

Spoon Catapults - Handout #2 - Horizontal & Vertical Motion

1. What forces were acting on the bullet that was fired compared to the bullet that was dropped?

2. When a football is punted, at what point in flight is the vertical velocity = 0?

3. Investigation:

Materials needed:

- 1 ping-pong ball
- Plastic spoons
- A meter stick
- Protractor
- Tape
- Colored Pencils
- Graph Paper

Roles: In your group of 4, you will each have one of the following roles. You will rotate roles after every 5 launches.

Launcher = person launching the ping-pong ball

Timer = person times the launch of each flight

Marker = person will use the tape and mark the landing spot

Measurer = person who measures the horizontal distance from the launch to landing spot (in meters).

Procedures & Data Collection:

- Use the colored tape and mark a spot on the ground as your "launch point". All launches will start here.
- The Launcher shoot 3 shots, trying to make them as similar a launch angle as possible.
- The Timer records each flight time.
- After each launch, the Marker will place a piece of tape at the "landing spot", and the Measurer will measure the distance between the launch and landing spot.

4. Once you get a fairly consistent launch, record 3 official times and their corresponding 3 official distances. Record these values in the table below. Average your three times and distances for the final boxes.

Fill in the times and distances for each trial:

Range 1 (cm):

Time1:

Range 2 (cm):

Time2:

Range 3 (cm):

Time3:

To find the height your ball flew, you must first find the average fall time. Keep in mind, your ball was rising for half of its flight, then fell for the other half. Therefore, to find the time it was falling you must divide your average time by 2.

Average fall time (t):

- 5) Now, you will find the vertex of the parabola. The equation for freefall of an object is

$$D = 1/2 (g) (t^2)$$

Where d is the vertical distance traveled, g is the effect of gravity in meters/s², and t is the time in the air.

The effect of gravity, g, is 9.8 meters/s², which is 980 centimeters/s². Plug in gravity and the freefall time you found in step 4 to find the vertical distance your ball traveled.

D =

You now have the maximum vertical distance your ball traveled, which you know is the y value of the vertex.

y of the vertex:

6) To find the x value of the vertex, divide your average horizontal distance by 2 (from step 3).

x of the vertex:

7) Using the vertex you calculated and a start point of (0,0), use vertex form to find **a** .

vertex form: $y = a(x-h)^2 + k$

The point (h, k) represents the vertex

8) Write the final equation for the flight of your ball in standard form:

y =

Graph the flight of your Skittle based on your equation. Be sure to show your work, because there are a few different ways you can go about graphing this. *Make sure to graph (0,0), the vertex, and 3 additional points.*