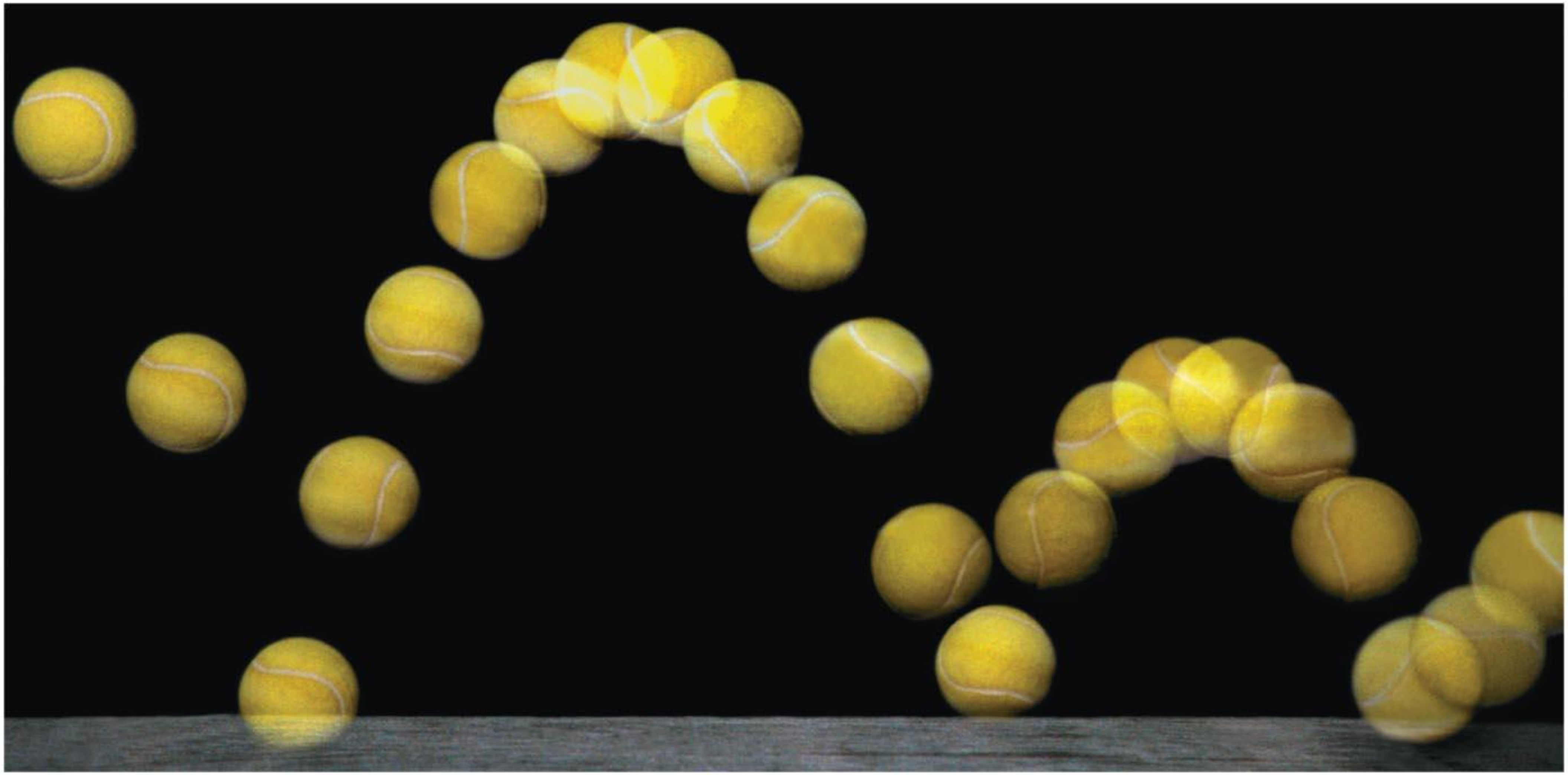
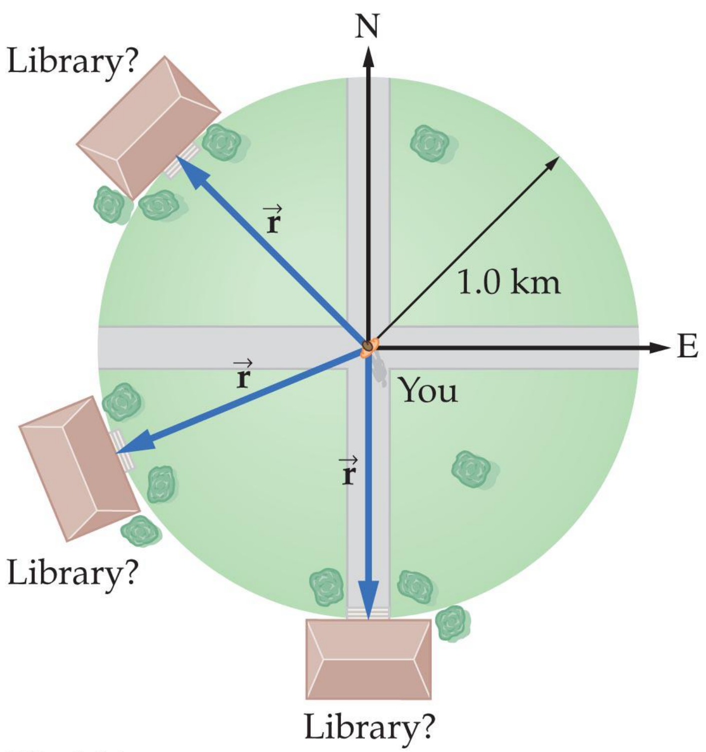
Motion in two dimensions.



