

Name:

Date:

Class:

# PhET Roller Coaster Simulation Worksheet **Answer Key**

**Objective:** To recreate a roller coaster in the skate park simulator and use data to explain how the energy changes over time.

## Phase 1: Explore the Phenomenon

### ASK & RESEARCH

What do you already know? What are we trying to find out?

Think back to the paper roller coaster your team built earlier in this unit.

**Where on your track was your marble moving the *fastest*? Where was it moving the *slowest*?**

Fastest point: **at the bottom of the biggest drop (the lowest point)** Slowest point: **at the top of the starting hill (the highest point)**

**Here is the mystery: Your marble always slowed down and eventually stopped. Where do you think its energy went? Was it destroyed?**

**Example:** The energy was not destroyed. The rubbing between the marble and the track (friction) turned some of the movement energy into heat, so the marble gradually slowed down and stopped.

Today you get “X-ray vision.” Go to the **PhET Energy Skate Park** simulation and let’s find out:  
<https://phet.colorado.edu/en/simulations/energy-skate-park>

- Click the **Playground** screen.
- Drag pieces of track to build a coaster (a starting hill, a drop, and a loop or hill).
- Click the **energy bar-graph** icon so you can see the **Potential, Kinetic, Thermal, and Total** energy bars.

## Phase 2: The Engineering Challenge

★ **Your Challenge:** Recreate your team’s roller coaster in the simulation. Then change one variable at a time to collect data that answers the mystery: *Where does the energy go?*

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## PLAN

Design your tests before you start. Change one variable at a time.

**You will change three variables: the starting height, the rider's mass, and the friction.**  
Which one will you test first, and what do you predict will happen to the energy?

Example: I will test the starting height first. Prediction: A higher starting hill gives the rider more potential energy, so it will reach a higher top speed (more kinetic energy) at the bottom.

## CREATE & TEST

Recreate your coaster, then run your tests and record every result.

**Take a screenshot of your coaster with the energy bar graph showing and paste it in the box below.**

[A student's screenshot of their recreated coaster in the Playground screen with the Potential, Kinetic, Thermal, and Total energy bars visible.]

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Run a trial for each change. For every trial, record what happened to the energy bars and where the rider was fastest or where it stalled.

| Trial | Which variable did you change, and to what? (height / mass / friction) | What happened to the energy bars? (Potential, Kinetic, Thermal, Total)               | Where was the rider fastest? Did it complete the track or stall? |
|-------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------|
| 1     | Height — raised the starting hill                                      | Potential bar started taller; kinetic bar was taller at the bottom; total bar higher | Fastest at the bottom, completed the track                       |
| 2     | Height — lowered the starting hill                                     | Smaller potential bar to start; lower kinetic bar; total bar lower                   | Slower overall; stalled before the last hill                     |
| 3     | Mass — heavier skater                                                  | All energy bars larger (more potential and kinetic); total bar higher                | Fastest at the bottom, completed the track                       |
| 4     | Mass — lighter skater                                                  | All energy bars are smaller; total bar lower                                         | Completed the track when the hill was tall enough                |
| 5     | Friction — added friction                                              | Thermal bar grew; potential + kinetic shrank each pass; total stayed the same        | Slowed each pass; stalled partway                                |
| 6     | Friction — none (frictionless)                                         | No thermal energy; potential and kinetic traded off; total bar stayed constant       | Kept going; completed the track easily                           |

**IMPROVE**

Use what you learned to adjust your coaster.

Adjust your track or your variables so the rider completes the whole track. What did you change, and what happened to the total energy when you added or removed friction?

Example: I raised the starting hill and lowered the later hills, and I reduced the friction. With less friction, less energy turned into thermal energy, so more stayed as potential and kinetic energy and the rider had enough to finish. The total energy bar stayed the same either way — friction just moved more of it into thermal energy.

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### Phase 3: Analyze & Explain

Complete this part on your own, using the data you and your partner collected.

**Look for the patterns in your data.** Complete each sentence below using one of the variables you changed (height, mass, or friction). (Example: As the height increases, the potential energy increases.)

As the **height** increases, the **potential** energy **increases**.

As the **mass** increases, the **kinetic** energy **increases**.

As the **friction** increases, the **thermal** energy **increases**.

**Now fill in each blank using evidence from your trials:**

The **kinetic energy increases** when **the rider moves faster / reaches the lowest points of the track**.

The **potential energy decreases** when **the rider drops to a lower height / speeds up**.

The **thermal energy increases** when **there is more friction on the track**.

The **total amount of energy** stays the **same**.

**Answer our mystery: Where does the energy go when the roller coaster slows down and stops?** Use your trial data as evidence and explain how you know the **total energy** is *conserved*. Use the words **potential energy**, **kinetic energy**, **thermal energy**, **friction**, and **total energy** in your answer.

Example: The energy is never destroyed — it changes form. At the top of the hill, the rider has the most potential energy. As it drops, that potential energy transforms into kinetic energy, so the rider moves fastest at the lowest point. Friction between the rider and the track turns some of that kinetic energy into thermal energy (heat), which is why the rider slowly loses speed and finally stops. The total energy of the system stays the same the whole time; the motion energy did not disappear; it just became thermal energy. This shows energy is conserved.