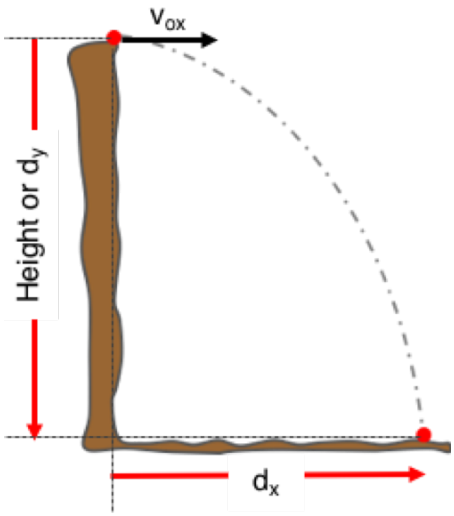
Solving Horizontally-Launched Projectile Problems

Lesson Notes

What is a Horizontally-Launched Projectile?

Horizontally-launched projectiles are objects projected in a horizontal direction from an elevated position.



- The initial vertical velocity of a horizontally-launched projectile is 0 m/s.
  v_{oy} = 0 m/s
- Projectiles have a constant horizontal velocity.
  a_x = 0 m/s/s
- Projectiles accelerate vertically at 9.8 m/s/s, ↓.
  a_y = - 9.8 m/s/s

Problem-Solving Tips and Strategies

Projectile problems must be solved using two sets of kinematic equations. Horizontal and vertical motion parameters must be kept separate from one another.

Horizontal: $d_x = v_{ox} \cdot t$

Vertical: $d_y = v_{oy} \cdot t - 4.9 \cdot t^2$ $\qquad v_{fy} = v_{oy} - 9.8 \cdot t$

$v_{fy}^2 = v_{oy}^2 - 19.6 \cdot d_y$ $\qquad d_y = [\ (v_{oy} + v_{fy})/2\ ] \cdot t$

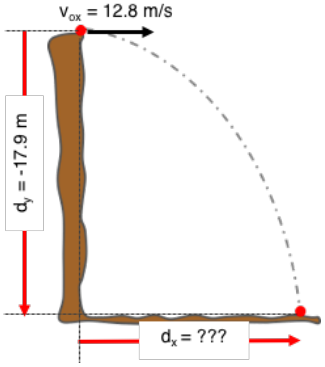
Strategy:

1. Read the problem carefully. Diagram it.
2. ID known values; relate to corresponding symbol.
3. ID the unknown value; use the variable symbol.
4. Select the appropriate equation to use.
5. Substitute known values; solve for unknown.

Use of an X-Y Table

An "X-Y Table" is a useful means of organizing the given information in a projectile problem. It helps keep x- and y- variable values separate.

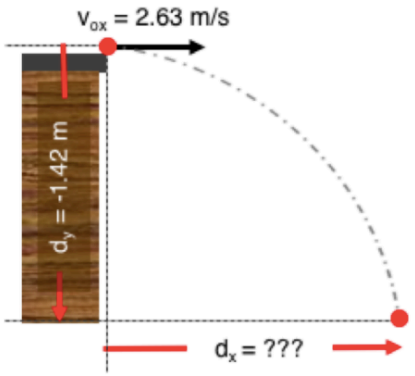
Sample Problem: A ball is thrown horizontally at 12.8 m/s from the top of a 17.9-m high cliff. How far from the base of the cliff does it land?



X	Y
d_x = ???	d_y = -17.9 m
v_{ox} = 12.8 m/s	v_{oy} = 0 m/s
a_x = 0 m/s^2	a_y = -9.8 m/s^2

Example 1

A ball rolls off a 1.42-m high table with a speed of 2.63 m/s. How far from the base of the table will it land?



Strategy

Read/Diagram
ID Knowns
ID Unknown
Pick Equation
Substitute/Solve

X	Y
d_x = ???	d_y = -1.42 m
v_{ox} = 2.63 m/s	v_{oy} = 0 m/s
a_x = 0 m/s^2	a_y = -9.8 m/s^2

$d_y = v_{oy} \cdot t - 4.9 \cdot t^2$

$-1.42 = \cancel{0 \cdot t} - 4.9 \cdot t^2$

$(-1.42/-4.9) = t^2$

$t = \sqrt{(-1.42/-4.9)} = 0.5383 \ldots$ s

$d_x = v_{ox} \cdot t$

$d_x = (2.63) \cdot (0.5383 \ldots)$

d_x = 1.42 m (1.41579… m)

Example 2

A student throws a book horizontally out a dorm window with a speed of 12.5 m/s. The book lands on the ground 31.8 m from the base of the building.How high is the window above the ground?

Example 3

A stone is thrown from the top of a 52.5-m high vertical cliff and lands in the water below at a location 43.8 m from the bottom of the cliff. Determine the velocity with which the stone is thrown.