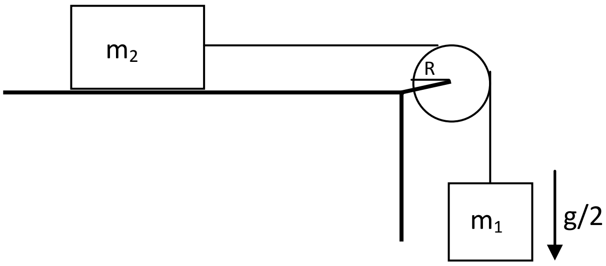
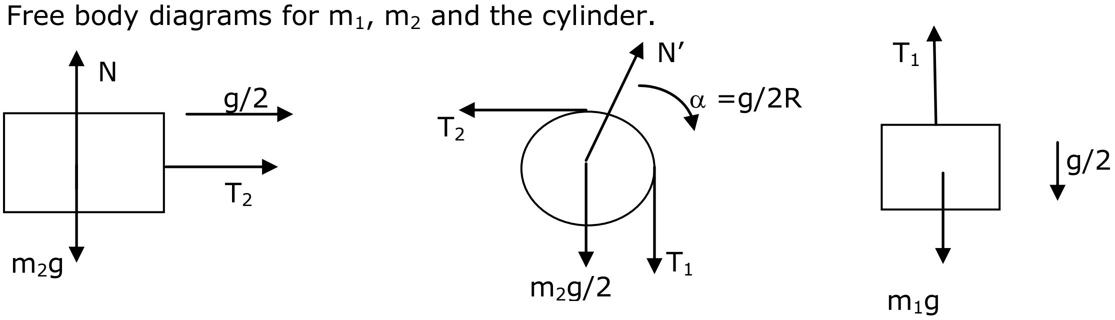
Q- Two blocks of mass m_1 and m_2 are attached by a string which passes over a cylinder of mass $m_2/2$ and radius R, free to rotate about its horizontal axis. Block m_1 is hanging and m_2 is on the frictionless horizontal table as in the figure. If the string does not slip on the cylinder and m_1 descends with acceleration g/2, find

(a) Tension in horizontal and vertical parts of the string.

(b) Ratio m_1/m_2



(a) Free body diagrams for m_1, m_2 and the cylinder.



The vertical forces on the block of mass m_2 are its weight m_2g and the normal reaction of horizontal surface N and will be balanced and the acceleration g/2 is provided by the tension T_2 only hence according to the Newton's law of motion we have

$$T_2 = m_2(g/2) = \tfrac{1}{2} m_2 g$$

As the hanging block is moving down with acceleration g/2, we can write equation of motion as

$$m_1 g - T_1 = m_1(g/2)$$

gives $T_1 = m_1 g - m_1 g/2 = \tfrac{1}{2} m_1 g$

(b) Now the tensions T_1 and T_2 are creating torques on the cylinder in opposite directions about the axis of rotation and as the angular acceleration α will be g/(2R) we can write

$$T_1 * R - T_2 * R = I * g/(2R)$$

Where I is the moment of inertia of the cylinder about its axis and is equal to

$$I = \frac{1}{2} * \frac{m_2}{2} * R^2 = \frac{m_2 R^2}{4}$$

Thus $(T_1 - T_2) * R = \dfrac{m_2 R^2}{4} * \dfrac{g}{2R}$

Substituting the values of T_1 and T_2 and solving this equation gives us

$$\frac{m_1 g}{2} - \frac{m_2 g}{2} = \frac{m_2 g}{8}$$

Gives $m_1 = 5m_2/4$

Or $m_1/m_2 = 5/4$