7C Conservation of Energy

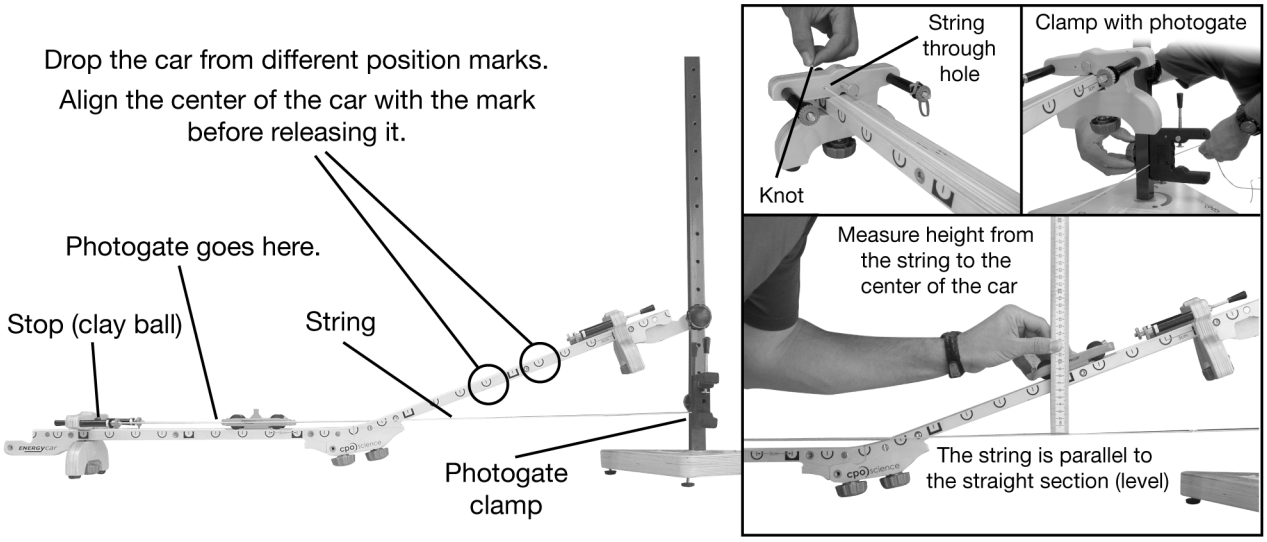
What limits how much a system may change?

A car launched up the hill at a given speed will never go higher than a certain point. A car rolling downhill will only reach a certain speed. Why? The answer is that nature keeps an exact balance of energy. Speed uses one form of energy and height uses another. This investigation explores the exchange of energy.

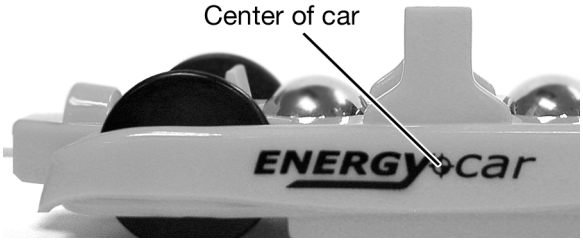
Materials

- Energy Car
- Physics stand
- Data Collector and one photogate
- Electronic scale (or triple-beam balance)
- Clay
- String
- Meter stick

1 Energy exchange from potential to kinetic



1. Set up the track with the steeper hill and a level section. Make the level section as level as you can. Attach a photogate at the bottom of the hill on the level section.



2. Thread a string though the hole in the lower stop and use a photogate to clamp the other end of the string to the stand. Adjust the string so it is parallel to the level section of the track.
3. Drop the car from each 5-cm mark on the hill and measure the speed with the photogate. Measure the height of the car from the string to the center of the car.
4. Measure the mass of the car and record it in the table.

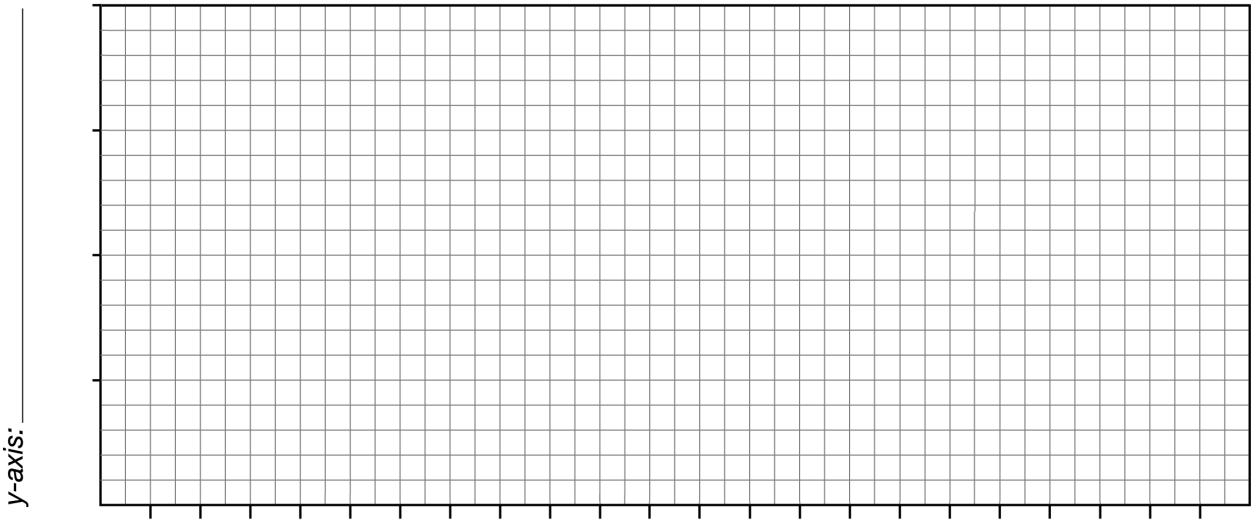
Table 1: Height and speed data

Drop Height (m)	Mass of car (kg)	Photogate time (s)	Speed (m/s)

2 Thinking about what you observed

a. Graph the speed of the car vs. the height.

Title: _____



b. What does the graph tell you about the relationship between speed and drop height?

_____

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3 Analyzing the data

a. Use the formula for potential energy to fill in the second column of Table 2.

b. Use energy conservation to derive a formula for the speed of the car in terms of the energy it has at the start. (Hint: your formula should include only two variables, velocity and height.)

c. Use the formula you just derived to fill in the column for the predicted speed of the car.

d. Plot the curve for the predicted speed on the same graph as you made in part 2a above.

Table 2: Energy data and predicted speeds

Drop Height (m)	Potential energy (J)	Predicted speed (m/s)	Measured speed from Table 1 (m/s)

4 Thinking about what you observed

a. Explain the relationship between speed and height using the idea of energy conservation.

b. Explain any difference between the predicted and measured speeds. If there is a difference, what does it tell you about the energy of the car as it rolls along the track?

c. Let the car roll downhill, bounce off the rubber band and go back up hill again. Does it reach the same height as it was dropped from? Explain why or why not using the idea of energy conservation.

d. Challenge experiment. Use a rubber band to launch the car uphill so it goes through the photogate with the same speed as it had going down. You won't be able to get it precisely the same, but come as close as you can. If the speeds are the same, the car's kinetic energy is also the same. Does the car reach the same height on the hill that it was dropped from to get the same speed in part 1? Explain any difference using the idea of energy.