

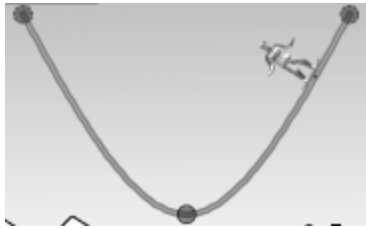
## Energy Skate Park – Pie Charts

Open the following site:

<http://phet.colorado.edu/simulations>

Click on the work, energy and power title on the left side of the screen. Choose “energy skate park”. We will use “Energy Skate Park” to study energy pie charts

You will see a simulated skater going back and forth on a U-shaped track as shown in the figure below.



On the right and below this graphic, you will see controls that allow you to adjust the appearance of the graphic and also allow you to display additional information.

In the upper left, you will see a short set of track labeled, “Drag to add Track.” If you click on this and drag it into the graphic, you can produce more simulated track, and you can click and drag the circles to change the lengths and shapes of parts of the track.

You can also click on the skater to drag him to any starting position that you want.

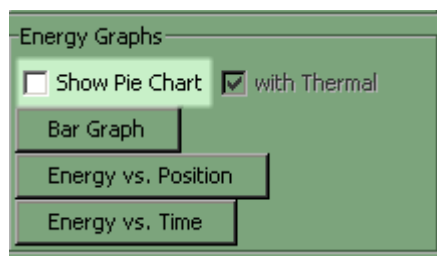
To begin this activity, drag a section of additional track from the upper left to the right side of the original track so that they join to form one track. Adjust the track by clicking and dragging the circles till the track has one peak and two valleys of different heights. It should look similar to the figure below. Test your track to be sure that the skater stays on the track by placing the skater on the top of the ramp on the left. If he does not stay on the track, you may have to raise or lower the middle peak.



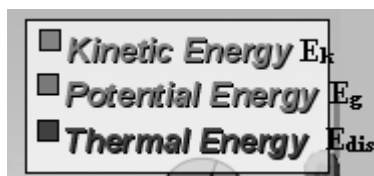
You will be using pie charts to indicate how energy is distributed among storage modes. The storage modes are  $E_k$  (“Kinetic Energy”),  $E_g$  (Gravitational “Potential Energy”) and  $E_{\text{therm}}$  (for “Thermal Energy”).

1. Sketch what you think the pie charts will look like for the skater at each of the blue dots. (i.e. you should have 5 pie charts)

To the right of the graphic, find the “Energy Graphs” section, and select “Show Pie Chart.”



You are now ready to examine how energies change for the skater as he moves along the track. Note the color-coded energy key in the upper right of the graphic.



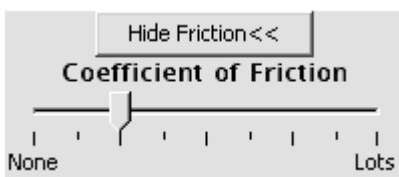
Place the skater on the highest point of the track on the left, let him roll and watch what happens to the different energies in the pie chart. If the skater flies off the track, use the blue circles to adjust the track until the skater stays on all the way. If the changes are going too fast for you, use the slider under the graphic to adjust viewing speed between “slow” and “normal.”



You can also use the “Pause” and “Step” buttons to the right of the slider to look at the pie chart for any given position along the track. Sketch out the track and draw the actual pie charts you observe at their locations on the track.

2. How do your sketches from your prediction compare to the actual pie charts on the graphic at each location? Did your charts overestimate any of the energy storage modes? Which one(s)? Can you explain how the results were different from what you expected? Talk and share your ideas with each other. If anyone in your group had a different explanation than you did, what was it, and how did your group resolve any differences?

3. On the bottom of the controls on the right (you may have to scroll down to find it), find and select the “track friction” button. With the slider all the way to the left, as it has been located above (this is the default position), friction between skater and track is zero. You will adjust the slider two notch to the right. (be sure that with thermal energy is checked in the Energy graphs tool box.



Before you again run the simulation, sketch what you think the pie charts will look like for the skater at each of the blue dots. Note how the motion will be different with the added friction.

Start the skater at the top left, and run the simulation. In the space below carefully draw the five actual pie charts as they appear at each of the blue dots on the track.

4. How do your sketches compare to the pie charts on the graphic at each location? Did your charts overestimate any of the energy storage modes? Which one(s)? Can you now explain how the results were different from what you expected? If anyone in your group had a different explanation than you did, what was it, and how did your group resolve the difference?

5. What did you notice that was different this time compared to the run without friction?

6. What happens to the amount of  $E_{\text{therm}}$  as time passes? How is this different from what happened between the other modes of energy storage?

7. Does the size of the pie stay the same? What can you conclude from this?

8. Name all of the things that are interacting in this situation.

9. Make adjustments to your track, look for any variations from what you've seen so far and make notes about the differences.