Edgenuity

Warm-Up | Projectile Motion

Lesson Question

How can the motion of a projectile be described?

Lesson Goals

Explore projectile motion.

- **Recognize** that the horizontal and vertical motions of a projectile are **independent**.
- **Identify** examples of projectile motion.
- **Solve** problems involving **projectile** motion.

Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you

B projectile

D inertia

A projectile motion

C parabolic

A. the curved motion that results from the combination of an object's horizontal inertia and the force due to gravity pulling the object downward

B. an object that is set in motion following a path in which the only force acting on it is gravity

C. having the shape of a parabola

D. the natural tendency of objects to resist a change in motion

Warm-Up | Projectile Motion

Vectors

- Vectors are used to describe motion in [two] dimensions.
- Vectors can be broken down into *x* and *y* components.
- The components of a vector are the two parts of a vector that are [perpendicular] to each other.

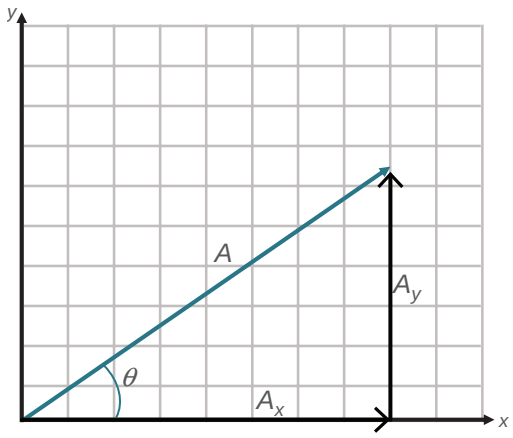
[$\cos\theta$] $= \frac{A_x}{A}$

$\sin\theta = \frac{A_y}{A}$

If we rearrange these we now get:

$A_x = A\cos\theta$

$A_y = A$ [$\sin\theta$]



Instruction | Projectile Motion

Slide 2

Projectile Motion

- **Projectile motion** is the curved motion that results from the combination of an object's horizontal **inertia** and the force due to gravity pulling the object downward.
- Examples of projectile motion:
  - A ball rolling off a table
  - A cannon firing a cannonball
  - A player shooting a jump shot
- **Projectiles** follow a parabolic path.

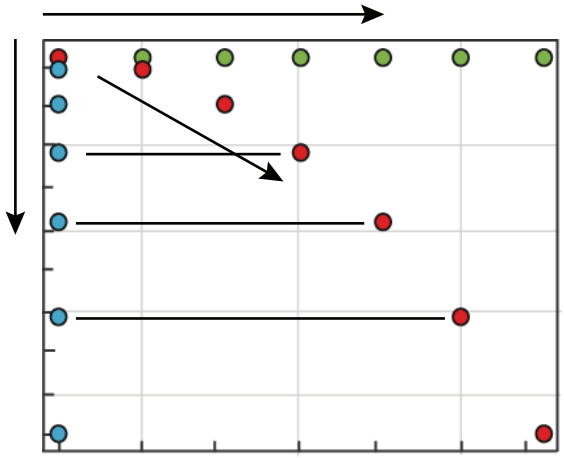
- Projectile motion is a combination of horizontal and vertical motion.
- The combined effect of both motions produces the parabolic path that projectiles follow.
- Each motion, however, is completely independent of each other.

Instruction | Projectile Motion

Slide 5

Horizontally Launched Projectiles

- Horizontal motion:
  - Velocity is [constant].
  - [Acceleration] is zero.
- Vertical motion:
  - Velocity is changing.
  - Acceleration is – [9.8] m/s^2.



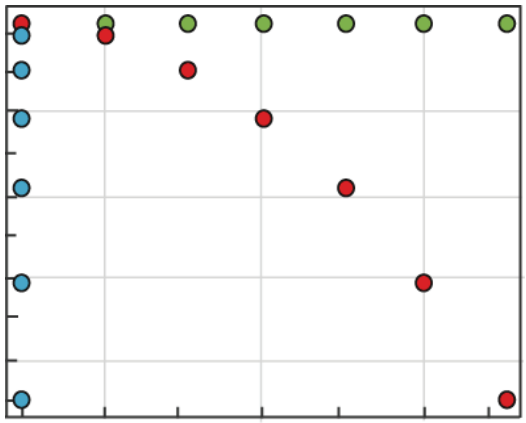
Slide 7

Horizontally Launched Projectiles

- Horizontal motion:
  - $v_x = \text{constant}$
  - $\Delta x =$ [$v_x \Delta t$]

$$v_x = \frac{\Delta x}{\Delta t}$$

- Vertical motion:
  - $v_y = a_y \Delta t$ ← [–9.8] m/s^2
  - $v_y^2 =$ [$2ay\Delta y$]
  - $\Delta y =$ [$\frac{1}{2}$] $a_y(\Delta t)^2$



Slide 7

Horizontally Launched Projectiles

EXAMPLE

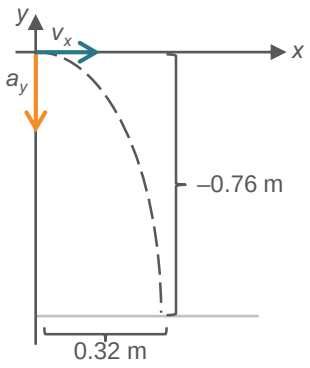
A pencil rolls off a desk that is 0.76 m tall. If the pencil hits the floor 0.32 m from the base of the desk, how fast was the pencil rolling?

