Launch by Launch

Track a ball's motion in two dimensions.

PHY.2.4 "Use vectors and mathematical analysis to explore the 2D motion of objects. (i.e., projectile and circular motion)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what stays constant, circle what gravity changes, and number the two displacement equations. These marks will help you track horizontal and vertical motion separately.

Three Balls in Flight

1. At a school field, three launchers send balls into the air from ground level. Each ball starts with a rightward velocity and an upward velocity. Treat air resistance as negligible and use a downward gravitational acceleration of 10 m/s^2. These conditions let you track each ball with separate horizontal and vertical velocity components.

2. Gravity changes only the vertical component. After t seconds, vertical velocity is $v_y = v_{yo} - 10t$, while horizontal velocity remains v_{xo}. Displacement from the launch point is $x = v_{xo}t$ and $y = v_{yo}t - 5t^2$. At the highest point, vertical velocity is zero, even though the ball still moves horizontally.

3. The table lists three possible launches from the same spot. The total flight time ends when the ball returns to its starting height. Since upward and downward travel take equal time, the highest point occurs halfway through the flight. To find that point's horizontal distance, multiply horizontal velocity by half the flight time. Keep directions attached to velocity answers.

BALL LAUNCH DATA

Launch	Initial horizontal velocity (m/s right)	Initial vertical velocity (m/s up)	Total flight time (s)
A	6	10	2
B	6	20	4
C	6	30	6

2 ANSWER WITH EVIDENCE

Use the passage

1. For launch B, calculate the ball's vertical velocity 1 second after release. Give its direction.

2. For launch A, calculate the ball's horizontal and vertical displacement 1 second after release.

3. For launch C, how far horizontally has the ball traveled when it reaches its highest point? Show your calculation.

4. For launch B, calculate the horizontal and vertical velocity components just before the ball lands. Give both directions.

3 YOUR TURN

Your own words

Imagine a fourth ball leaves the same spot at 8 m/s right and 15 m/s up. Show calculations for its highest-point time and coordinates, total flight time, and horizontal landing distance; include units.

Launch by Launch

PART 1 · READ AND MARK

Underline what stays constant, circle what gravity changes, and number the two displacement equations. These marks will help you track horizontal and vertical motion separately. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For launch B, calculate the ball's vertical velocity 1 second after release. Give its direction.	**$v_y = 20 - 10(1) = 10$ m/s upward.**
2	For launch A, calculate the ball's horizontal and vertical displacement 1 second after release.	**$x = 6(1) = 6$ m right; $y = 10(1) - 5(1)^2 = 5$ m up.**
3	For launch C, how far horizontally has the ball traveled when it reaches its highest point? Show your calculation.	**The highest point occurs at $6 \div 2 = 3$ s. Horizontal displacement is $6(3) = 18$ m right.**
4	For launch B, calculate the horizontal and vertical velocity components just before the ball lands. Give both directions.	**Horizontal velocity is 6 m/s right. Vertical velocity is $20 - 10(4) = -20$ m/s, or 20 m/s down.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

At the highest point, $0 = 15 - 10t$, so $t = 1.5$ s. Its coordinates are $x = 8(1.5) = 12$ m right and $y = 15(1.5) - 5(1.5)^2 = 11.25$ m up. The total flight time is $2(1.5) = 3$ s. The landing distance is $8(3) = 24$ m right.

Accept a negative vertical velocity in place of "downward" when the sign convention is clear. Coordinates are measured from the launch point.