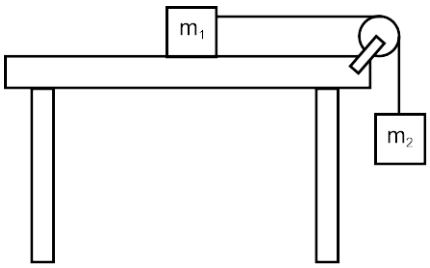
Pre-Exam - Unit 2 - Dynamics

AP Physics: Free Response

Clearly show the method you used and steps involved in arriving at your answers. It is to your advantage to do this, because you may earn partial credit if you do and will receive little or no credit if you do not.



1. A student would like to find the coefficient of kinetic friction between a block and a wooden table as pictured. Assume equipment usually found in a school physics laboratory is available.
    a. Describe an experiment to determine the coefficient of kinetic friction.

        i. What quantities need to be measured and what equipment is needed to measure each one? You do not have access to any electronic sensors.

        ii. Describe the overall procedure to be used, including any steps necessary to reduce experimental uncertainty.

    b. Describe how the student should analyze the data collected in part (a) to calculate the coefficient of kinetic friction.

    c. Derive an equation for the coefficient of kinetic friction in terms of m_1, m_2, and the acceleration of the blocks, a.

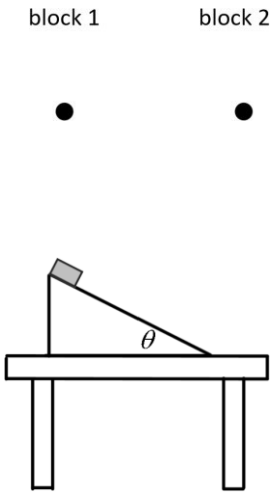
    A large mass is now affixed to the top of block 1 and the experiment is repeated.

    d. Does the coefficient of kinetic friction increase, decrease, or stay the same after the mass is added?

        _____increase _____decrease _____stay the same

        Briefly explain your reasoning without deriving or using equations.

e. The string is cut when the blocks are in motion. Draw all the forces at this moment for each of the blocks on the diagram below.



2. A block is placed on the surface of an inclined plane of length *L* whose surface is raised to an angle *θ* above a table. The coefficient of kinetic friction between the block and the incline is μ_k. The block is released and accelerates down the ramp. The surface of the table has negligible friction.

   a. Derive an equation for the velocity of the block at the bottom of the incline. Express your answers in terms of *L*, *θ*, and μ_k and physical constants.

   b. The inclined plane is placed further back on the table so that the distance the block travels on the table is doubled. How will this change the maximum horizontal range *R* of the block as measured horizontally across the floor?

      _____increases _____decreases _____stays the same

      In a clear, coherent paragraph-length response that may also contain equations and drawings, explain your reasoning.

   c. A student is trying to model the magnitude of range *R*. The student writes down the following two equations, each of which includes a positive constant *C* with appropriate units, the velocity of the block *v* on the table, and the height of the table *h*.

      i. $R = \frac{Cv}{\sqrt{h}}$

      ii. $R = Cv\sqrt{h}$

Which equation better mathematically models this experiment?
_____Equation (1) _____Equation (2)

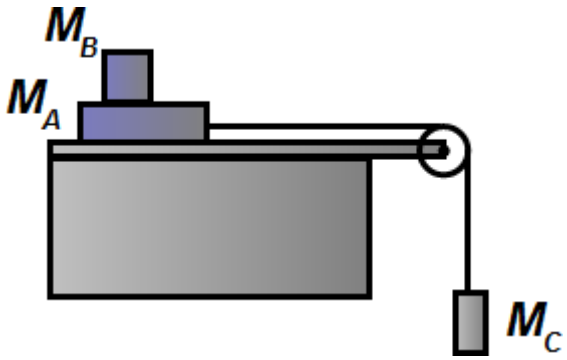
Briefly explain why the equation you selected is plausible and why the other equation is not plausible.

Sandpaper is placed on the table, but the block still slides off the table.

d. How will this change the time it takes for the block to fall to the ground after it reaches the edge of the table?

_____Increases _____decreases _____stays the same

Justify your answer without the use of equations.



3. Block B, with a mass M_B, rests on the top of block A, with a mass M_A, which is placed on a horizontal tabletop. A light string attached to block A passes over a frictionless and massless pulley and is connected to block C which is suspended from the pulley. The coefficient of kinetic friction between the table and block A is μ_{kA} and between block A and B is u_{kB}. The coefficient of static friction between the table and block A is μ_{sA} and between Block A and B is u_{sB}.

   Express all answers in terms of the given quantities and physical constants.

   a. Assume block C is at rest. Derive equations for the following:
      i. Tension in the string
      ii. Friction force between block A and the table

   b. Assume block C falls at constant speed. Derive equations for the following:
      i. Tension in the string
      ii. Friction force between block A and the table

c. Block C does not fall at a constant speed. Derive an equation for the acceleration of the system of blocks A, B, and C. Assume that all blocks move at the same rate.

d. As the acceleration of the system of blocks increases, describe what happens to the friction between block A and B.