Where Energy Goes

Investigate energy changes in a spring-launched cart

PS.1.a "Plan and carry out investigations to explore how mechanical energy is transformed within a system, including kinetic energy, gravitational potential energy, elastic potential energy, and work."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline actions that do work, circle the three forms of mechanical energy, and number the energy changes after release in order to trace energy through the system.

A Cart Climbs a Hill

1. A small cart waits at the bottom of a track that rises into a hill. A spring behind the cart is compressed and held by a catch. The system we will study includes the cart, spring, track, and Earth. A hand does work on the spring by pushing it inward: the hand exerts a force while the spring moves. That work increases the spring's elastic potential energy. When the catch opens, the spring pushes the cart. Elastic potential energy decreases as the cart gains kinetic energy, the energy of motion. The cart then climbs, slowing as its gravitational potential energy increases.

2. To investigate these changes, a team keeps the cart's mass, starting place, and track angle the same. In each trial, they compress the spring by a measured distance, release the cart without another push, and record its speed just after it leaves the spring. They also mark the greatest vertical height the cart reaches above its starting height. A longer compression should store more elastic potential energy, so the team predicts a faster launch and a higher climb. Three trials at each compression distance help the team check whether the pattern repeats. Measuring vertical height, rather than distance along the slope, makes the gravitational comparison meaningful.

3. The team's model predicts that kinetic energy is greatest near the bottom, after the spring has finished pushing, and that gravitational potential energy is greatest at the cart's highest point. At that point, the cart briefly stops before rolling back down, changing gravitational potential energy into kinetic energy. The spring does work on the cart while it pushes the cart forward; after contact ends, the spring no longer does work on it. If the cart rises less than an ideal no-friction model predicts, friction and air resistance have transferred some mechanical energy to thermal energy in the surroundings. The team should not claim that energy disappeared.

2 ANSWER WITH EVIDENCE

Use the passage

1. Before release, what does the hand do that adds energy to the system, and where is that energy stored?

2. How does the team test whether compressing the spring farther changes the cart's motion and climb? Name what they change and two things they measure.

3. Trace the mechanical energy changes from the moment the catch opens until the cart reaches its highest point.

4. Suppose the cart climbs less than an ideal no-friction model predicts. What does the passage suggest happened to some of its mechanical energy?

3 YOUR TURN

Your own words

Plan a test using a system other than a cart on a ramp. Describe how work adds energy, how kinetic, gravitational potential, and elastic potential energy change, what you would vary and measure, and what you would keep the same.

Where Energy Goes

PART 1 · READ AND MARK

Underline actions that do work, circle the three forms of mechanical energy, and number the energy changes after release in order to trace energy through the system. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Before release, what does the hand do that adds energy to the system, and where is that energy stored?	**The hand does work by pushing the spring inward. That energy is stored as elastic potential energy in the spring.**
2	How does the team test whether compressing the spring farther changes the cart's motion and climb? Name what they change and two things they measure.	**They change the spring's compression distance and measure the cart's speed after it leaves the spring and its greatest vertical height.**
3	Trace the mechanical energy changes from the moment the catch opens until the cart reaches its highest point.	**Elastic potential energy decreases as the spring pushes the cart and the cart gains kinetic energy. As the cart climbs, kinetic energy decreases while gravitational potential energy increases.**
4	Suppose the cart climbs less than an ideal no-friction model predicts. What does the passage suggest happened to some of its mechanical energy?	**Friction and air resistance transferred some mechanical energy to thermal energy in the surroundings. The energy did not disappear.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would launch a foam ball straight up with a rubber band. My hand does work as it stretches the band, storing elastic potential energy. On release, the ball gains kinetic energy. As it rises and slows, its gravitational potential energy increases. I would vary how far I stretch the band and measure the ball's greatest height in three trials at each stretch distance. I would use the same ball and launch from the same height each time. Air resistance may transfer some mechanical energy to thermal energy.

Accept other testable systems if the response identifies work, all three mechanical energy forms, a variable to change, a measurement, and a condition to keep the same. Energy changes should follow the student's chosen system.