Cart Forces

Use motion evidence to draw conclusions about Newton's laws.

PHY.2.7 "Analyze real-world applications to draw conclusions about Newton's three laws of motion using online simulations, probe systems, and/or laboratory experiences."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline one motion observation in each paragraph, circle the forces that could explain it, and write 1, 2, or 3 beside each observation to identify the Newton law it supports.

Moving an Airport Cart

1. At an airport, a student models a luggage cart in a simulation. With rolling resistance turned off, the cart moves at a steady speed after a short push ends. With rolling resistance turned on, it slows after the push ends. In both runs, the student checks the displayed net force, the combined effect of all forces on the cart.

2. Next, a force probe measures pulls on a low-friction lab cart, and a motion sensor measures its acceleration. The class subtracts a small resistance force from each pull to find the net force shown below. Each trial begins at rest. These trials model how airport workers move carts with different loads.

LAB CART TRIALS

Trial	Total mass (kg)	Net force (N)	Acceleration (m/s^2)
A	2	4	2
B	4	4	1
C	2	8	4

3. Finally, consider a worker walking while pushing a cart. In a lab, force probes on a shoe model and a floor model register equal forces in opposite directions during contact. The shoe pushes the floor backward, and the floor pushes the shoe forward. Those forces act on different objects, so they do not cancel each other on the worker.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which simulation run best supports Newton's first law? What does the cart's motion show about its net force after the push?

2. Compare trials A and B. How does doubling the mass while keeping the net force the same affect acceleration, and which law does this support?

3. Compare trials A and C. What does doubling the net force reveal about acceleration when mass stays the same?

4. Why do the two shoe-and-floor forces not cancel on the worker? Explain how one of those forces helps the worker move.

3 YOUR TURN

Your own words

Choose a real-world motion other than a luggage cart or walking. Plan a simulation or probe test: state what you would change or measure, predict two observations, and explain how they would support two different Newton laws.

Cart Forces

PART 1 · READ AND MARK

Underline one motion observation in each paragraph, circle the forces that could explain it, and write 1, 2, or 3 beside each observation to identify the Newton law it supports. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which simulation run best supports Newton's first law? What does the cart's motion show about its net force after the push?	**The run without rolling resistance. The cart keeps a steady speed after the push, showing that its net force is zero.**
2	Compare trials A and B. How does doubling the mass while keeping the net force the same affect acceleration, and which law does this support?	**Acceleration falls from 2 to 1 m/s^2. This supports Newton's second law.**
3	Compare trials A and C. What does doubling the net force reveal about acceleration when mass stays the same?	**Acceleration doubles from 2 to 4 m/s^2, consistent with Newton's second law.**
4	Why do the two shoe-and-floor forces not cancel on the worker? Explain how one of those forces helps the worker move.	**The equal, opposite forces act on different objects. The floor's forward force on the shoe helps the worker move forward, consistent with Newton's third law.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would model a skateboard on level ground in a simulation and measure its speed and acceleration. With resistance turned off, the board should keep the same speed after the rider stops pushing; this supports the first law because the net force is zero. Keeping the mass fixed, I would double the forward net force and expect twice the acceleration, supporting the second law.

Accept equivalent conclusions supported by the passage or trial data. For the open task, look for two distinct, accurate law-based conclusions tied to predicted observations.