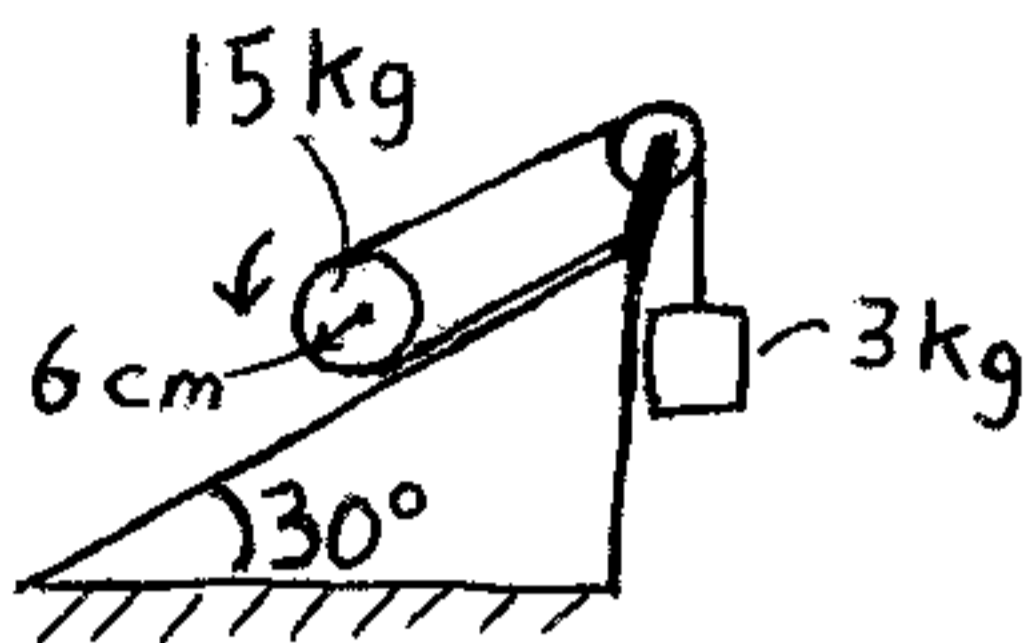


This is a force and motion problem involving rotation, rolling, and torque.

