ROLLER COASTERS – SLOPES IN ACTION

Objective: The goal of this project is to explore the effect of slope on the decisions made in roller coaster design.

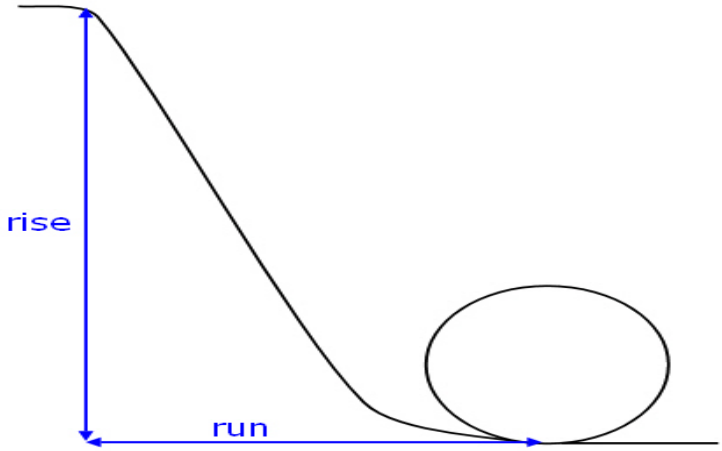
Question: What should the slope of a hill be in order for a marble to make it safely through a loop-the-loop?

Materials Needed:

- Two 6 foot sections of foam pipe insulation
- Marble
- Scissors
- Masking tape
- Tape measure or ruler/yard stick
- Desk or shelf for roller coaster's starting position

Introduction: In this construction project, you will use foam pipe insulation to make a "roller coaster" track. For the roller coaster cars, you will need a marble. You could do this project in a science class to investigate the conversion of potential energy to kinetic energy, but we will just try to determine the minimum (or smallest) slope at which the marble easily makes it through the loop-the-loop you constructed.

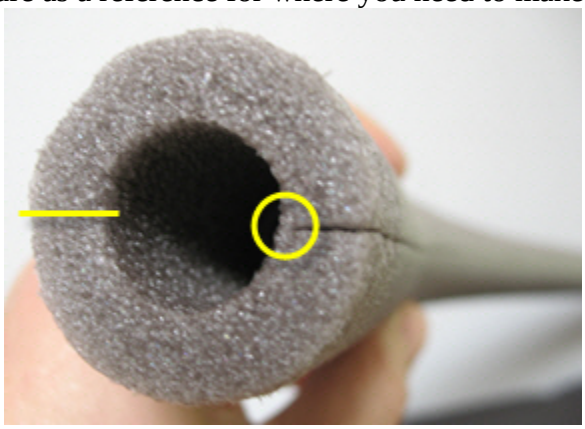
You will conduct several tests (about 10) at different slopes to see whether the marble can loop the loop or not. In other words you will be measuring many slopes. Remember that we will be expressing slope as the ratio $\frac{rise}{run}$. *Rise* will be the height of the starting point, and *run* will be the horizontal distance from the starting point to the beginning of the loop. Use the following diagram to help you determine both *rise* and *run*.



Remember the goal is to determine the minimum slope at which the "roller coaster car" will safely navigate the loop.

Procedures of the Experiment

1. Cut the foam pipe insulation in half to make two U-shaped channels. Use the following picture as a reference for where you need to make the cuts.



Notice the circle and the line; make cuts at these points along the entire length of the tubing.

2. You are eventually going to construct a loop. Choose a diameter for your loop; you many want to start small (in the range of 30 centimeters to 50 centimeters). With what diameter did you choose to begin? _____
3. You should now have two lengths of U-shaped foam. To form the track, tape these two together, end-to-end. The joint (where the pieces meet in the middle) should be as smooth as you can get it.
4. Curl part of the track into a loop which has the diameter you indicated in step #2. Tape the track together where the two tracks meet at the bottom.
5. Raise an end of the track up to make a ramp coming down into the loop, and tape the top of the ramp in place on your desk or another shelf in the classroom.
6. Now tape the loop down to the floor.
7. You are now ready to take measurements and fill in table #1. Measure the diameter of the loop, the height of the starting point of the track (rise), and the horizontal distance from the track starting point to the beginning of the loop (run). Refer to the illustration in the introduction if necessary.
8. Run the marble down the track a total of 10 times. Record the number of times it successfully goes through the loop.
9. Change the height and repeat steps 7 and 8. If, with the first height, the marble made it through the loop most of the time, choose a lower height. If, with the first height, the marble fails to make it through the loop most of the time, choose a greater height.
10. Choose one last height and repeat steps 7 and 8 once more.

Trial 1

Diameter: _____ Rise: _____ Run: _____ Slope: _____ = ____
[ratio]

Test #	Was it a successful run (did the marble make it through)?
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

How many times was your test successful? _____ Write this as a percent of the total tests. _____

Trial 2

Diameter: _____ Rise: _____ Run: _____ Slope: _____ = ____
[ratio]

Test #	Was it a successful run (did the marble make it through)?
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

How many times was your test successful? _____ Write this as a percent of the total tests. _____

Trial 3

Diameter: _____ Rise: _____ Run: _____ Slope: _____ = ____
[ratio]

Test #	Was it a successful run (did the marble make it through)?
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

How many times was your test successful? _____ Write this as a percent of the total tests. _____

Conclusions

Discuss the following questions with complete sentences.

At what slope was the roller coaster track most successful? How many times did the marble make a successful run? Suppose you were really a roller coaster designer. Would you be satisfied with the success rate of your best slope (the smallest slope at which the roller coaster was most successful)? What percent of success would an actual designer hope to see? Discuss how the changes you made in the rise and run impacted the slope. Finally, what are some other things (besides slope) that may have affected the ball's ability to make it through the loop?

Review

Find the slope of a line passing through the given points.

a. (0, 2) and (2, 5)

b. (-2, 1) and (3, -1)

What is the slope of a vertical line?

What is the slope of a horizontal line

What is the slope of a vertical line?

What is the slope of a horizontal line?