Name _____ Class _____ Date _____

Velocity of a Projectile

When a ball rolls down an inclined plane, then rolls off the edge of a table, the ball becomes a projectile with some positive horizontal velocity and an initial vertical velocity of zero. However, the length of time that the projectile stays in the air depends not on the horizontal velocity but on the height of the table above the ground. The horizontal velocity determines how far the projectile travels during the time it is in the air.

In this lab, you will roll a ball down an inclined plane, off the edge of a table, and onto a piece of carbon paper on the floor. You will design your own experiment by deciding the details of the setup and the procedure, including how many trials to perform, the angles of the inclined plane, and how high up the plane you will release the ball. Your experiment should include trials with the plane inclined to different angles and multiple trials at different heights along the plane at each angle of inclination. Your procedure should include steps to measure the height from which the ball is released, the length of the ball's travel along the plane, and the horizontal displacement of the ball after it leaves the table.

OBJECTIVES

Measure the velocity of projectiles in terms of the horizontal displacement during free fall.

Compare the velocity and acceleration of projectiles accelerated down different inclined planes.

MATERIALS LIST

- aluminum sheet, edges covered with heavy tape
- C-clamp
- cardboard box
- cord
- inclined plane
- masking tape
- meterstick
- packing tape
- several large sheets white paper
- several sheets carbon paper
- small metal ball
- small metal washer
- support stand and clamp
- towel or cloth

SAFETY

- Tie back long hair, secure loose clothing, and remove loose jewelry to prevent its getting caught in moving or rotating parts. Put on goggles.
- Perform this experiment in a clear area. Falling or dropped masses can cause serious injury.

Procedure

1. Study the materials provided, and read the Analysis and Conclusions questions. Design an experiment using the provided materials to meet the objectives stated above and to allow you to answer the questions.

2. Write out your lab procedure on a separate sheet of paper, including a detailed description of the measurements to take during each step and the number of trials to perform. Record your measurements for each trial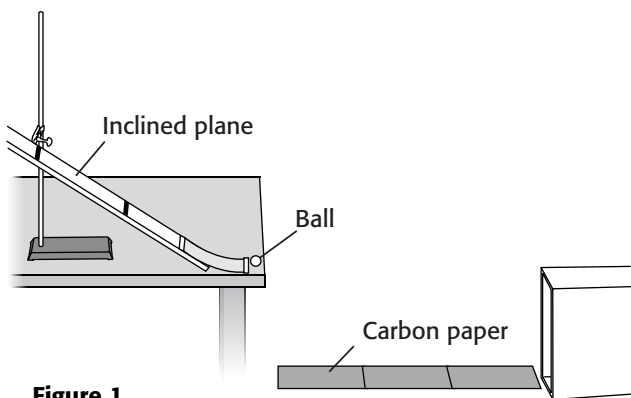 in the data table below. You may use **Figure 1** as a guide to one possible setup. Your setup should include a box to catch the ball at the end of each trial.

Figure 1

Trial	Height of Ramp (m)	Length of Ramp (m)	Displacement Δx (m)	Displacement Δy (m)
1				
2				
3				
4				
5				
6				
7				
8				

3. Ask your teacher to approve your procedure.

4. Follow all steps of your procedure.

5. Clean up your work area as directed by your teacher.

Velocity of a Projectile *continued*

Analysis

1. **Organizing Data** Find the time interval for the ball's motion from the edge of
   the table to the floor using the equation for the vertical motion of a projectile.
   In those equations, Δy is the vertical displacement of the ball after it leaves
   the table. The result is the time interval for each trial.

2. **Organizing Data** Using the time interval from item 1 and the value for
   Displacement Δx, calculate the average horizontal velocity for each trial
   during the ball's motion from the edge of the table to the floor.

3. **Constructing Graphs** Plot a graph of average horizontal velocity versus height
   of release. You may use graph paper, a computer, or a graphing calculator.

4. Constructing Graphs Plot a graph of average horizontal velocity versus length of travel along the plane. You may use graph paper, a computer, or a graphing calculator.

Conclusions

5. Drawing Conclusions What is the relationship between the height of the inclined plane and the horizontal velocity of the ball? Explain.

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6. Drawing Conclusions What is the relationship between the length of the inclined plane and the horizontal velocity of the ball? Explain.

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7. Evaluating Methods Why might using the vertical displacement to calculate the time interval be more reliable than using a stopwatch for each trial?

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| Velocity of a Projectile *continued*

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8. Applying Conclusions In which trials would the total velocity of the ball when it hits the ground be the greatest?

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Extension

9. Designing Experiments Design an experiment to test the assumption that the time the ball is in the air is independent of the horizontal velocity of the ball. If you have time and your teacher approves your plan, carry out the experiment.