CONCEPTUAL PHYSICS LAB AVERAGE SPEED

PURPOSE: To determine your average speed in a particular event, and to use your average speed to calculate an unknown distance.

INTRODUCTION: Average speed is a measure of how fast an object moves over a certain time period:

$$average\ speed = \frac{total\ distance\ covered}{time\ interval} \qquad \text{or} \qquad s = \frac{d}{t}$$

MATERIALS:
Stopwatch, tape measure or meter sticks

PROCEDURE:
Part A: Average Speed Determination
For this part of the lab, you need to choose an activity such as walking or running, and determine your average speed for that activity.

1. Use a tape measure to mark a distance somewhere between 15 and 20 meters; record this distance:_____
2. Record your chosen activity: _____
3. Construct a data table below for additional information necessary to solve the problem. Be sure to allow for multiple trials.

4. While collecting your data, try to keep your speed as constant as possibly. Your times should not vary by too much!
5. Calculate your average speed for this activity in the space below, being sure to show all your work and include units in your calculations.

Part B: Determination of the Unknown Distance

While you are outside, your teacher will identify an unknown distance, and you will try to determine what that distance is ***without*** directly measuring it.

1. How will you use the average speed you determined in Part A to calculate the unknown distance?

2. Construct a data table below for additional information necessary to solve the problem. Be sure to allow for multiple trials.

3. While collecting your data, try to maintain the same speed as you used in Part A of this lab.
4. Calculate the unknown distance, being sure to show all your work and to include units in your calculations.

5. Find out from your instructor what the actual distance was that you were measuring. Then calculate your *percent error* using the following formula:

$$percent\ error = \frac{|MeasuredValue - RealValue|}{RealValue} \times 100$$

Part C: Thinking Further

A ball placed at the top of a 3.00-meter long ramp is released from rest, and rolls down the ramp, reaching the bottom 1.80 seconds later.

1. Draw a sketch of the ramp and the ball at the top. Label all known quantities.

2. What is the ***average speed*** of the ball during its motion down the ramp?

3. Based on what you know about calculating averages, determine the ***instantaneous speed*** of the ball when it reaches the very ***bottom*** of the ramp.

4. Based on what you know about acceleration, determine the acceleration of the ball as it rolls down the ramp.

TEACHER NOTES:

Discuss with students the fact that they'll need to attempt to keep a consistent speed across trials in the first part of the lab, so that they'll be able to have useful data for determining the distance in the second part of the lab.

At the start of the school year, students may need assistance in developing a data table. In most cases, students will want to create something like this:

Trial #	Measured time to travel distance (seconds)
1	
2	
3	
Average time (seconds) ->	

The strategy in Part B consists of having students understand that they can rearrange the $s = \frac{d}{t}$ equation to yield $d = st$.

Part C asks students to consider how the *average* speed is related to changing speeds when the initial speed is 0:

$$v_{average} = \frac{v_{initial} + v_{final}}{2}$$

$$v_{average} = \frac{0 + v_{final}}{2} \text{ when object starts from rest}$$

$$v_{final} = 2 \times v_{average}$$

The topic of acceleration is also introduced, although some students may not yet be ready to actually perform this calculation.

$$a = \frac{change\ in\ velocity}{time} = \frac{\Delta v}{\Delta t}$$

$$a = \frac{v_{final} - v_{initial}}{t}$$