Some figures are from Pearson Physics by Walker. Used with permission. Revised 10.7.2020

Honors Physics Chapter 4
Review:
Scalar
Vector
Resultant

KEY VOCABULARY WORD:
Magnitude (means size without respect to direction)
Magnitude = absolute value (just like in math)



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What is the resultant velocity of an airplane that normally flies at 200 km/hr if it encounters a 50 km/hr tailwind?

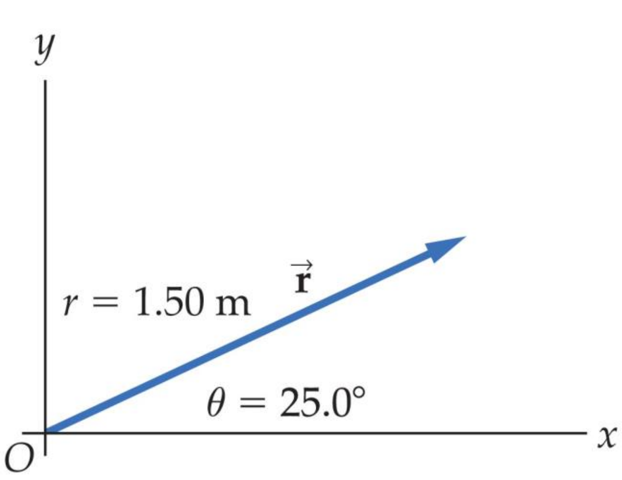
How about if it encounters a 50 km/hr headwind?

An airplane heads due North at an airspeed of 70 mi/hr. If there is a wind from the East at 20 mi/hr, what is the resultant ground speed of the plane?

Our crew can row at 2 mi/hr in still water. If they head due North and the current is from the West at 1 mi/hr, find their resultant speed relative to the shore.

In addition to adding vectors to find the resultant, you can also break a vector into pieces. The process is called resolving a vector into its components.

A vector may be resolved into any number of components, but we almost always use two components at right angles to each other.
The two components are frequently, but not always, horizontal and vertical.



