***Roller Coaster Design and Redesign***

**Design Task**

Design and build a segment of roller coaster for a marble using foam track. Sketch a diagram of your roller coaster, label the dimensions of your coaster on the diagram. Based on your model calculate:

* the theoretical speed at which the marble reaches the bottom of your roller coaster track assuming no loss of mechanical energy. Be sure to include rotational kinetic energy in your calculation.
* the actual speed at which the marble reaches the bottom of your roller coaster track. The only tools you are permitted to use for this determination are one and two meter sticks.
* the total amount of energy lost to the environment during the roller coaster.

Write a ***detailed*** explanation of how you completed each of these three calculations.

**Redesign Task**

Redesign your segment of roller coaster to make a more efficient track. Sketch a diagram of your roller coaster, label the dimensions of your coaster on the diagram. Repeat the same three calculations you completed for your first roller coaster.

**Design Analysis**

1. You calculated the amount of energy lost by your first design. In what forms was this energy lost? Be specific in analyzing the motion of your first roller coaster.
2. What percent improvement in energy loss were you able to make in your redesign?
3. How did you modify your roller coaster to improve its efficiency? What do you think was the most effective at reducing energy loss?
4. How much work was done on the marble in completing its run on your first roller coaster? Explain how you completed this calculation.
5. What force was doing this work on the marble?
6. How much work was done on the marble in completing its run on your second roller coaster?
7. How much power was developed as the marble completed the second roller coaster? Explain how you completed this calculation.
8. What percentage of the total energy of the marble at the bottom of your track was translational kinetic energy and what percentage was rotational kinetic energy?
9. How would the translational speed of the marble at the bottom of the track be affected if the mass of the marble were doubled?
10. How would the translational speed of the marble at the bottom of the track be affected if the marble had been a hollow sphere instead of a solid sphere? Give a numeric answer and show how you arrived at your result.