

# 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 a different device that uses stored energy to cause motion, make light, or make sound. In 3 to 5 sentences, name the energy change, state one design criterion and two constraints, then describe a test result and one refinement.

---

---

---

**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?                              | <b>Stored energy in the twisted rubber band changed into motion energy as the cart moved.</b>                                                                        |
| 2 | What were the two constraints, and what was the design criterion?                                    | <b>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.</b> |
| 3 | What evidence showed that the team needed to refine the first design, and what change did they make? | <b>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.</b>                |
| 4 | How did the second test show that the refined cart met its criterion?                                | <b>The cart traveled 115 centimeters, which is more than one meter.</b>                                                                                              |

**PART 3 • YOUR TURN (SAMPLE ANSWER)**

I will build a cardboard spinner powered by a stretched rubber band. It changes stored energy in the rubber band into motion energy as the spinner turns. My criterion is for it to spin at least five seconds, and my constraints are one rubber band and 15 minutes. In my first test it spins for three seconds, so I will make the cardboard blades smaller and test it again.

Accept equivalent descriptions of the energy conversion and evidence-based refinement. In Part 3, responses should include a valid stored-energy device, a criterion, two actual constraints, a test result, and a sensible change based on that result.