

Calculating Average Speed of a Rolling Marble

INTRODUCTION AND OBJECTIVES

In a typical paper roller coaster, the speed of a marble will increase and decrease many times. In this activity, you will find the speed of the marble in different portions of a paper roller coaster. Finally, you will also find the average speed of the marble during the entire trip down the paper roller coaster.

EQUIPMENT NEEDED

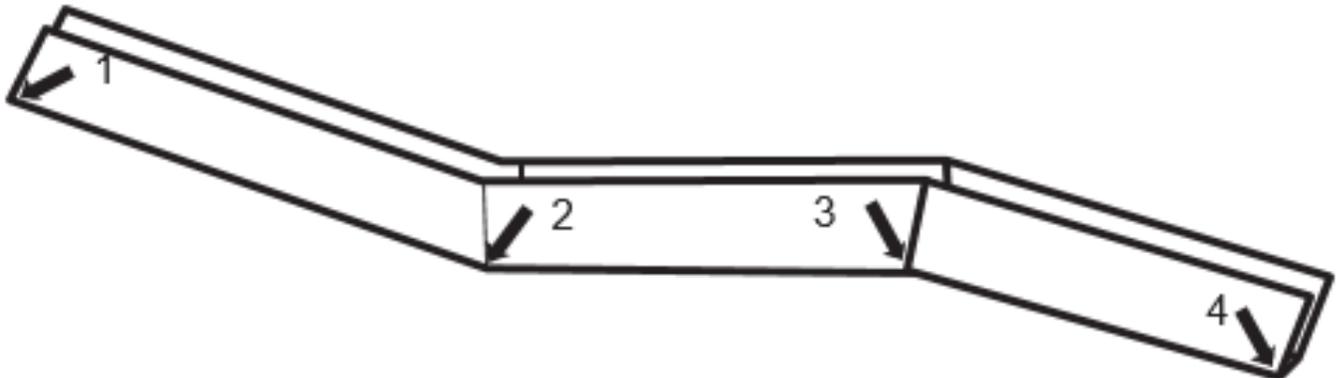
- Completed roller coaster
- Tape measure or meter stick
- Pencil
- Calculator
- String

PROCEDURE

I. Selecting starting and ending points.

1. Divide your **entire** paper roller coaster into three different sections by placing marks on the tracks.
2. Label the beginning of the roller coaster with a “1.” See the image below for guidance.
3. About 1/3 of the way down the roller coaster, label the track with a “2.”
4. About 2/3 of the way down the roller coaster, label the track with a “3.”
5. Label the end of the roller coaster with a “4.”

An example of how to label the paper roller coaster. Please note that your roller coaster should be significantly longer than the example.

