Answer on Question#53175 - Physics - Other

A block of mass ($m_1 = 5\ \text{kg}$) on a rough, horizontal surface is connected to a ball of mass ($m_2 = 2\ \text{kg}$) by a lightweight inextensible cord over a light weight, frictionless pulley, as shown in Figure 1 below. A force of magnitude $F = 80\ \text{N}$ acting at an angle $\theta = 30°$ with the horizontal is applied to the block, accelerating the block of mass to the left. The coefficient of the kinetic friction between the block and the surface is $\mu = 0.25$.

a) Draw the free body diagram of the masses m_1 and m_2.

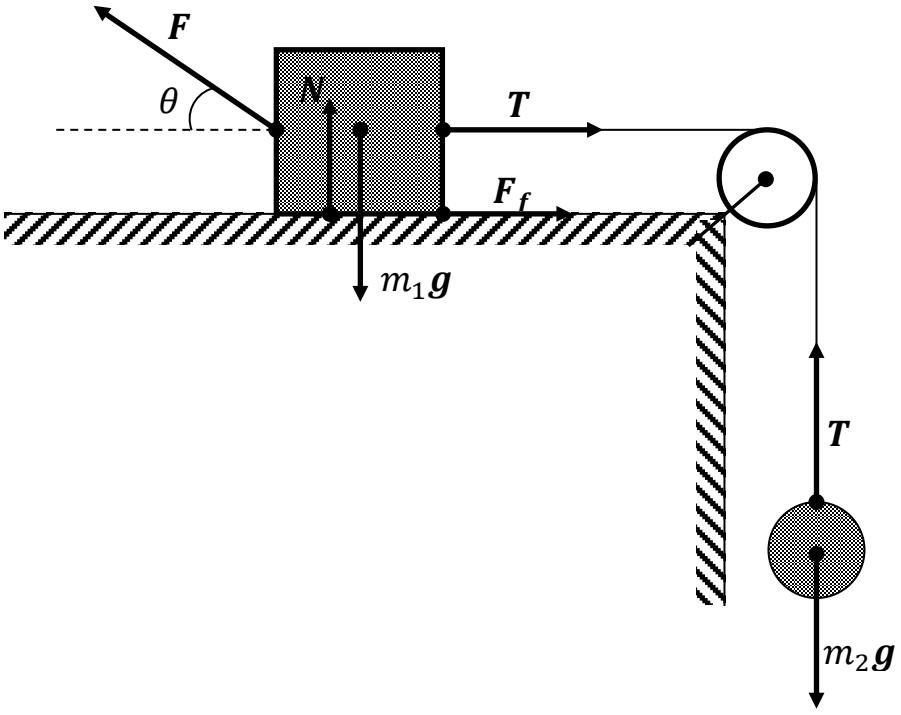
b) Determine the normal force N acting on mass m_1.

c) Determine the kinetic friction force F_f acting on mass m_1.

d) Determine the acceleration a of the system.

Solution:

a)



b) According to the Newton's second law (in projection on vertical axis) we obtain

$$N + F \cdot \sin\theta = m_1 g$$

We'll assume that $g = 10\frac{\text{m}}{\text{s}^2}$. Therefore

$$N = m_1 g - F \cdot \sin\theta = 5\text{kg} \cdot 10\frac{\text{m}}{\text{s}^2} - 80\text{N} \cdot \sin 30° = 10\text{N}$$

c) The kinetic friction is given by

$$F_f = N \cdot \mu = 10\text{N} \cdot 0.25 = 2.5\text{N}$$

d) According to the Newton's second law (in projection on horizontal axis) we obtain

$$m_1 \cdot a = F \cdot \cos\theta - T - F_f$$

$$m_2 \cdot a = T - m_2 g$$

Adding these two equations we obtain

$$(m_1 + m_2)a = F \cdot \cos\theta - m_2 g - F_f$$

$$a = \frac{F \cdot \cos\theta - m_2 g - F_f}{m_1 + m_2} = \frac{80\text{N} \cdot \cos 30° - 2\text{kg} \cdot 10\frac{\text{m}}{\text{s}^2} - 2.5\text{N}}{5\text{kg} + 2\text{kg}} = 6.7\frac{\text{m}}{\text{s}^2}$$

Answer:

b) 10N
c) 2.5N
d) $6.7\frac{\text{m}}{\text{s}^2}$