Physics 1P Traeger

Tennis Ball Launch: A Good Review of the Principles of Projectile Motion

Name: Key Period: ______ Date: ______________________

Purpose: To review the concepts of projectile motion in a real-world scenario.

Materials: Water Balloon Launcher, Protractor with string and paperclip plumb bob, Tennis Balls, 30 Meter tape, Safety Glasses, Timer

This is Based on Experimental Data from one student group. The data here is not perfect.

Procedure:

1. Get in to groups of 6-7. Go outside to the football field, baseball field, or softball field with your tennis balls, water balloon launcher, protractor, 30 meter tape, stop watch, and a pencil. Make sure to select an area for your launch where no one downrange is going to be hit by the launched balls. Also make sure to wear your safety glasses at **all** times.
2. Launch your tennis balls with the same amount of pull back on the launcher each time. You might want to do some initial tests to make sure that your balls do not fly too far. If they do, back off on your pull back. Once you have noted the correct amount of pull back, you will use this same amount for each trial.
3. Launch your tennis balls at 15°, 30°, 45°, 60°, and 75° angles, doing 3 trials for each angle. Record your data in the table below.

Trial	Distance traveled in X direction (meters)	Hang Time (seconds)	Velocity in X Direction (meters/second) Calculate for Average Only
15° Launch 1	41.7 m	2.29 s	------------------------------
15° Launch 2	57 m	2.31 s	------------------------------
15° Launch 3	—	—	------------------------------
15° Launch Average	49.4 m	2.3 s	~~[illegible]~~ 21 m/s
30° Launch 1	51.0 m	1.9 s	------------------------------
30° Launch 2	55.0 m	2.0 s	------------------------------
30° Launch 3	—	—	------------------------------
30° Launch Average	53.0 m	2.0 s	27 m/s
45° Launch 1	54.0 m	1.6 s	------------------------------
45° Launch 2	58.0 m	2.0 s	------------------------------
45° Launch 3	—	—	------------------------------
45° Launch Average	56.0 m	1.8 s	31 m/s
60° Launch 1	49 m	2.0 s	------------------------------
60° Launch 2	38 m	1.4 s	------------------------------
60° Launch 3	—	—	------------------------------
60° Launch Average	44.0 m	1.7 s	~~26.7 m/s~~ 26 m/s
75° Launch 1	37.0 m	1.4 s	------------------------------
75° Launch 2	43.0 m	1.6 s	------------------------------
75° Launch 3	—	—	------------------------------
75° Launch Average	40.0 m	1.5 s	27 m/s

4. Analyze your data. Which launch angle produced the greatest distance? Why is this if you think about vector components in the x and y directions?

This data suggests that the 45° launch angle gives the greatest distance, This is because the x and y components of velocity are equal.

5. Analyze your data. Which launch angle produced the greatest hang time? Use your physics equations $x = v_x * t$, $y_f = y_o + v_{oy} * t + \frac{1}{2} * g * t^2$, or $v_{fy} = v_{oy} + g * t$ to find out how **high** the ball went vertically at its greatest launch angle. Show work. Hint: You will need to use some trigonometry to find out the initial velocity in the y direction. The y velocity and the time are needed to calculate the height. The data suggests that the 15° launch angle produced the greatest hang time, but this cannot be possible. The 75° angle should give the greatest hang time. Due to experimental error, I will use the 45° launch angle to calculate the height. See page 3 for calculations

See math on P.3

6. Now that you know the magnitude of the y velocity and the magnitude of the x velocity, you can find the velocity that the tennis ball left the launcher at. Show work and calculate the overall velocity of the tennis ball at the ~~greatest launch angle~~. 45° angle.

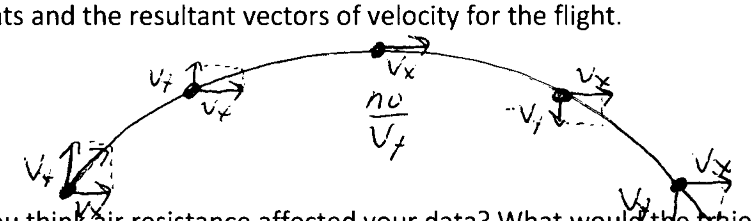
See P. 3 for work.

7. Provided that you pulled the launcher back equally each time, what was the overall velocity of the tennis ball at each launch angle. The overall velocity for each launch should be the same. This would theoretically be 43.4 $\frac{m}{s}$ if the launcher was pulled back the same distance each time

8. Analyze your data to determine a relationship between launch angle and distance. Which angles produced the same horizontal distance of travel? Why is this?

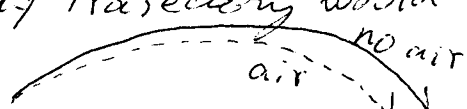
Complementary angles (15° and 75°)(30° and 60°) should produce the same distance horizontally, This is because of the trade off between x and y vector components.

9. Make a drawing below showing the flight of the tennis ball at the ~~greatest launch angle~~ 45°. You should pick 5 positions along the flight to draw a scaled vector diagram showing the x and y components and the resultant vectors of velocity for the flight.



10. How do you think air resistance affected your data? What would the trajectory with air resistance and without air resistance look like? Draw this below.

Air Resistance would slow the x and y velocity, so a likely trajectory would look like this



Conclusion: What did you learn from this lab? What are some possible sources of error in this lab?

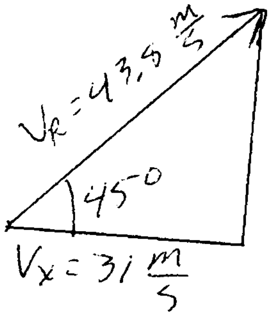
This is the most important part, as there is a lot of error in this

Math for problem 5

The data for 75° is in erro[r] so, I used 45°.

The data for a 45° angle is used here.

First, Use Trigonometry to find the initial velocity in the y direction. The velocity in the x direction is $31\frac{m}{s}$, so use this and tangent function to find velocity in y direction



$V_y = 31\frac{m}{s}$

$\tan 45° = \frac{V_y}{31\frac{m}{s}}$, so $V_y = 31\frac{m}{s}\tan 45°$

$$\boxed{V_y = 31\frac{m}{s}}$$

Use $y_f = y_0 + V_{0y}t + \frac{1}{2}gt^2$ to calculate height in y direction. Take $\frac{1}{2}$ of total time in air.

$1.85 \div 2 = 0.95$

$y_f = 0.5\,m + (31\frac{m}{s} \cdot 0.95) + \frac{1}{2} \cdot (-9.8\frac{m}{s^2})(0.95)^2$

↑ The approximate launch height

$0.5\,m + 27.9\,m + (-4.0\,m) = \boxed{24.4\,m}$

Math for Problem 6

Use the pythagorean theorem to find the resultant vector (hypotenuse in the triangle above.

$\vec{V_R} = \sqrt{(31\frac{m}{s})^2 + (31\frac{m}{s})^2} = \sqrt{1922\frac{m^2}{s^2}}$

$$\boxed{\vec{V_R} = 43.8\frac{m}{s}}$$