Marble to Light

Investigate an energy pathway through a moving system

PHS.7.2 "Use scientific investigations to explore the transformation of energy from one type to another (e.g., potential to kinetic energy, and mechanical, chemical, electrical, thermal, radiant, and nuclear energy interactions)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline one energy pathway from the raised marble to the LED's light, and number the energy forms in order. Circle two observations that provide evidence for the pathway.

Can a Rolling Marble Light an LED?

1. A marble starts at the top of a track beside a paddle wheel. The wheel's shaft turns a small generator connected to an LED. A student releases the marble without pushing it. As the marble rolls down, its gravitational potential energy decreases and its kinetic energy increases. When it strikes a paddle, some of its kinetic energy becomes the wheel's rotational kinetic energy. The generator converts some of that mechanical energy into electrical energy, which the LED converts into radiant energy, or light, and thermal energy. The marble, wheel, and air also gain a little thermal energy through friction.

2. To investigate, the student releases the marble from a low point and a higher point on the same track. They use the same marble, wheel, and room lighting for every run. They record whether the LED lights and count wheel turns using a mark on the rim and slow-motion video. They also note the sound at impact. In a typical low release, the LED glows briefly and the wheel turns about twice. In a typical higher release, the LED appears brighter and the wheel turns about four times. These are observations, not measurements of the total energy produced.

3. The higher starting position gives the same marble more initial gravitational potential energy. The brighter LED and greater number of wheel turns suggest that more energy reaches the wheel and generator. They do not prove that all the marble's lost potential energy becomes light. Some energy remains in the moving marble after impact, while some spreads as sound and thermal energy in the track, wheel, generator, and LED. To test the effect of height more carefully, the student could measure release height and marble speed just before impact across repeated runs. The observations support an energy pathway, not a complete energy balance.

2 ANSWER WITH EVIDENCE

Use the passage

1. Trace the energy pathway from the raised marble to the LED's light. Name the energy forms in order.

2. What did the student change between releases, and what stayed the same? How does this help test the effect of starting height?

3. What two observations suggest that the higher release transferred more energy to the wheel and LED? Why can these observations not show how much energy became light?

4. Identify two ways energy from the marble can end up somewhere other than the LED's light.

3 YOUR TURN

Your own words

Design an investigation with a wind-up toy car to test how winding affects its motion. In 4 to 5 sentences, state what you would change, measure, and keep the same, then trace at least two energy transformations and explain where some energy spreads.

ANSWER KEY

Marble to Light

HIGH SCHOOL · PHS.7.2

PART 1 · READ AND MARK

Underline one energy pathway from the raised marble to the LED's light, and number the energy forms in order. Circle two observations that provide evidence for the pathway. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Trace the energy pathway from the raised marble to the LED's light. Name the energy forms in order.	**Gravitational potential energy becomes the marble's kinetic energy, then the wheel's rotational kinetic energy. The generator converts mechanical energy to electrical energy, and the LED converts some electrical energy to radiant energy.**
2	What did the student change between releases, and what stayed the same? How does this help test the effect of starting height?	**The student changed the release height while keeping the marble, wheel, and room lighting the same. This makes height the main difference between the two sets of observations.**
3	What two observations suggest that the higher release transferred more energy to the wheel and LED? Why can these observations not show how much energy became light?	**The wheel turned about four times instead of twice, and the LED appeared brighter. Neither observation measures the amount of energy emitted as light.**
4	Identify two ways energy from the marble can end up somewhere other than the LED's light.	**Some energy remains as the marble's kinetic energy after impact. Some transfers to sound or thermal energy in parts of the system.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I will wind the same toy car two turns or four turns before releasing it on a flat floor. I will measure how far it travels before stopping in five trials at each setting. I will keep the car, floor, and release method the same. Winding stores elastic potential energy in the spring, which becomes the car's kinetic energy as it moves. Some energy transfers to thermal energy through friction and to sound as the wheels roll.

Accept equivalent descriptions of the wheel's motion as mechanical or rotational kinetic energy. For the open task, accept other measurable aspects of the car's motion if the student controls relevant conditions and identifies plausible energy transformations.