A Hilly Ride
5th Grade

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References:

Modified from a lesson taught by Dave Marhover at Whetstone High School.

Benchmarks:

SLC 9: Provide examples of transformation and/or conservation of matter and energy in simple physical systems.

Benchmark: Students will explore the transformation of energy within living and physical systems.

SLC 3:Make inferences from observations of phenomena and/or events.

Objectives:

Students will identify situations in which kinetic and potential energy are exchanged, and correctly identify the direction of energy transfer. Students will explain why there is a limit to the amount of kinetic energy gained in terms of conservation of energy. Students will identify friction as the source of energy transfer from kinetic to thermal energy.

Materials:

- marbles or matchbox cars (one per group)
- clear flexible tubing big enough for marble, or flexible car tracking
- Rulers with metric markings
- tape
- books/boxes/canisters (things on which to prop up the track).
- Ring stands- one per group

Initial Demonstration:

Prop up the track 20 cm from the surface on which it sits and allow the rest of the track to lay on this surface. Rest the car on the top of the track and allow it to fall down. Ask the students why the car started moving. (They will probably say gravity). Put the car on a flat surface where it will not roll. Ask the students why the car is not rolling now. If no one brings up the word, introduce the words "**potential energy**." Explain that this means the car has the "potential" or the "possibility" to move when it is up. The Energy is stored in its "upness." Ask the students how much **potential energy** they think the car has at the top of the track. Ask the students if they think the car would go over a hill. Put a small hill in the track (less than 5 cm). Allow the car to go over the hill. Tell

the students that their group must figure out what is the highest hill the car can go over without being pushed.

Target Observations:

- Objects have stored energy when they are up, that is when they are above a surface and have the potential to fall.

Target Model Model:

- Stored energy will allow an object to move when it is released.
- Stored energy is called "potential energy"
- Motion energy is called "kinetic energy"

Procedure:

Give each student a track with one end fixed at 20 cm above the surface of the floor or their desks. Give them tape a ruler and a car. They should play with the track for about 10 minutes to see how high they can make the hill before the car won't go over it. If the hill is taller than about 18 cm, remind them that they cannot push the car, they have to just release it from the top of the track. If one group finishes before the others, have them see if it makes a difference if they have a loop rather than a hill.

What did the students find? The highest hill should be no higher than 20 cm (or the height of the first hill). You can't get out more potential energy than you put in. This is called conservation of energy. In all likelihood, they found their hill to be less than 20 cm. The energy did not disappear, it was changed to another form. Ask the students what slowed the car down (friction). **Friction** turns motion (**kinetic energy**) into **thermal energy**. The car does not feel warmer to them, but they can feel the effects of friction by rubbing their hands together.

Target Revised Model:

- You cannot get more energy out of a system than you put in. (Conservation of energy).
- **Potential energy** can be changed into **kinetic energy** or **thermal energy**.
- Friction makes a system less efficient.

Procedure:

Ask the students to make a track that will allow the car to stop on its own within 10 cm of the end of the track. Students should draw the track in their journals and label where the car has the most **potential energy** and where the car has the most **kinetic energy** (is moving the fastest).

Ask students why roller coasters don't have loud screeching brakes. Do roller coasters arrive back at the start without help? (They don't, they usually have chains that pull them to the top of the first hill). Why can't the roller coasters get back to the start on their own? (Friction causes them to lose some of their energy to heat).

Target Revised Model:

- The car has the most potential energy at the top of the track, before it is moving
- The car has the most kinetic energy at the bottom of the track

Summary:

Energy can change forms. In this experiment, potential energy (from gravity) is changed into kinetic (motion) energy. Some of the potential energy doesn't get turned into kinetic energy- instead, it becomes heat energy because of friction.