The Safer Case

Use collision evidence to evaluate and refine a protective design.

HS-PS2-3 "Apply scientific and engineering ideas to design, evaluate, and refine a device for example, one that minimizes the force on a macroscopic object during a collision..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each change to the case, circle each force and damage result, and number the changes in the order they were tested. Use your marks to trace how the team improved its design.

A Case for a Fragile Artifact

1. At a museum, a team needs a reusable case for shipping a small ceramic artifact. A sudden stop during a fall can crack it even when the case stays intact. The team models the artifact with a 0.50 kg test block carrying a fragile ceramic disk. An accelerometer inside the block measures its acceleration during impact. Multiplying the block's mass by its peak acceleration gives an estimate of its peak net force. The goal is to keep the disk uncracked while lowering that force. Every case must also fit within the same outside dimensions.

2. The engineers build Case A with a thin foam liner. They drop each case from the same height onto the same hard floor, using five fresh, identical test blocks and disks per design. For Case A, the mean peak net force is 240 N, and three of five disks crack. Case B uses a thicker foam liner. Its mean peak net force is 150 N, but two disks still crack. Video shows the block in Case B sliding toward an uncovered corner just before impact. A longer stopping time can reduce the average force needed to stop an object, but exposed corners can still concentrate impacts.

3. The team keeps Case B's foam but adds a folded cardboard cradle that holds the block away from the corners. The cradle fits inside the same outer case, so shipping size does not change. In five new drops, Case C has a mean peak net force of 110 N, and no disks crack. These results favor Case C for this particular drop test, not for every possible accident. A case may strike a different surface or land in another position. Before choosing a final design, the team plans repeated tests from several heights and angles, plus checks that the case can be reused.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which case should the museum choose based on these drop tests? Support your choice with both force and damage evidence.

2. How did the change from Case A to Case B affect the results? Explain why the team still needed to improve the design.

3. How did the video observation guide the change from Case B to Case C? What evidence supports that change?

4. Why can't the team claim Case C will protect the artifact in every fall? Name one test that would provide more evidence.

3 YOUR TURN

Your own words

Design a protective package for a glass vial that must fit inside a fixed-size shipping box. In 4 to 6 sentences, describe your design, explain how it could lower collision force, and propose a fair drop test with a damage measure and one result that would make you revise the package.

The Safer Case

PART 1 · READ AND MARK

Underline each change to the case, circle each force and damage result, and number the changes in the order they were tested. Use your marks to trace how the team improved its design. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which case should the museum choose based on these drop tests? Support your choice with both force and damage evidence.	**Case C. It had the lowest mean peak net force, 110 N, and none of its five disks cracked.**
2	How did the change from Case A to Case B affect the results? Explain why the team still needed to improve the design.	**Thicker foam lowered the mean peak net force from 240 N to 150 N and reduced cracked disks from three to two. Two disks still cracked, so the design did not yet meet the goal of keeping disks uncracked.**
3	How did the video observation guide the change from Case B to Case C? What evidence supports that change?	**The block slid toward an uncovered corner, so the team added a cradle to hold it away from the corners. Case C's mean peak net force was 110 N, and no disks cracked.**
4	Why can't the team claim Case C will protect the artifact in every fall? Name one test that would provide more evidence.	**The team tested only one drop height and floor in these trials. Repeated drops from another height, at different angles, or onto another surface would provide more evidence.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would suspend the glass vial on elastic straps inside the box so it cannot touch the walls. The straps could stretch during a drop, giving the vial more time to stop and reducing its average stopping force. I would drop this package and an equally sized box with a rigid holder from the same height onto the same floor five times each. I would use identical vials and count how many crack in each package. If a suspended vial struck a wall or cracked, I would shorten the straps and retest.

Accept designs that identify a plausible way to reduce collision force and compare results under controlled drop conditions. A revision trigger should be a specific observable result, such as damage or contact with the box.