Name: _____ Class Period: _____

Rollercoaster

Measurements PE and KE: Part 1

Background:

Students explore the physics exploited by engineers in designing today's roller coasters, including potential and kinetic energy, friction and gravity. First, they learn that all true roller coasters are completely driven by the force of gravity and that the conversion between potential and kinetic energy is essential to all roller coasters. Second, they consider the role of friction in slowing down cars in roller coasters. Finally, they examine the acceleration of roller coaster cars as they travel around the track. During the associated activity, student's design, build and analyze model roller coasters they make using foam tubing and marbles (as the cars).

Purpose:

Students will be able to design, describe and show how to calculate PE and KE as a marble moves along a roller coaster track. In addition, students will be able to show the relationship between PE and KE and how they are related to the principle of conservation energy.

Materials:

Foam pipe insulation tubing	Large marble	Plastic cup
Small marble	Wall or desk	Meter Stick

Procedure 1:

Design 1:

1. Build a roller coaster that has an initial height of 40 cm. You must have one loop and the marble must not leave the track.
2. Time the large marble as it goes down the track.
3. Find the mass of the large marble. Record your results on your data table.
5. Repeat the procedure 3 times.
6. Calculate the PE and the KE of the large marble.
7. Repeat the steps for the small marble.

Procedure 2:

Design 2:

1. Change only the starting point or initial height of your roller coaster to 70 cm.
2. Time the large marble as it goes down the track.
3. Find the mass of the large marble. Record your results on your data table.
5. Repeat the procedure 3 times.
6. Calculate the PE and the KE of the large marble.
7. Repeat the steps for the small marble.

Date Table 1: Height of roller coaster _____ cm Convert to meters = _____

Marble size	Mass of marble (g)	Mass of marble (Kg)	Time 1	Time 2	Time 3	Mean Time (s)	GPE (J)	KE (J)
Large								
Small								

Date Table 2: Height of roller coaster _____ cm Convert to meters: _____

Marble size	Mass of marble (g)	Mass of marble (Kg)	Time 1	Time 2	Time 3	Mean Time (s)	GPE (J)	KE (J)
Large								
Small								

Analysis:

Calculate the PE and KE for each marble at each height.

1. Gravitational Potential Energy

- Calculate PE = mgh

2. Kinetic Energy

- Measure the length of the foam tube. d = _____
- Calculate the speed at which the marble leaves the roller coaster (use the average time in your calculation): v = d/t

- Calculate KE = ½ mv^2

Discussion Questions:

1. How does the mass of the marble change the travel time? Does your data support your answer? Justify your answer.

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2. When you increased the height of the track, did this change affect the travel time of your marble? Would it increase or decrease you travel time? Justify your answer.

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3. How does the gravitational potential energy of the marble at the top of each hill compare for both designs? Can you explain why there is a difference?

_____

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4. How does the kinetic energy (KE) at the bottom of each hill compare for design I and design II? Can you explain why there is a difference?

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5. In the absence of friction and other sources of energy loss, how should the values for the marble's PE at the beginning and KE at the end compare?

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6. In realistic analyses, frictional effects and energy loss must be accounted for. Was there a big difference in the PE calculated and the KE calculated for **design I**? Explain why or why not. Was the difference bigger or smaller than you expected?

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7. For **design I**, calculate the energy lost as the marble went through the roller coaster. (Hint: PE = KE + energy lost)

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8. Describe as many possibilities as you can think of for energy to be lost as the marble makes its way through the roller coaster.

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