27 On a Roll

Purpose

To investigate the relationship between the stopping distance and the height from which a ball rolls down an incline.

Required Equipment/Supplies

6-ft length of 5/8-inch aluminum channel
support about 30 cm high
marble
wood ball
steel ball
tennis ball
meterstick
piece of carpet (10 to 20 feet long and a few feet wide)
graph paper or overhead transparency

Optional Equipment/Supplies

computer
light probe with interface
light source
data plotting software

Discussion

When a moving object encounters friction, its speed decreases unless a force is applied to overcome the friction. The greater the initial speed, the more work by the friction force is necessary to reduce the speed to zero. The work done by friction is the force of friction multiplied by the distance the object moves. The friction force remains more or less constant for different speeds as long as the object and the surface stay the same.

In this experiment, you will investigate the relationship between the initial height of a rolling ball and the distance it takes to roll to a stop.

Assemble apparatus.

Procedure

Step 1: Assemble the apparatus shown in Figure A. Elevate the ramp to a height that keeps the marble on the carpet when started at the top of the ramp.

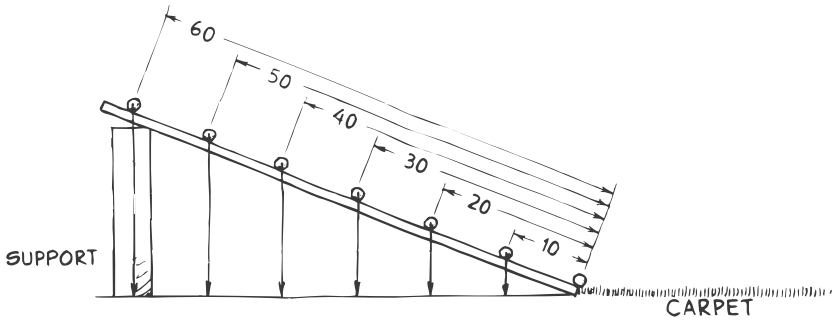

Fig. A

Roll marble onto carpet.

Step 2: Release the marble at intervals of 10 cm along the ramp as shown in Figure A. Measure the vertical height from the floor or table to the release point on the ramp. Also measure the distance required for the marble to roll to a complete stop on the carpet. Roll the marble three times from each height and record the stopping distances in Data Table A.

Repeat using different balls.

Step 3: Repeat Step 2 using a wood ball, a steel ball, and a tennis ball. Record the heights and distances in Data Table A.

Graph data.

Step 4: On the graph paper provided by your teacher, construct a graph of average stopping distance (vertical axis) vs. height (horizontal axis) for each of the four balls.

1. Describe the shapes of the four graphs you made.

2. How did the stopping distances of the different types of balls compare?

3. Compare your results with those of the rest of the class. Does the mass of the ball affect the stopping distance?

Name Period Date

Data Table A

OBJECT	POSITION ON RAMP	HEIGHT	STOPPING DISTANCE			AVERAGE STOPPING DISTANCE	SPEED AT BOTTOM	SPEED SQUARED
			TRIAL 1	TRIAL 2	TRIAL 3			
MARBLE								
STEEL BALL								
TENNIS BALL								
WOOD BALL								

4. Based on your data, what factors would seem to determine the stopping distance of automobiles?

Going Further (Optional)

Graph speed vs. height.

Step 5: Use a light probe to time the marble at the bottom of the incline. Repeat for each of the release heights. Compute the speeds by dividing the diameter of the marble by the measured times. Record the speeds in Data Table A. Make a graph of speed (vertical axis) vs. height (horizontal axis) on graph paper.

Repeat using different balls.

Step 6: Repeat Step 5 for the steel ball, wood ball, and tennis ball.

5. Describe the shape of the four graphs you made.

Graph square of speed vs. height.

Step 7: Compute the square of the speed and record in Data Table A or use data plotting software to plot the square of the speed (vertical axis) vs. height (horizontal axis) for the marble, steel ball, wood ball, and tennis ball.

6. Describe the shape of the four graphs you made.