## PHYSICS

April 7th, 2020

## PROJECTILE MOTION

## LESSON GOALS

Students will use a simulation to evaluate projectile motion and to check the calculations of projectile motion problems.


## THE BOY ON THE TOWER THROWS A BALL 20 METERS DOWNRANGE AS SHOWN.

## Quick Review

Hint: this is a two step problem!


## WHAT IS HIS PITCHING SPEED?

## Quick Review Answer

THE BOY ON THE TOWER THROWS A BALL 20 METERS DOWNRANGE
AS SHOWN


USE THE EQUATION FOR SPEED AS A "GUIDE TO THINKING".

$$
v=\frac{d}{t}
$$

d is 20 m ; BUT WE DONT KNOW +... THE TIME THE BALL TAKES TO GO 20 m . BUT WHILE THE BALL MOVES HORIZONTALLY 20 m . IT FALLS A VERTICAL DISTANCE OF 5 m . WHICH TAKES 1 SECOND... $\mathrm{SO} t=1 \mathrm{~s}$.

$$
v=\frac{d}{t}=\frac{20 \mathrm{~m}}{1 \mathrm{~s}}=20 \mathrm{~m} / \mathrm{s}
$$

## Projectile Motion Simulation

Introduction - You will use a computer simulation today to reinforce your ideas of Projectile Motion. Since this is "inquiry based", you're not supposed to know everything going in, but learn as we walk through the lesson. You must read all instructions carefully to get full credit. Let's get started!

## Website : https://phet.colorado.edu/en/simulation/projectile-motion

Click on the "play" icon, then double click on "Lab" Make sure to use HTML 5 Version


## Using the Simulation to check our work

Imagine a ground level cannon at the circus was shooting a cannon ball with an initial velocity of $20 \mathrm{~m} / \mathrm{s}$ at $75^{\circ}$ above the horizontal with no air resistance. We are going to predict its range and check with the simulation.

1) Draw the scenario:
2) Using the sin and cosine functions, calculate $\mathrm{V}_{\mathrm{x}}$-Horizontal component and $\mathrm{V}_{\mathrm{y}}$ - Vertical component. (Hint: $\mathrm{V}_{\mathrm{x}}$ and $V_{y}$ are the legs of the right triangle from the drawing). Show all work
3) We will use the following formula to calculate the time to the top of the flight path:

$$
v_{f}=v_{y}+a t
$$

Since at the top of the flight, the $V_{f}=0$, we have

$$
\begin{aligned}
& 0=v_{y}+\text { at } s 0 \ldots . \quad-v_{y}=a t \\
& t=-\left(\mathbf{V}_{y} / a\right) \quad\left(\text { Remember, } a=-9.81 \mathrm{~m} / \mathrm{s}^{2}\right)
\end{aligned}
$$

4) Using the bold formula above, acceleration due to gravity $=-9.81 \mathrm{~m} / \mathrm{s}^{2}$, and your $v_{y}$ that you calculated above, solve for ( t ). Show all work.

## Using the Simulation to check our work

6) The value you just solved for is half of the time the ball is in the air. (Remember, it's just to the top of the flight path). So take your time and double it.
7) Now, you solved for the total time in flight. Next, we'll solve for distance in the $x$ direction. We'll use the following formula:

$$
v_{x}=d_{x} / t \quad \text { Rearranging for distance we get: } \quad d_{x}=v_{x}^{*} t
$$

Using your $v_{x}$ that you calculated above, and the TOTAL flight time (the one you doubled), calculate the distance in the $x$ direction. Show work.

Checking your prediction:
Set the cannon up to $20 \mathrm{~m} / \mathrm{s}$ at $75^{\circ}$. Move the red and white target to your predicted distance in the $x$ direction. Fire the cannon.

Did the ball hit the target?

## Using the Simulation to check our work

Complete the calculations again using an initial launch speed of $30 \mathrm{~m} / \mathrm{s}$ and an initial launch angle of $35^{\circ}$. Check your results with the simulation. Show all work.


## Additional Practice

Choose different angles and launch speeds and repeat the step to calculate range. Then use the Sim to check your results.