Given:

$\Delta y =$ [−0.76] m

$\Delta x = 0.32$ m

$a_y = -g = -9.8\ \text{m/s}^2$



Unknown:

$v_x = ?$

We can use the equation:

$$\Delta x = v_x \Delta t$$

SOLVE FOR *T*

To solve for V_x, we first need to solve for time, *t,* by rearranging the formula:

$$\Delta y = \frac{1}{2} a_y (\Delta t)^2$$

Plugging in values we have:

$\Delta t =$ [$\sqrt{\frac{2\Delta y}{a_y}}$]

$$\Delta t = \sqrt{\frac{2(-0.76\ \text{m})}{(-9.8\ \text{m/s}^2)}}$$

$\Delta t =$ [0.39] s

Slide 7

SOLVE THE ORIGINAL FORMULA

So if we rearrange our first formula to solve for v_x, we get:

$$v_x = \frac{\Delta x}{\Delta t}$$

$$v_x = \boxed{\frac{\Delta x}{\Delta t}}$$

$$= \frac{0.32\,\text{m}}{0.39\,\text{s}}$$

$$= \boxed{0.82}\ \text{m/s}^2$$

10

Projectiles Launched at an Angle

- Objects launched at an angle have an initial vertical component and an initial horizontal component to their [velocity].
- The vertical and horizontal components of the initial velocity can be determined using the sine and cosine functions.
  - $v_{ix} = v_i$ [$\cos\theta$]
  - $v_{iy} = v_i$ [$\sin\theta$]

Instruction | Projectile Motion

Slide 10

- Horizontal motion:
  - Velocity is constant.
  - Acceleration is [zero].
- Vertical motion:
  - Velocity is [changing].
  - Acceleration is –9.8 m/s^2.

- Horizontal motion:
  - $v_x = v_{ix} = v_i \cos\theta =$ [constant]
  - $\Delta x = ($ [$v_i \cos\theta$] $) \Delta t$
- Vertical motion:
  - $v_{fy} = v_i \sin\theta +$ [a_y] Δt
  - $v_{fy}^2 =$ [v_i^2] $(\sin\theta)^2 + 2a_y\Delta y$
  - $\Delta y = (v_i \sin\theta)\Delta t +$ [$\frac{1}{2} a_y (\Delta t)^2$]

Slide 10

EXAMPLE

Riley and Miguel are playing catch. Riley throws the ball at an angle of 25° relative to the ground at a speed of 23.0 m/s. The ball travels 42.0 m to Miguel, who catches the ball. How long was the ball in the air?

Given:

$$\theta = \boxed{25^\circ}$$

$$v_i = 23.0 \text{ m/s}$$

$$\Delta x = 42.0 \text{ m}$$

Unknown:

$$\Delta t = ?$$

The equation that we need to use is:

$$\Delta x = (\boxed{v_i \cos\theta}) \Delta t$$

$$\Delta t = \frac{\Delta x}{(v_i \cos\theta)}$$

$$= \frac{42.0 \text{ m}}{(23 \text{ m/s})(\cos 25^\circ)}$$

$$= \boxed{2.0} \text{ s}$$

Summary | Projectile Motion

Lesson Question

How can the motion of a projectile be described?

Answer

(Sample answer) The motion of a projectile can be described by evaluating the horizontal and vertical components of velocity independently for the moving object.

Slide 2

Review: Key concepts

- Projectile motion is the curved motion that results from the combination of an object's horizontal [inertia] and the force due to gravity pulling the object downward.
- Projectile motion is a combination of horizontal and vertical motion. Each motion, however, is completely independent of each other.
  - Horizontal motion:
    - Velocity is [constant] and acceleration is zero.
  - Vertical motion:
    - Velocity is changing and acceleration is $-9.8\ m/s^2$.

Summary | Projectile Motion

Slide 2

Review: Key concepts

	Horizontally Launched Projectile	Projectile Launched at an Angle
Horizontal Motion	$v_x =$ [constant] $\Delta x = v_x \Delta t$	$v_x = v_{ix} = v_i \cos\theta = \text{constant}$ $\Delta x = (v_i \cos\theta)\Delta t$
Vertical Motion	$v_y = a_y \Delta t$ $v_y^2 = 2a_y \Delta y$ $\Delta y =$ [$\frac{1}{2} a_y$] $(\Delta t)^2$	$v_{fy} = v_i \sin\theta + a_y \Delta t$ $v_{fy}^2 = v_i^2 ($[$\sin\theta$]$)^2 + 2a_y \Delta y$ $\Delta y = (v_i \sin\theta)\Delta t + \frac{1}{2} a_y (\Delta t)^2$

Use this space to write any questions or thoughts about this lesson.