Name____

Physics 110 Quiz #4, May 2, 2025

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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1. A block of mass m slides along a horizontal surface with an initial velocity v_i when it encounters a ramp inclined at an angle ϕ measured with respect to the horizontal. Friction exists only on the ramp with coefficient of friction μ. What is the net work done by all of the forces that act on the block as the block slides up the ramp, comes to rest, and slides back down the ramp? That is, in the round trip from the bottom of the ramp up the ramp back down the ramp to the bottom again, how much work was done on the block? Hint: You may need: $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$.

$$W_{net}=W_{net,u}+W_{net,d}=\left(W_{F_{N,u}}+W_{F_{W,u}}+W_{F_{fr,u}}\right)+\left(W_{F_{N,d}}+W_{F_{W,d}}+W_{F_{fr,d}}\right)$$

$$W_{net}=mgx\cos(90+\phi)+\mu mg\cos\phi\cos 180+mgx\cos 90\text{-}\phi+\mu mg\cos\phi\cos 180$$

$$W_{net}=-mgx\sin\phi-\mu mgx\cos\phi+mgx\sin\phi-\mu mgx\cos\phi$$

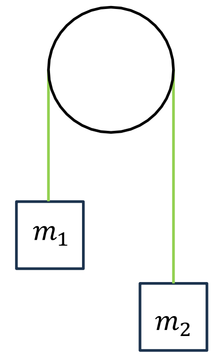
$$W_{net}=-2\mu mgx\cos\phi$$

2. Using the work-kinetic energy theorem, what is the speed of the block when it returns to the bottom of the ramp?

$$W_{net}=-2\mu mgx\cos\phi=\Delta K=\tfrac{1}{2}mv_f^2-\tfrac{1}{2}mv_i^2$$

$$v_f=\sqrt{v_i^2\text{-}4\mu mgx\cos\phi}$$

3. Consider the following arrangement of masses m_1 and m_2 connected by a light string passing over a massless pulley. Fully describe the total changes in energy for each of the masses m_1 and m_2, assuming $m_1<m_2$.



Mass m_1 starts from rest and falls. As it falls it loses gravitational potential energy but speeds up and its kinetic energy increases.

Mass m_2 starts from rest and rises. As it rises it gains gravitational potential energy but also speeds up and its kinetic energy increases.

4. Using energy ideas, if m_1 is released from rest, what will be the speed of m_2 if m_2 travels vertically a distance h, assuming $m_1<m_2$.

$$\Delta E_{system} = 0 = \Delta K_1 + \Delta K_2 + \Delta U_{g2} = \frac{1}{2}m_1 v_{1f}^2 + \frac{1}{2}m_1 v_{2f}^2 \text{-} m_1 gh + m_2 gh$$

$$m_2 gh = \frac{1}{2}(m_1 + m_2)v_f^2 \rightarrow v_f = \sqrt{2\left(\frac{m_1 - m_2}{m_1 + m_2}\right)gh}$$

5. What is the net work done by the tension force in the string?

$$W_{net} = W_{net,F_{TL}} + W_{net,F_{TR}} = F_{TL}h\cos 180 + F_{TR}h\cos 0 = F_T h - F_T h = 0$$