

KINEMATICS DAY 11: PROJECTILES — HORIZONTAL LAUNCH

WARMUP Components First (Day 10 Review)

Find the x and y components of a 15 m/s velocity directed 53° above the horizontal. (Day 10's triangle work — this is the doorway to every projectile problem.)

THE AXES DON'T TALK TO EACH OTHER

Horizontal (x): no acceleration.

$$v_x = v_0 \text{ (constant!)} \cdot x = v_0 t$$

Vertical (y): free fall from rest.

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

Time is the only thing the 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 — components first, then the Pythagorean theorem.

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.

YOU DO Exercise 2: Find the Launch Speed

A coin slides off a table 4.9 m tall 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?

AP FRQ One Marble, Four Pictures (Representations)

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 x - t , v_x - t , y - t , and v_y - t for the full flight.

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

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.)