

1: Motion

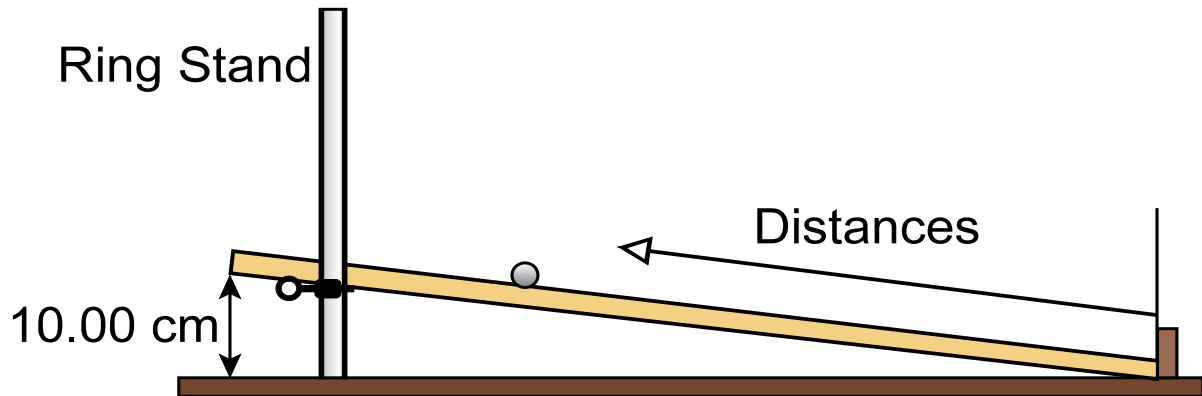
Lab: Galilean Ramp

Name _____

AP/Inquiry Physics

There are fundamental principles governing the motion of all objects, from supersonic aircraft to glaciers. This lab is similar to experiments conducted by Galileo Galilei several hundred years ago which laid the foundations for modern-day physics.

Set up the equipment as shown in the diagram below:



Use the ring stand and ring to raise one end of the track until the distance between the bottom of the track and the tabletop is 10.00 cm.

You will be varying distance. Mark off (**on masking tape**) the following distances from the lower end of the track: 25.00 cm, 50.00 cm, 75.00 cm, 100.00 cm, 125.00 cm, 150.00 cm, and 175.00 cm. Be sure the tape will not interfere with the motion of the ball. You will measure the time required for the ball to travel each of those seven distances.

1. Begin taking data by placing the ball at the 175.00 cm mark. To start the ball the same way each time, keep it at the mark on the incline with a pencil until you are ready to release it and begin timing. Don't push or spin the ball when you pull the pencil away! Start a stopwatch as the ball is released and stop the watch as the ball reaches the stop. Make **three** measurements of time to as many decimal places as possible, ensuring that the difference between the highest and lowest measurements is no more than 0.10 s. Record those values in the table on the reverse.
2. Gather the same data as before, but start the ball at the mark that will make the distance equal to 150.00 cm. Make three measurements of time and record them in the table.
3. Repeat the data gathering process for each of the other distances. Record the data in the table.

Distance (cm)	Time (s)	Average Time (s)	
175.00			
150.00			
125.00			
100.00			
75.00			
50.00			
25.00			

The Idea ANSWER ALL QUESTIONS IN COMPLETE SENTENCES, EXCEPT FOR MATH FORMULAS

1. Identify the independent and dependent variables in this experiment.

Use the computer to create a graph of distance traveled along the incline versus **average** time. Graphs involving time always plot time horizontally on the x-axis and the other variable vertically on the y-axis. This can violate the usual practice of placing the independent variable on the x-axis and the dependent on the y-axis.

When inputting the data you need to decide if (0,0) is a valid point to include. **SHOW YOUR GRAPH TO MR. M BEFORE PRINTING.** After you have his approval, print a graph for each member of the group. Save your data as H#G#L1A, with your hour and group numbers in place of the pound signs.

2. What is the shape of the line on your graph? (Is it straight or is it curved? If it is curved, state whether it looks parabolic, hyperbolic, etc.)

3. The shape of a graph illustrates the mathematical relationship between the independent and dependent variables. What does your graph specifically show you about the relationship between distance and time?

4. Express the relationship you described in question 3 as a proportionality: _____

5. According to the graph, what was the ball doing as it went down the track?

ANSWER ALL QUESTIONS IN COMPLETE SENTENCES, EXCEPT FOR MATH FORMULAS

6. The above graph has a best-fit curve. What type of fit did you instruct the computer to perform (linear, quadratic, inverse, etc.)?
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7. In question 4, you expressed the basic proportionality between the independent and dependent variables. Your best-fit curve allows you to now express the precise equation for your group's data. Use your graph to fill in the missing values in this equation. **Round off the values to the appropriate number of significant figures.**

$$d = \underline{\hspace{2cm}} + \underline{\hspace{2cm}} t + \underline{\hspace{2cm}} t^2$$

Soon we will examine *how* the speed of the ball was changing.

ANSWER ALL QUESTIONS IN COMPLETE SENTENCES, EXCEPT FOR MATH FORMULAS

8. What kind of fit did you perform on the above speed vs. time graph?

9. What does this graph's shape indicate about the relationship between speed and time? (Be specific!)

10. Express the relationship you described in question 9 as a proportionality: _____

11. How was the speed changing as the ball went down the track? (Go beyond your answer to question 5.)

12. Your graph allows you to formulate an equation that fits your data. Write that equation below, substituting the appropriate variable letters for x and y, and rounding off the numbers to the proper significant figures.

Types of Laboratory Error

Type	Examples	Prevention	Discussion
personal error (mistakes)	mis-reading a scale or incorrectly rearranging an equation or calculating a figure	check against lab partners' work; redo parts of lab as needed when error discovered	none ; should be corrected before lab is submitted
systematic error	miscalibration or uncontrolled variables (e.g. friction); includes unavoidable timing errors	calibrate equipment when possible; think through procedures to minimize error	identify any uncontrollable variables (do not include variables causing random error)
random error	estimating the last digit on a scale reading; minor variations in temperature or air pressure	eliminate when possible; can never be completely eliminated	none

13. In a few sentences, discuss the systematic error in this laboratory.
