Two Launches, Two Paths

Read position and velocity data to explain projectile motion.

P.1.c "Analyze and interpret data to explain changes in the vector quantities of position, velocity, and acceleration in two-dimensional projectile motion, including projectiles launched horizontally and at an angle."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentence that explains how to find displacement, and circle the sentence that explains how to find a change in velocity. Then number the table rows in time order so you can track each ball's motion.

A Launch Station Experiment

1. At a station, two balls share the horizontal starting coordinate x = 0. Ball H begins 45 meters above the ground and launches horizontally. Ball A starts at ground level and launches upward at an angle. Rightward and upward are positive directions. Ignore air resistance. Gravity accelerates each ball downward at 10 meters per second squared.

2. The table records each ball at one-second intervals. A position pair gives horizontal distance x followed by height y, both in meters. A velocity pair gives horizontal component v_x followed by vertical component v_y, both in meters per second. The two balls share x = 0 at launch, not the same starting height.

POSITION AND VELOCITY AT ONE-SECOND INTERVALS

Time (s)	Ball H position (x, y), m	Ball H velocity (v_x, v_y), m/s	Ball A position (x, y), m	Ball A velocity (v_x, v_y), m/s
0	(0, 45)	(10, 0)	(0, 0)	(10, 20)
1	(10, 40)	(10, -10)	(10, 15)	(10, 10)
2	(20, 25)	(10, -20)	(20, 20)	(10, 0)
3	(30, 0)	(10, -30)	(30, 15)	(10, -10)

3. To analyze motion, compare pairs from different times rather than looking at height alone. Subtract earlier position coordinates from later ones to find displacement. Do the same with velocity components to find a change in velocity. A positive vertical component points upward, a negative one points downward, and zero means no vertical motion at that instant.

2 ANSWER WITH EVIDENCE

Use the passage

1. From 1 s to 2 s, what is Ball H's displacement vector? What does its vertical component show?

2. From 1 s to 2 s, what is Ball A's displacement vector? Compare its vertical displacement with Ball H's over the same interval.

3. How does Ball A's velocity change from 1 s to 3 s? Use that change to calculate its acceleration vector.

4. At 2 s, compare the balls' heights and vertical velocities. Why do the heights alone not tell you whether each ball is rising or falling?

3 YOUR TURN

Your own words

Design a different horizontal launch. Choose a starting height of at least 30 m and a rightward speed, then give your ball's position and velocity vectors at 0, 1, and 2 s using an acceleration of (0, -10) m/s^2. Explain how gravity changes the vectors.

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PART 1 · READ AND MARK

Underline the sentence that explains how to find displacement, and circle the sentence that explains how to find a change in velocity. Then number the table rows in time order so you can track each ball's motion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	From 1 s to 2 s, what is Ball H's displacement vector? What does its vertical component show?	**Ball H's displacement is (10, -15) m. It moves 15 m downward.**
2	From 1 s to 2 s, what is Ball A's displacement vector? Compare its vertical displacement with Ball H's over the same interval.	**Ball A's displacement is (10, 5) m. Ball A rises 5 m while Ball H falls 15 m.**
3	How does Ball A's velocity change from 1 s to 3 s? Use that change to calculate its acceleration vector.	**Its velocity changes by (0, -20) m/s over 2 s, so its acceleration is (0, -10) m/s^2.**
4	At 2 s, compare the balls' heights and vertical velocities. Why do the heights alone not tell you whether each ball is rising or falling?	**Ball H is at 25 m with vertical velocity -20 m/s, so it is falling. Ball A is at 20 m with vertical velocity 0 m/s. Height gives a location, not a direction of motion.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I chose a starting height of 50 m and a rightward speed of 7 m/s. At 0 s, position is (0, 50) m and velocity is (7, 0) m/s. At 1 s, position is (7, 45) m and velocity is (7, -10) m/s. At 2 s, position is (14, 30) m and velocity is (7, -20) m/s. Gravity decreases the vertical velocity by 10 m/s each second, while horizontal velocity stays at 7 m/s.

Accept equivalent vector notation. For Part 3, check that horizontal velocity stays constant, vertical velocity changes by -10 m/s each second, and positions match the student's chosen launch.