12 Work and Power

Name_____

Lab A: WORKING WITH AN INCLINED PLANE

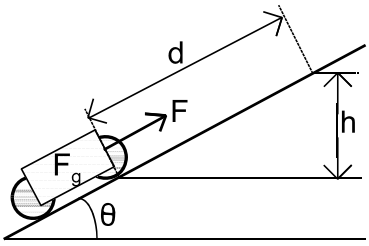
Inquiry Physics

An inclined plane is a simple machine used to lift objects by moving them diagonally rather than lifting them straight up. The inclined plane allows you to exert less force in raising an object to a certain height than would be needed to directly lift the object. In using an inclined plane, however, there is a trade-off, just as there is in using any type of simple machine. In this lab you will examine the use of an inclined plane and identify the trade-off in using it. This lab will help you understand an important concept in physics about force and distance.

EXPLORATION

You will be pulling a "Hall's carriage" up an adjustable inclined plane. A Hall's carriage is a wheeled cart that can hold various weights and, more importantly, is designed to have very low friction both internally and with the surface it rolls over. Thus, we can safely ignore frictional effects in this lab.

The diagram shows the variables associated with an inclined plane. Those are the variables with which you will experiment.



θ = angle of the plane to the horizontal
h = height carriage is moved through
d = parallel distance carriage is moved through
F_g = load moved up the plane
F = force exerted up the plane

A. First set the angle θ on the inclined plane. Record that value in the table. Do not change that angle during each series of measurements. Weigh the carriage and record this ***unloaded*** weight in the space above the table.

B. Measure a distance **d** along the plane through which you can pull the cart with constant velocity. Noting the precise distance **d** along the plane the carriage will be pulled over, use the trigonometric formula **h = (d)(sin θ)** to calculate **h**. Record **d** and **h** in the table.

C. Place the 500 gram mass in the carriage. Record the ***total*** weight of the ***loaded*** carriage as the first weight $\mathbf{F_g}$ in the table. Now use the spring scale to pull the carriage up the plane. Be sure the force needed to pull the object up the plane, **F**, is exerted **parallel** to the plane. Record **F** in the table.

D. Repeat the above procedure with 750 grams in the carriage. Keep the angle, θ, of the plane the same.

E. Repeat the procedure again with 1000 grams in the carriage.

F. You have now completed one set of measurements. Change the angle, θ, of the plane and repeat steps A–E to obtain a complete set of measurements for two different angles.

Carriage's Unloaded Weight = _____ N (include this in your total F_g below)

Table

θ (°)	F_g (N)	h (m)	F (N)	d (m)	Left Side	Right Side	% diff.

THE IDEA

Look at the variables **F_g**, **h**, **F**, and **d**. These four variables can be related by a single mathematical equation. (Much like **F**, **m**, and **a** are related by the single equation **F = ma**.) Experiment with common math operations (addition, subtraction, multiplication, and division) to find the equation.

Show how well your equation fits the data by calculating out the left side of the equation in the first shaded column of the table. Then calculate out the right side of the equation in the second shaded column.

EXAMPLE: If your equation were **F_g+h = F - d**, you would calculate **F_g + h** for each trial and put the results in the first shaded column. You would then calculate **F - d** for each trial and put the results in the second shaded column.

Next, calculate the percentage difference between the two sides of your equation in the last shaded column. Remember that the formula for percentage difference is:

$$\%\ difference = \frac{larger - smaller}{average} \times 100$$

Write the equation you have found below:

The equation you have found will introduce us to the concept of ***work***. We will use this concept to explain the purpose and limitations of simple machines like the inclined plane.