Cart Test Clues

Use controlled runs to connect net force and motion

PS.PS2.1 "Analyze and interpret data to support the claim that a causal relationship exists between the net force exerted on an object and the resulting change in motion, as described in Newton's second law of motion."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentences that state the shared starting speed and run time. Circle two net-force entries from runs with the same mass, then number their final-speed entries in the same order.

A Cart on the Track

1. At a skate park, a technician tests a small wheeled cart on a straight, level track. A motor pulls the cart while a sensor records its speed. The technician adjusts the motor so that the **net force**, the combined effect of all forces along the track, stays constant during each run.

2. Each cart begins at rest. The sensor measures its speed exactly two seconds after the pull starts. The technician changes the net force while keeping mass fixed, then changes mass while keeping net force fixed. The table reports the net force along the track, not just the motor's pull.

CART RUNS

Run	Mass (kg)	Net force (N)	Speed after 2 s (m/s)
A	2	0	0
B	2	2	2
C	2	4	4
D	2	6	6
E	4	4	2

3. Newton's second law states that acceleration equals net force divided by mass. Acceleration measures how quickly velocity changes. Because every run starts at rest and lasts the same time, a larger final speed means a larger acceleration. To test a causal claim, compare runs that differ in only one planned condition; otherwise, several changes might explain the result.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare runs A and B. What evidence shows that changing net force changed the cart's motion?

2. Compare runs B and D. How did the change in net force affect the change in speed?

3. Compare runs C and E. What does this pair show about the role of mass when net force stays the same?

4. Why would comparing only runs D and E be weak evidence that net force caused their different speeds?

3 YOUR TURN

Your own words

Plan two new runs using a 3 kg cart that starts at rest and is pulled for two seconds. Use net forces of 3 N and 9 N, predict each final speed, and explain in three sentences how the results would test whether net force causes a change in motion.

ANSWER KEY

Cart Test Clues

PART 1 · READ AND MARK

Underline the sentences that state the shared starting speed and run time. Circle two net-force entries from runs with the same mass, then number their final-speed entries in the same order. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare runs A and B. What evidence shows that changing net force changed the cart's motion?	**With mass fixed at 2 kg, increasing net force from 0 N to 2 N raised the speed after two seconds from 0 m/s to 2 m/s.**
2	Compare runs B and D. How did the change in net force affect the change in speed?	**At the same mass, tripling net force from 2 N to 6 N tripled the speed gained in two seconds, from 2 m/s to 6 m/s.**
3	Compare runs C and E. What does this pair show about the role of mass when net force stays the same?	**At 4 N, doubling mass from 2 kg to 4 kg reduced the speed gained in two seconds from 4 m/s to 2 m/s.**
4	Why would comparing only runs D and E be weak evidence that net force caused their different speeds?	**Both net force and mass differ between those runs, so the speed difference cannot be attributed to net force alone.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

With a net force of 3 N, the 3 kg cart would accelerate at 1 m/s² and reach 2 m/s after two seconds. With a net force of 9 N, it would accelerate at 3 m/s² and reach 6 m/s. Because mass, starting speed, and time stay the same, the larger speed gain supports the claim that greater net force causes greater acceleration.

Accept equivalent comparisons that identify the controlled conditions and use the table's values accurately. For Your Turn, the predicted speeds must be 2 m/s and 6 m/s.