# Speed at the Bottom

Use a ramp simulation to explain changes in mechanical energy.

**PHY.3.3** "Through real-world applications, draw conclusions about mechanical potential energy and kinetic energy using online simulations and/or laboratory experiences."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline the starting heights and bottom speeds in each trial, circle the evidence that energy transfers to the track, and number the two conclusions about how height and friction affect motion.

### Testing a Skate-Park Ramp

1. In a skate-park design lab, Maya models a 50-kilogram cart rolling down a ramp to test how starting height affects its speed. The simulation measures height above the ramp's bottom and speed at that bottom. She releases the cart from rest at a height of 1 meter on a smooth, nearly frictionless track. Its speed at the bottom is about 4.4 meters per second. On a second run, she starts at 2 meters and records about 6.3 meters per second at the bottom. The cart, track shape, and measurement point stay the same.

2. At either starting point, the cart has gravitational potential energy because it is above the bottom. Its kinetic energy is zero at release because it is not yet moving. As it rolls down, gravitational potential energy decreases and kinetic energy increases. At the bottom, the cart's gravitational potential energy relative to that point is zero, while its kinetic energy is greatest for that run. The higher release gives the cart more initial gravitational potential energy. Comparing the two bottom speeds supports this conclusion: a higher starting point produces more kinetic energy at the bottom when friction is negligible.

3. Maya repeats the 2-meter release but switches on friction to model a rougher track. The cart still begins at rest, but its bottom speed is 5.0 meters per second rather than 6.3 meters per second. The simulation reports that 355 joules of the cart's initial energy became thermal energy in the wheels and track. Energy has not disappeared; less of it remains as kinetic energy. Thus, friction leaves less energy as motion at the bottom even though the cart starts with the same gravitational potential energy. Designers must consider surface resistance when estimating a rider's speed.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. Compare the two nearly frictionless runs. What do their bottom speeds show about the effect of starting height on kinetic energy?

2. As the cart rolls from its starting point to the bottom, how do its gravitational potential energy and kinetic energy change?

3. The two 2-meter runs begin with the same gravitational potential energy. Why does the rough-track run end with less kinetic energy?

4. Could Maya use 4.4 meters per second as an exact bottom-speed prediction for a rough-track run starting at 1 meter? Explain using her results.

## 3 YOUR TURN

Your own words

Design a toy-car test in which you send the same car up a ramp at two different starting speeds. In four sentences, explain how you would set and measure the speeds, what height you would measure, which run you predict will climb higher, and how kinetic and gravitational potential energy account for your prediction.

ANSWER KEY

# Speed at the Bottom



## PART 1 · READ AND MARK

Underline the starting heights and bottom speeds in each trial, circle the evidence that energy transfers to the track, and number the two conclusions about how height and friction affect motion. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | Compare the two nearly frictionless runs. What do their bottom speeds show about the effect of starting height on kinetic energy? | **Starting at 2 meters produced a bottom speed of about 6.3 m/s, compared with 4.4 m/s from 1 meter. The higher start produced more kinetic energy at the bottom.** |
| 2 | As the cart rolls from its starting point to the bottom, how do its gravitational potential energy and kinetic energy change? | **Gravitational potential energy decreases as height decreases, while kinetic energy increases as the cart gains speed.** |
| 3 | The two 2-meter runs begin with the same gravitational potential energy. Why does the rough-track run end with less kinetic energy? | **Friction transfers some of the initial energy to thermal energy in the wheels and track, leaving less as kinetic energy.** |
| 4 | Could Maya use 4.4 meters per second as an exact bottom-speed prediction for a rough-track run starting at 1 meter? Explain using her results. | **No. The 4.4 m/s result came from a nearly frictionless track. The 2-meter trials show that friction lowers bottom speed, but they do not give an exact speed for a rough-track run from 1 meter.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

I would use two spring-launcher settings to send the same toy car toward the same uphill ramp. I would measure its speed at the ramp's bottom and the greatest vertical height it reaches in each run. The faster run should climb higher because the car has more kinetic energy at the bottom to convert into gravitational potential energy. I would keep the ramp surface the same so friction does not change between runs.

Accept answers that connect greater starting height with greater bottom speed and kinetic energy, and friction with energy transferred to thermal energy. For the open task, accept any workable way to set and measure two starting speeds and compare the resulting heights.