Name: _____ AP PHYSICS 1 Date: _____

KINEMATICS DAY 9: PROJECTILES — HORIZONTAL LAUNCH

WARMUP **Day 8 Review**

A 15 m/s velocity points 53° above the horizontal. Which component pair is correct?

□ **A.** v_x = 9.0 m/s; v_y = 12 m/s

□ **B.** v_x = 12 m/s; v_y = 9.0 m/s

□ **C.** v_x = 15 m/s; v_y = 15 m/s

□ **D.** v_x = 7.5 m/s; v_y = 7.5 m/s

Check one → convince your neighbor in one sentence.

Physics in the Wild — The Bullet Drop Experiment: Fire a bullet perfectly horizontally and drop an identical bullet from the same height at the same instant: they hit the ground *at the same time* (MythBusters actually did it — within 40 ms). Horizontal speed has zero effect on falling. That one fact — the axes don't talk to each other — is all of projectile motion.

TWO INDEPENDENT PROBLEMS

Horizontal (x): no acceleration.

$v_x = v_0$ (constant!) · $x = v_0 t$

Vertical (y): free fall from rest.

$v_y = gt$ $h = \frac{1}{2}gt^2 \rightarrow t = \sqrt{(2h/g)}$

Time is the only thing the two axes share. Find t from the fall height, then hand it to the horizontal equation.

WE DO **Exercise 1: Off the Cliff**

A ball rolls off a 19.6 m cliff moving horizontally at 15 m/s. Find **(a)** the time to land, **(b)** the horizontal distance from the cliff base, and **(c)** the impact speed (both components first!).

FRQ Type 4 of 4 — Translation Between Representations: the AP exam asks you to move between words, pictures, graphs, and equations describing the *same* motion. The grader wants to see that your motion diagram, your graphs, and your equations all tell one consistent story.

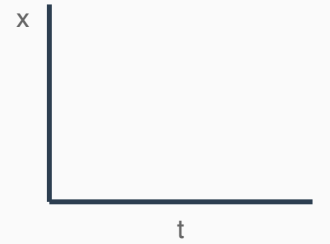
AP FRQ · REPRESENTATIONS

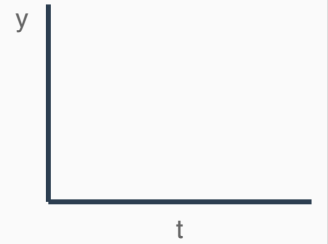
One Marble, Four Pictures

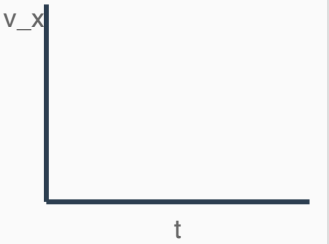
A marble rolls off the edge of a level table and lands on the floor. Take t = 0 at the instant it leaves the table, x horizontal, and y the distance *fallen* (downward positive).

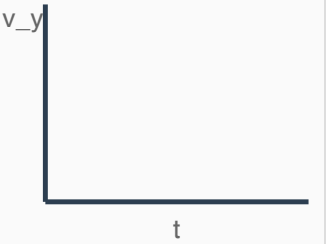
(a) Draw a motion diagram: dots for the marble's position at equal time intervals from launch to landing, with a velocity arrow at each dot. Mind the spacing of the dots in each direction.

(b) Sketch each graph for the full flight:









(c) In one or two sentences, justify the shape of your v_y graph using the marble's acceleration.

WORKING BACKWARD

YOU DO **Exercise 2: Find the Launch Speed**

A coin slides off a table 4.9 m tall (it's a very tall table — go with it) and lands 6.0 m from the table's base. **(a)** How long was it in the air? **(b)** How fast was it sliding when it left the table?

The most common projectile error: using the launch speed in the vertical equations. For a *horizontal* launch, the initial vertical velocity is zero — the fall starts from rest no matter how fast the object moves sideways.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Range

A ball rolls off a 4.9 m ledge at 6.0 m/s. Find the fall time and where it lands.

P2 Launch Speed

An object launched horizontally from 19.6 m up lands 24 m out. Find its launch speed.

P3 The Supply Drop

A plane flying horizontally at 50 m/s releases a package that falls for 3.0 s. Find **(a)** the plane's altitude and **(b)** how far ahead of the drop point the package lands.

P4 Aim High

A dart leaves a blowgun horizontally at 10 m/s, aimed straight at a bullseye 2.0 m away. By how much does the dart miss below the bullseye? *(This is why darts players aim high.)*