

Acceleration and Slope

Complete
using class data
on page 61

OVERVIEW AND PURPOSE

When a downhill skier glides down a mountain without using her ski poles, her velocity increases and she experiences acceleration. How would gliding down a hill with a greater slope affect her acceleration? In this investigation you will

- calculate the acceleration of an object rolling down two ramps of different slopes
- determine how the slope of the ramp affects the acceleration of the object

MATERIALS

- 2 meter sticks
- masking tape
- marble
- 2 paperback books
- ruler
- stopwatch
- calculator

Problem

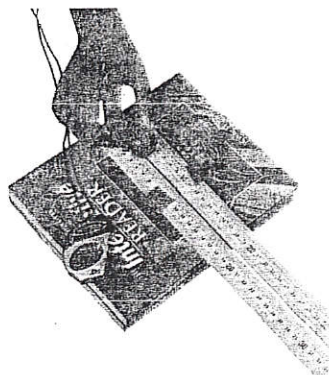
How does the slope of a ramp affect the acceleration of an object rolling down the ramp?

Hypothesis

Write a hypothesis to explain how changing the slope of the ramp will affect acceleration. Your hypothesis should take the form of an "If . . . , then . . . , because . . ." statement.

Procedure

- 1 Make a ramp by laying two meter sticks side-by-side. Leave a small gap between the meter sticks.
- 2 Use masking tape as shown in the photograph to join the meter sticks. The marble should be able to roll freely along the groove.



Name _____

Period _____

Date _____

- 3 Set up your ramp on a smooth, even surface, such as a tabletop. Raise one end of the ramp on top of one of the books. The other end of the ramp should remain on the table.
- 4 Make a finish line by putting a piece of tape on the tabletop 30 cm from the bottom of the ramp. Place a ruler just beyond the finish line to keep your marble from rolling beyond your work area.
- 5 Test your ramp by releasing the marble from the top of the ramp. Make sure that the marble rolls freely. Do not push on the marble.
- 6 Release the marble and measure the time it takes for it to roll from the release point to the end of the ramp. Record this time under Column A for trial 1.

TABLE 1. TIME FOR MARBLE TO TRAVEL DOWN RAMP

Height of Ramp (cm)	Trial Number	Column A Time from release to end of ramp	Column B Time from end of ramp to finish line
Ramp 1: <u>1.4</u> cm	1	4.13 s	0.75 s
	2	4.10 s	0.84 s
	3	4.19 s	0.89 s
	4	4.08 s	0.82 s
	Totals		
		Average	Average
Ramp 2: <u>2.8</u> cm	1	2.82 s	0.57 s
	2	3.01 s	0.69 s
	3	2.85 s	0.53 s
	4	2.89 s	0.52 s
	Totals		
		Average	Average

- 7 Release the marble again from the same point, and record the time it takes the marble to roll from the end of the ramp to the finish line. Record this time in Column B for trial. Repeat and record three more trials.
- 8 Raise the height of the ramp by propping it up with both paperback books. Repeat steps 6 and 7.

Observe and Analyze

1. **Record Observations** Draw the setup of your procedures. Be sure your data table is complete.



2. **Identify Variables and Constants** Identify the variables and constants in the experiment.

3. **Calculate**

Average Time For ramps 1 and 2, calculate and record the average time it took for the marble to travel from the end of the ramp to the finish line.

Final Velocity For ramps 1 and 2, calculate and record v_{final} using the formula below.

$$v_{final} = \frac{\text{distance from end of ramp to finish line}}{\text{average time from end of ramp to finish line}}$$

Acceleration For ramps 1 and 2, calculate and record acceleration using the formula below. (Hint: Speed at the release of the marble is 0 m/s.)

$$a = \frac{v_{final} - v_{initial} \text{ (speed at release)}}{\text{average time from release to bottom of ramp}}$$

Conclude

1. **Compare** How did the acceleration of the marble on ramp 1 compare with the acceleration of the marble on ramp 2?

2. **Interpret** Answer the question posed in the problem.

3. **Analyze** Compare your results with your hypothesis. Do your data support your hypothesis?

4. **Evaluate** Why was it necessary to measure how fast the marble traveled from the end of the ramp to the finish line?

5. **Identify Limits** What possible limitations or sources of error could have affected your results? Why was it important to perform four trials for each measurement of speed?
