VELOCITY & ACCELERATION

Experiment 3

INTRODUCTION:

Acceleration of objects due to free fall is large and somewhat difficult to measure, due to the short times required to measure. Hundreds of years ago Galileo found that one could "slow down" the acceleration by not letting things fall straight down. Rather, he made them "fall" at an angle; in other words he let them fall down an inclined plane. In this way they didn't cover as much distance in a given time interval and the change in speed was slower.

In this experiment, we let an object roll down an inclined plane and measure the time and distance it requires to make the trip. We can determine the average speed of the object by dividing the distance covered by the time required. We will also determine the object's acceleration by determining the change in speed from start to the end of its travel.

APPARATUS& MATERIALS:

- ruler
- wooden block
- plastic cup
- plastic tubing
- steel balls of various size
- stopwatch

PROCEDURE:

1. Determine the mass of each ball and record in Table 1 on the Report Form. Use the plastic cup to support the balls on the balance.
2. Set up a ramp by placing the wooden block underneath the ruler, at one end. Use the plastic tubing at the other end of the ruler to stop the balls from rolling off the table. Record the length of the ramp (30 cm) in Table 1 on the Report Form.
3. Position a steel ball in the groove in the middle of the ruler, and hold it at the top of the ramp, using a pencil or pen. Then release it quickly and smoothly so that it rolls down the ramp.
4. Use a stopwatch to measure the time it takes the ball to roll down the ramp.
5. Practice removing the pencil so that a smooth start can be carried out. Also practice using the stopwatch so that it can be reliably started and stopped at the beginning and finish of the trip.
6. Release the ball from the top of the ramp and measure the time it takes to travel to the end of the ramp. Make at least three time determinations and enter them into Table 1. Average the three trials and use this average time for further calculations and graphs.
6. Repeat step 5 using another ball of different mass.

CALCULATIONS:

1. Determine the average speed for each ball by using the equation below, and record in Table 2 on the Report Form.

$$\text{average speed} = \frac{\text{distance}}{\text{average time}}$$

2. Use the relationships shown below to determine the final speed, and record in Table 2 on the Report Form.

$$\text{average speed} = \frac{\text{speed}_{(\text{final})} + \text{speed}_{(\text{initial})}}{2}$$

Rearranging the above,

$$\text{speed}_{(\text{final})} = 2\ (\text{average speed}) - \text{speed}_{(\text{initial})} =$$

3. Determine the acceleration for each ball, using the equation below, and record in Table 2 on the Report Form. Recall that the initial speed of the ball at the top of the ramp is zero.

$$\text{acceleration} = \frac{\text{final speed - initial speed}}{\text{average time}}$$

Name:_____

REPORT FORM

Experiment 3

Table 1

Mass of ball (g)	*Distance of ramp (cm)*	*Time (sec)*			
		Trial 1	*Trial 2*	*Trial 3*	*Average*

Table 2

Ball Size	*Quantity*	*Answer (include units)*	*Show calculations here*
SMALL	***Average Speed***		
	Final Speed		
	Acceleration		
LARGE	***Average Speed***		
	Final Speed		
	Acceleration		

QUESTIONS:

1. Complete the statements below:
   A. The large ball was _____times heavier than the small ball, while the average speed of the large ball was _____ times the average speed of the small ball. Within the margin of probable experimental error, does the speed of the ball depend on the mass of the ball? _____.

   B. The large ball was _____times heavier than the small ball, while the acceleration of the large ball was _____ times the acceleration of the small ball. Within the margin of probable experimental error, does the acceleration of the ball depend on the mass of the ball? _____.

2. Why is it easier to do this experiment with an inclined ramp rather than dropping the balls straight to the ground?

3. What do you think would happen to the acceleration of the ball if the angle of incline was increased? Explain.

4. What would the acceleration of the ball be if the angle of incline was increased to 90?? Explain.