ROLLER COASTERS!

Name: _____ Group Members: _____

PURPOSE

To construct your own unique roller coaster and calculate the speed, potential energy, kinetic energy, mechanical energy and conservation of energy.

BACKGROUND

The force of gravity propels roller coasters once they have been dragged to the top of the first hill and released. This gives them the term "gravity rides". As the roller coaster moves through its different design elements (loops, corkscrews, twists and turns), the cars gain and lose speed. Throughout the ride, the initial potential energy gained at the top of the first hill transforms into kinetic energy and back into potential energy. The roller coaster will never rise again to the same height as the first hill due to energy loses from friction.

YOUR CHALLENGE

Design a marble roller coaster! You have two days to complete your design and calculations. The marble should **slow down and stop at the end of the track** to create a safe roller coaster. The roller coaster should have at least one (1) loop and/or corkscrew, one (1) change in direction and one hill (other than the first drop)

You will need to choose five (5) sections along the roller coaster to make observations. At the end of these sections, you will need to calculate the kinetic energy, potential energy, and mechanical energy. Using Logger Pro, determine the average speed in each of your chosen sections.

MATERIALS

- Any materials you can find in the classroom.
- Materials suggested as rails: insulation or plastic tubing

PROCEDURE

1. Using the tubing you have selected, build your roller coaster. Test while you build to ensure the marble makes it to the end!
2. Choose points along your roller coaster to make observations.
3. Determine the necessary data at the sections you specified.
4. Draw a schematic of your design.

ROLLER COASTER DESIGN

OBSERVATIONS

Start by filling out the table values for **length of the section, height at the end of the section and time**. The remaining values are calculated.

Mass of Marble: _____

Length of Track between start and position 2: _____

THEORETICAL

Position	Start	2	3	4	End
Height, *h*					
Potential Energy, E_g					
Kinetic Energy, E_k					
Speed, *v*					
Mechanical Energy, E_T					

$$E_g = mgh \qquad E_k = \frac{1}{2}mv^2 \qquad E_T = E_k + E_g$$

EXPERIMENTAL

Position	Start	2	3	4	End
Height, *h*					
Speed, v_{av}	0 m/s				
Potential Energy, E_g					
Kinetic Energy, E_k	0 J				
Mechanical Energy, E_T					
% of *E* lost					

WHAT TO MEASURE

Show all your calculations on a separate piece of paper!

- Speed
  - Determine the speed at a single point using Logger Pro.
- Potential Energy – calculate using $E_g = mgh$.
- Kinetic Energy – calculate using $E_k = ½mv^2$.
- Mechanical Energy – calculate using $E_T = E_g + E_k$.
- % of *E* lost

$$\%\text{ of } E \text{ lost} = \frac{\text{Theoretical Mechanical Energy} - \text{Experimental Mechanical Energy}}{\text{Theoretical Mechanical Energy}} \times 100$$

QUESTIONS

1. What kind of energy does the marble have at the start of the roller coaster? Explain.

2. As the marble rolls down the first incline what energy transfer is taking place? Explain.

3. Where is the kinetic energy the greatest? How do you know?

4. What kinds of energy does the marble have at the top of the first hill? Which one is larger?

5. What energy transfer takes place as the marble moves through the vertical loop?

6. Does the marble experience friction as it moves through the roller coaster? How do you know? Where does this energy go?

7. Determine the average force of friction on the marble between the start and position 2. Show all your work.