

## Speedometer Cubed Lab

### Teacher's Guide

**Topic:**

One Dimensional Kinematics

**The following information is provided to the student:**

**Question:**

What is the speed of an object as determined by a meter stick and a stopwatch, a ticker tape timer and a meter stick and a motion detector? How do the three methods of determining speed compare in terms of their accuracy and precision?

**Purpose:**

To determine the speed of an object using three different methods and to compare the accuracy and precision of the results of each method.

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 an organized and labeled record of the measurements resulting from each of the three methods of measuring speed – stopwatch and meter stick method, ticker tape and meter stick method, and LabPro motion detector method. Both measured and calculated data should be listed; work should be shown. The Conclusion/Discussion should identify the speed values determined from each method. An error analysis should be performed; the accuracy and precision of each method should be compared; reasons for such conclusions should be explained.

**Materials Required:**

Toy car (either battery-powered constant speed or wind-up), meter stick, stopwatch or timing device, ticker tape timer, ticker tape, carbon disc, masking tape, computer-interfaced motion detector.

**Description of Procedure:**

This is a higher-tech version of the Speedometer Lab. It involves the use of three methods for determining the speed of a toy car. All three methods will provide a distance-time ratio for the car. The meter stick and stopwatch method will allow the student to either measure the time for the car to move a designated distance or measure the distance traveled in a designated time. Using the ticker tape timer, tape can be taped to the car and pulled through the timer in order to leave a trace of dots on the tape. Knowing the timer's *tick rate*, a meter stick can be used to determine the distance traveled over the course of 20 ticks (or 50 ticks or ...). The time between ticks is simply the reciprocal of the tick rate; a 50 Hz timer places ticks on the tape every 0.020 seconds; so the distance traveled (measured with a meter stick) over 40 ticks is the distance traveled in 0.80 seconds. The motion detectors provide position and time data in both tabular and graphical form. Either representation can be used to determine a distance traveled in a corresponding time.

**Alternative Materials and Procedure:**

If ticker tape timers and/or computer-interfaced motion detectors are not available, consider using the Speedometer Lab instead.

**Safety Concern:**

## The Laboratory

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* (especially the use of meter sticks as swords) and off-task behaviors should not be tolerated.

### Suggestions, Precautions, Notes:

1. If ticker tape timers are not available in sufficient quantity, a single set-up (or two) at the teacher station will allow for quick acquisition of ticker tapes. The process goes much quickly if students bring their cars up and the teacher tapes the ticker tape to the car and assists with the process.
2. If the motion detector is not detected the small car, a 4"x6" note card can be taped to the front or rear end so that it is vertical to the table surface or floor. The detector typically has no difficulty detecting the note card.
3. Extensive information on the use of ticker tape timers is available online. For instance see: [http://www.practicalphysics.org/go/Experiment\\_265.html](http://www.practicalphysics.org/go/Experiment_265.html)

### Auxiliary Materials:

None

### Scoring Rubric:

<b>K2. Speedometer Cubed Lab</b>	<b>Score</b>
____ Included, labeled and organized all parts of the lab report. ____ Data section includes measured and calculated data for each of the three methods of speed measurement. Data is organized and clearly labeled. Work is shown for calculations. Units are stated for all numerical values. ____ Conclusion/Discussion identifies the three different speed values. An error analysis is performed, the accuracy and precision of the three different methods is evaluated; explanations for such judgments are given. Discussion is thorough and reveals understanding.	____/____

### Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/1DKin/u111d.cfm>

<http://www.physicsclassroom.com/Class/1DKin/u112b.cfm>

### Connections to Minds on Physics Internet Modules:

Sublevels 3, 5, and 6 of the Kinematic Concepts module are a suitable accompaniment to this lab:

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