

## Summary

Trajectory is the route an object (projectile) takes while different forces are acting on it. Often, on Earth, the course it takes is parabolic. A parabola looks like an oval cut into half with two symmetrical sides. It takes on this shape because there is generally an upward force, which makes up one half of the parabola; a downward force (gravity), which makes up the other half of the parabola; all the while it had a directional force acting on it.

When throwing a football down the field, the quarterback will arc his throw upwards to gain additional flight time while also picking a direction for the ball to go besides straight up. The football will move yards down the field in the direction thrown until gravity pulls it down all the way and the ground (or another player) prevents further movement.

## Safety

Always make sure to not aim your "Trajectory Demonstrating Apparatus" at anything other than designated non-living targets.

## Materials

1 Toilet Paper Tube

1 Pencil (Sharpened or not)

2 Rubber bands

Tape

\*If needed- 1-hole puncher

## Hypothesis

When testing the trajectory of your apparatus, how far do you think it will go? Can you hypothesize ways that may make it go farther?

### Procedure

- 1) Cut the toilet paper tube along its length (“hotdog style”)
- 2) Cut approximately 1 inch off of the tube and set it to the side
- 3) With the remaining portion of tube, roll it as tightly as possible and tape down so it keeps its new shape.  
-Begin along the line your first cut, folding it into the tube and roll across in that direction so it is a longer tube
- 4) Take your pencil (or hole puncher) and, carefully, punch a hole through towards one end of the long tube you just created.
- 5) Force your pencil through the hole and push it until equal sides of the pencil are sticking out each direction.
- 6) Take another pencil (or hole puncher) and, carefully, punch two holes into the little piece of toilet paper roll you had set aside. One hole should be set a little in on the shorter ends.
- 7) Cut each of your rubber bands so that they are each a longer string as opposed to a circle.
- 8) Tie one end of each rubber band to an end of the pencil
- 9) Tie the other end of the rubber band through one of the holes put into the smaller piece of tube
- 10) Grip the longer piece of tube so that the pencil, rubber bands, and “sling” towards the bottom of your hand
- 11) Place a projectile (such as a marshmallow) in the sling, give it a tug back and let it go to see trajectory in motion.

### Further Experiments

What would happen if you use a thicker rubber band?

Does the angle you fire affect the distance the projectile goes?

What would happen if you use longer rubber bands?