Lab #5 - Introduction

The goal of the experiment was to determine the spot an iron ball will land when launched from a cannon at a specific angle. The experiment was done by collecting data in three seperate parts. The first part was determining the balls velocity using time, the second part was determining velocity with respect to position (x and y) and last part was using the information gathered from the earlier parts to calculate the landing point for the ball when launched at an angle.

• Setup & Procedures

The equipment used was the cannon and iron ball, a measuring yard stick, a white paper, black paper that will mark the paper when ball makes contact and a stop watch.
The experiment begins with cannon being placed with no launching angle. The ball will be launched and will travel a distance where it will make contact

with the papers and leave a mark. That mark will then be recorded and measured from the cannon to the spot of impact, this will be distance traveled or range. Another group member will use a stop watch to measure the time it took from launch to impact, this will be repeated for twenty trials. Using the information we are then able to derive the equations: $x(t) = x_i + v_i t + \frac{1}{2} a t^2$

$y(t) = y_i + v_i t + \frac{1}{2} a t^2$

$(v_f)^2 = v_i^2 + 2 a \Delta y$

$v_f = v_i + a \Delta t$

w/out time deriv

$\frac{x_f - x_i}{t} = v_{xi}$

$\rightarrow v_f = v_i + a \Delta t$

$\frac{v_f - v_i}{a} = t$

$y_f = y_i + \frac{1}{2} a t^2$

$y_f - y_i = \frac{1}{2} a t^2$

$\frac{y_f - y_i}{\left(\frac{1}{2} a\right)} = t^2$

$t = \sqrt{\frac{2\Delta y}{g}}$

$x_f - x_i = v_{xi} \left(\sqrt{\frac{2\Delta y}{g}}\right)$

Data & Analysis

When placed at a 45 degree angle

$x(t) = x_i + v_i t + \frac{1}{2} a t^2$ (0 and 0)

$y(t) = y_i + v_i t + \frac{1}{2} a t^2$ (0)

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-(v_i) + \sqrt{(v_i)^2 - 4(-\frac{1}{2}a)(y_i)}}{2(-\frac{1}{2}a)}$$

$$\boxed{t = \frac{v_{yi} + \sqrt{v_{yi}^2 + 2g y_i}}{g}}$$

$v_{iy} = v_i \sin\theta$ $\quad v_{ix} = v_i \cos\theta$

$v_{iy} = (6.25)\sin(45)$ $\quad = 6.25 \cos 45$

$= 4.42$ m/s $\quad = 4.42$ m/s

$$t = \frac{(4.42) + \sqrt{(4.42)^2 + 2(9.8)(.37m)}}{9.8}$$

$t = .979$ s

$x(t) = 4.42$ m/s $\cdot$ .979 s

$\boxed{x(t) = 4.33 \text{ m}}$

a) 4.33m = Range
b) .979s = time
c) .37m = Vert distance.

Conclusions.

After completing the calculations from the experiment the exit velocity of the iron ball was determined both experimentally and analytically using the formula derivatives it was determined that the exit velocity of the ball was 6.25 m/s at a time of .349s this was different from the experimental values which were 8.20 m/s at an average time of .266s. The uncertainty in the predictions came from latency of the pressing of the stop watch. These calculations were then used when determining the landing spot of the cannonball launched at an angle. Trigonometry functions where used to find the values in respect to x and y positions ($V_{ix} = V_i \cos\theta$ & $V_{iy} = V_i \sin\theta$). the angle was given at 45°, and the landing zone was determined to be 4.33 m.

Trial	Time	Range (cm)	Vi (w/ time)	Vi w/o time)
1	0.25	2.171	8.684	0.71622732
2	0.22	2.21	10.0454545	0.63028004
3	0.31	2.171	7.00322581	0.88812188
4	0.19	2.203	11.5947368	0.54433276
5	0.34	2.162	6.35882353	0.97406916
6	0.25	2.187	8.748	0.71622732
7	0.18	2.209	12.2722222	0.51568367
8	0.28	2.183	7.79642857	0.8021746
9	0.44	2.202	5.00454545	1.26056008
10	0.44	2.197	4.99318182	1.26056008
11	0.31	2.185	7.0483871	0.88812188
12	0.34	2.192	6.44705882	0.97406916
13	0.22	2.173	9.87727273	0.63028004
14	0.15	2.171	14.4733333	0.42973639
15	0.19	2.202	11.5894737	0.54433276
16	0.19	2.178	11.4631579	0.54433276
17	0.21	2.18	10.3809524	0.60163095
18	0.31	2.16	6.96774194	0.88812188
19	0.25	2.159	8.636	0.71622732
20	0.25	2.174	8.696	0.71622732
Average	0.266	2.18345	8.90399983	0.76206587
St Dev	0.08081167	0.01624314	2.54465061	0.23151811
y	0.597			
g	9.8			