Cart Design Detectives

Track energy, evidence, and better designs.

4-PS3-4 "Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each sentence that tells about an energy change, circle the constraints, and number the testing and refining actions in order. These marks will show how evidence helped improve the device.

A Rubber-Band Cart

1. A design team built a small cart powered by a twisted rubber band. Twisting the band stored energy in it. When the team released the band, the axle turned and the cart moved across the floor. The device changed stored energy into motion energy. Their goal, or design criterion, was for the cart to travel at least one meter without anyone pushing it.

2. The team had only cardboard, two straws, four bottle caps, tape, and one rubber band. These limits were constraints because they restricted the materials the team could use. The team also had 20 minutes to build and test. On the first test, the cart rolled 60 centimeters, so it did not meet the one-meter criterion. The team needed evidence to decide what to change.

3. They noticed that one bottle-cap wheel rubbed against the cardboard. The team moved the straw axle so the wheel could spin freely. Then they tested the cart again and measured 115 centimeters. The new design met the criterion. By comparing measurements from both tests, the team could explain that changing the axle reduced rubbing and improved the cart's motion.

2 ANSWER WITH EVIDENCE

Use the passage

1. What energy conversion happened when the rubber-band cart was released?

2. What were the two constraints, and what was the design criterion?

3. What evidence showed that the team needed to refine the first design, and what change did they make?

4. How did the second test show that the refined cart met its criterion?

3 YOUR TURN

Your own words

Design, build, test and refine a different stored-energy device with your teacher. Suggested device: a cardboard ramp that releases a toy ball from rest and makes it roll at least 50 cm past the ramp end. Use only cardboard, tape, books and a toy ball; allow 15 minutes, and keep the ramp top at most 15 cm high. Use a ruler on a clear, level floor. Sketch your design on separate paper. Build it, release without pushing, and record the distance past the end in cm. Change one feature based on your observation, such as ramp height within the limit or a rough join, then retest on the same floor with the same ball and release method. Record both results even if the criterion is not met. In 3 to 5 sentences, explain the stored-energy-to-motion change, criterion, two constraints, actual results and refinement. Use separate paper for the record and explanation if needed.

ANSWER KEY

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GRADE 4 · 4-PS3-4

PART 1 · READ AND MARK

Underline each sentence that tells about an energy change, circle the constraints, and number the testing and refining actions in order. These marks will show how evidence helped improve the device. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What energy conversion happened when the rubber-band cart was released?	**Stored energy in the twisted rubber band changed into motion energy as the cart moved.**
2	What were the two constraints, and what was the design criterion?	**The constraints were the limited materials and the 20-minute build-and-test time. The criterion was for the cart to travel at least one meter without a push.**
3	What evidence showed that the team needed to refine the first design, and what change did they make?	**The cart traveled only 60 centimeters, and a wheel rubbed against the cardboard. The team moved the straw axle so the wheel could spin freely.**
4	How did the second test show that the refined cart met its criterion?	**The cart traveled 115 centimeters, which is more than one meter.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Illustrative completed record only: I built a ramp that changed stored gravitational energy of the raised ball–Earth system into motion as the ball rolled down. My criterion was 50 cm past the ramp end, with only the listed materials and 15 minutes. My first test reached 35 cm, so I taped a rough join smooth without changing the height. My second test reached 58 cm, meeting the criterion, although more trials would be needed to check whether the change reliably helped.

Preserve the four passage answers: 60 cm is below 1 m and 115 cm is above 1 m. For the learner task, require an actual design/build, measured first test, justified change and measured retest, plus a 3–5-sentence explanation. Check constraints, unit and common measurement origin. Accept unsuccessful or unexpected results; never require the fictional sample distances. Raising the ball stores gravitational potential energy in the ball–Earth system, which decreases as motion increases. A teacher-approved alternative stored-energy device is acceptable if learners actually design, test and refine it and document their evidence.