Cart Force Lab

Read data, reason with an equation, and describe a graph

P.2.b "Use mathematical, graphical, and narrative methods to explain the relationships among net force, mass, and acceleration of a single object."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the equation that connects net force, mass, and acceleration. Then circle the table values for two trials you could compare while keeping either mass or net force the same.

What Moves the Cart?

1. A team tests a wheeled equipment cart on a straight, level track. A pull forward and rolling resistance backward act at the same time. The **net force** is the forward pull minus the backward resistance. Sensors record the cart's mass and acceleration for four trials. Positive acceleration points forward along the track.

2. Newton's second law connects the measurements: net force = mass × acceleration, or $F_{net} = ma$. In the table, each row describes one trial of the cart with different added loads or pulls. Acceleration is measured in meters per second squared (m/s^2); one newton equals one kilogram times one meter per second squared.

CART TRIALS

Trial	Mass (kg)	Net force (N)	Acceleration (m/s^2)
A	2	4	2
B	2	8	4
C	4	8	2
D	4	12	3

3. The table can also become a graph: put net force on the horizontal axis and acceleration on the vertical axis. Plot trials with the same mass to see how acceleration changes as net force changes. Compare trials with the same net force to test what added mass does. Keep the compared variable fixed when drawing a conclusion.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the equation from the passage to check whether trial D's net force matches its mass and acceleration. Show your calculation.

2. Compare trials A and B. With mass unchanged, how does doubling the net force affect acceleration?

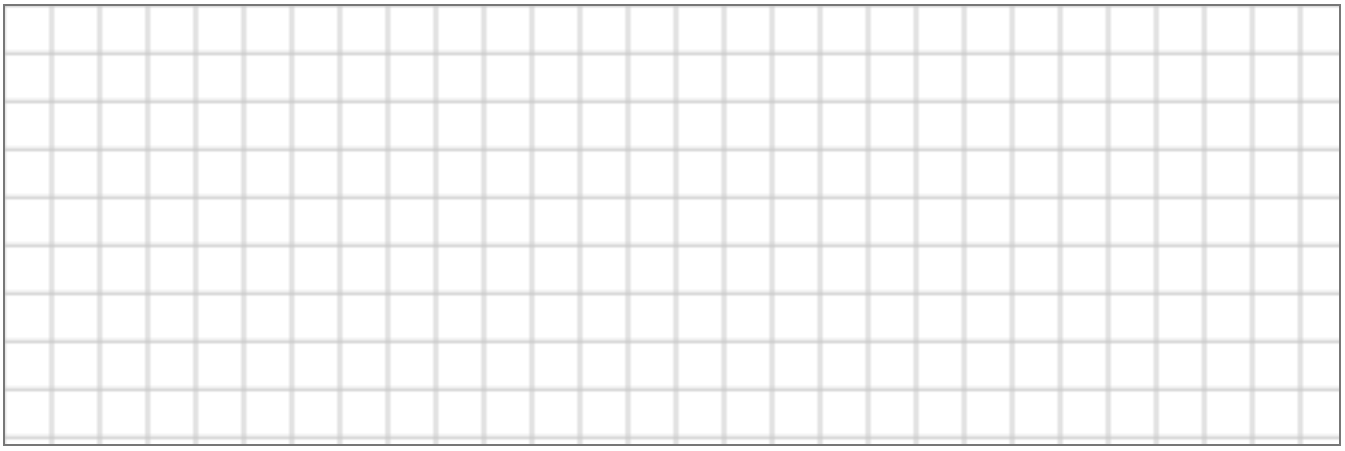
3. Compare trials B and C. With net force unchanged, how does doubling the mass affect acceleration?

4. If you graph acceleration against net force for trials A and B, what two points would you plot? What does the slope mean for a 2 kg cart?

3 YOUR TURN

Your own words

Choose a cart mass not used in the table and three different positive net forces. Calculate each acceleration, plot acceleration against net force on the grid, and write two sentences explaining the pattern using the equation and the graph's slope.



Cart Force Lab

PART 1 · READ AND MARK

Underline the equation that connects net force, mass, and acceleration. Then circle the table values for two trials you could compare while keeping either mass or net force the same. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the equation from the passage to check whether trial D's net force matches its mass and acceleration. Show your calculation.	**$F_{net} = ma = (4\ kg)(3\ m/s^2) = 12\ N$, which matches trial D.**
2	Compare trials A and B. With mass unchanged, how does doubling the net force affect acceleration?	**Mass stays at 2 kg. Net force doubles from 4 N to 8 N, and acceleration doubles from 2 to 4 m/s^2.**
3	Compare trials B and C. With net force unchanged, how does doubling the mass affect acceleration?	**Net force stays at 8 N. Mass doubles from 2 kg to 4 kg, and acceleration halves from 4 to 2 m/s^2.**
4	If you graph acceleration against net force for trials A and B, what two points would you plot? What does the slope mean for a 2 kg cart?	**Plot (4 N, 2 m/s^2) and (8 N, 4 m/s^2). The slope is 0.5 $(m/s^2)/N$: each additional newton of net force adds 0.5 m/s^2 of acceleration when mass is 2 kg.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Plotted points for a 5 kg cart: (5 N, 1 m/s^2), (10 N, 2 m/s^2), and (15 N, 3 m/s^2). Because $a = F_{net}/m$, each 5 N increase in net force increases acceleration by 1 m/s^2 while mass stays at 5 kg. The points form a straight line with a slope of 0.2 $(m/s^2)/N$.

Accept any mass other than 2 kg or 4 kg and any three different positive net forces with correctly calculated, labeled points. The two sentences should connect the pattern to the equation and interpret the graph's slope.