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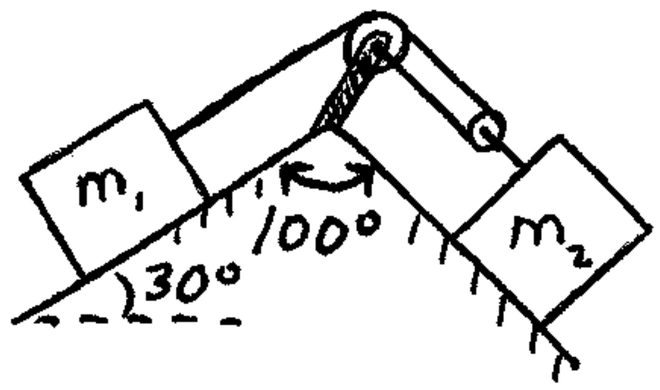
Sep. 23, 2020

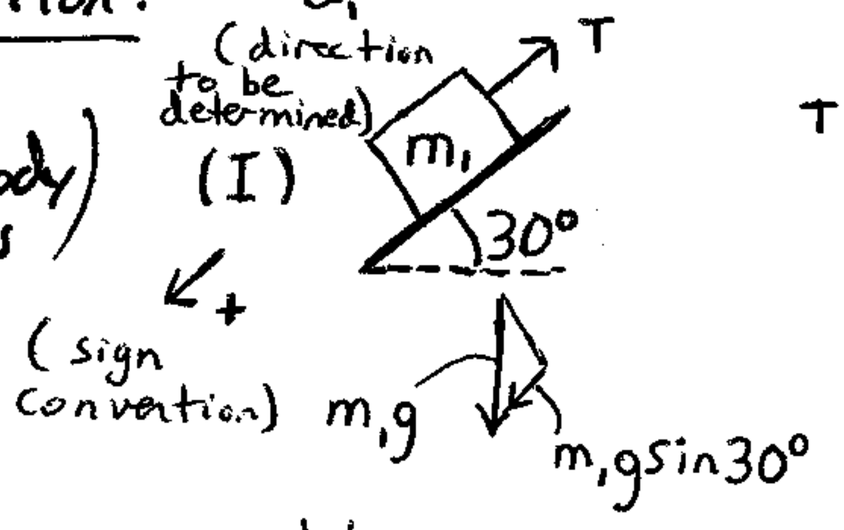
This is a force and motion problem involving pulleys.

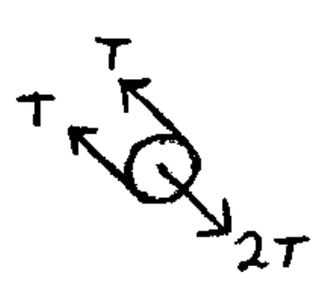


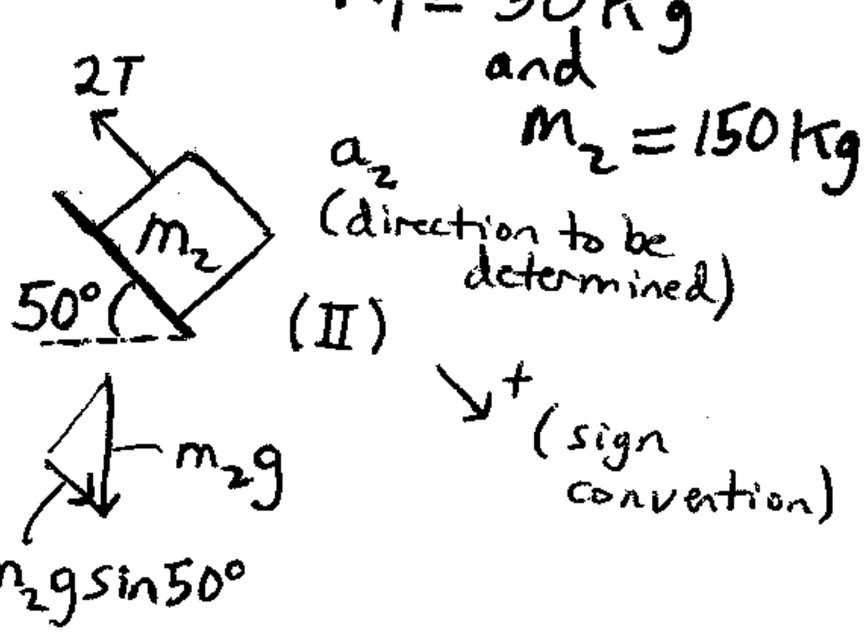
In the pulley system shown, the two blocks are released from rest. The sliding surfaces are frictionless, and the mass of the rope and pulleys is negligible. Determine the acceleration of each block and the tension in the rope. Note that $m_1 = 50\,kg$ and $m_2 = 150\,kg$.

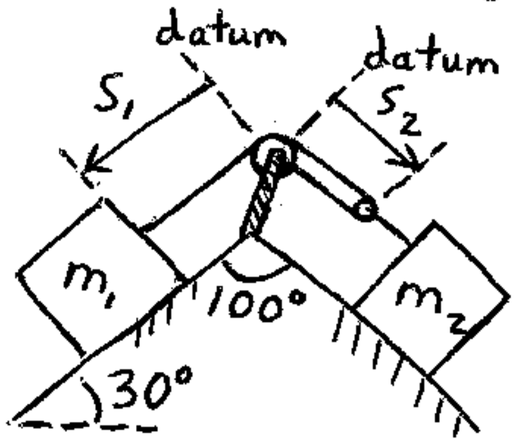
Solution:

Free-body diagrams









$s_1 + 2s_2 = L$ (constant length)

differentiate twice with respect to time:

$$\rightarrow a_1 + 2a_2 = 0 \quad (1)$$

(I) Apply Newton's second law:

$$m_1 g \sin 30° - T = m_1 a_1 \quad (2)$$

(II) Apply Newton's second law:

$$m_2 g \sin 50^\circ - 2T = m_2 a_2 \quad (3)$$

Substitute known values into equations (1)-(3):

$(1) \Rightarrow \quad a_1 + 2a_2 = 0$

$(2) \Rightarrow \quad 50(9.8)\sin 30^\circ - T = 50 a_1$

$(3) \Rightarrow \quad 150(9.8)\sin 50^\circ - 2T = 150 a_2$

Solve equations (1)-(3):

$a_1 = -3.63 \text{ m/s}^2$
$a_2 = 1.82 \text{ m/s}^2$ (answer)
$T = 426.74 \text{ N}$