(a) A vector defined in terms of its length and direction angle

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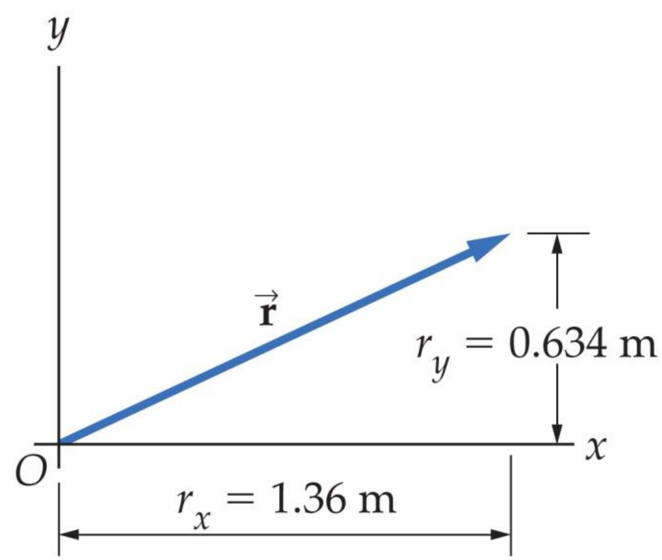

(b) The same vector defined in terms of its x and y components

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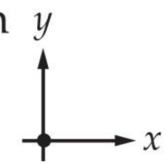

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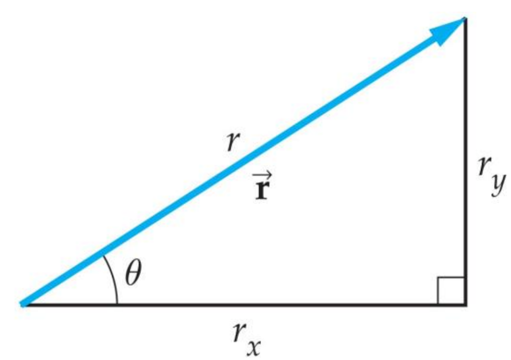


$r_x = r \cos\theta$
$r_y = r \sin\theta$

Example:

Tyler Wels just got a job at Burger King. (His parents are very proud!) He is
sweeping up after the store closed. He is pushing the broom with a force of 10. pounds. The handle makes an angle of 30. degrees with the floor. How much of his force is pushing the broom forward and how much is pushing down?

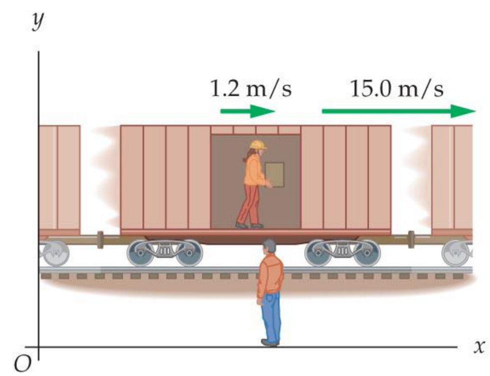
If Tyler changed the angle to 20 degrees would the horizontal component of the force increase, decrease, or remain the same?

Example:

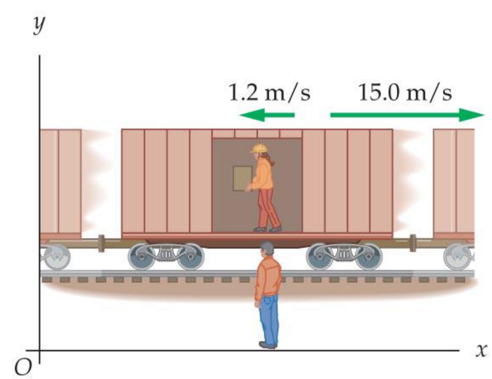
Ray Fernandez is pulling Hayden Tardio in a little red wagon. The handle of the wagon makes an angle of 20. degrees with the horizontal. If he is pulling with a force of 15 pounds, calculate the horizontal and vertical components of the force.

