A projectile is an object that is thrown or struck or shot and then travels under the influence of gravity.

**L-5 Projectile motion**

**Projectile Examples**

- Tennis ball
- Golf ball
- Football
- Softball
- Soccer ball
- bullet
- Hockey puck
- Basketball
- Volleyball
- Arrow
- Shot put
- Javelin

These are all examples of things that are projected, then go off under the influence of gravity.

**Not projectiles**

- Jet plane
- Rocket
- Car (unless it looses contact with ground)

The key to understanding projectile motion is to realize that gravity acts vertically.

- it affects only the vertical part of the motion, not the horizontal part of the motion.

**Demonstration**

- We can see that the horizontal and vertical motions are independent.
- The red ball falls vertically.
- The yellow ball was given a kick to the right.
- They track each other vertically step for step and hit the ground at the same time.
In the absence of gravity a bullet would follow a straight line forever. With gravity it **FALLS AWAY** from that straight line!

Football without gravity

**No gravity is good for kickers**

**Basketball – without gravity**

**Hitting the target – aim high, not directly at the target**
Path of the Projectile

- Horizontal velocity
- Vertical velocity
- Rising portion
- Falling portion
- Distance downfield (range)
- Height

1) The projectile has both a vertical and horizontal component of velocity
2) The only force acting on the projectile once it is shot is gravity (neglecting air resistance)
3) At all times the acceleration of the projectile is $g = 10 \text{ m/s}^2$ downward
4) The horizontal velocity of the projectile does not change throughout the path

Key points, continued

5) On the rising portion of the path gravity causes the vertical component of velocity to get smaller and smaller
6) At the very top of the path the vertical component of velocity is ZERO
7) On the falling portion of the path the vertical velocity increases

More key points

8) If the projectile lands at the same elevation as its starting point it will have the same vertical SPEED as it began with
9) The time it takes to get to the top of its path is the same as the time to get from the top back to the ground.
10) The range of the projectile (where it lands) depends on its initial speed and angle of elevation

Maximum Range

- When an artillery shell is fired the initial speed of the projectile depends on the explosive charge – this cannot be changed
- The only control you have is over the angle of elevation.
- You can control the range (where it lands) by changing the angle of elevation
- To get maximum range set the angle to $45^\circ$

Interactive

- [http://galileo.phys.virginia.edu/classes/109N/more_stuff/Applets/ProjectileMotion/jarapplet.html](http://galileo.phys.virginia.edu/classes/109N/more_stuff/Applets/ProjectileMotion/jarapplet.html)
- [http://jersey.uoregon.edu/vlab/Cannon/](http://jersey.uoregon.edu/vlab/Cannon/)
The ultimate projectile: Putting an object into orbit

- Imagine trying to throw a rock around the world.
- If you give it a large horizontal velocity, it will go into orbit around the earth!