

Trigger Frame: the video frame when the trigger was pulled. This will be  $t=0$ .

Projectile Launch Time: the time at which the projectile motion began. This tells us how long the launcher interacted with the projectile.

$x_0(m)$ ,  $y_0(m)$ : Initial position for the projectile motion. Used to calculate predicted range.

$v_{ix}$  (m/s),  $v_{iy}$  (m/s): Components of the initial velocity for the projectile motion. Used to calculate the predicted range.

**Launch Angle (degrees):** the angle of the initial velocity relative to the horizontal.

**Actual Range (m):** the experimental range of the projectile measured in the field.

Difference (m): The difference between the predicted range and the actual range. This will usually be a negative number due to air resistance.

Average: the average value for each column is collected below.

Uncertainty: the calculated uncertainty in the data columns.

1. Open each video in Tracker
2. Establish coordinate system at the base of the launch and use the stakes along the base to determine distances.
3. Find the frame at which the launcher is triggered, set that to  $t=0$
4. Track the position of the ball to give position, velocity and acceleration data.
5. Find the frame with the maximum velocity at which point the ball has lost contact with the launcher to determine the launch position, and velocities.
6. Use launch data to predict the range based on simple projectile motion.

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		Trigger	Projectile Launch	Projectile Launch						Launch angle	Actual	Predicted			
	File Name	Frame (t=0)	Frame	Time(s)	x (m)	y (m)	vx (m/s)	vy (m/s)	v (m/s)	(degrees)	Range (m)	Range (m)	Difference	%Diff	Notes:
Launch 1	IMG_0028.MOV	132	140	0.27	-1.62	2.04	4.50	17.50	18.07	75.59	11.20	16.56	5.36	32.37%	Very high angle
Launch 2	IMG_0029.MOV	630	640	0.33	-1.32	2.16	11.36	13.12	17.36	49.12	14.85	32.19	17.34	53.86%	Very large difference between predicted and actual - wind?
Launch 3	IMG_0030.MOV	112	121	0.30	-1.11	2.36	11.27	11.66	16.22	45.97	13.70	28.94	15.24	52.67%	Very large difference between predicted and actual - wind?
Launch 4	IMG_0031.MOV	136	144	0.27	-0.99	2.50	13.55	12.91	18.71	43.61	32.25	38.15	5.90	15.46%	Added a fifth elastic band - seems to have stabilized it - also began watching to wait for wind to slow down.
Launch 5	IMG_0032.MOV	165	172	0.23	-1.43	2.10	10.12	16.70	19.52	58.79	28.75	35.71	6.96	19.49%	
Launch 6	IMG_0033.MOV	245	254	0.30	-0.98	2.69	11.07	13.52	17.47	50.69	28.25	32.60	4.35	13.35%	
Launch 7	IMG_0034.MOV	434	443	0.30	-0.75	2.76	13.59	11.56	17.84	40.38	30.20	35.03	4.83	13.79%	
Launch 8	IMG_0035.MOV	239	247	0.27	-0.96	2.51	13.09	11.38	17.34	40.99	27.20	33.05	5.85	17.71%	
Launch 9	IMG_0036.MOV	261	269	0.27	-1.06	2.42	13.56	12.24	18.26	42.07	28.05	36.35	8.30	22.84%	
Launch 10	IMG_0038.MOV	213	221	0.27	-1.18	2.44	11.04	14.28	18.05	52.29	28.75	33.95	5.20	15.31%	
	Average (Launc 4-10):			0.27	-1.05	2.49	12.29	13.22	18.17	46.97	29.06	34.98	5.91	16.85%	
	Uncertainty (Launch 4-10):			0.01	0.08	0.08	0.56	0.70	0.29	2.66	0.63	0.74	0.51	1.29%	
Launch 11	IMG_0039.MOV	554	561	0.23	-1.14	2.51	13.31	17.49	21.98	52.73	40.60	49.36	8.76	17.75%	This was the extra launch with 7 elastic bands. Significant increase in velocity and range.
					From Launch 4 to Launch 10 the results were very consistent, and relatively close ~17% of the predicted range. Because the baseball was moving faster, the effects of wind and air resistance would be greater for Team 2.										