

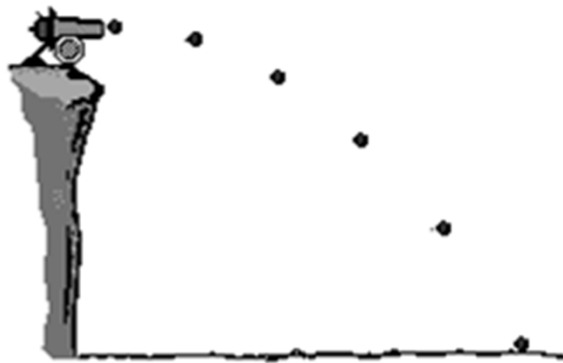
Projectile Motion

- **Projectiles**
 - > objects given an initial velocity that then move under the force of gravity
- **Trajectory**
 - > the path followed by a projectile
 - > The path is a curve called a parabola

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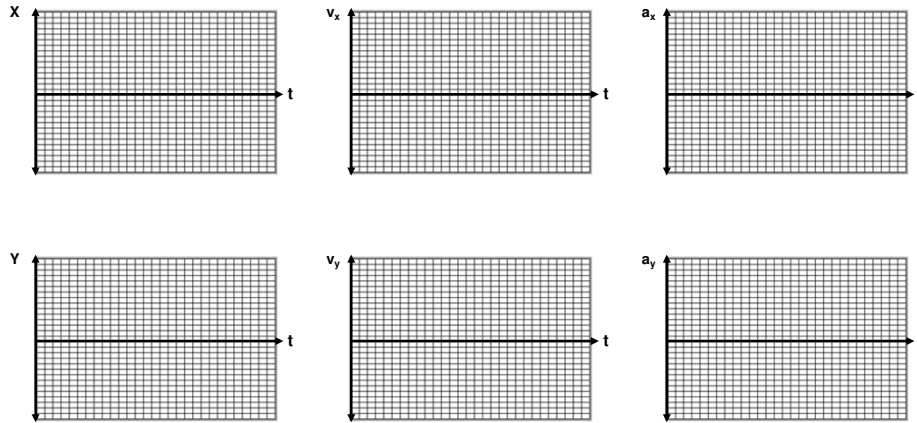
Velocity Vectors

- How do the velocities in each direction change over time?



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Horizontal Projectile Graphs



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Independence of Dimensions

- Since the horizontal and vertical motion of an object are independent of each other, the motion equations can be used to determine the exact position of a projectile.
 - > Time is the only the variable that links the two dimensions.
- However, we must first distinguish between the x and y components of any vectors.

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Independence of Dimensions

- With no acceleration in the horizontal direction, we can find the horizontal position by using the equation:
 - >
- The velocity in the horizontal direction will not change, therefore:
 - >

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Independence of Dimensions

- Since there is acceleration (gravity) in the vertical direction the position can be found using the equation:
 - >
- The acceleration causes a change in velocity in the vertical direction. We can find the final velocity using the equations:
 - >
 - >

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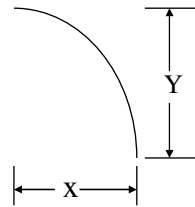
Horizontal Projectile Problem

- A marble is thrown horizontally at a speed of 5.47 m/s from the top of a platform 1.3 m high.
 - > How long is the marble in the air?
 - > How far from the platform does the marble land?
 - > What are the horizontal and vertical components of the velocity just before the marble hits the ground?

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Horizontal Projectile Problem

- Find the time

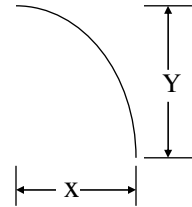


Remember time is the same for both vertical and horizontal motion

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Horizontal Projectile Problem

- Find the horizontal distance



- Find the components of the final velocity

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Horizontal Projectile Problem #2

- You are at the top of a 3.5 m high stair case. A friend at the bottom of the stairs forgot her pencil and asks you for one. You notice that she is 8.5 m horizontally away from you. What horizontal velocity should you throw the pencil at to ensure that she gets the pencil?

