Draw a free body diagram of m_1 and another free body diagram of m_2. Using these diagrams, apply Newton's second law to each mass. Assume that the tension in the string is the same on each mass and that they have the same acceleration. From these two equations, find an expression for the acceleration of m_1 in terms of m_1, m_2, and g.

Solution:
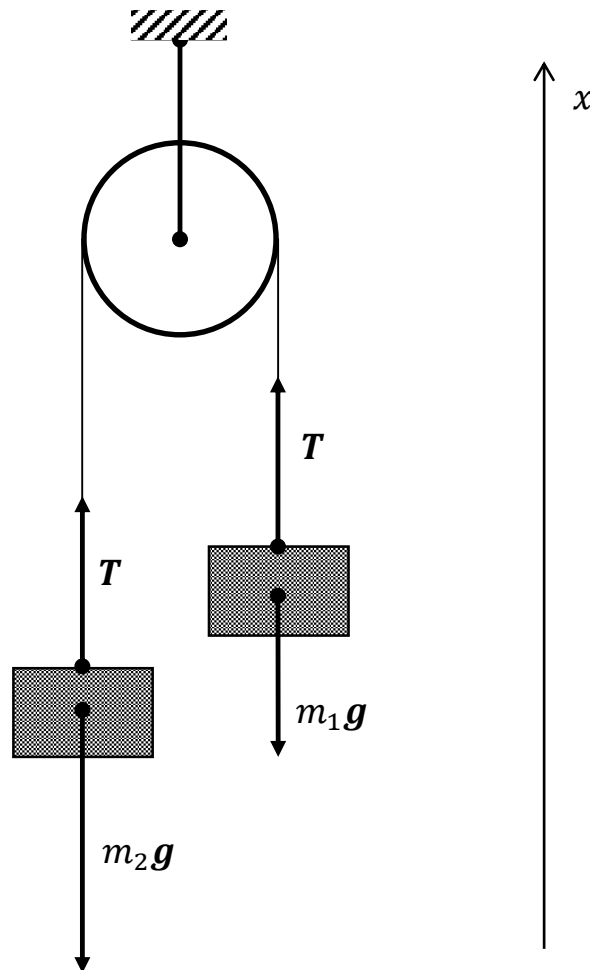
Let's first apply Newton's second law to mass m_1 (projection on the axis x)

$$m_1 a = T - m_1 g$$

Let's now apply Newton's second law to mass m_2 (projection on the axis x)

$$-m_2 a = T - m_2 g$$

(the acceleration of the second mass has the opposite direction)

Expressing T from the first equation we obtain

$$T = m_1 a + m_1 g$$

Substituting this into the second equation we obtain

$$-m_2 a = m_1 a + m_1 g - m_2 g$$

And finally

$$a = \frac{m_2 - m_1}{m_1 + m_2} g$$

Answer: $a = \frac{m_2 - m_1}{m_1 + m_2} g$.