Catapult Statistics:

TEST 1:

Variables:

Control:	None
IV:	projectile type
DV:	distance from the ball's launch point to the first bounce (cm)
Confounding variables:	not launching the ball at the same angle each time
	catapult could move slightly in between launches
	person watching the landing spot could be off in saying where ball lands
	dowels shift out of position slightly between launches
Constants:	double rubber band catapult
	rest dowel position 1
	stop dowel position 3
	fulcrum position 1
	force dowel position 2
	rubber band in position 5

Test 1 Data (all data is in cm):

Trial	large wood ball	golf ball	wiffle ball	ping pong ball
1	381.1	196.4	403.9	360.5
2	376.7	206.1	407.5	342.9
3	356.8	198.1	390.2	344.4
4	355.5	210.4	387.2	333.5
5	362.4	211.4	372.1	358.3
6	346.6	200.1	395.2	360.4
7	329.9	199.1	347.9	350.9
8	388.4	200.3	369.9	350.4
9	403.9	204.4	364.2	350.1
10	310.4	201	357.1	338.1
11	363.9	200.3	357.6	343.5
12	360.8	201.1	351.4	348
13	336.1	200.1	347.9	367.9
14	364.6	199.9	350.9	364.8
15	375.6	199.9	334.4	370.9

ANOVA 1:

treatments pair	Bonferroni and Holm TT-statistic	Bonferroni p-value	Bonferroni inferfence	Holm p-value	Holm inferfence
A vs B	24.9353	0.00E+00	** p<0.01	0.00E+00	** p<0.01
A vs C	1.3042	1.1849289	insignificant	0.1974882	insignificant
A vs D	1.3398	1.1143373	insignificant	0.3714458	insignificant
B vs C	26.2395	0.00E+00	** p<0.01	0.00E+00	** p<0.01
B vs D	23.5955	0.00E+00	** p<0.01	0.00E+00	** p<0.01
C vs D	2.644	0.0636492	insignificant	0.0318246	* p<0.05

A = large wood ball
B = golf ball
C= wiffle ball
D = ping pong ball

Summary:

We ran an ANOVA test to determine if there was a difference between all the groups, which were the different types of projectile.

The data we used is the data on sheet 1, the 15 trials per projectile (4 types of projectile) of the distance that the projectile first landed from being launched in the catapult in centimeters.

The null hypothesis is there is no significant difference between the distances traveled by the large wood ball, golf ball, wiffle ball and ping pong ball.

p = 1.1102e-16

We should reject the null hypothesis because the p value is less than 0.05, and even less than 0.01 so there is an incredibly low probability that the differences in the data were due to random variation. The data is significant.

We ran a Bonferroni Holm post hoc test because the variances of the ANOVA were unequal.

According to both the Bonferroni and Holm, there is a significant difference between the large wood ball and golf ball data, the golf ball and wiffle ball data and the golf ball and ping pong ball data. Since the Bonferroni test does not account for type 2 errors and the Holm test does, the data for wiffle ball vs ping pong ball was insignificant for the Bonferroni, although very close to 0.05, but it was significant in the Holm.

We conclude that the golf ball's data was significantly different compared to all the other projectiles' data, while the other groups were insignificantly different compared to each other. We can reject the null hypothesis for the B group, that there is no significant difference between the golf ball data and the other data, but we accept the null hypothesis for the other pairwise comparisons.

We used astata.com to calculate the p-values for the ANOVA and Bonferroni-Holm tests.

TEST 2:

All of the data given is in centimeters.

	Stopping Dowel Position			
Trial	**1 (A)**	**2 (B)**	**3 (C)**	**4 (D)**
1	94	174	351	469
2	101	188	357	461
3	102	164	359	485
4	99	177	371	479
5	96	191	381	474
6	94	187	379	482
7	97	191	367	512
8	99	203	364	503
9	97	192	362	452
10	94	204	348	485
11	98	179	352	501
12	102	193	363	511
13	104	204	369	521
14	92	219	374	531
15	93	211	369	463

ANOVA 2:

treatments pair	Bonferroni and Holm TT-statistic	Bonferroni p-value	Bonferroni inferfence	Holm p-value	Holm inferfence
A vs B	17.3785	0.00E+00	** p<0.01	0.00E+00	** p<0.01
A vs C	49.1755	0.00E+00	** p<0.01	0.00E+00	** p<0.01
A vs D	72.0561	0.00E+00	** p<0.01	0.00E+00	** p<0.01
B vs C	31.7971	0.00E+00	** p<0.01	0.00E+00	** p<0.01
B vs D	54.6777	0.00E+00	** p<0.01	0.00E+00	** p<0.01
C vs D	22.8806	0.00E+00	** p<0.01	0.00E+00	** p<0.01

Summary:

We will run an ANOVA because there are more than 2 groups and we would like to see if there is a significant difference between any of the 4 groups.

The data we will be using is shown on the left. It is 15 trials per setting of the stopping dowel where 1 is the bottom and it increases in height until 4, the top, and it is the distance that a constant projectile traveled in centimeters from the launch point.

The null hypothesis is that there is no difference between the first, second, third and fourth stopping dowel position data.

p-value = 1.1102e-16

We will use the Bonferroni-Holm test because the ANOVA test ran on astata.com said the variances were unequal.

All groups are significantly different. Stopping dowel position 1 is significantly different from positions 2, 3 and 4, position 2 is significantly different from positions 1, 3, 4, position 3 is significantly different from positions 1,2, 4 and position 4 is significantly different from positions 1, 2, 3.

Since all the groups were significantly different compared to each other, changing the position of the stopping dowel created a significant difference in distances traveled by the ball. There is a correlation between stopping dowel position and distance traveled. We rejected the null hypothesis.

We used astata.com to perform the ANOVA and Bonferonni-Holm tests.