# Cushion the Crash

Design and test a model helmet using Newton's laws.

**P.6.6.1** "Use an engineering design process to create or improve safety devices (e.g., seat belts, car seats, helmets) by applying Newton's Laws of motion. Use an engineering design process to define the problem, design, construct, evaluate..."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline the team's design goal, number the three helmet versions in the order they were tested, and circle the sentences that explain how Newton's laws act during the crash.

### A Helmet for a Clay Head

1. When a skateboard stops at a curb, a rider's head can keep moving forward. This is Newton's first law: an object keeps moving unless a force changes its motion. A class team wants to design a model helmet that protects a clay ball called the "head." They place the ball inside a small paper cup that acts as the helmet shell. The cup rides in a toy cart. When the cart hits a block, the shell stops, but the clay ball presses against the helmet's front lining.

2. The team sets a goal: make the flat spot on the clay ball as small as possible. They first line the cup with one sheet of paper. They release the cart from a mark on a ramp and measure a flat spot 8 millimeters wide. Next, they replace the paper with a thick foam lining. From the same ramp mark, the foam-lined helmet leaves a flat spot 4 millimeters wide. Keeping the ramp mark, cart, and clay ball size the same makes the two tests fair.

3. The team reasons that foam lets the moving head slow down over more time. By Newton's second law, a smaller change in speed each second means a smaller force on the head if its mass stays the same. The head pushes on the foam, and the foam pushes back on the head with an equal force in the opposite direction, as Newton's third law states. To improve their design, the team adds a second foam layer. In another fair test, the flat spot measures 3 millimeters.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. Why does the clay head press against the front lining after the cart hits the block? Use Newton's first law in your answer.

2. Why did the team choose foam instead of paper? Use the test results and Newton's second law to explain.

3. What did the team keep the same in the first two tests, and why did that matter?

4. How did the team improve the helmet after testing the first foam lining? What result showed whether the change helped?

## 3 YOUR TURN

Your own words

Design a safety device for a toy passenger in a rolling cart that stops suddenly. In 4 to 5 sentences, state the problem, describe how you would build the device, explain one Newton's law, and tell how you would test and improve your design.

**ANSWER KEY**

# Cushion the Crash

**GRADE 6 · P.6.6.1**

## PART 1 · READ AND MARK

Underline the team's design goal, number the three helmet versions in the order they were tested, and circle the sentences that explain how Newton's laws act during the crash. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | Why does the clay head press against the front lining after the cart hits the block? Use Newton's first law in your answer. | **The clay head keeps moving forward when the cart stops because an object in motion keeps moving until a force changes its motion.** |
| 2 | Why did the team choose foam instead of paper? Use the test results and Newton's second law to explain. | **Foam lets the head slow down over more time, reducing its acceleration and the force on it. The flat spot was 4 millimeters wide with foam, compared with 8 millimeters with paper.** |
| 3 | What did the team keep the same in the first two tests, and why did that matter? | **They kept the ramp mark, cart, and clay ball size the same so they could compare the effects of the two linings fairly.** |
| 4 | How did the team improve the helmet after testing the first foam lining? What result showed whether the change helped? | **They added a second foam layer. The flat spot decreased from 4 millimeters to 3 millimeters, showing that the change helped.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

My problem is keeping a toy passenger from flying forward when its cart stops. I would build a seat belt from a fabric strip and tape its ends to the cart. Newton's first law explains why the passenger keeps moving until the belt pushes back. I would roll the cart from the same ramp mark with and without the belt and measure how far the passenger moves. If the belted passenger still slips, I would shorten the strip and test again from that mark.

Accept other workable devices and fair tests. The response should connect a design choice to a correctly applied Newton's law and describe a possible improvement based on test results.