Name ________________________

Calculating Potential Energy and Kinetic Energy of a Rolling Marble

INTRODUCTION AND OBJECTIVES

The Law of Conservation of Energy states that energy can be neither created nor destroyed. However, energy can change from one form to another. In the case of a marble on a paper roller coaster, a marble starts at the top of the roller coaster with a relatively large amount of potential energy and no kinetic energy. As the marble starts rolling down the roller coaster, the amount of potential energy stored in the marble decreases while its kinetic energy increases. Potential energy is also converted into heat energy due to friction. In this experiment, you will be calculating the change in potential energy of a marble traveling between two points on a paper roller coaster and compare that to the kinetic energy that was gained by the marble during that same time.

EQUIPMENT NEEDED

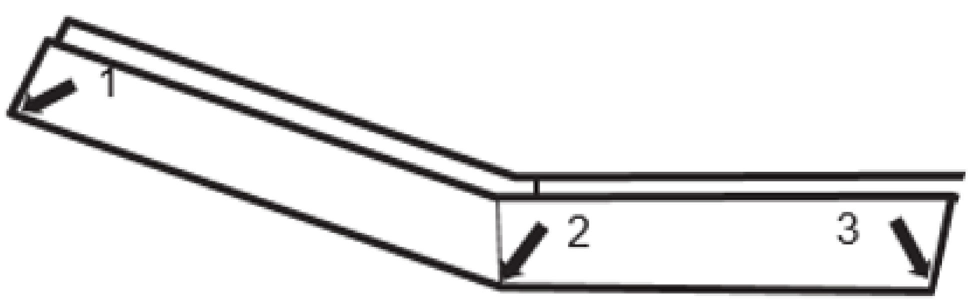
- Completed roller coaster
- Ruler
- Pencil
- Scale
- Calculator
- Stopwatch device

PROCEDURE

I. Selecting the starting and ending points

1. Choose a portion of the roller coaster in which the marble accelerates and then keeps a fairly constant speed.
2. Label the beginning of the hill "1", the end of the hill "2", and the end of the final section "3". You will be measuring the distance between each of these points so make sure that those distances will be easy to measure.

An example of how to label the paper roller coaster. Please note that for this activity, you will select one section of your roller coaster to label, rather than the whole roller coaster from beginning to end.



II. Calculating the gravitational potential energy of the marble

1. To simplify calculations, treat the height of point 2 as the reference point where gravitational potential energy equals zero.
2. The gravitational potential energy of the marble depends on the height of the starting point compared to the ending point of the marble's path.
3. Gravitational potential energy equals (mass)*(acceleration due to gravity)*(height). This can be written as ***P.E.= mgh.***
4. Measure the mass of the marble. Convert the mass of the marble to kilograms. Enter your result below.
5. Find point A's height above point B in centimeters and then convert to meters. Enter the data in the table below.

Mass of the marble, *m* (kg)	______ grams	______ kg
Acceleration due to gravity, *g* (m/s^2)	9.8 m/s^2	9.8 m/s^2
Height of point 1 above point 2, *h* (m)	______ cm	______ meters
Gravitational potential energy at point 1, *mgh*, (J)		______ Kg* m/s^2

III. Calculating the kinetic energy of the marble

1. The total kinetic energy of the marble is made of two parts, the kinetic energy due to its linear motion and the kinetic energy due to its rotation.
2. A marble that is rolling has more kinetic energy than a marble that is sliding along at the same speed.
3. For this activity,you will calculate just the linear kinetic energy.
4. The marble's kinetic energy due to its linear motion is one half its mass times its velocity squared. It can be written as $K.E._l = {}^1/_2 mv^2$.
5. Use the mass of the marble calculated in section II.
6. Find the velocity of the marble between points 2 and 3. Use a stopwatch (device) to determine how long it takes to get from point 2 to point 3 after you release the marble at point 1. **Divide the distance between points 2 and 3 by the time elapsed** to calculate the velocity. Conduct three trials to determine the average velocity between points 2 and 3.
7. Calculate the average linear kinetic energy of the marble.

	Distance (cm)	Distance (meters)	Time(s) Trial 1	Time(s) Trial 2	Time(s) Trial 3	Average Time(s)	Average Velocity (meters/second)
Point 2 to Point 3							

Average Velocity (meters/second)	
Mass (Kg)	
Linear Kinetic Energy (Joules) K.E. = $^1/_2 mv^2$	

IV. Analysis

1. What is the total mechanical energy of the marble at point 1, before the marble starts to roll?

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2. What is the total mechanical energy of the marble at point 3?

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3. Compare your answers to questions 1 and 2. Should these answers be the same? Why or why not? (**Hint: think about the Law of Conservation of energy and energy transformations.)**

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