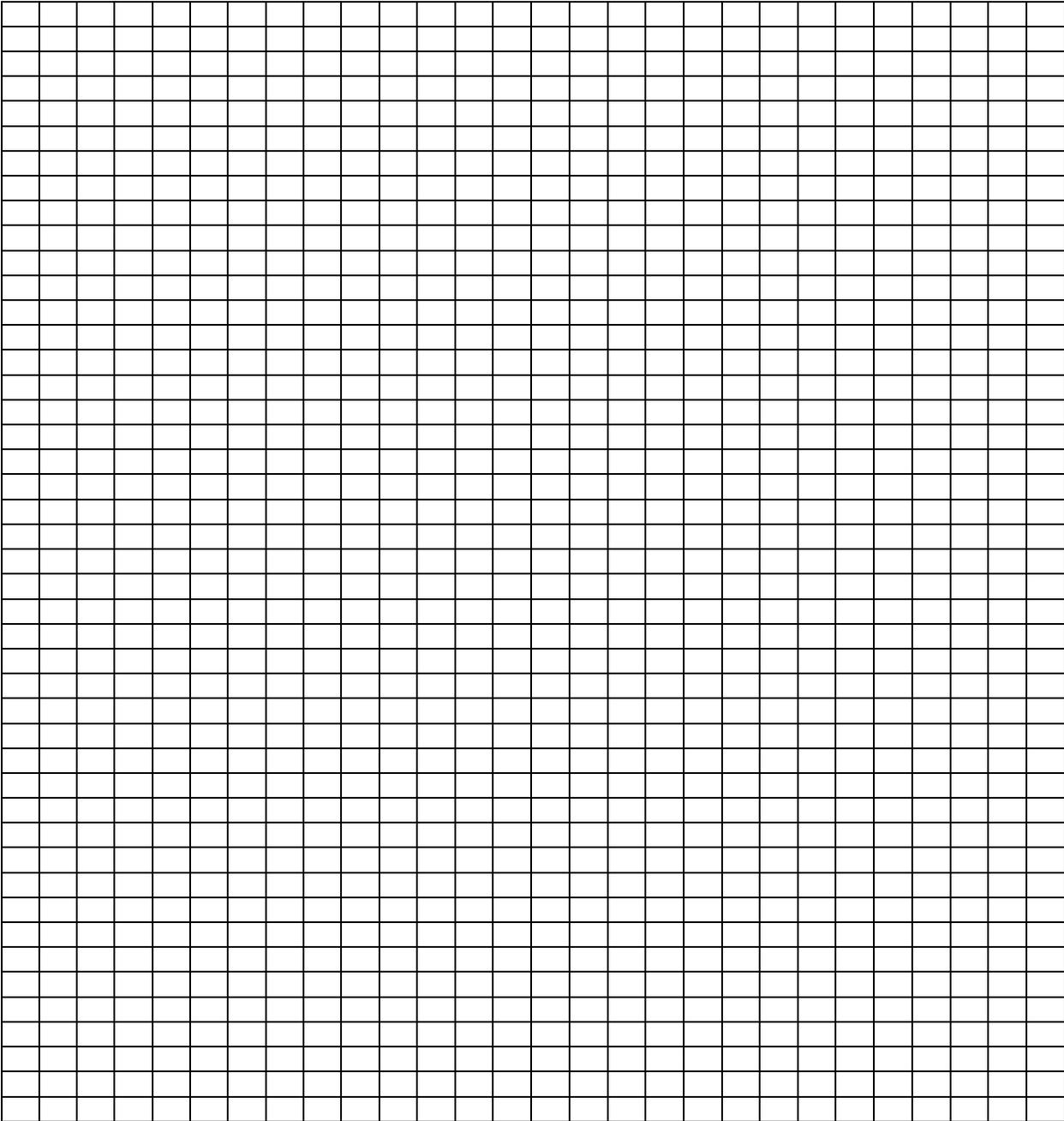


II. Measuring Distances between points

1. Measure the distance that the marble must travel to get from point 1 to point 2. To do this, lay one end of a string on the track at point 1. Stretch the string along the path that the marble will travel. Mark the string where it meets point 2 on the track. Remove the string from the track and measure the length of the string that reached from point 1 to point 2 when it was lying on the track. Record the distance in centimeters in the data table. Convert the distance to meters and record it in the data table.
2. Use the same procedure to measure the distance from point 2 to point 3 and the distance from point 3 to point 4. Record these distances in centimeters in the data table. Then convert them to meters and record them in the data table.
3. Measure the amount of time it takes for the marble to roll from point 1 to point 2. To do this, release the marble at point 1 and use a stopwatch (device) to find how long it takes for the marble to reach point 2. Record this time in the data table. Repeat this procedure **three** times and record your results in the data table. Find the **average** for the three trials and enter that time in the data table.
4. Measure the amount of time it takes for the marble to roll from point 2 to point 3. **Do not release the marble at point 2.** Instead, release the marble at point 1 again and start the stopwatch when it passes point 2. Stop the timer when the marble passes point 3. Repeat for three trials and calculate the average.
5. Measure the amount of time it takes for the marble to roll from point 3 to point 4. **Do not release the marble at point 3.** Instead, release the marble at point 1 again and start the stopwatch when it passes point 3. Stop the timer when the marble reaches point 4. Repeat for three trials and calculate the average.
6. Calculate the average speed of the marble between point 1 and point 2. Divide the distance between point 1 and point 2 by the average amount of time that it took to get from point 1 to point 2. Enter the speed of the marble in the data table. Use the correct units in the table.
7. Calculate the average speed of the marble between point 2 and point 3. Record your result in the table. Repeat the same steps to calculate the average speed of the marble between point 3 and point 4.

	Distance (cm)	Distance (meters)	Time(s) Trial 1	Time(s) Trial 2	Time(s) Trial 3	Average Time(s)	Average Speed (meters/second)
Point 1 to Point 2							
Point 2 to Point 3							
Point 3 to Point 4							
Point 1 to Point 4							

III. Graph the speeds of point 1 to 2, point 2 to 3, and point 3 to 4 from trial 1, trial 2, and trial 3. Each line should represent a different trial.



IV. Analysis

1. Between which two points did the marble have the highest average speed? Why do you think that the marble was moving the fastest on this part of your roller coaster?

2. Between which two points did the marble have the lowest average speed? Why do you think that the marble was moving the slowest on this part of your roller coaster?

3. If you wanted to decrease your roller coaster's average speed from the top (point 1) to the bottom (point 4), how would you redesign it?

4. Calculate the average speed of the marble during the entire trip down the paper roller coaster.

	Distance (cm)	Distance (meters)	Time(s) Trial 1	Time(s) Trial 2	Time(s) Trial 3	Average Time(s)	Average Speed (meters/second)
Point 1 to Point4							