An airplane is moving at 150 mi/hr. If it is heading 50 degrees North of East, find the Northward component of the plane's velocity.

Relative Motion



(a)



(b)

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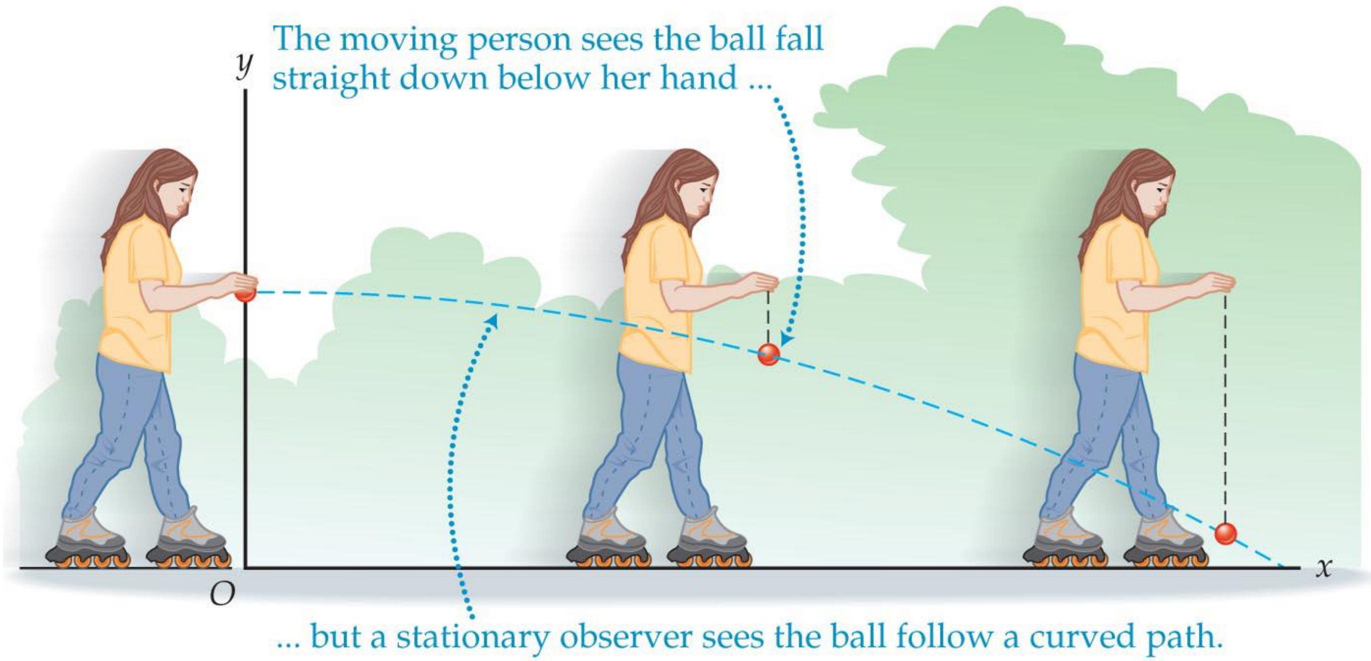
Projectile Motion:
Projectile is a type of motion in 2 dimensions (horizontal and vertical) which occurs when an object is projected into the air, usually at an angle.



