

Stopping Distance Lab

Teacher's Guide

Topic:

Work, Energy and Power

The following information is provided to the student:

Question:

What is the mathematical relationship between the stopping distance of a car and the initial speed of the car before braking?

Purpose:

To determine the mathematical relationship (i.e., equation) relating the stopping distance of a car and the initial speed of the car before braking.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion and a Discussion of Results. The Data section should organize the collected data in a table with labeled column headings and units. A plot of stopping distance versus speed should be included; linear or power regression should be performed and the results (equation, statistical information, etc.) should be reported. The Conclusion should answer the question posed in the Purpose. The Discussion of Results section should use theoretical considerations to discuss the expected relationship; the degree to which the experimental results match the theoretically predicted results should be discussed.

Materials Required:

Hot Wheels Car; Hot Wheels track; wood board; photogate system; photogate flag; masking tape; small box; meter stick.

Description of Procedure:

A wood board is inclined by elevating one of its ends on lab bench or seat top. A couple of pieces of Hot Wheels track are secured to the board with masking tape. The end of the track extends 1 foot beyond the end of the board onto the level floor. A photogate is placed on the floor near the end of the track. A Hot Wheels car is equipped with a photogate flag. The car is released from about 1 foot above the ground; it rolls down the track, through the photogate and collides with the box. Upon collision, the box-car system skids a short distance before stopping. The stopping distance is measured. Trials are repeated for varying starting heights, resulting in greater speeds and longer stopping distances. The photogate times and flag widths are used to determine the speed of the car before skidding to a stop. The set of speed-stopping distance data is plotted in an effort to determine the mathematical equation.

Alternative Materials and Procedure:

Alternative materials and procedures are not recommended.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

The Laboratory

Suggestions, Precautions, Notes:

1. The small boxes which were used to hold a 10-pack of 3.5-inch computer disks work great for this lab. These boxes are to find these days. Any small box will do as long as it slides freely across the floor and is big enough for the Hot Wheels car to fit inside of.
2. Tiled floors work much better than carpeted floors due to the lower friction coefficients.
3. Two meter sticks (if available) can be aligned parallel to the track and extending outward from just past the photogate for an additional meter. The meter sticks will force the box-car system to skid along a straight line. If placed appropriately, they also make a convenient means of measuring the stopping distance.
4. If the collision of the Hot Wheels car with the box were perfectly elastic, then one would expect that the stopping distance of the box/car system would be equal to the square of the speed of the car just prior to the collision. The collision is not elastic.
5. This lab presents a great opportunity to discuss with students some physics of safe driving. As the speed of a car increases, the distance required for the car to stop is roughly proportional to the square of that speed. Doubling the speed causes the stopping distance to be quadrupled. It follows from this relationship that the following distances for highway speeds need to be considerably greater than the following distances for city driving. Like a handful of our lessons, this is a lesson that can save some lives.

Auxiliary Materials:

None

Scoring Rubric:

E11. Stopping Distance Lab	Score
<ul style="list-style-type: none">___ Included, labeled and organized all parts of the lab report.___ Data section includes a table of collected data with column headings and units clearly stated. Included a graph of d vs. v or d vs. v^2 or ... ; axes are clearly labeled. Results of a linear or power regression analysis are reported.___ Conclusion states the mathematical equation relating d and v; used appropriate symbols in the equation.___ Discussion of Results discusses the theoretical basis for the relationship between d and v; used physics equations and mathematical manipulations to present the expectations. The degree to which theory and experiment agree is discussed. Discussion reveals understanding.	___/___

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/energy/u5l2b.cfm>

<http://www.physicsclassroom.com/Class/energy/u5l2bc.cfm>

Connections to Minds on Physics Internet Modules:

Sublevels 9 and 10 of the Work and Energy module are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/mop/module.cfm>