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Horizontal Projectile Problem #2

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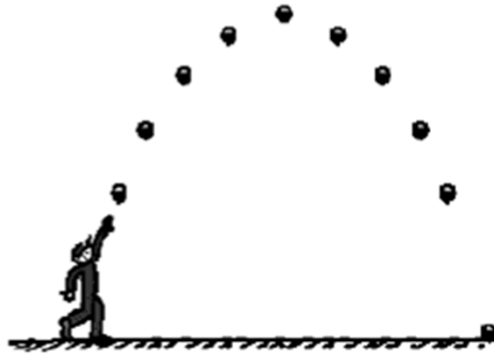
Projectiles Launched at an Angle

- When projectiles are launched at an angle, they are given an initial horizontal and vertical velocity.
- The horizontal distance the projectile travels is called the range.

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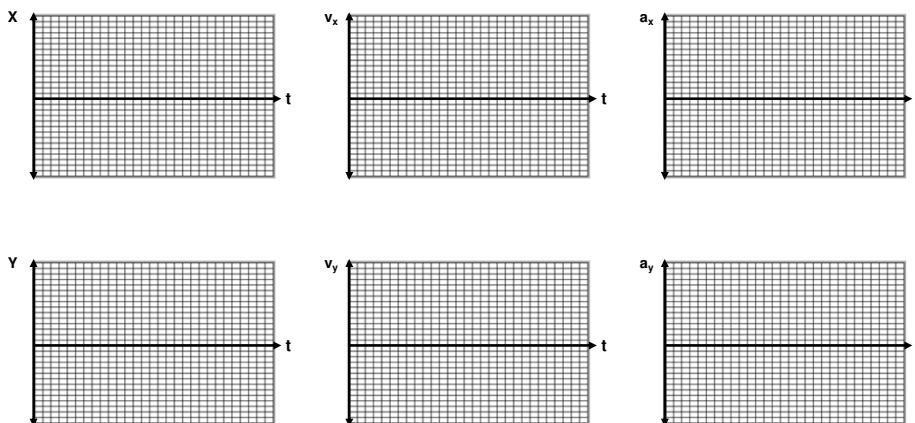
Velocity Vectors

- How do the velocities in each direction change over time?



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Projectile at an Angle Graphs



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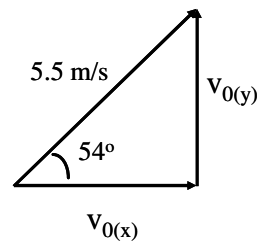
Angled Launch Problem

- A ball is thrown with a initial velocity of 5.5 m/s at an angle of 54° . Find:
 - > the time in the air.
 - > how high the ball went.
 - > the range when it reaches it's launch height.

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Angled Launch Problem

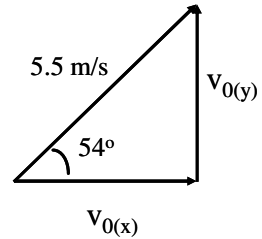
- Find components



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Angled Launch Problem

- Find time

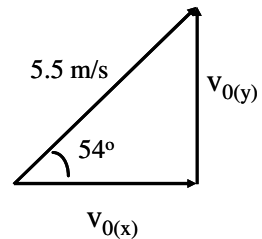


- Remember time is the same for both vertical and horizontal motion
- If the final vertical displacement is not zero, then use the quadratic formula

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Angled Launch Problem

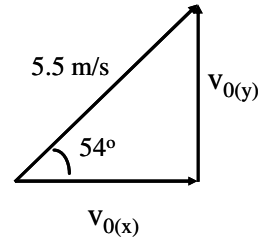
- Find Max height



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Angled Launch Problem

- Find range



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Projectiles Launched at an Angle

- It can be proven using trigonometric identities that the range of the projectile can be found using:

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$$R = \frac{v_0^2 \sin 2\theta}{g}$$

Note: This can only be used when the projectile is launched and lands at the same height. ($\Delta y = 0$)

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Angled Launch Problem #2

- **A ball is thrown with a initial velocity of 4.6 m/s at an angle of 33° from a office window 14.2 meters high.**

Find:

- > **the time in the air.**
- > **how high the ball went.**
- > **the distance away from the building where the ball will hit.**

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Angled Launch Problem #2

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Angled Launch Problem #2

- **What is the total velocity at the max height, launch height, and just before it hits the ground?**