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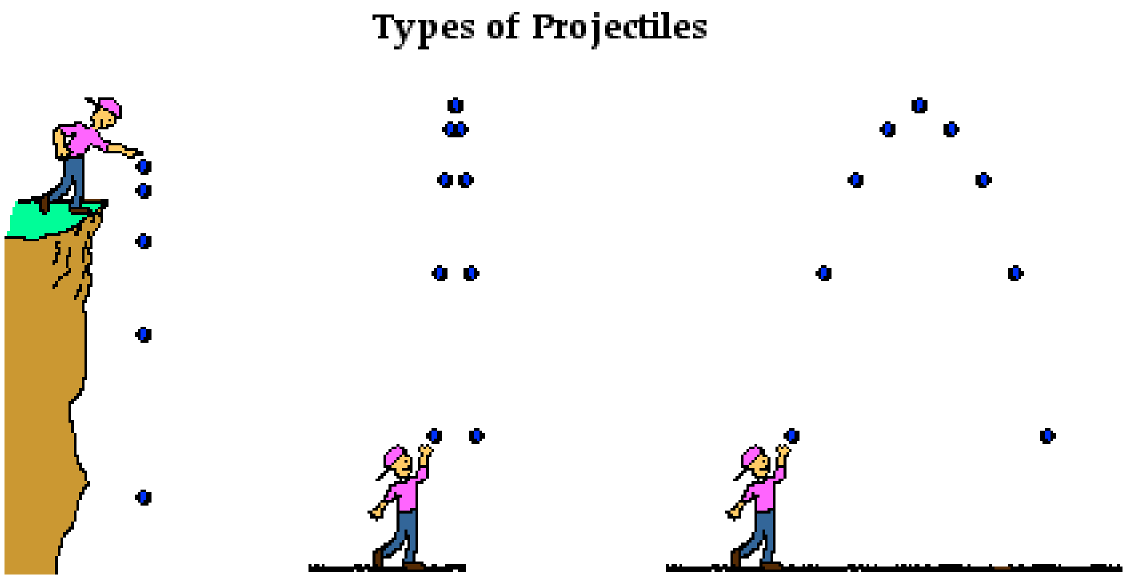
Examples of projectile motion:

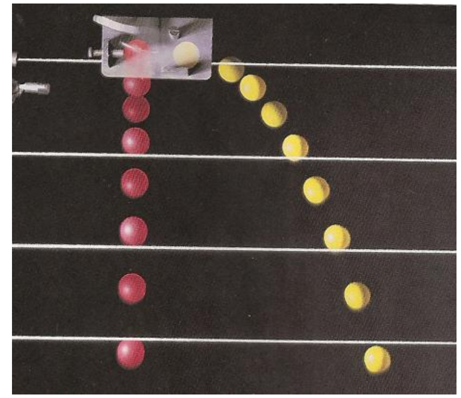
A soccer player kicks a ball at 35 m/s at an angle of 30 degrees with the ground. Find the horizontal and vertical components of the speed of the ball.

Examples of projectile motion:
A person fires a gun with a muzzle velocity of 295 m/s at an angle of 20 degrees above the horizontal find the horizontal and vertical components of the initial velocity.

Very, very, very important idea for projectile motion:

Mutually perpendicular vectors are independent.





