

Galileo For a Day Lab

Teacher's Guide

Topic:

Newton's Laws of Motion

The following information is provided to the student:

Question:

What effect does minimizing friction have upon the motion of an object after an initial push is applied to it?

Purpose:

To determine the effect of minimizing friction upon the subsequent motion of an object after it is set in motion by an initial push.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion, a Discussion of Results and Post Lab Questions. The Data section should include a velocity-time graph with several lines or several velocity-time graphs with one line; the graphs should be labeled and communicate the effect of minimizing friction upon the subsequent motion of the object. The Conclusion should respond to the question raised in the Purpose of the lab (as always). The Discussion of Results section should reference the Data section and discuss the supporting evidence for the conclusion; a statement should be made about the expected result under a condition of no friction. The sheet of Post-Lab questions should be answered and posted into your notebook.

Materials Required:

Cart equipped with an adjustable friction feature; track; computer-interfaced motion detector.

Description of Procedure:

The motion of a cart with a varying amount of friction is observed. Students push the cart and observe the subsequent motion occurring after the push. Students use a motion detector to detect the motion of a cart; the velocity-time graphs are analyzed. The trial is repeated with less friction; the post-push motion is again observed. The process is repeated with less and less friction in each consecutive trial.

Alternative Materials and Procedure:

Regardless of the materials and methods used, two things are required: a means of easily reducing the amount of friction the object experiences and a means of quickly determining the rate of deceleration which occurs during the post-push stage. A motion detector and a velocity-time graph is a very efficient means of observing the relative deceleration. If not available, the use of a photogate system or a ticker tape trace would be the most efficient alternatives.

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.

Suggestions, Precautions, Notes:

The Laboratory

1. [Pasco Scientific](#) sells low friction carts with a Friction Cart Accessory (ME-9457). A screw is turned clockwise and counter-clockwise in order to increase and decrease the amount of friction which the cart encounters.
2. This lab introduces students to some of Galileo's thoughts regarding force and motion. The main outcome of the lab is that students learn that a force is not required to keep an object moving. In fact, it is a force (friction) which causes a moving object to slow down.
3. It is best to run the trials in such a manner that the amount of friction is reduced in each consecutive trial; that is, from lots of friction to very little friction.

Auxiliary Materials:

The following page is provided to the student for completion and inclusion in their lab notebook.

Post-Lab Questions:

A portion of Newton's first law of motion is "... an object in motion will stay in motion at the same speed and in the same direction unless acted upon by *an unbalanced force*." The idea is that **forces, when unbalanced, cause acceleration**. The diagrams below represent force diagrams. The various forces acting on a rightward moving cart are shown. The size of the arrow represents the strength or magnitude of the force.

Diagram A

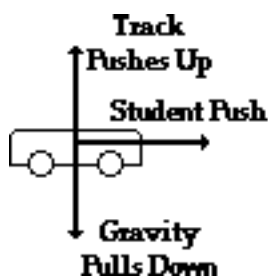


Diagram B

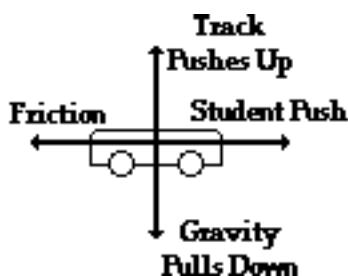


Diagram C

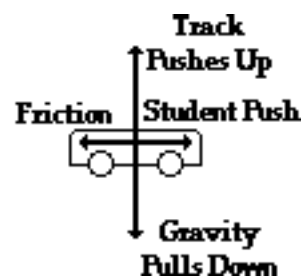


Diagram D

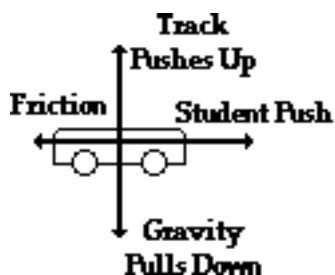


Diagram E

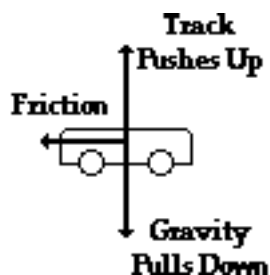


Diagram F

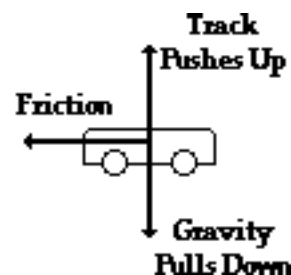
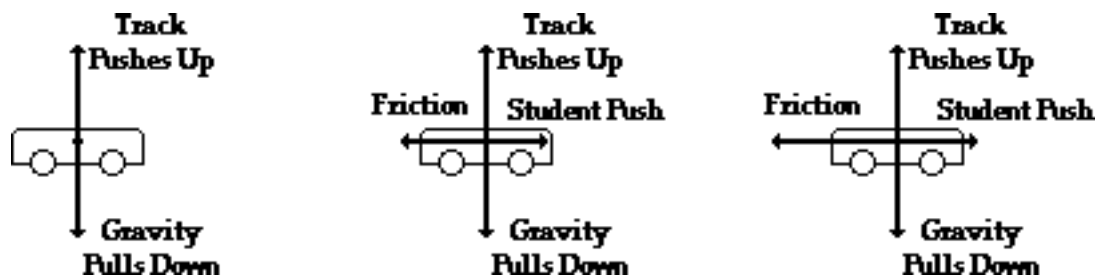


Diagram G

Diagram H

Diagram I

The Laboratory



Which force diagram corresponds to the motion of the cart during the ...

- ... push-phase _____
- ... the no-push phase (maximum friction) _____
- ... the no-push phase (medium friction) _____
- ... the no-push phase (absolutely no friction) _____

Scoring Rubric:

NL2. Galileo for a Day Lab	Score
<ul style="list-style-type: none"> ___ Included, labeled and organized all parts of the lab report. ___ Data section includes a record of your investigation – showing the various velocity-time graph results for the trials of varying friction. Graphs are clearly labeled (axes labels and information about the level of friction). Graphs appear accurate and suitable to the task of drawing a conclusion. ___ Conclusion accurately answers the question posed in the purpose (as always). ___ Discussion of Results discusses how the evidence (observations from the Data section) supports such a conclusion. Accurately <i>extrapolated</i> the results of study to predict the expected result under the condition of no friction. ___ Post-lab questions were included and completely and accurately answered. 	___/___

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/newtlaws/u2l1c.cfm>

<http://www.physicsclassroom.com/Class/newtlaws/u2l1d.cfm>

Connections to Minds on Physics Internet Modules:

Sublevel 1 of the Newton's Law module is a suitable accompaniment to this lab:

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