7.3: Using PhET to Study the Work-Energy Theorem

In the PhET simulation below, click on the "Measure" tab. Leave all of the default settings as they are. Place the skater at the top of the ramp and release them. They should continue to skate up and down the ramp endlessly since there is no friction. Place the measurement sensor at the top of the ramp. Attempt to adjust the sensor until the kinetic energy reads zero as the skater passes the sensor.

Exercise 7.3.1

As the skater goes down the ramp, describe the work being done on them is coming from what force?

A. Friction

B. Gravity

C. Unable to determine

Answer

B.

Exercise 7.3.2

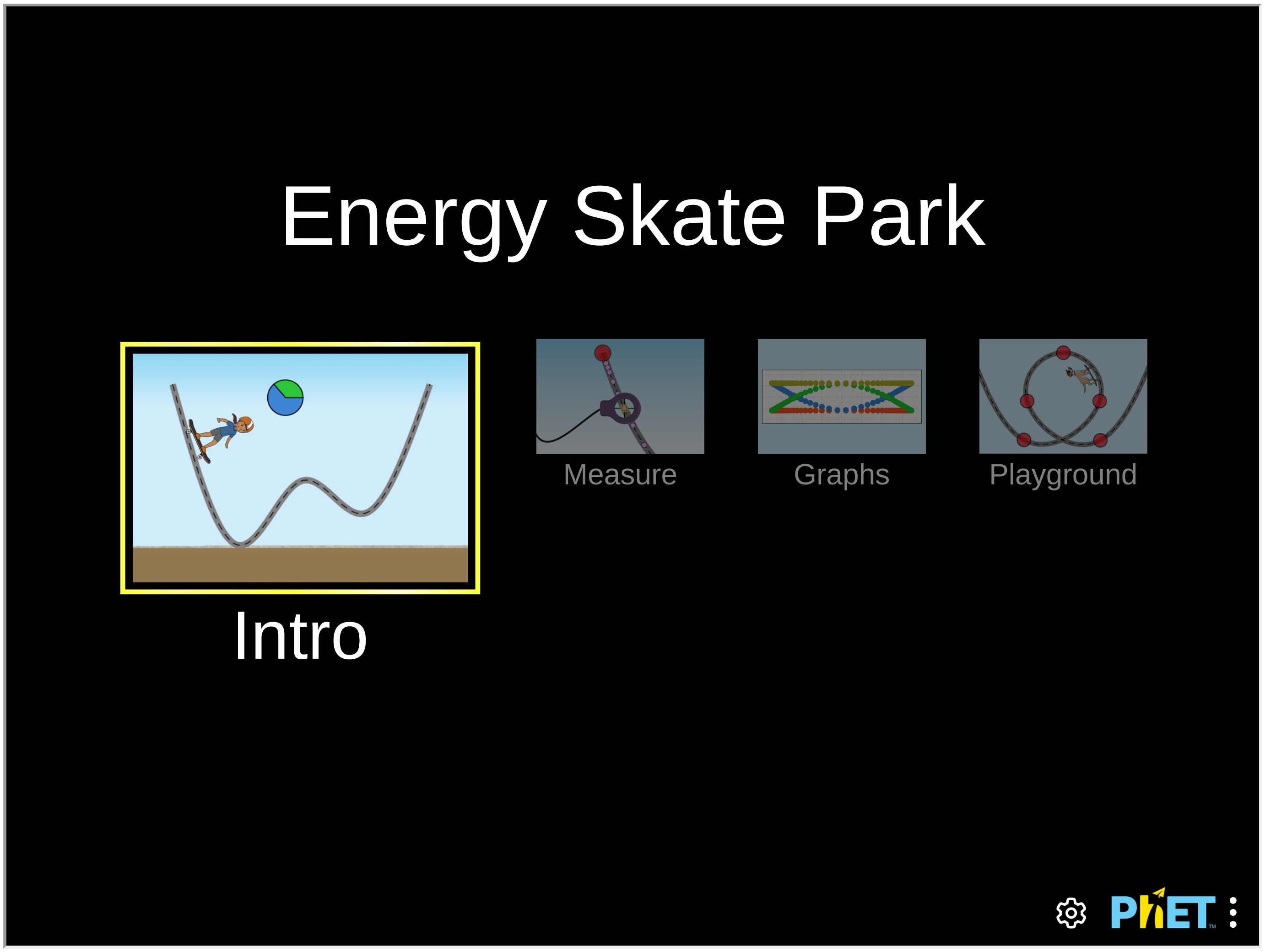
As the skater goes from the top of the ramp to the bottom, how much work is done on them?

Answer

$mgh = 60 \times 9.8 \times 6 = 3528\text{J}$

Does the sensor's measurement of potential energy agree with the amount of work you calculated above? If the kinetic energy is not zero, does the sum of potential and kinetic energy sum to the calculated energy above?

![LibreTexts logo]



Move the measurement sensor to the bottom of the ramp. Try to place it so that the potential energy is zero. How does the kinetic energy compare to the calculation of gravitational work from above?

Olivia's Thoughts

The skater begins at the top of the ramp with zero kinetic energy and 3528 J of potential energy. As the skater goes to the bottom of the ramp, gravity is continuously doing work on the skater. As the potential energy drops, it is converted as work by the force of gravity to kinetic energy. At the bottom of the ramp, all of the potential energy has been used to do work on the skater. The skater's kinetic energy is now equal to the original potential energy. Since gravity is a conservative force, the conversion of energy from potential to kinetic is complete, without losses. As a check of the relationship

$$W = \Delta K$$

you can calculate that the skater's speed at the bottom should be

$$mgh = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

$$mgh = \tfrac{1}{2}mv_f^2 - 0$$

$$gh = \tfrac{1}{2}v_f^2$$

$$v_f = \sqrt{2gh}$$

$$v_f = \sqrt{2 \cdot 9.8 \cdot 6} = 10.8 \mathrm{m/s}$$

Next, increase and decrease the skater's mass. Notice their motion does not change. This is seemingly a contradiction. Can you explain why this scenario has mass independent motion?

Now, set the friction to a small value. What do you observe happening? Place the measuring sensor somewhere on the ramp. You should notice the thermal energy has a value when it did not when there was no friction. Where is the skater's energy going?
