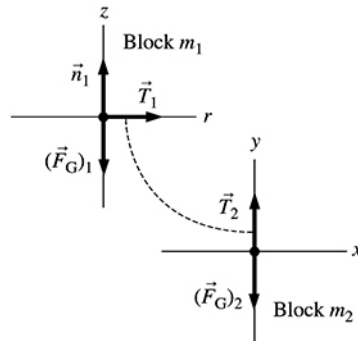
Visualize:

Pictorial representation

Known

| m_1 | m_2 | r |

Find

v

Solve: The tension in the string causes the centripetal acceleration of the circular motion. If the hole is smooth, it acts like a pulley. Thus tension forces $\vec{T}_1$ and $\vec{T}_2$ act as if they were an action/reaction pair. Mass m_1 is in circular motion of radius r, so Newton's second law for m_1 is

$$\sum F_r = T_1 = \frac{m_1 v^2}{r}$$

Mass m_2 is at rest, so the y-equation of Newton's second law is

$$\sum F_y = T_2 - m_2 g = 0 \text{ N} \Rightarrow T_2 = m_2 g$$

Newton's third law tells us that $T_1 = T_2$. Equating the two expressions for these quantities:

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