

Roller Coasters and Energy

Purpose: To investigate energy relationships for a roller coaster car.

Getting Ready: Navigate to the Roller Coaster Model in the Physics Interactives section of The Physics Classroom website:

<http://www.physicsclassroom.com/Physics-Interactives/Work-and-Energy/Roller-Coaster-Model>

Path:

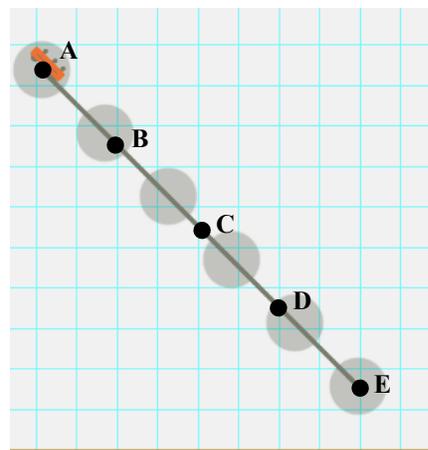
physicsclassroom.com => Physics Interactives => Work and Energy => Roller Coaster Model

Once the Interactive opens, get acquainted with how it functions. Know how to **Start**, **Pause**, **Step**, and **Reset** the simulation. Observe the three different tabs at the top of the simulation for toggling between **Ramp**, **Loop**, and **Bumps**. Observe that each track design can be further modified by dragging a grey circle to a different position. Experiment with the three controls for showing the **Velocity** vector and **Force** vectors and toggling **Track Drag** on and off. Once acquainted with the program, select the **Ramp** button to reset the simulation to default settings and then perform the following studies:

Section 1: Basic Energy Relationships

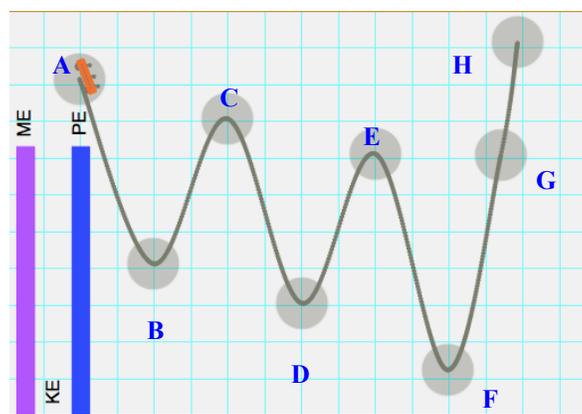
- Click/tap the **Start** button and observe the motion. View the bar charts and the velocity value as the coaster car moves. Complete the following paragraph by entering total mechanical energy (**ME**), kinetic energy (**KE**), and potential energy (**PE**). The labeled locations refer to the graphic at the right.

As the coaster car rolls down the track from A to E, the _____ values decrease and the _____ value increase and the _____ values remain constant. The _____ is greatest at point A and smallest at point E. However, the _____ is smallest at point A and largest at point E.



Section 2: Hill Design

- Click/tap on the **Bumps** tab at the top of the Interactive. Then drag the grey circles to modify the track so that it looks like the track design at the right. Pay attention to the background grid to help with the design. Note that Dot G is at the same height as Dot E; make sure that the same is true of your final design.
- Run the simulation. Does the coaster car travel as high as point H? _____ Give an explanation for why it does or doesn't reach point H.



4. How does the speed at point E compare to the speed at point G? _____
Explain why this is true.
5. Rank the PE for the eight locations, from the lowest PE to the highest PE. Write letters in the blanks and place $<$ or $=$ symbols between the letters.
- _____
6. Rank the KE for the eight locations, from the lowest KE to the highest KE. Write letters in the blanks and place $<$ or $=$ symbols between the letters.
- _____
7. Mac and Tosh are arguing about the track design. Mac claims that the car is moving fastest at point F because it is furthest along the track. Tosh disagrees, claiming that the car moves fastest at point F because point F is at the lowest height. Who do you agree with? _____ Make a modification of the track design for point F and gather some evidence to support one claim or the other. Then discuss what changes you made, what observations were made, and the reasoning that supports one of the claim of either Mac or Tosh.
8. Does changing the height of point C affect the speed of the coaster car at point D? Try it and find out. Once certain of the answer, make a claim and support it with evidence (data) and reasoning.