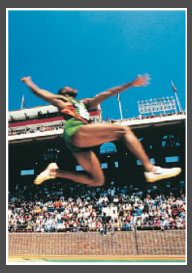
Projectile Motion



Displacement and velocity, resolved into components, can be used to understand and predict the motion of objects thrown into the air.
Projectile Motion: the curved path that an object follows when thrown, launched, or otherwise projected near the surface of Earth

MCHS Honors Physics 2014-15

Projectile Motion is Two-Dimensional

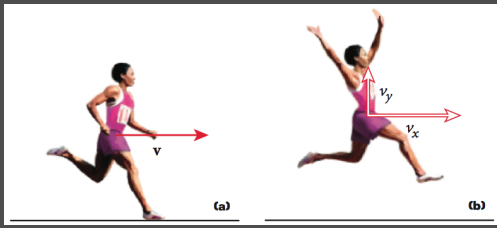
- How can you know the displacement, velocity, and acceleration of a ball at any point in time during its flight?
- All of the kinematic equations could be rewritten in terms of vector quantities.
- However, when an object is propelled into the air in a direction other than straight up or down, the velocity, acceleration, and displacement of the object do not all point in the same direction.
- This makes the vector forms of the equations difficult to solve.

Projectile Motion is Two-Dimensional

- One way to deal with these situations is to avoid using the complicated vector forms of the equations altogether.
- If we apply the technique of resolving vectors into components, then we can apply the simpler one-dimensional forms of the equations for each component.
- As before, we can recombine the components to determine the resultant.

Components simplify projectile motion

- When the long jumper is in the air, his velocity has both a horizontal and a vertical component.



What is Projectile Motion?

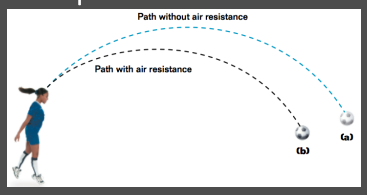
- In this section, we will focus on the form of two-dimensional motion called projectile motion.
- Objects that are thrown or launched into the air and are subject to gravity are called projectiles.
- Some examples of projectiles are softballs, footballs, and arrows when they are projected through the air.
- Even a long jumper can be considered a projectile.

What's a Parabola?

- Projectiles follow parabolic trajectories
- Many people mistakenly believe that projectiles eventually fall straight down in much the same way that a cartoon character does after running off a cliff.
- But if an object has an initial horizontal velocity in any given time interval, there will be horizontal motion throughout the flight of the projectile.

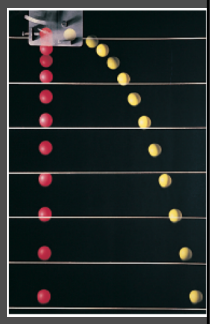
What About Air Resistance?

- This velocity would not be constant if we accounted for air resistance.
- With air resistance, a projectile slows down as it collides with air particles.



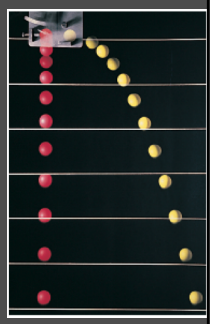
The Horizontal Component is Constant

- For the purposes of samples and exercises in this class, the horizontal velocity of the projectile will be considered constant.
- Projectile motion is free fall with an initial horizontal velocity



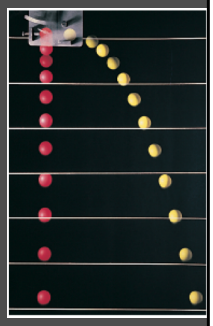
The Horizontal Component is Constant

- The red ball falls straight down. It has no motion in the horizontal direction.
- It starts from rest ($v_{y,i}$ = 0 m/s) and proceeds in free fall.
- Note also that Δy is negative.



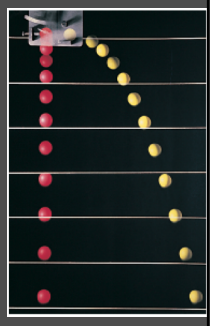
The Horizontal Component is Constant

- The yellow ball is launched to the right, so notice that it undergoes the same horizontal displacement during each time interval.
- This means that the ball's horizontal velocity remains constant throughout the projectile's flight.



The Horizontal Component is Constant

- The launched ball has no initial velocity in the vertical direction.
- The launched yellow ball is also in free fall (like the red ball).
- In any time interval, the launched ball undergoes the same vertical displacement as the ball that falls straight down.
- For this reason, both balls reach the ground at the same time.



The Horizontal Component is Constant

- To find the velocity of a projectile at any point during its flight, find the vector that has the known components:
  - Use the Pythagorean theorem to find the magnitude of the velocity
  - Use the tangent function to find the direction of the velocity