Skateboard Physics Lab Report

Vocabulary
Give a very brief description of the following terms:

- kinetic energy (KE): _____
- gravitational potential energy (PE): _____
- thermal energy: _____
- mechanical energy: _____
- conservation of energy:_____

Part I. Learning How to Use the Simulation:

1. As the skate park opens on your screen, observe the movements of the skater in the half pipe.
   - Does the skater reach the same height on the opposite sides of the track? _____

     Where does he move the fastest? _____
   - What do the pause and step buttons do (under the skater screen)? _____
   - What do the blue dots on the track allow you to do? _____
   - Grab a piece of track, and add it to the exiting track. Manipulate the old and new sections to become familiar with the construction techniques.

2. Turn on the Energy Pie Chart, Energy vs. Position Graph, and Bar Graph. (You may need to move things around a little to see everything.)
   - On all three visual aids, what colors represent potential energy, kinetic energy, and total energy?_____
   - On the Energy vs. Position Graph, what is the total energy of the skater? _____J
   - Where does the skater have the largest kinetic energy and the largest potential energy? _____
   - It should be clear on the Energy vs. Position Graph and Bar Graph that the total energy is really the mechanical energy, which is the sum of the _____ and _____ energies.

3. Reset the simulation: Display the grid, Potential Energy Reference, and the Bar Graph. The potential energy (PE) reference level is at ground level. Move the PE reference while the skater is moving and answer the following questions.
   - As the PE reference level is moved, does the motion of the skater change? _____
   - In the Bar Graph, what happens to the total energy as the PE reference level is raised?_____
   - Raise the PE reference to get zero total energy.
     - As the skater moves down the slope, is the PE positive or negative?_____
     - As the skater moves down the slope, is the KE positive or negative?_____
   - Using the Energy vs. Position Graph, what is the maximum KE of the skater?_____
     - Does the KE part of the graph change as the PE reference changes?_____

- Does the maximum change in PE change as the PE reference is moved?_____

Skateboard Physics Lab Report – Part II

Student A says that the location of the PE reference is critical because it changes the total energy and total energy is important. Just look at the world. We need more energy.

Student B says that the location of the PE reference is a matter of convenience and can be chosen anywhere to make calculations and understanding easier. It is the change in PE that matters.

Which student is correct? Explain.

4. Reset the simulation: Display the grid, PE reference, and Energy vs. Position box. Set the skater on the ground. Set the gravity to 10 (for simplicity), open the Edit Skater box, and set the mass of the skater to 100 (for simplicity). Be aware that the bounciness and stickiness are related to the skill of the skater and will not be altered now.
   - Calculate the work to lift the skater to a height of 5 m. work = (force)(distance) = mgh = _____ J.
   - At the height of 5 meters, the reading on the Energy vs. Position box is _____ J.
   - Use the tape measure to find the distance from the PE reference to the bottom of the ramp. This distance is _____ m.
   - Place the skater on the ramp at the 5 m height. The skater now has a change in PE from the top of his path to the bottom of his path. The PE is now _____ J.
   - The maximum KE of the skater is now _____J.

Student A says the work done in raising the skater against gravity is equal to the change in gravitational PE. Work done against gravity is the source of the potential energy. The maximum KE of the skater is equal to the maximum change in PE as he skates the half pipe.

Student B says the skater has the same KE regardless of the PE level, so the work done has nothing to do with the KE or PE. Student A is just playing with numbers.

Which student is correct? Explain.

5. Reset the simulation: Display the grid, PE reference, and Energy vs. Time box. Pause the motion. Set the PE reference at the bottom of the half pipe. Run the motion for a short time and pause the motion again.
   - Examine the controls in the Energy vs. Time box. Briefly describe the function of the following controls:
     - Rewind:
     - Playback:
     - Step:
     - The grey bar:

- With the motion paused, move the friction bar from none to the middle of the scale. Push play, and observe the motion until the skater stops moving and pause the action.
  - What is the red energy component? _____
  - What is the final value of the thermal energy? _____ KE? _____ PE? _____
  - What is the final value of the total energy? _____ J
- With the motion playing, push the "clear heat" button.
  - Describe what happens to the various energy components.

Student X says that friction caused energy to be lost from the skater. In the end, the skater did not have any energy. Energy was not conserved.

Student Y agrees that mechanical energy was not conserved, but if thermal energy is included then all of the energy is accounted for. What do you think?

6. Reset the simulation: Display the grid, PE reference, and energy box of your preference. From the tracks option at the top of the display, select the fly off (bug) track. Remove the friction, and place the skater at the 5 meter height and play the motion. With the friction removed, the skater does not lose mechanical energy unless he jumps and lands. At that point, he loses some energy. Set the skater at the five meter height, and verify that he loses mechanical energy on the jump. Then find the height from which he just makes it over the hump, but does not lose energy.
   - Describe the skater's motion starting from 4.5 m.
   - Describe the skater's motion starting from 4 m.
   - Describe the skater's motion starting from 3.5 m.

7. Using the set up from 6 above, right click the track with your mouse and select the roller coaster mode. Describe the behavior of the motion and energy with this track option.

8. Reset the simulation: Display the grid and PE reference. Locate the show path and clear buttons in the green area to the right of the skater. When the skater is near the top of the left side, push the show path button and then the stop button so that a series of purple dots is displayed. Using the mouse, click one of these and display information. This information will disappear when the dot is clicked again. Experiment with this feature, with the PE reference line set at different levels.
   - Describe how this feature works and what information is displayed.