Answer on Question #71361, Physics / Mechanics

A block of masses m_A is on a plane inclined at an angle θ with the horizontal. It is attached to another mass m_B by means of string that passes over a pulley at the top of the incline. For m_A = 8kg, m_B = 5kg, θ = 20°, and the coefficient of kinetic friction between m_A and the plane is 0.3. Calculate the (a) acceleration of the masses and (b) the tension in the string when the system is moving.

Solution:

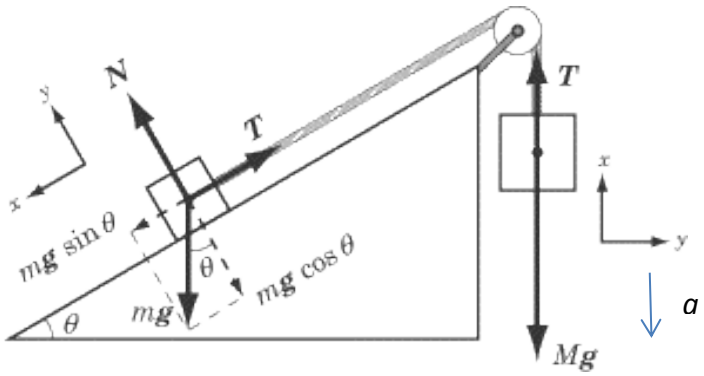
Given:

$m_A = m = 8$ kg,

$m_B = M = 5$ kg,

$\theta = 20°$,

$\mu_k = 0.3$



First, let's determine the net force acting on each of the masses. Applying Newton's Second Law we get:

$$\text{for mass } m_B: \quad m_B g - T = m_B a$$

$$\text{for mass } m_A: \quad T - m_A g \sin\theta - \mu_k N = m_A a$$

Adding these two equations together, we find that

$$m_B g - T + T - mg \sin\theta - \mu_k N = m_B a + ma$$

$$m_B g - m_A g \sin\theta - \mu_k N = a(m_B + m_A)$$

The friction force

$$\mu_k N = \mu_k m_A g \cos\theta$$

Thus,

$$a = \frac{g(m_B - m_A \sin\theta - \mu_k m_A \cos\theta)}{(m_B + m_A)}$$

$$a = \frac{9.81 \cdot (5 - 8 \cdot \sin 20° - 0.3 \cdot 8 \cdot \cos 20°)}{(8+5)} = 0.00647 \approx 0.0065 \text{ m/s}^2$$

The tension is

$$T = m_B(g - a) = 5 \cdot (9.81 - 0.0065) = 49.02 \text{ N}$$

Answer. a) $a = 0.0065$ m/s^2; b) $T = 49.02$ N.