Cart Data Detectives

Use a mathematical model to analyze motion data.

PS.1.c.iii "interpreting, analyzing, and evaluating data apply mathematical concepts and processes to scientific questions"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the words that name the changed, controlled, and measured variables, circle every number with its unit, and number the sentences that explain how scientists evaluate data.

Testing Force and Motion

1. To test how force affects motion, a student used a low-friction cart and a force sensor. The cart's mass stayed at 0.50 kg for every trial. The student pulled with different forces, then measured the cart's acceleration. The table records one set of results. Because mass was controlled, changes in acceleration can be compared to changes in force.

CART TEST RESULTS

Trial	Force (N)	Mass (kg)	Measured Acceleration (m/s^2)
1	1.0	0.50	1.9
2	2.0	0.50	4.1
3	3.0	0.50	5.8
4	4.0	0.50	8.0

2. Newton's second law gives a mathematical model for this test: force equals mass times acceleration, or F = ma. When mass is 0.50 kg, the model predicts acceleration by dividing force by 0.50 kg. Data rarely match a model perfectly. Differences may come from sensor limits, friction, or rounding. Scientists compare measured and predicted values before making a claim.

3. The results can support a claim only if the comparison is fair. Here, force is the changed variable, mass is controlled, and acceleration is the measured response. A useful analysis states a numerical pattern, such as how much acceleration changes when force changes. It also names a limitation. Repeating trials and averaging accelerations would reduce measurement variation.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use F = ma to calculate the predicted acceleration for Trial 3. Show the calculation.

2. How far is Trial 3's measured acceleration from its predicted acceleration? State whether it is higher or lower.

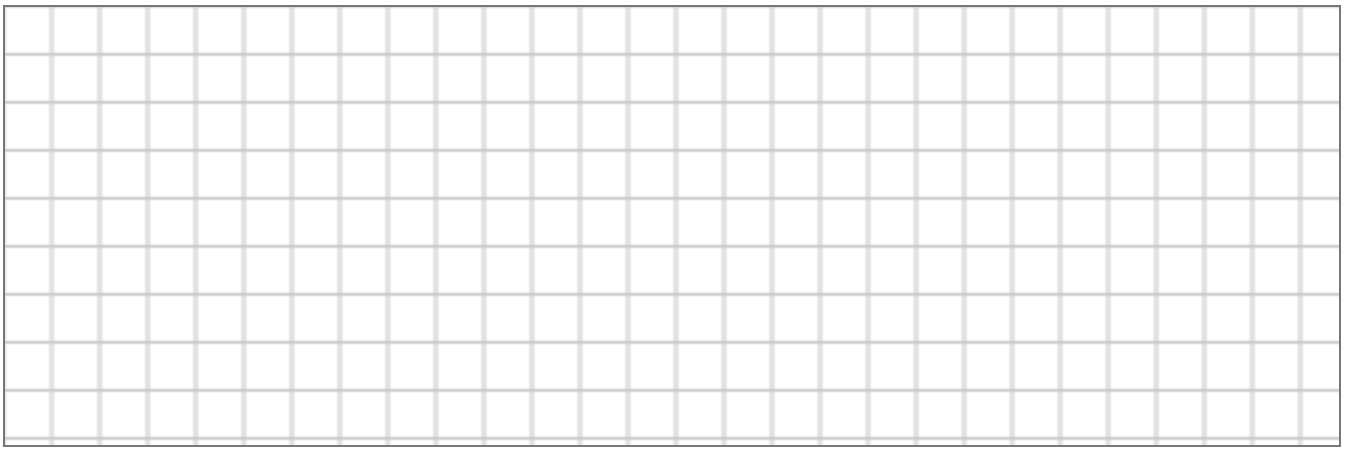
3. Which variable was controlled in this investigation, and how did controlling it make the comparison fair?

4. Do the data support the claim that acceleration increases as force increases? Use at least two data pairs as evidence.

3 YOUR TURN

Your own words

On the grid, create a fair new cart test. Choose three whole-number force values from 1 to 4 N, keep mass at 0.50 kg, calculate each acceleration using F = ma, and plot force on the horizontal axis and acceleration on the vertical axis. Under the graph, write two sentences that state the pattern and explain why the test is fair.



Cart Data Detectives

PART 1 · READ AND MARK

Underline the words that name the changed, controlled, and measured variables, circle every number with its unit, and number the sentences that explain how scientists evaluate data. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use F = ma to calculate the predicted acceleration for Trial 3. Show the calculation.	**a = F ÷ m = 3.0 N ÷ 0.50 kg = 6.0 m/s^2.**
2	How far is Trial 3's measured acceleration from its predicted acceleration? State whether it is higher or lower.	**It is 0.2 m/s^2 lower than predicted.**
3	Which variable was controlled in this investigation, and how did controlling it make the comparison fair?	**Mass was controlled at 0.50 kg. Keeping mass constant allows acceleration changes to be compared with force changes.**
4	Do the data support the claim that acceleration increases as force increases? Use at least two data pairs as evidence.	**Yes. For example, 1.0 N produced 1.9 m/s^2, while 2.0 N produced 4.1 m/s^2. Also, 3.0 N produced 5.8 m/s^2 and 4.0 N produced 8.0 m/s^2.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Graph points: (1 N, 2 m/s^2), (2 N, 4 m/s^2), and (4 N, 8 m/s^2). With mass held at 0.50 kg, acceleration increases as force increases. This is a fair test because force changes while mass stays the same.

Accept any three correctly calculated points using a constant mass of 0.50 kg, so acceleration equals twice the force value. The written claim should identify the increasing pattern and explain that holding mass constant makes the comparison fair.