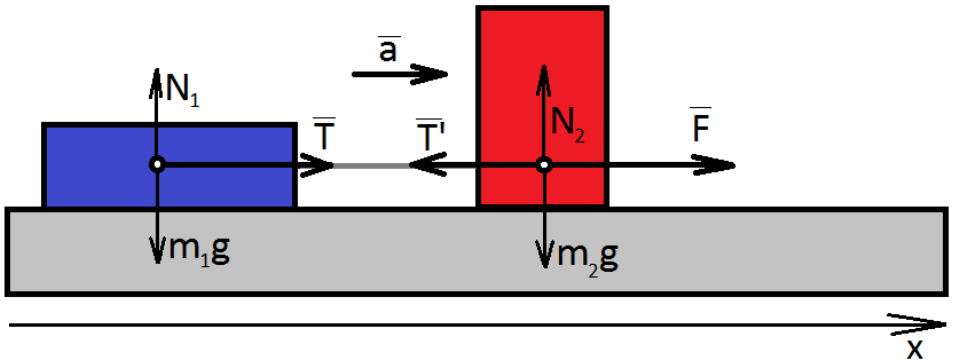
A horizontal force of 600 N pulls two masses 10kg and 20kg lying on a frictionless surface connected by a light string. What is the tension in the string? Does the answer depend on the which mass end the pull is applied?

Solution:

Because the string is thin and inextensible, then:

$$\vec{T} = -\overrightarrow{T'};\ |\vec{T}| = |\overrightarrow{T'}|$$



The general case (instead of mass $10kg\ and\ 20kg \rightarrow m_1\ and\ m_2, F = 600N$)

Newton's second law for the mass m_1:

$$\overrightarrow{m_1 g} + \overrightarrow{N_1} + \vec{T} = m_1\vec{a}$$

$$x: T = m_1 a \qquad (1)$$

Newton's second law for the mass m_2:

$$\overrightarrow{m_2 g} + \overrightarrow{N_2} + \vec{T} + \vec{F} = m_2\vec{a}$$

$$x: F - T' = m_2 a \qquad (2)$$

$$T = T'$$

$$(1) in\ (2): \qquad F - m_1 a = m_2 a$$

$$a = \frac{F}{m_1 + m_2} \qquad (3)$$

$$(3) in (1): \qquad T = m_1 a = \frac{m_1 F}{m_1 + m_2}$$

If $m_1 = 10kg\ and\ m_2 = 20kg$:

$$T = \frac{10kg \cdot 600N}{10kg + 20kg} = 200N$$

If $m_1 = 20kg\ and\ m_2 = 10kg$:

$$T = \frac{20kg \cdot 600N}{10kg + 20kg} = 400N$$

Answer: if end the pull is applied to mass $20kg$, tension in the string is $T = 200N$; if end the pull is applied to mass $10kg$, tension in the string is $T = 400N$.