The Laboratory

Free Fall Lab

Teacher's Guide

Topic:

One Dimensional Kinematics

The following information is provided to the student:

> **Question:**
> How can the acceleration of a free-falling object be described? Is it constant or changing? Is it directed upward or downward? Is there a magnitude that is commonly associated with it?
>
> **Purpose:**
> To describe the acceleration of a free-falling object as being either constant or changing; as being directed upward, downward or both (depending on some other variable); and as having a particular numerical value.
>
> A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion and a Discussion of Results. The Data section should include a sketch of the velocity-time graph representing the object's motion. Results of the slope analyses should be organized in a table; an average of all trials (except those which are obvious outliers) should be recorded. Class data should be recorded and labeled as such. The Conclusion should respond to the questions raised in the Purpose of the lab. The Discussion section should include an error analysis.

Materials Required:

Computer-interfaced motion detector and accompanying software; soccer ball (or ball of comparable size and mass).

Description of Procedure:

Students use a motion detector to detect the motion of a soccer ball. Once the motion detector is started and the ball is held for a couple of seconds, it is dropped and falls to the ground. The data can be represented upon a velocity-time graph. The slope of the graph becomes the focus of the lab and the source of answers to the lab's questions. The procedure is easily repeated in an effort to obtain reproducible results. Most software programs associated with motion detectors allow the user to highlight a section of the graph and then click a button to obtain results of a linear regression analysis.

Alternative Materials and Procedure:

Any ball which is large enough to be easily detected by the motion detector and massive enough to overwhelm drag forces is suitable for this lab. If a motion detector is not available, a ticker tape timer can be used to collect position-time data. This process becomes cumbersome as the position-time data must be used to calculated instantaneous velocities with respect to time.

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 working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated. If a heavy object is dropped, warn students to clear the area below the drop location before dropping.

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Suggestions, Precautions, Notes:
1. It is helpful to pool class results for the slope and regression constant. Averaging all results typically leads to the expected results.
2. Place the motion detector above the ball so as to protect the detector from a ball collision.
3. Don't be afraid to have students detect the fall and the bounces. The motion which occurs between each consecutive bounce (contact with the ground) is also a free fall motion. The shape of the line on the v-t graph is identical to the shape of the line during the initial falling motion.

Auxiliary Materials:

None

Scoring Rubric:

K9.	**Free Fall Lab**	**Score**
____	Included, labeled and organized all parts of the lab report.	
____	Data section includes sketch of the velocity-time graph. The highlighted region used to determine the slope is shown on the graph. A table of several trials is recorded with column headings and units; slope values for each trial are reported. An average of all reasonable trials is recorded. Class data is reported and labeled.	____/____
____	Conclusion describes the free fall acceleration of the object, accurately responding to each of the three parts of the Purpose.	
____	Discussion of Results appropriately evaluates the reliability of the data; personal data is compared to class data and to the theoretical value. A percent error analysis is performed; work is shown and labeled. Reveals understanding.	

Connections to The Physics Classroom Tutorial:

This lab is a suitable accompaniment to the reading at:

http://www.physicsclassroom.com/Class/1DKin/u1l5b.cfm

http://www.physicsclassroom.com/Class/1DKin/u1l5c.cfm

Connections to Minds on Physics Internet Modules:

None