

Lab #18

Inclined Planes: Why It Is Hard to Go up a Steep Hill

Name: _____

Date: _____

In this lab you will investigate how the force parallel to a hill increases as the angle increases. This parallel force is a component of, or part of, the gravitational force. You must oppose the parallel force if you are to prevent yourself from sliding down a hill. As the parallel force increases, you have to exert more force. This effect is evident when you go up a hill on a bicycle.

Materials

pulley	cart with a way to attach extra mass
ramp	spring scale
string	
protractor	

Procedure

1. Attach your pulley to the ramp, tie one end of the string to the cart, and tie a loop in the other.
2. When the ramp is level (at zero degrees), there is no parallel component of the gravitational force. Gravity in that case points in a direction perpendicular to the ramp. In a data table record this value next to zero degrees.
3. Raise your ramp so it is at 10 degrees. Use a protractor to measure the angle and record the force shown on the spring scale (see Figure 18). Repeat the measurement as you increase the angle in increments of 10 degrees until you reach 90 degrees. Record these values in your data table.
4. Add mass to your cart and repeat the measurements every 10 degrees from 0 to 90 degrees.
5. Finally, use a block ^{& with sandpaper} instead of a cart with wheels. Find the force as you vary the angle in 10-degree increments.

6. Add mass to the block and repeat the measurements.

NOTE: WITH THE BLOCK, PULL PARALLEL TO THE PLANE SLOWLY UNTIL THE BLOCK JUST STARTS TO MOVE.

USE LOGGER PRO EXPERIMENT 12 IN PHYSICS WITH COMPUTER FOLDER

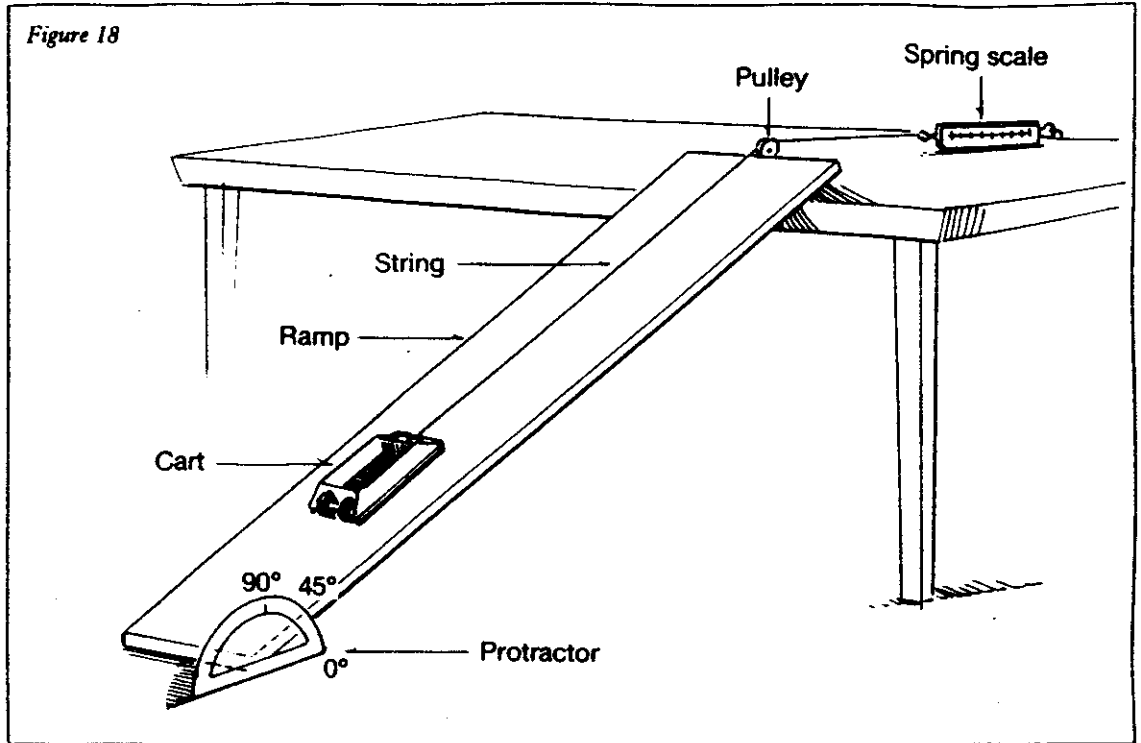
(continued)

Lab #18

**Inclined Planes: Why It Is Hard
to Go up a Steep Hill (*continued*)**

Name: _____

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Data table Cart

Angle	Spring scale force (N)	$mg\sin\Theta$	Difference
0			
10			
20			
30			
40			
50			
60			
70			
80			
90			

Data table cart- extra mass

Angle	Spring scale force (N)	$mg\sin\Theta$	Difference
0			
10			
20			
30			
40			
50			
60			
70			
80			
90			

Data table block sandpaper

Angle	Spring scale force (N)	$mg\sin\Theta$	Difference	Normal force $mg\cos\Theta$	Coefficient of static friction
0					
10					
20					
30					
40					
50					
60					
70					
80					
90					

Data table block same sandpaper and more mass

Angle	Spring scale force (N)	$mg\sin\Theta$	Difference	Normal force $mg\cos\Theta$	Coefficient of static friction
0					
10					
20					
30					
40					
50					
60					
70					
80					
90					

Using graphical analysis

- 1) Make a graph of Force vs angle for the cart and the cart with extra mass
- 2) Make a graph of Force vs angle for the block and the block with extra mass
- 3) Make a graph of friction force vs Normal force. The slope of the graph should equal to the coefficient of friction for the surfaces used. The coefficient of friction for both plots should be the same.

Questions

- 1) What kind of curves do the graphs for 1 and 2 above look like. (hint- it's **NOT** one of the 3 major graphical relationships)

- 2) What was the effect of adding more mass to the cart and the block?

- 3) Why was the graph of force vs angle for the block different than the graph of force vs angle for the cart?

- 4) What is the percentage difference between your values for the coefficient of friction?

Quiz #18

**Inclined Planes: Why It Is
Hard To Go up a Steep Hill**

1. As the angle of a hill increases, the force required to keep you from slipping down
 - a. increases.
 - b. increases and then decreases.
 - c. decreases.
 - d. decreases and then increases.
2. In this lab you will measure the forces exerted on a cart and the
 - a. size of the cart.
 - b. length of the ramp.
 - c. angle of the ramp.
 - d. time for the cart to move 1 m.
3. The gravitational force on the cart on the ramp will always point
 - a. horizontally.
 - b. at a 45-degree angle from the horizontal.
 - c. vertically.
 - d. It can't always be determined.
4. When you are drawing your graph, you are supposed to use Xs when plotting values for the cart alone. The Os are used to allow you to see the difference between those values and the values for
 - a. a different mass.
 - b. a different length.
 - c. a different set of angles.
 - d. the vertical force.
5. When you walk up a hill, the frictional force opposes the
 - a. gravitational force.
 - b. parallel component of the gravitational force.
 - c. normal component of the gravitational force.
 - d. normal component of the frictional force.