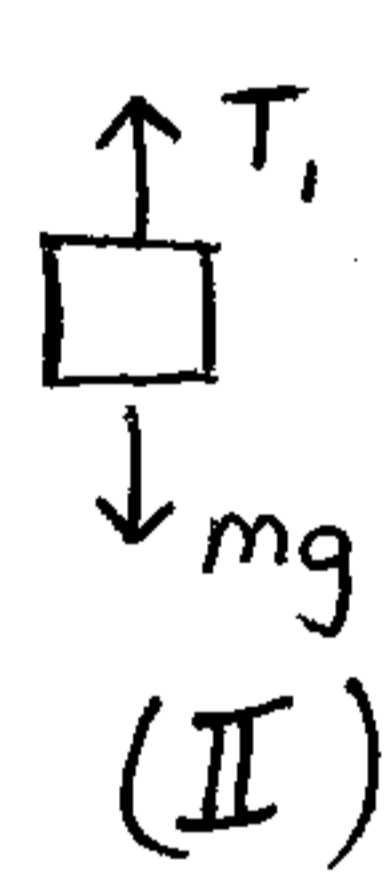
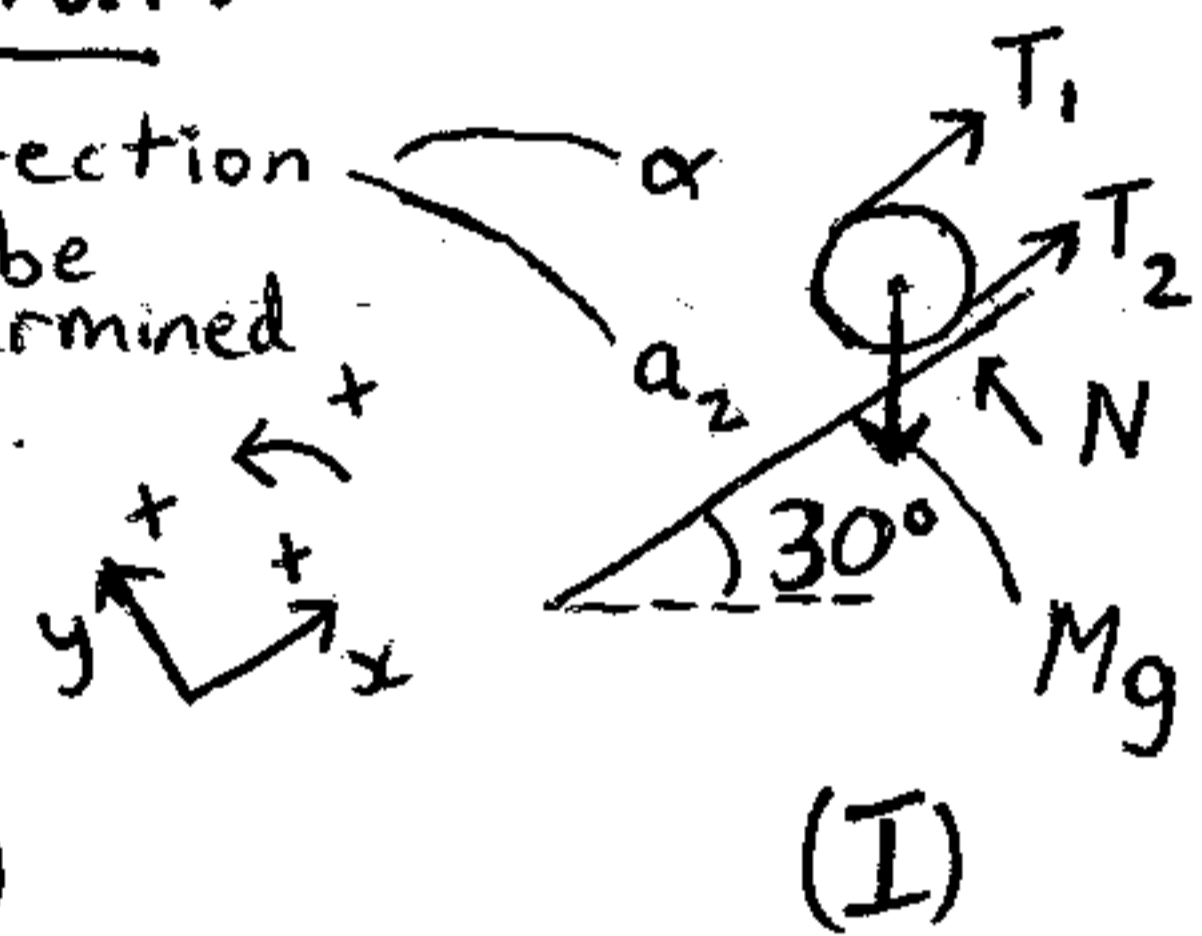


In the pulley system shown, determine the acceleration of the block. The mass of the belt and pulley is negligible.

Solution:

Note: Each FBD for each body can have its own distinct reference frame and sign convention - true for all problems

you can assign a direction if you want, but it's not necessary



direction to be determined

you can assign a direction if you want, but it's not necessary

since the correct direction comes out of the answer

From the kinematics, and sign convention for each body:

$$a_1 = -2a_2 \quad (1)$$

$a_2$  is the acceleration of the center of mass of the cylinder.

$$(2) \quad a_2 = -\alpha R, \quad R = 0.06 \text{ m}$$

(the cylinder is rotating as if it were rolling without slipping)

since the correct direction comes out of the answer

true for all problems

true for all problems

(I) Apply Newton's second law:

$$\sum F_x = ma_x$$

$$\Rightarrow -Mg \sin 30^\circ + T_1 + T_2 = Ma_2 \quad (3)$$

Apply Newton's second law in angular form:

$$\sum \tau_G = I_G \alpha, \quad I_G = \frac{1}{2} MR^2$$

$$\Rightarrow T_2 R - T_1 R = I_G \alpha \quad (4)$$

(II) Apply Newton's second law:

$$T_1 - mg = ma_1 \quad (5)$$

Substitute  $m = 3 \text{ kg}$ ,  $M = 15 \text{ kg}$ ,  $R = 0.06 \text{ m}$ ,  
and  $I_G = \frac{1}{2} (15) (0.06)^2$  into  
equations (1)-(5) and solve the unknowns.

$$a_1 = 0.85 \text{ m/s}^2, \quad a_2 = -0.426 \text{ m/s}^2, \quad \alpha = 7.10 \text{ rad/s}^2$$

$$T_1 = 31.96 \text{ N}, \quad T_2 = 35.15 \text{ N}$$

(answer)