

Roller Coaster Energy Activity
Written by Robin Reinarts and Kelly VanDusen

Objectives: After completing this project, student should be able to:

- construct a roller coaster that will accelerate a marble to speeds of at least 2 m/s
- calculate terminal velocity, kinetic energy and potential energy for the marble
- explain how the law of conservation of energy relates to the roller coaster

Materials: stopwatch, meter stick, paper and pencil, 2 pieces of pipe insulation, masking tape, marble, balance, calculator. All other materials used for coaster must be provided by students.

Hypothesis: Which will be larger, the PE (Potential Energy) at the beginning of the track, or the KE (Kinetic Energy) at the end of the track? Answer in a complete sentence.

Procedures:

1. Obtain the materials from the teacher, mark the marble so that you will be able to identify yours. Find the mass of your marble on the balance and convert it from grams to kilograms.
2. Title a piece of notebook paper, "Log Sheet." Record the mass of your marble. Divide it into 3 sections labeled Trial 1 to Trial 3. Leave plenty of room! You may use more than one piece of paper.
3. On the log, draw a **simple straight track** roller coaster design and then build it with the pipe insulation. The end of the coaster must touch the ground. This is Trial 1.
4. **Measure** the each part of the coaster (starting height, height and width of loops, track length, etc.) so that you can **REPLICATE** your results and **record** the measurements on the drawing in your log.
5. Measure 2 m from the end of your roller coaster track and mark it with a piece of tape. This will be the 2 m distance you use to find your marble's speed.
6. Roll the marble down the track, **timing** the marble from the end of the track until it hits the piece of tape. **Record the time** in your log.
7. Use the time from step 6 to determine the terminal velocity of your marble ($v = d/t$) and **record the speed** in your log.
8. Repeat steps 3-7 above for trials 2 and 3, trying different designs. **BE SURE TO MEASURE AND RECORD EVERYTHING!!!**
9. After the 3 trials, decide which design will get you the most points using the grading criteria chart. **Build** this coaster to show your teacher. **Test** it several times before you are graded by the teacher. If you aren't sure you have the same marble as you started with, find and record its mass again.
10. **Record** the starting height, time, marble mass and drawing of your roller coaster.
11. After you have been graded, **calculate** the Potential Energy (PE) of your marble at its starting point and the Kinetic Energy (KE) of the marble at the end of the track on your log. Show your work and box your answers.
$$PE = mgh \qquad KE = 1/2mv^2$$
12. Compare the PE and KE, noting in the log any differences between them. Also note any other forms of energy you witnessed during your trials.
13. Complete the conclusions below and staple to your log, then hand it in.

Final Trial to Be Graded:

Starting height (m): _____ Time (s): _____ Mass of Marble (kg): _____

Speed (m/s): _____ PE (J): _____ KE (J): _____

Drawing:

Conclusions: What happened to the potential energy of the marble as it traveled through the track? _____

Why did this happen? _____

Was your hypothesis supported by this experiment? Why or why not? _____

Does your roller coaster obey the law of conservation of energy? Explain why or why not. _____

Grading Criteria:

**complete log = 30 pts.
Marble completes track = 20 pts.
each hill = +10 pts.
each curve = +10 pts.
each loop = +20 pts.
conclusions = 10 pts.**

**speed < 2 m/s = +0 pts.
speed 2-3 m/s = +5 pts.
speed 3-4 m/s = +10 pts.
speed > 4 m/s = + 15 pts.**

TOTAL POINTS EARNED= _____