Cart Forces

Use force models to predict a cart's acceleration.

8.11 "Use models to demonstrate each of Newton's laws of motion and explain the effect of net force on objects. a. Use mathematical representations to explain how the sum of external forces on an object and the object's mass affect its..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the rule for finding net force, circle the acceleration equation, and number the statements about Newton's three laws 1, 2, and 3. Use your marks to explain the cart trials.

A Cart on the Track

1. At a school science fair, students test a wheeled cart on a level track. A rightward pull and a leftward resisting force act on the cart. Picture the cart as a box with an arrow for each force. Subtract the leftward force from the rightward force to find the net force and its direction.

2. The cart's change in motion follows Newton's second law: acceleration equals net force divided by mass, or $a = F_{net} / m$. Force is measured in newtons (N), mass in kilograms (kg), and acceleration in meters per second squared (m/s^2). The table gives four separate trials. Each cart starts at rest, and the forces stay constant.

FOUR CART TRIALS

Trial	Cart mass (kg)	Pull right (N)	Resistance left (N)
A	2	10	2
B	4	10	2
C	2	6	2
D	2	2	2

3. Newton's first law predicts that balanced forces leave a resting cart at rest, or a moving cart at constant velocity. In Newton's third law, the puller pulls the cart and the cart pulls the puller back with equal strength in opposite directions. Those forces act on different objects, so they do not cancel on the cart.

2 ANSWER WITH EVIDENCE

Use the passage

1. For trial A, find the net force and the cart's acceleration. Include directions.

2. Trials A and B have the same forces. Calculate each acceleration, then explain why they differ.

3. Calculate the acceleration in trial C. Compare it with trial A and explain what caused the difference.

4. Find the net force and acceleration in trial D. Use Newton's first law to describe what happens to the cart.

3 YOUR TURN

Your own words

Invent a cart trial with a mass and two opposite horizontal forces that do not match any table row. Write a labeled arrow model, calculate the net force and acceleration, and explain how Newton's first and third laws apply.

Cart Forces

PART 1 · READ AND MARK

Underline the rule for finding net force, circle the acceleration equation, and number the statements about Newton's three laws 1, 2, and 3. Use your marks to explain the cart trials. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For trial A, find the net force and the cart's acceleration. Include directions.	**Net force: 10 N − 2 N = 8 N right. Acceleration: 8 N / 2 kg = 4 m/s² right.**
2	Trials A and B have the same forces. Calculate each acceleration, then explain why they differ.	**Both have a net force of 8 N right. A accelerates at 4 m/s² right, while B accelerates at 2 m/s² right because B has twice the mass.**
3	Calculate the acceleration in trial C. Compare it with trial A and explain what caused the difference.	**C's net force is 4 N right, so its acceleration is 2 m/s² right. A accelerates at 4 m/s² right. The carts have the same mass, but C has a smaller net force.**
4	Find the net force and acceleration in trial D. Use Newton's first law to describe what happens to the cart.	**The forces balance, so net force and acceleration are both zero. By Newton's first law, the cart remains at rest.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Arrow model for a 3 kg cart: 15 N right → cart ← 3 N left. Net force = 15 N − 3 N = 12 N right. Acceleration = 12 N / 3 kg = 4 m/s² right. By Newton's first law, the unbalanced force changes the cart's velocity. By Newton's third law, the cart pulls the puller left with 15 N while the puller pulls the cart right with 15 N.

Accept equivalent calculations with correct units and directions. In the open task, the third-law pair must act on different objects, not be the two opposing forces on the cart.