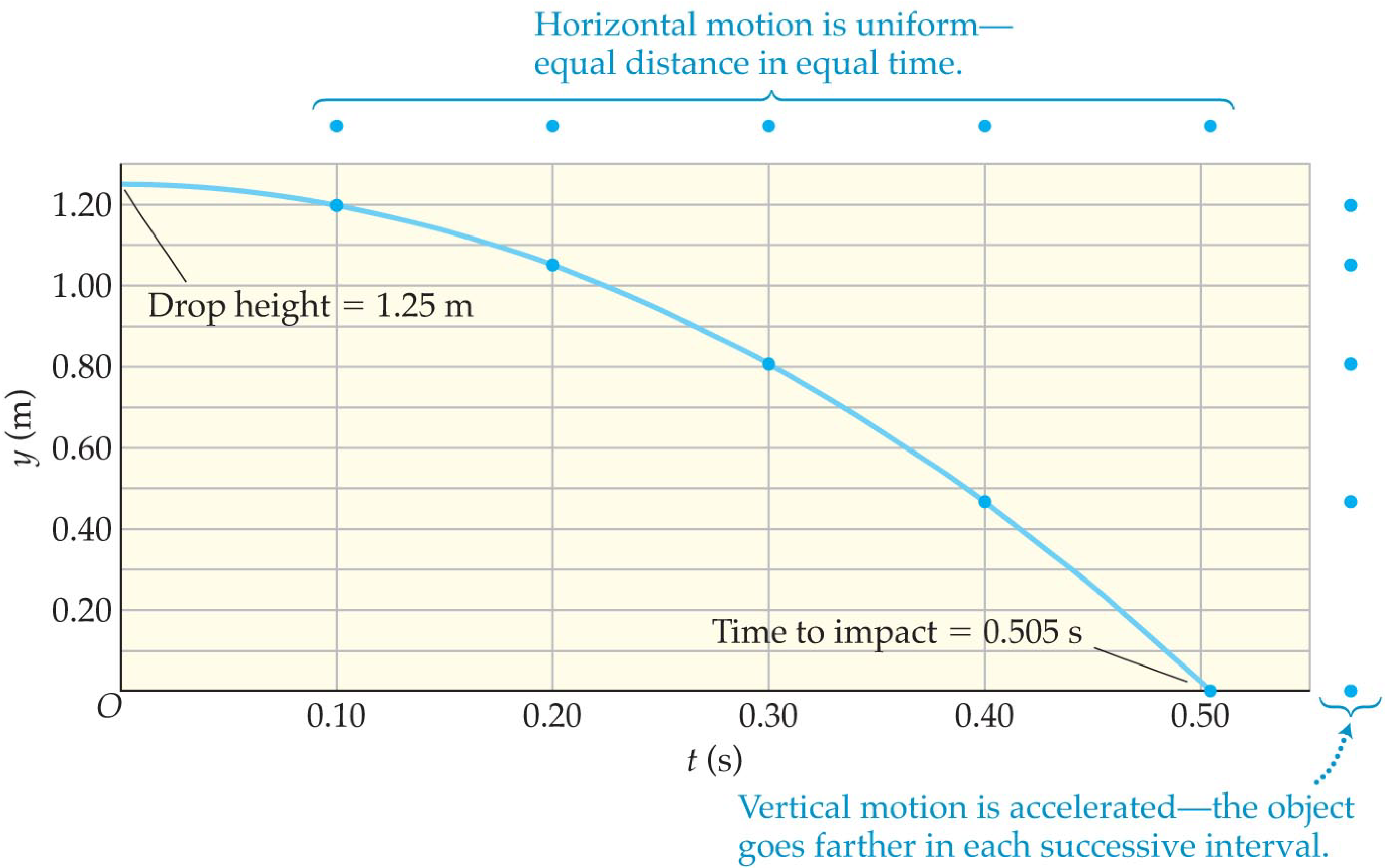
Gravity acts vertically ONLY!

Gravity has NO horizontal component!

So, if we want to describe projectile motion, we break it down
into horizontal and vertical components and treat them independently.

In this demonstration note that the horizontal motion is constant speed but the vertical motion is not. Carefully note the magnitude and direction of the acceleration of gravity.

https://www.physicsclassroom.com/Physics-Interactives/Vectors-and-Projectiles/Projectile-Simulator/Projectile-Simulator-Interactive



