Multiple Object Non Accelerated Motion

Background:

Friction is the resisting force encountered when one tries to slide one surface over another; this force acts along surfaces in contact. The force necessary to overcome friction depends on the nature of the materials in contact, i.e., their roughness or smoothness but not on the area of contact. Experimentally it was found that the force of friction is directly proportional to the normal force. The constant of proportionality is called the coefficient of friction.

When the contacting surfaces are actually sliding one over the other, the force of friction is given by:

$$F_f = \mu_k F_N$$

Where F_f is the force of friction and is parallel to the surfaces and points opposite to the direction of motion, F_N is the normal force and μk is the coefficient of friction. The subscript k stands for kinetic, meaning μ_k is the coefficient that applies when the surfaces are moving one with respect to other. It is called the coefficient of kinetic (or sliding) friction.

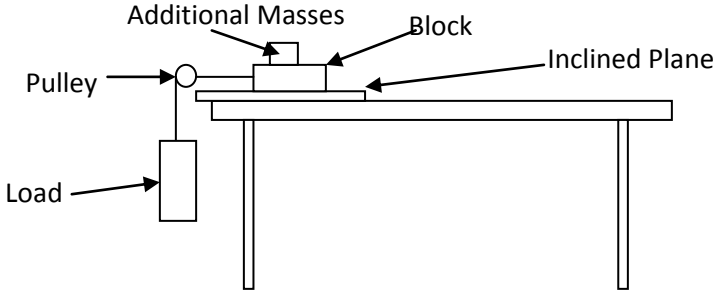
A method of checking the proportionality of F_f and F_N and of determining the proportionality constant μ_k is to have one of the surfaces horizontal with a pulley fastened at one end. The other surface is the bottom face of a block, which rests on the plane and has a cord that passes over the pulley and carries weights. The weights are varied until the block moves at a constant speed after having been started with a slight push. Since there is no acceleration, the net force is zero, which means the frictional force is equal to the weight of the block and can be increased by placing weights on top of the block. Thus corresponding values of F_f and F_N are known, and plotting them will show whether F_f and F_N are indeed proportional. The slope of the graph gives μk.

Objective:

In this lab you are going to explore the factors that affect the force of sliding friction and determine the coefficient of sliding friction between two wooden surfaces.

Procedure:

1) Find the mass of the wooden block using the triple beam balance and record the mass on your own paper.
2) Calculate the weight of the block and record it on your own paper.
3) Measure the three dimensions of the block of wood.
4) Place the inclined plane in a horizontal position (θ=0°) on the lab table with its pulley projecting beyond the table's edge (as shown in the figure to the right). Be sure that the surfaces of both the board and the wood block are clean, dry and free of any dust or grit. Begin the experiment by setting the block on with its largest surface in contact with the board's surface. Run the string which is attached to the block over the pulley and attach it to the load platform.



5) Place some masses on the platform (remember the platform has mass too). Slowly increase the load until it is just sufficient to keep the block sliding slowly with a constant speed after it has been started with a very small push. Record the mass of the load and the weight of the load and surface area in contact with the plane.
6) Turn the block of wood on its side and place it on the inclined plane. Repeat step 5 and record the mass, weight and surface area on your own paper.
7) Place the block so the largest surface area is again in contact with the inclined plane. Place masses (additional masses on the diagram) of 100, 200, 300, 400 and 500 grams on top of the block. Record the load (mass and weight) needed in each case.
8) Using Calc on your netbook, graph the Load (weight) as your dependent variable and Normal Force as your independent variable. Determine the best fit trendline and equation for your graph.

Questions:

1) Does the surface area in contact with the inclined plane have any bearing on the load required to keep the block moving at a constant speed. Explain using the results of your experiment.
2) Does your graph show frictional force is directly proportional to normal force? How can you tell?
3) What is the coefficient of kinetic friction according to your results?
4) Calculate the % error if the real value of 0.4. Show your calculations.
5) Write a reflection for this lab. Discuss the relationship between surface area and friction and how, if at all, this lab helped focus your understanding of the force of friction in a two object system.

Questions:

1) Does the angle of incline affect the coefficient of friction? Explain your answer based on the results of your experimentation.
2) Does motion up or down the incline affect the coefficient of friction? Explain your answer based on the results of your experimentation.
3) Write a reflection for this lab. In your reflection, discuss how, if at all, this lab helped focus your understanding of the force of friction and the motion of a multi-object system.