Cart Force Lab

Use numbers to explain changes in acceleration

8.11.a "Use mathematical representations to explain how the sum of external forces on an object and the object's mass affect its acceleration."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle "net force" and "mass" in the equation. In the table, mark one pair of trials with the same mass and a different pair with the same net force.

Testing a Robot Cart

1. At a school robotics test, a motor pulls a small cart along a straight track. A hand can push the other way, so the forces may partly cancel. The **net force** is the sum of all forces, counting opposite directions as negative. If the pull wins, the cart accelerates toward the pull.

2. Acceleration describes how quickly velocity changes. For a cart starting from rest, greater acceleration means its speed rises faster each second. Newton's relationship is acceleration = net force ÷ mass. For example, a 3 kg cart with a net force of 9 N accelerates at 3 m/s². The table lists four other trials.

ROBOT CART TRIALS

Trial	Mass (kg)	Net force (N)	Acceleration (m/s²)
A	2	6	3
B	2	10	5
C	4	6	1.5
D	4	12	3

3. The net force in each trial points toward the finish line. Compare trials with the same mass to isolate the effect of force. Compare trials with the same net force to isolate the effect of mass. If a motor pulls forward while friction acts backward, subtract friction from the pull before using the relationship.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare trials A and B. How does changing the net force affect acceleration when mass stays the same? Use numbers from the table.

2. Compare trials A and C. How does changing mass affect acceleration when net force stays the same? Use numbers from the table.

3. In trial D, suppose the motor pulls forward with 12 N and friction pulls backward with 4 N. What is the net force, and what acceleration would the 4 kg cart have?

4. What net force would give the cart in trial C the same acceleration as the cart in trial B? Show how you know.

3 YOUR TURN

Your own words

Invent a school cart test with a 5 kg cart and two forces acting in opposite directions. Choose the forces, calculate the net force and acceleration, then explain what happens to acceleration if the cart's mass doubles but the net force stays the same.

ANSWER KEY # Cart Force Lab

PART 1 · READ AND MARK

Circle “net force” and “mass” in the equation. In the table, mark one pair of trials with the same mass and a different pair with the same net force. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare trials A and B. How does changing the net force affect acceleration when mass stays the same? Use numbers from the table.	**At 2 kg, increasing net force from 6 N to 10 N increases acceleration from 3 to 5 m/s².**
2	Compare trials A and C. How does changing mass affect acceleration when net force stays the same? Use numbers from the table.	**At 6 N, doubling mass from 2 kg to 4 kg halves acceleration from 3 to 1.5 m/s².**
3	In trial D, suppose the motor pulls forward with 12 N and friction pulls backward with 4 N. What is the net force, and what acceleration would the 4 kg cart have?	**The net force is 12 − 4 = 8 N forward. Acceleration is 8 ÷ 4 = 2 m/s² forward.**
4	What net force would give the cart in trial C the same acceleration as the cart in trial B? Show how you know.	**Trial B accelerates at 5 m/s². A 4 kg cart needs a net force of 4 × 5 = 20 N.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

A motor pulls a 5 kg cart forward with 18 N while friction pulls backward with 3 N. The net force is 18 − 3 = 15 N forward, so acceleration is 15 ÷ 5 = 3 m/s² forward. If the mass doubles to 10 kg while net force stays at 15 N, acceleration becomes 15 ÷ 10 = 1.5 m/s², half as much.

Accept any correctly marked equal-mass pair and equal-net-force pair. For Your Turn, accept any two opposite forces with a positive forward net force and calculations that correctly show acceleration halving when mass doubles.