Online Lab: Conservation of Energy

Name: Date:

Instructor: Section:

Theory:

A skater is started from rest on a track and the speeds of the car at various points along the track are measured using a Measurement Tool. The potential energy is calculated from the measured height and the kinetic energy is calculated from the speed. The total energy is calculated for two points on the track and compared.

If the skater is released from the top of the hill so it easily makes it over the top of the loop, the speed of the skater can be measured at the top of the loop and the centripetal acceleration as well as the apparent weight (normal force) on the skater can be calculated.

The total energy (E) of the skater is equal to its kinetic energy (K) and its potential energy (U).

$$E = K + U \tag{1}$$

$$K = \frac{1}{2}mv^2 \tag{2}$$

where m is the mass of the skater and v is the speed of the skater.

$$U = mgh \tag{3}$$

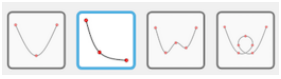
where $g = 9.8\ m/s^2$ is the acceleration due to gravity and h is the height of the skater above the position where the potential energy is defined to be zero.

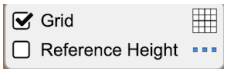
If friction can be ignored, the total energy of the skater does not change. The Law of Conservation of Energy is stated as

$$E = \text{constant} \implies K_{initial} + U_{initial} = K_{final} + U_{final} \tag{4}$$

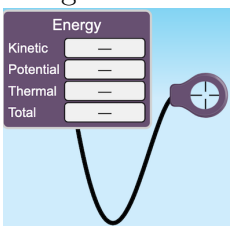
Online Experiment Setup Instructions:

1. Go to the following website:
   http://phet.colorado.edu/sims/html/energy-skate-park/latest/energy-skate-park_en.html
2. Click Intro on the PHeT simulation.
3. Description of the Buttons used during the Experiment is given below:

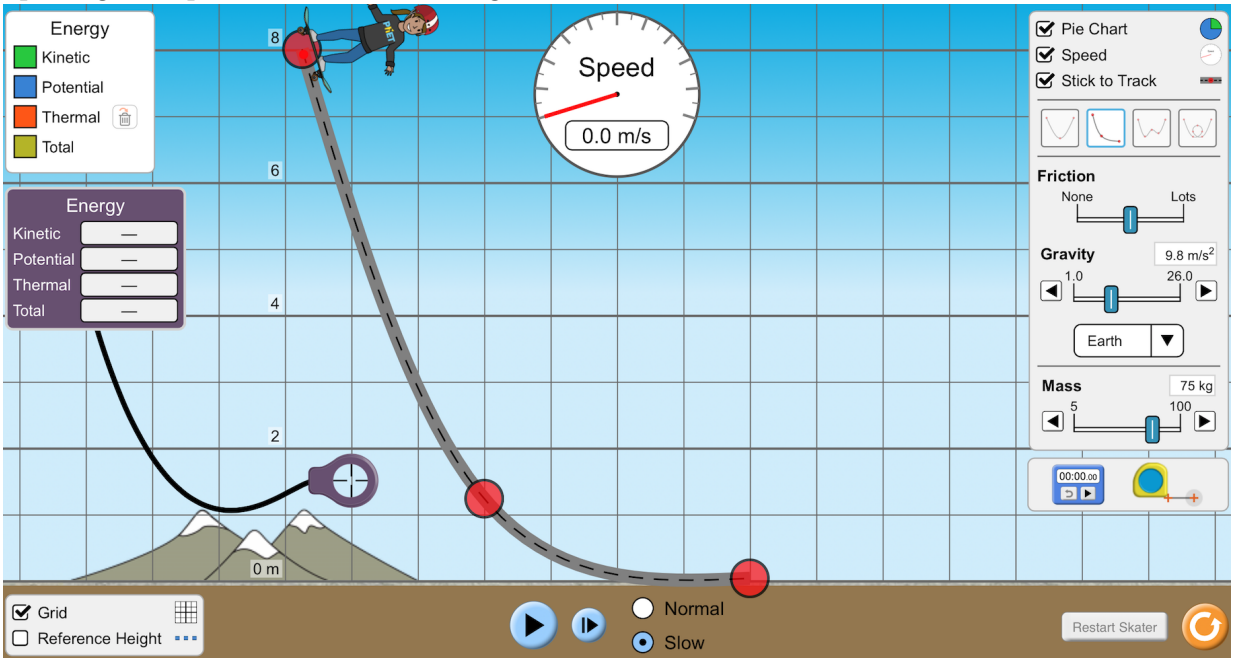
   (a) The Track panel has a variety of tracks to choose from. 

