SECOND MIDTERM

Name (print) K. Smith Name (signed)__________

Discussion Instructor (circle): Condella DiCarlo Ganesan Hollier Reeve

Discussion Section # _______

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Masses \( m_1 = 1.0 \text{ kg} \) and \( m_2 = 3.0 \text{ kg} \) are connected by a stretched rope. Mass \( m_2 \) is just over the edge of the ramp, as shown. The coefficient of kinetic friction of each mass with the surface is 0.21. At \( t = 0 \) the system is given an initial velocity of \( v_0 = 11.0 \text{ m/s} \) which starts \( m_2 \) down the ramp. Assume the rope and ramp are long enough that \( m_1 \) always stays on the flat, and \( m_2 \) always stays on the ramp. The pulley is massless and frictionless.

(a) Draw complete free body diagrams and separate force diagrams for each mass.

(b) Calculate the velocity of the system as a function of time.

(c) Find the displacement after 0.50 s.

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\begin{align*}
\text{(a) } & \quad \text{Draw complete free body diagrams and separate force diagrams for each mass.} \\
\text{(b) } & \quad \text{Find acceleration: } (a_{v1x} = a_{v2x} = a) \\
M_1: & \quad a_{v1x} = \frac{\Sigma F_x}{M_1} = \frac{N_1 - M_1 a}{M_1} = 0 \Rightarrow N_1 = M_1 a \\
M_1: & \quad a_{v1x} = \frac{\Sigma F_x}{M_1} = \frac{T - f_{k1x}}{M_1} = T = m_1 a + m_2 a + m_2 g \cos \theta \\
M_2: & \quad a_{v2x} = \frac{\Sigma F_x}{M_2} = \frac{N_2 - M_2 g \sin \theta}{M_2} = 0 \Rightarrow N_2 = M_2 g \sin \theta \\
M_2: & \quad a_{v2x} = \frac{\Sigma F_x}{M_2} = \frac{m_2 g \sin \theta - f_{k2x}}{M_2} = m_2 a = m_2 g \sin \theta - M_2 N_2 = m_2 g \sin \theta - m_1 a - m_2 a - m_2 g \cos \theta \\
\text{collect } a: & \quad a (m_1 + m_2) = m_2 g \sin \theta - m_1 a - m_2 a - m_2 g \cos \theta \\
\text{so, } & \quad a = \frac{m_2 g \sin \theta - m_1 a - m_2 a - m_2 g \cos \theta}{m_1 + m_2} = 1.92 \text{ m/s}^2 \\
\text{Velocity as a function of time: } & \quad \mathbf{v}(t) = v_0 + at \\
\text{Velocity at } t = .5 \text{sec: } & \quad \mathbf{v}(.5) = 11.0 \text{m/s} + 1.92 \text{m/s}(.5) = 11.0 \text{m/s} + 0.96 \text{m/s} \\
\text{(c) Displacement: } & \quad \Delta x = \mathbf{v}_0 t + \frac{1}{2} a t^2 = 11.0 \text{m/s} (.5) + \frac{1}{2} (1.92 \text{m/s}^2)(.5)^2 = 5.73 \text{m} \\
\Delta x = 5.73 \text{m}
\end{align*}
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