

Energy Skate Park — Kinetic vs Potential Energy Worksheet

Name: _____ Class: _____ Date: _____

Open the free **Energy Skate Park** simulation by PhET (eolclassroom-online.com/classroom-simulations/ or phet.colorado.edu). Useful equations: **PE** = **m** × **g** × **h** and **KE** = $\frac{1}{2} \times m \times v^2$, where m is mass (kg), g is gravity (9.8 m/s² on Earth), h is height (m) and v is speed (m/s).

Part A — Watch the energy change (Intro screen)

Choose the **Parabola** track. Turn on **Energy Bar Graph**, **Pie Chart**, **Speed** and **Grid**. Set Friction to zero. Drag the skater to the top of one side and let go.

1. Where on the track is the skater's **potential energy** (blue) the greatest?

2. Where is the **kinetic energy** (green) the greatest? Where is the skater fastest?

3. Sketch the bar graph at three points: the top, halfway down and the bottom.

At the top	Halfway down	At the bottom

4. What happens to the **total energy** (purple) as the skater moves? Explain why.

5. If the skater is released 4 m above the bottom, how high will it go on the other side (no friction)? Why?

Part B — Add friction

Slowly move the **Friction** slider to the right and restart the skater from the same point.

6. What happens to the **thermal energy** (red) over time?

7. What happens to the **total energy** now? Is energy lost, or does it change form?

8. Where does the skater finally stop, and what form is all of its energy in?

Part C — Measure the energy (Measure screen)

Set Friction to zero and keep the mass at **60 kg**. Release the skater from rest. Drag the **Energy Sensor** to three points on the track and record the values.

Point	Height (m)	Speed (m/s)	Potential energy (J)	Kinetic energy (J)	Total energy (J)
Start					
Middle					
Bottom					

9. Use $PE = m \times g \times h$ to calculate the potential energy at your starting point. Does it match the sensor? Show your work.

10. Use your starting PE to **predict** the speed at the bottom (hint: all PE becomes KE, so $\frac{1}{2} \times m \times v^2 = m \times g \times h$). Compare with the sensor.

Part D — Change the mass and the gravity

11. Change the skater's **mass** and release it from the same height. What happens to the energy values? What happens to the speed at the bottom?

12. Explain why mass does not change the speed at the bottom (hint: look at the equation in question 10).

13. Change the gravity setting from **Earth** to **Moon**. How does the skater's motion change? Does it still reach the same height on the other side?

Part E — Graphs and loops

14. On the **Graphs** screen, record a run of Energy vs. Position. Describe the shape of the kinetic and potential energy lines and how they relate to each other.

15. On the **Intro** screen, choose the **Loop** track. Find the lowest starting point that lets the skater go all the way around the loop. Why must the skater start higher than the top of the loop?

Answer Key (Teacher Copy)

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Example values assume mass 60 kg, $g = 9.8 \text{ m/s}^2$ and no friction. Student values will depend on where they release the skater.

Part A

1. At the highest points of the track (the start and the top of the other side).
2. At the lowest point of the track. The skater is fastest there.
3. Top: all potential, kinetic zero. Halfway down (in height): potential and kinetic about equal. Bottom: all kinetic, potential zero (when the reference height is at the bottom). The total bar stays the same in all three.
4. Total energy stays constant. With no friction, energy only changes between potential and kinetic; none is lost (conservation of energy).
5. About 4 m. With no friction the total energy is constant, so the skater reaches the same height where all energy is potential again.

Part B

6. Thermal energy increases with every pass.
7. Total energy stays the same. Energy is not lost; friction converts kinetic energy into thermal energy (heating the track and the skater).
8. At the lowest point of the track. Its energy has become thermal energy (plus any potential energy relative to the reference height if the reference line is not at the bottom).

Part C

Example for a release from rest at 5.0 m:

Point	Height (m)	Speed (m/s)	PE (J)	KE (J)	Total (J)
Start	5.0	0.0	2,940	0	2,940
Middle	2.5	7.0	1,470	1,470	2,940
Bottom	0.0	9.9	0	2,940	2,940

9. $PE = 60 \text{ kg} \times 9.8 \text{ m/s}^2 \times 5.0 \text{ m} = 2,940 \text{ J}$. Small differences come from reading the height.
10. $\frac{1}{2} \times m \times v^2 = m \times g \times h$, so $v = \sqrt{(2 \times g \times h)} = \sqrt{(2 \times 9.8 \times 5.0)} \approx 9.9 \text{ m/s}$.

Part D

11. A heavier skater has more potential, kinetic and total energy (energy is proportional to mass), but the speed at the bottom is the same.
12. Mass appears on both sides of $\frac{1}{2} \times m \times v^2 = m \times g \times h$, so it cancels: $v = \sqrt{2gh}$. Speed depends only on gravity and height.
13. On the Moon the skater moves much more slowly, because gravity is weaker (about one-sixth of Earth's). Without friction it still reaches the same height on the other side, because energy is still conserved.

Part E

14. The lines are mirror images: where potential energy is high, kinetic energy is low, and the reverse. Their sum (total energy) is a flat line when there is no friction.
15. At the top of the loop the skater must still be moving fast enough to stay on the track, so it needs some kinetic energy there. Its total energy must therefore be greater than the potential energy at the top of the loop. That means it must start higher than the top of the loop. (For a circular loop of radius r with no friction, the minimum starting height is $2.5 r$ above the bottom.)