Physics 7AW Homework 6 — Friction, Pulleys, Tension

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Physics 7AW - WAT 2020 edition

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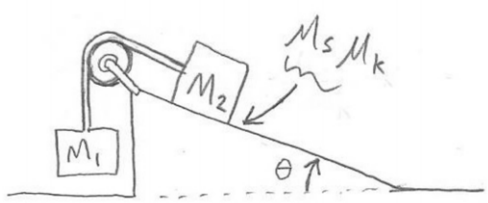
Exercise 1. Two blocks are tied together by an ideal rope that passes over an ideal pulley so that one block of mass M_1 hangs from one end of the rope and the other block of mass M_2 rests on an incline making an angle with respect to the horizontal, as shown in the diagram. The static and kinetic coefficients of friction for the interface between the ramp and the bottom surface of the second block are μ_s and μ_k, respectively.



a) Draw 2 free body diagrams, one showing all forces acting on the hanging block alone, and a second diagram for the block on the incline by itself. Assume that the blocks are not moving

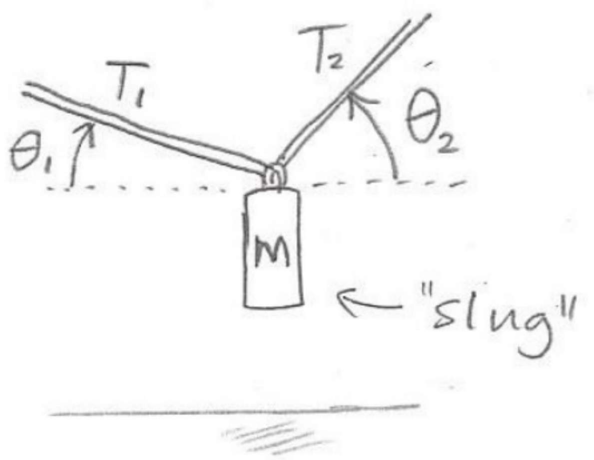
b) What is the magnitude of the normal force acting on M_2? Express your answer in terms of θ, M_2, and any relevant physical constants

c) What is the maximum possible value for the mass M_1 of the hanging block if the blocks are not moving? Express your answer in terms of θ, μ_s, and M_2

d) Now consider the situation in which the second block is **sliding up the ramp**. In that case, what is the acceleration of the hanging block? Express your answer in terms of M_1, M_2, μ_k, θ and any relevant physical constants.

e) If the second block is **sliding up the ramp**, then what is the tension in the rope? Express your answer in terms of M_1, M_2, μ_k, θ and any relevant physical constants.

Exercise 2. A weight called a "slug" of mass M is suspended by two ideal ropes (they don't stretch or compress), each tied to the top of the slug. The two ropes are at potentially different angles θ_1 and θ_2 from the horizontal, as shown in the diagram.



a) If the slug is not moving over some extended period of time, then what is the tension T_1 in the first rope during this time? Express your answer in terms of M, θ_1, θ_2, and any relevant physical constants.

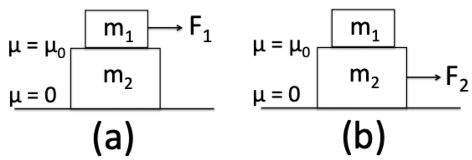
For the rest of this problem assume θ_1 θ_2 are equal to just θ

b) If the slug is not accelerating and $\theta_1 = \theta_2 = \theta$ what is the relationship between T_1 and T_2? Please show your work or justify your answer.

c) If the two angles are the same, then what is T_1 if the slug and both ropes are accelerating straight upwards with an acceleration of magnitude a? Express your answer in terms of M, θ, and a, and any relevant physical constants.

d) If the two angles are the same, $\theta_1 = \theta_2$, then what is T_1 if the slug and both ropes are accelerating **horizontally to the right** as viewed in the diagram with an acceleration of magnitude a'? Express your answer in terms of M, θ, a', and any relevant physical constants

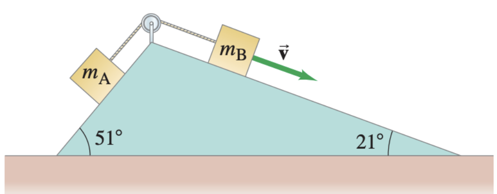
Exercise 3. Consider a small mass with $m = m_1$ sitting on top of a larger mass with $m = m_2$ which in turn sits on a table. Between the two blocks, the coefficient of static friction is equal to the coefficient of kinetic friction which are both equal to μ. There is no friction between the lower block and the table.



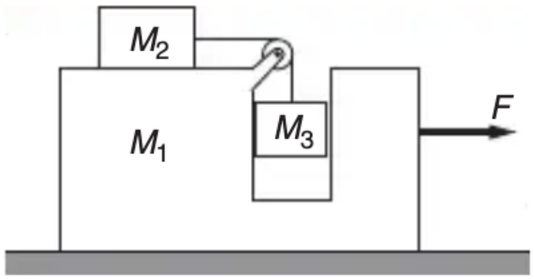
a) Make a force diagram. How much force can be applied to the top block with $m = m_1$ before slipping between the blocks occurs?

b) Make a force diagram. How much force can be applied to the bottom block with $m = m_2$ before slipping between the blocks occurs?

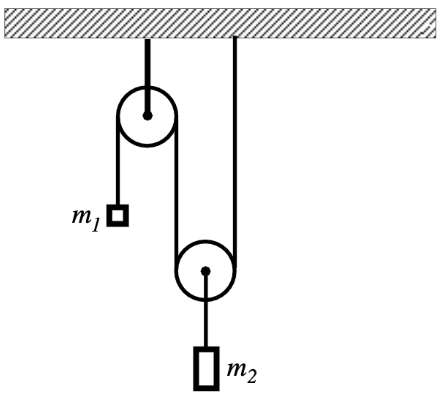
Exercise 4. Two masses $m_A = 2.0$kg and $m_B = 5.0$kg are on inclines and are connected together by a string as shown in Fig. The coefficient of kinetic friction between each mass and its incline is $\mu_k = .30$ If m_B moves up, and m_A moves down, determine their acceleration. [Ignore masses of the (frictionless) pulley and the cord.]



Exercise 5. (optional) A "pedagogical machine" is illustrated in the sketch. All surfaces are friction less. What force F must be applied to M_1 to keep M_3 from rising or falling?

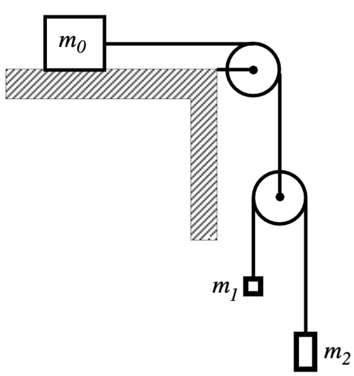


Exercise 6. (optional) Using masses m_1 and m_2 and gravitational acceleration g, determine accelerations a_1 and a_2.



Hint: For this one it may be wise to give pulley on the right a mass m_p

Exercise 7. (optional) In the system below, masses of pulleys are small (ideal pulley) and friction is negligible. Find acceleration of body m_1



Hint: This is hard