   (b) Check the Grid box to overlay a grid over the track and skater. 

   (c) Measurement Tool: Drag and Place the cross hairs of the measurement tool to a point along the track to measure speed, height and energy.



   (d) Below show the Initial Setup for the procedure on Page 4. The Control Panel on the right is used to adjust various parameters such as Mass and Gravity along with opening the speedometer and letting the skater stick to the track.



Gravitational Potential and Kinetic Energy

1. Click the **Intro** tab on the bottom of the PHeT simulation.
2. Check the boxes for the **Pie Chart** and **Speed** in the upper right control panel.
3. Set the motion to **Slow**. **Place** the skater on the track. Click **Play**.
4. Observe as the skater moves across the track and how it changes the levels of Potential and Kinetic Energy. **Note: You can step, slow or pause the skater down at the bottom of the simulator window to help you observe**.

   Answer Either: Top, Middle, Bottom.

   (a) When is the gravitational potential energy the highest?

   (b) When is the gravitational potential energy the lowest?

   (c) When is the kinetic energy the highest?

   (d) When is the kinetic energy the lowest?

   (e) When are the kinetic and gravitational potential energy levels the same?

Gravity Affect on Energy

1. Click the **Measure** tab on the bottom of the PHeT simulation.
2. Turn on the **Pie Chart** to show kinetic and potential energy.
3. Select Earth under the Gravity section of the Control Panel to move the skater to Moon, where acceleration due to gravity is 1.6 m/s^2.

   Observe and Describe how the skater moves and what happens to the skater's potential and kinetic energy on the Moon compared to the Earth.

4. Move the skater to Jupiter, where acceleration due to gravity is 26 m/s^2.

   Observe and Describe how the skater moves and what happens to the skater's potential and kinetic energy.on Jupiter compared to the Earth.

Relationship Between Maximum Velocity and Kinetic Energy with Varying Mass and Height

1. Click the **Reset** Button on the bottom right of the PHeT simulation.
2. Check the boxes **Pie Chart** and **Speed** in the upper right control panel.
3. Check the **Grid** box (lower left) and Select **Track 2** in the upper right control panel.
4. **Drag** the top of track to adjust the Height to 8 m. Set the motion to **Slow**.
5. Perform a run for each associated Skater Mass and Track Height given in Table 1.
6. Measure the Maximum Velocity and Kinetic Energy of the skater at the bottom of the ramp (Height = 0 m) for each set of Mass and Heights in Table 2 below.
   Record your measurements in Table 1.

Table 1: Kinetic Energy and Speed with Varying Mass and Height

Mass (kg)	**Height (m)**	**Max Velocity (m/s)**	**Kinetic Energy (J)**
75 kg	8 m		
75 kg	6 m		
75 kg	4 m		
60 kg	8 m		
60 kg	6 m		
60 kg	4 m		
45 kg	8 m		
45 kg	6 m		
45 kg	4 m		

Observation and Analysis:

1. How did the final kinetic energy change with mass and height in this experiment? Is it what you expected?

2. How did the maximum velocity change with mass and height in this experiment? Is it what you expected?

Conservation of Energy

1. Click the **Reset** Button. Select **Track 2**. Check the **Grid** box (lower left).
2. **Drag** the top of track to adjust the Height to 8 m.
3. Set the Skater mass to **60 kg** and place them on the top of the track.
4. Set the motion to **Slow**. Click **Play** when ready. (See setup on Page 6.)
5. **For EACH point** Measure the Height and Speed of the skater at each point starting from the initial height of 8 meters along the ramp to the bottom where the Height = 0 m. Record these in Table 2.
6. Calculate the Potential Energy (U), Kinetic Energy (K) and Total Energy ($K + U$) of each data point using your measured values. Record these in Table 2.
7. Calculate the Initial Total Energy of the skater.
   Record your answer (**including units**) here:
8. Calculate the Final Total Energy of the skater.
   Record your answer (**including units**) here:
9. How much energy is lost? Where does it go?
10. Calculate the percent of total energy lost. $\%_{Lost} = \frac{Energy\ Lost}{Initial\ Energy}$

    Record your answer here:
11. Does the Total Energy for the skater stay about the same at each point? Explain why or why not?
12. **Take a photo or scan a copy showing all of your calculations and upload it with your Lab Report in D2L.**

Table 2: Conservation of Energy

Height (m)	Speed (m/s)	Potential Energy (J)	Kinetic Energy (J)	Total Energy (J)