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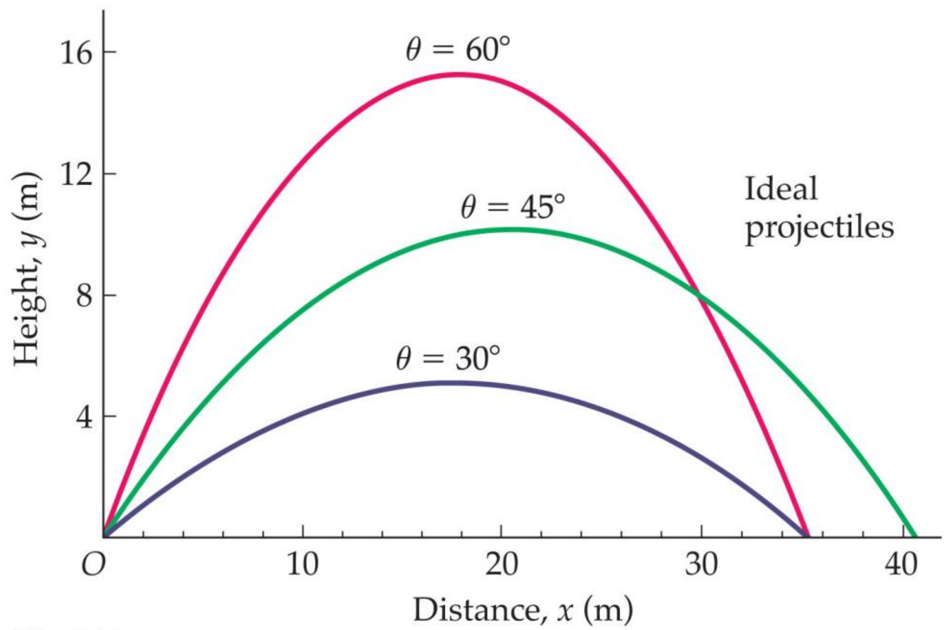
A projectile is launched at an angle into the air. Neglecting air resistance, what is its vertical acceleration?

What is its horizontal acceleration?

At which point in its path does a projectile have MINIMUM speed?

If air resistance is negligible, a projectile will rise to its maximum height in the same time it takes to fall from that height to the ground. This is because the effect of gravity when it is going up is the same as when it is falling back down.



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A major challenge!

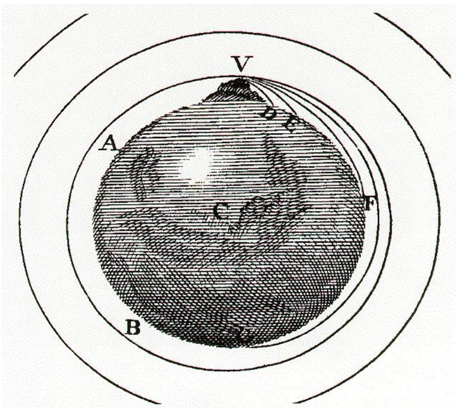
A boy is at the top of a 5 meter tower. He throws a baseball horizontally. It hits the ground 20 meters from the base of the tower. At what speed did he throw the ball?

Satellites

Ground is NOT flat. It is curved.

If the projectile is going horizontally FAST enough,
then the ground curves under it
and as it falls, it never hits the ground!

This is Newton's Cannon drawing.
He explained that if you fired a cannon on a high mountain at ever increasing speeds the ball would land at greater distances from the mountain. Eventually, if fired fast enough, the ball would never hit the ground.



http://www.ionaphysics.org/classroom/Assignments/Newton%27s%20Cannon/index.html

A ball is fired upward at 5.0 m/s. How long will it take to reach the top of its path? How long will it take to fall back to the ground?

A whale comes to the surface and then dives at an angle of 20 degrees below the horizontal. If he continues in a straight line for 150 m, how deep is he?

In Denver, after Halloween, children bring their jack-o-lanterns to the top of a tower and compete for accuracy in hitting a target on the ground. Suppose the tower is 9.0 meters high and the target is a horizontal distance of 3.5 meters from the launch point. If the pumpkin is thrown horizontally, what is the launch speed needed to hit the target?

Nerf Gun II

Assume you have a Nerf gun. You know that the muzzle velocity (the speed at which the projectile leaves the gun) is 11.0 m/s. Assume there is no air resistance:

(1) If you fire vertically, how high above its launch position will the dart go?

(2) Now you fire horizontally and you are 1.3 meters above the (assumed to be perfectly horizontal) ground. How far from you will the dart land?