Group Quiz 5

Group Number: Names:

Date:

Show all work. If you don't have enough room on this document, you can add pages.

[15 points total] In both problems below, you are given a block of mass M on a given surface with friction between them. The empirical formula for kinetic friction is

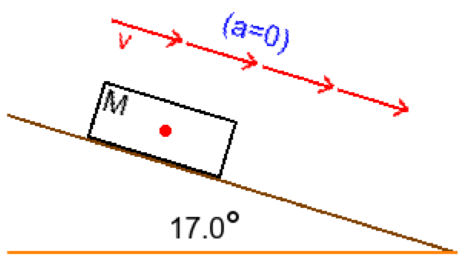
$$F_k = \mu_k N$$

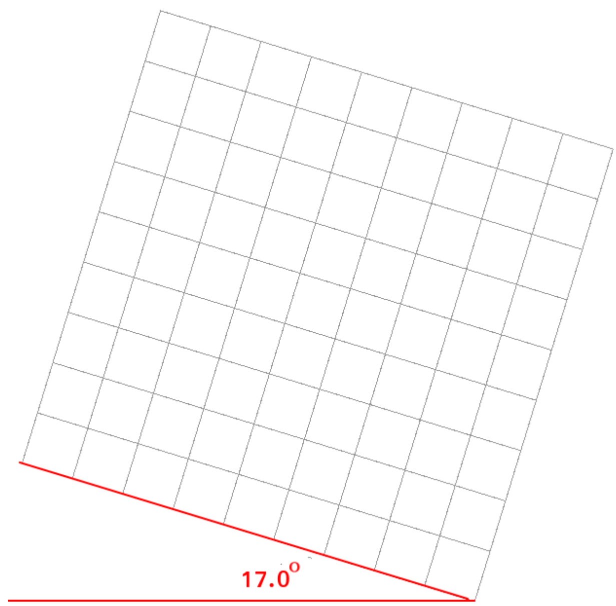
where N is the normal force and μ_k is the coefficient of kinetic friction.

In the given diagrams, the red dot indicates the block's center of mass. You can use these facts:

- $g = 9.80\,\mathrm{m/s^2}$ is the gravitational acceleration.
- $M = 3.50\,\mathrm{kg}$ is the mass of the block.
- m is the mass of the hanging block (problem 2), which is to be determined.
- μ_k is the coefficient of kinetic friction between the block of mass M and the surface.
- Disregard effects due to the air.
- Assume the string and the pulley are both ideal.

(1) [6 total] When the surface is tipped up to an angle of $\theta = 17.0°$, and the block given a gentle push, it slides down with a constant speed as illustrated below. This is a unique angle, when set to any other angle (from 0° to 90°), it will not move with a constant speed when given a gentle nudge.





/1 **(1.a)** In the grid space above right, construct a free body diagram (or force diagram) for the sliding mass. This should also include a coordinate system.

/3 **(1.b)** Apply Newton's second law in component form for the sliding mass. This should include two equations.

/1 **(1.c)** Using those equations and the kinetic friction law, derive a formula for the coefficient of kinetic friction μ_k in terms other measured or given quantities.

μ_k=______________(formula)

/1 **(1.d)** Compute the value of μ_k precise to three significant figures.

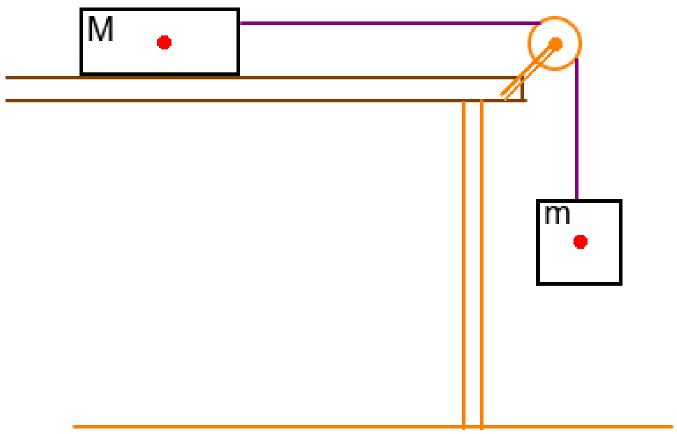
μ_k=______________(number)

[Problem 2 is on next page.]

(2) [9 total] We now use the same block and surface, but this time it is level. We attach another mass m using an ideal string and an ideal pulley as shown below. The mass m hangs over the edge of the table.

When we let go and give the block M a little push to the right, they are observed to move with a constant speed. When a different mass m is hanging, they will not move at a constant speed.

In this problem, use the same value of μ_k you had in problem 1. Your task is now to figure out the value of m that will give the situation of constant speed described above.



/2 **(2.a)** Construct free body diagrams (or force diagrams) for the sliding mass and the hanging mass. This should also include a coordinate system. Your diagrams should also include coordinate axes. (You should also make motion diagrams.)

/4 **(2.b)** Apply Newton's second law in component form for the sliding mass (two equations) and the hanging mass (one equation).

/2 **(2.c)** Using those equations and the kinetic friction law, derive a formula for the coefficient for the hanging mass m in terms other measured or given quantities.

m=______________(formula)

/1 **(2.d)** Compute the value of m precise to three significant figures.

m=______________kg (number)

[Done.]