

## Intro Screen

Explore different tracks and skaters, and investigate the relationship between the kinetic energy, potential energy, and thermal energy. Measure the speed and adjust the friction, gravity, and mass.

**OBSERVE** the energy in the system in real time

**DRAW** dot along path every 0.1 s

**EXPLORE** different tracks

**ADJUST** friction and gravity

**SELECT** skater; **SET** their mass

**ZOOM** to adjust scale

Energy Skate Park

## Measure Screen

Measure the energy at points along the skater's path. Experiment with different tracks and adjust the shape of the track by dragging the control points.

**MEASURE** the energy at the dots along the path

**VIEW** the skater's energy in a pie chart

**SET** the reference point for gravitational potential energy

**PAUSE** to facilitate measurement

Energy	
Kinetic	2152.2 J
Potential	-674.8 J
Thermal	0.0 J
Total	1477.4 J

Energy Skate Park

## Graphs Screen

Plot the skater's energy vs. position or time, and explore the conservation of energy. Drag the control points on the track to alter its shape.

**HIDE** the graph

**SELECT** the data to display in the graph

**PLOT** the energy vs. position or time

**CLEAR** data

**DRAG** tracer to replay data

**ADJUST** the depth of the well

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## Playground Screen

Build your own custom tracks, ramps, and jumps for the skater.

**CLICK** to edit the track

**CLEAR** the track

**VIEW** the grid

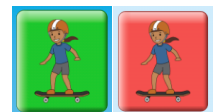
**MEASURE** the skater's speed

**DRAG** pieces up to build a custom track

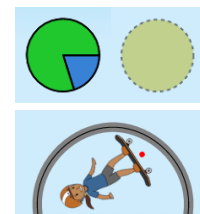
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## Complex Controls

- When the skater exits the screen, two additional return skater buttons appear on the screen. Clicking on either button will return the skater to the location of the button. The green button appears where the skater was most recently released, and the red button appears on the ground at the skater's starting position.

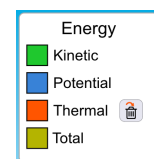


- The pie chart cannot display negative values. When the potential energy is negative, the pie chart displays only the total energy (right).
- The Stick to Track checkbox is on by default on all screens. When on, the track has a dashed midline. When off, the track midline is solid and the skater can fall off.



## Insights into Student Use

- Students may not notice or use the remove heat button located in the bar graph and pie chart. This feature is particularly useful to remove the heat that is created by the skater's initial collision with the track when the goal is to consider only the PE and KE in a frictionless environment.
- When setting up an experiment, it may be helpful to first pause the simulation. The step forward button is a good way to incrementally analyze.
- The path dots are drawn every 0.1s and are cleared when the skater turns around. When collecting data on the Measure Screen, pause the simulation before the path dots are cleared.



## Customization Options

The following query parameters allow for customization of the simulation, and can be added by appending a '?' to the sim URL, and separating each query parameter with an '&'.

Query Parameter and Description	Examples
<code>altAccelerationUnits</code> - displays the units of acceleration due to gravity in N/kg. The units can also be toggled within the Preferences menu.	<code>altAccelerationUnits</code>
<code>screens</code> - launches the screens listed after the '='. Each screen should be separated by a comma. For more information, visit the <a href="#">Help Center</a> .	<code>screens=1</code> <code>screens=4</code>

- The character sets are localizable for different regions/cultures. This can be accessed under Preferences > Localization.



## Model Simplifications

- When the skater lands on the track, the vertical component of their kinetic energy is converted to thermal energy. You can do experiments where there is no loss to thermal energy (only PE and KE conversions) by turning friction off and by making sure the skater doesn't leave the track.
- The height in the model is relative to the Reference Height, which is adjustable. When the Reference Height checkbox is off, potential energy will be zero at ground level.
- When the Reference Height is changed, the data in the Bar Graph, Pie Chart, and energy probe on the Measure screen will update dynamically. However, the data in the Energy vs. Position/Time graph on the Graphs screen will not be re-drawn.
- On the Measure screen, the data associated with the path dot represents the state of the model at the time it was drawn. If the mass, gravity, or friction is changed, the data associated with previously drawn dots will not retroactively change.
- The energy, height, and speed data displayed on the Measure screen is rounded to the nearest hundredths place. Due to rounding, calculations using the displayed values may result in small discrepancies.

- When Stick to Track is checked, the only factor that will affect the skater's ability to make it around the loop will be the energy in the system

## **Suggestions for Use**

### **Sample Challenge Prompts**

- Determine the factors that affect the skater's kinetic, potential, and thermal energy.
- Explain the Conservation of Mechanical Energy.
- Design an experiment to determine the relationship between kinetic energy and speed.
- Determine where along the track most of the energy get transferred to thermal energy.
- Compare the skater's energy for various reference heights. What changes? What stays the same?
- Build a track with a loop that the skater can complete.

### **Clicker Questions**

- Match the skater's energy pie chart with their location on the track.
- If the skater's kinetic energy is getting larger, determine the direction of their motion.
- Determine if the skater can make it over a hill (or around a loop) given their starting position.

See all published activities for Energy Skate Park [here](#).

For more tips on using PhET sims with your students, see [Tips for Using PhET](#).