

Objective:

Use the law of conservation of energy to design a roller coaster out of pipe insulation, ensuring that a marble will come to rest naturally within 10 cm from the end of the roller coaster.

Pre-Lab Question:

Briefly discuss the design of the roller coaster illustrated below and why it might be impractical according to the law of conservation of energy.



Materials (per lab group of 2-4 students):

- marble
- 6' section of pipe insulation, halved (3)
- masking tape (shared)
- stopwatch

Procedure:

1. Sketch an initial design for your roller coaster in the space provided, while adhering to the following criteria:
 - a. The roller coaster must have at least two loops.
 - b. The marble must come to a natural stop within 10 cm from the end.

2. Use masking tape to join each of your pipe segments together, creating a roller coaster according to your initial design and the requirements in step one.

3. After adjusting and finalizing your design, call the instructor over to witness three successive trials. Record your data in table one.

Data Table One: Roller Coaster Distance Trials

Trial #	Distance from End (cm)	Teacher Initials
1		
2		
3		
Total Distance (cm)		
Average Distance (cm)		

1. Determine and record the following:

- a. mass of marble (kg) _____
- b. height of roller coaster (m) _____
- c. height of first loop (m) _____
- d. height of second loop (m) _____
- e. formula for gravitational potential energy $PE_G =$ _____
- f. formula for kinetic energy $KE =$ _____

2. What is the linear distance (m) from the beginning of your roller coaster to the top of the first loop?

3. Using your stopwatch, determine the amount of time it takes for your marble to reach the top of the first loop. Measure this time for three trials and calculate the average. Record your results in Data Table Two.

Data Table Two: Roller Coaster Distance Trials - First Loop

Trial #	Linear Distance to First Loop (m)	Time (s)
1		
2		
3		
Average		
	Average Velocity (m/s)	

1. What is the linear distance (m) from the beginning of your roller coaster to the top of the second loop?

2. Using your stopwatch, determine the amount of time it takes for your marble to reach the top of the second loop. Measure this time for three trials and calculate the average. Record your results in Data Table Three.

Data Table Three: Roller Coaster Distance Trials - Second Loop

Trial #	Linear Distance to Second Loop (m)	Time (s)
1		
2		
3		
Average		
	Average Velocity (m/s)	

Questions to consider:

1. Using the information from your data tables above, determine the following:

a. What is the KE at the top of the first loop? Show your work in the space provided below:

b. What is the PE_g at the top of the first loop? Show your work in the space provided below:

c. What is the KE at the top of the second loop? Show your work in the space provided below:

d. What is the PE_g at the top of the second loop? Show your work in the space provided below:

e. What is the total mechanical energy of the system at the top of the roller coaster just before the marble starts rolling?

f. What is the total mechanical energy of the system at the bottom of the roller coaster just before the marble stops rolling?

- g. Compare your answers to e and f above. Should these answers be the same? Why or why not?**

- h. Based on your answers to e, f, and g above, how much work does friction do on the marble as it rolls down the coaster?**
