The Two-Cart Challenge

Design a launch that works for both carts

8.PS2.1 "Apply Newton's Third Law to design a solution to a problem involving the motion of two objects in a system.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two forces the carts exert on each other, circle the changes the team can make, and number the two places where the carts must stop. Use your marks to think about a design that works for both carts.

A Spring-Powered Delivery

1. At a clinic, two small wheeled carts must separate without a motor. A delivery cart needs to roll right to a taped loading line. A robot cart, facing it, must stay inside a short safety zone on the left. The carts start touching at a compressed spring bumper attached to the robot. A latch holds the bumper until a student releases it. Both carts have smooth wheels, but floor friction eventually stops them. The team can change the robot's mass and how far the spring is compressed.

2. When the latch opens, the robot's bumper pushes the delivery cart to the right. At the same time, the delivery cart pushes the robot to the left through the bumper. These forces act on different carts, point in opposite directions, and are equal in size. They do not cancel because they act on different objects. With the same push, a cart with more mass changes its motion less than a lighter cart. Once the carts separate, their push on each other ends, though both may keep rolling.

3. In the first test, the delivery cart stops before the loading line, while the robot stays inside its zone. The team has two adjustments available for the next test: compress the spring farther or attach removable weights to the robot. More compression increases the push on both carts, not just one. Extra mass makes the robot change its motion less during a push. The team plans to record where both carts stop after each trial. A useful design must meet both limits, not just move the delivery cart farther.

2 ANSWER WITH EVIDENCE

Use the passage

1. To launch the delivery cart toward the loading line, which way must the robot push it? What force acts on the robot at the same time?

2. The delivery cart stops short of the line. Which adjustment could help it roll farther, and what new problem must the team watch for?

3. After a stronger launch, the robot leaves its safety zone. How could the team reduce the robot's change in motion without removing the stronger launch?

4. Why must the team record where both carts stop before deciding whether a design works?

3 YOUR TURN

Your own words

Two skaters push off from each other on a smooth rink. One needs to glide right to a glove, while the other must stop before reaching cones on the left. In 3 to 4 sentences, design a plan using their starting spot and a supply pack that either skater can carry. Describe both forces, predict both skaters' motions, and explain how you would test the plan.

ANSWER KEY

The Two-Cart Challenge

GRADE 8 · 8.PS2.1

PART 1 · READ AND MARK

Underline the two forces the carts exert on each other, circle the changes the team can make, and number the two places where the carts must stop. Use your marks to think about a design that works for both carts. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	To launch the delivery cart toward the loading line, which way must the robot push it? What force acts on the robot at the same time?	**The robot pushes the delivery cart right. The delivery cart pushes the robot left with an equal force.**
2	The delivery cart stops short of the line. Which adjustment could help it roll farther, and what new problem must the team watch for?	**Compress the spring farther. The stronger push could send the robot out of its safety zone.**
3	After a stronger launch, the robot leaves its safety zone. How could the team reduce the robot's change in motion without removing the stronger launch?	**Add weights to the robot. Its greater mass makes its motion change less during the push.**
4	Why must the team record where both carts stop before deciding whether a design works?	**The push moves both carts in opposite directions. The delivery cart must reach the loading line, and the robot must stay inside its safety zone.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

They start far from the cones, and the skater on the left carries the supply pack. The left skater pushes the right skater toward the glove, while the right skater pushes the left skater toward the cones with an equal force. The pack's mass helps the left skater change motion less, but both skaters move. We test with a gentle push, then adjust the push while checking that one skater reaches the glove and the other stops before the cones.

Accept other workable plans that account for equal, opposite forces on the two skaters and check both outcomes. Do not accept a plan that claims extra mass weakens only one force in the pair.