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U3 Lab Report

Purpose:

To determine the mathematical & graphical relationship between time, position, and velocity in various dimensions utilizing video analysis.

Materials:

- rubber bouncy ball
- Camera app on iPad
- Graphical vernier video on iPad
- Meter stick

Procedure:

1. Get the ball.
2. Have two people stand a distance apart.
3. Measure the distance between the two people and record it in meters.
4. Set the iPad up so that when videoing you are able to see both people fully as well as the ball at its full height (maximum and minimum points).
5. Begin videoing.
6. Have the two members pass the ball back and forth a few times while filming.

7. Stop the video.
8. Put the video into the vernier video and extract the data by setting up points of reference and a scale.

Raw Data:

	Data Set 1		
	Time (s)	X (m)	Y (m)
1	0.00	-0.077	0.136
2	0.07	-0.240	0.361
3	0.13	-0.378	0.463
4	0.20	-0.501	0.515
5	0.27	-0.629	0.530
6	0.40	-0.880	0.412
7	0.47	-0.982	0.305
8	0.53	-1.115	0.167

Table:

	Data Set 1		
	Time (s)	X (m)	Y (m)
1	0.00	-0.077	0.136
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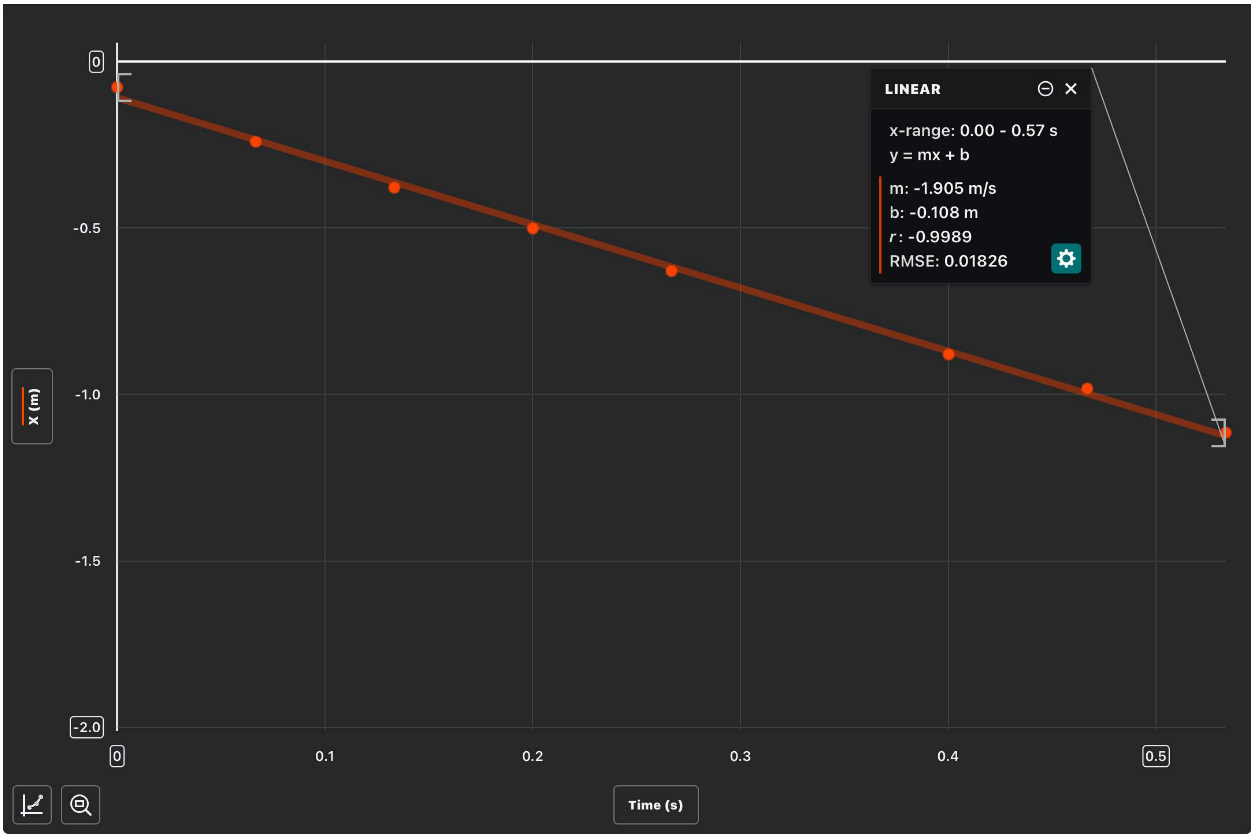
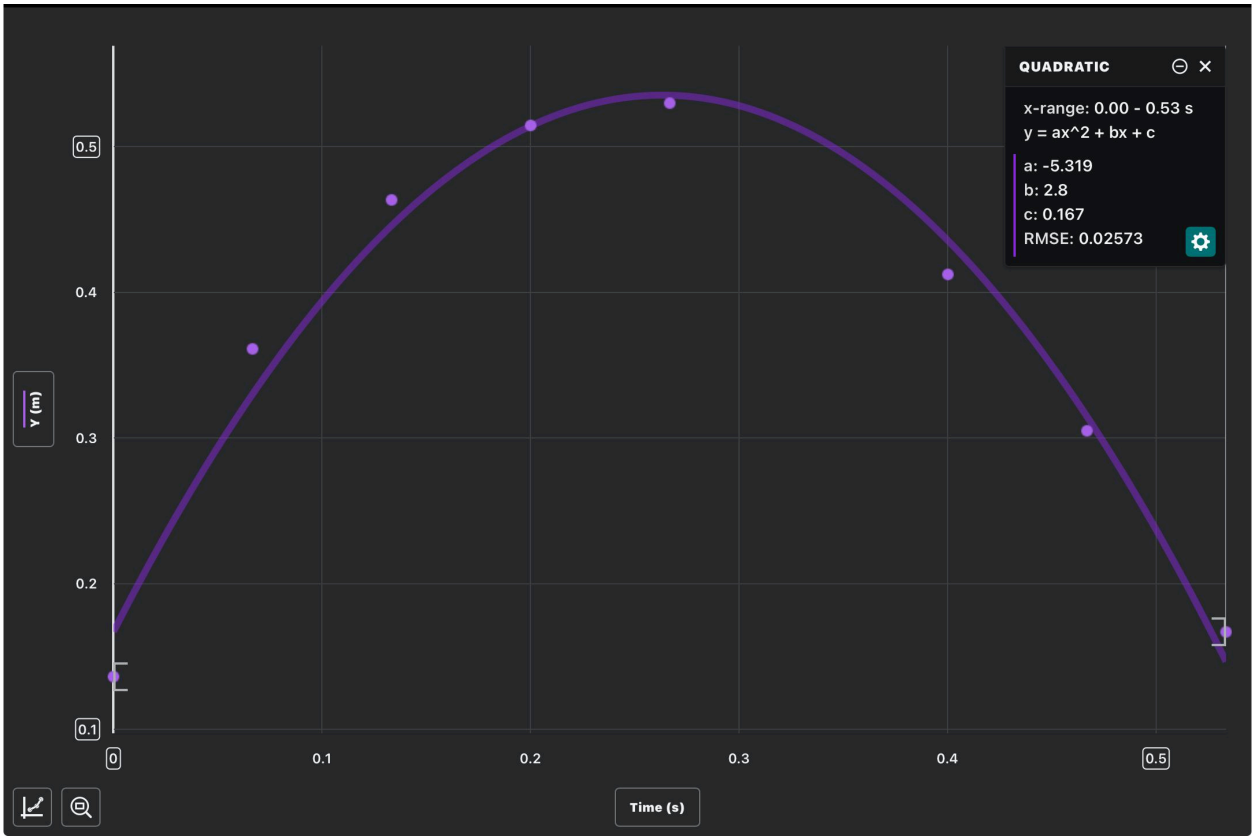
	Time (s)	Velocity X (m/s)	Velocity Y (m/s)
1	0.00	-1.905	2.800
2	0.07	-1.905	2.055
3	0.13	-1.905	1.618
4	0.20	-1.905	0.673
5	0.27	-1.905	-0.072
6	0.40	-1.905	-1.455
7	0.47	-1.905	-2.200

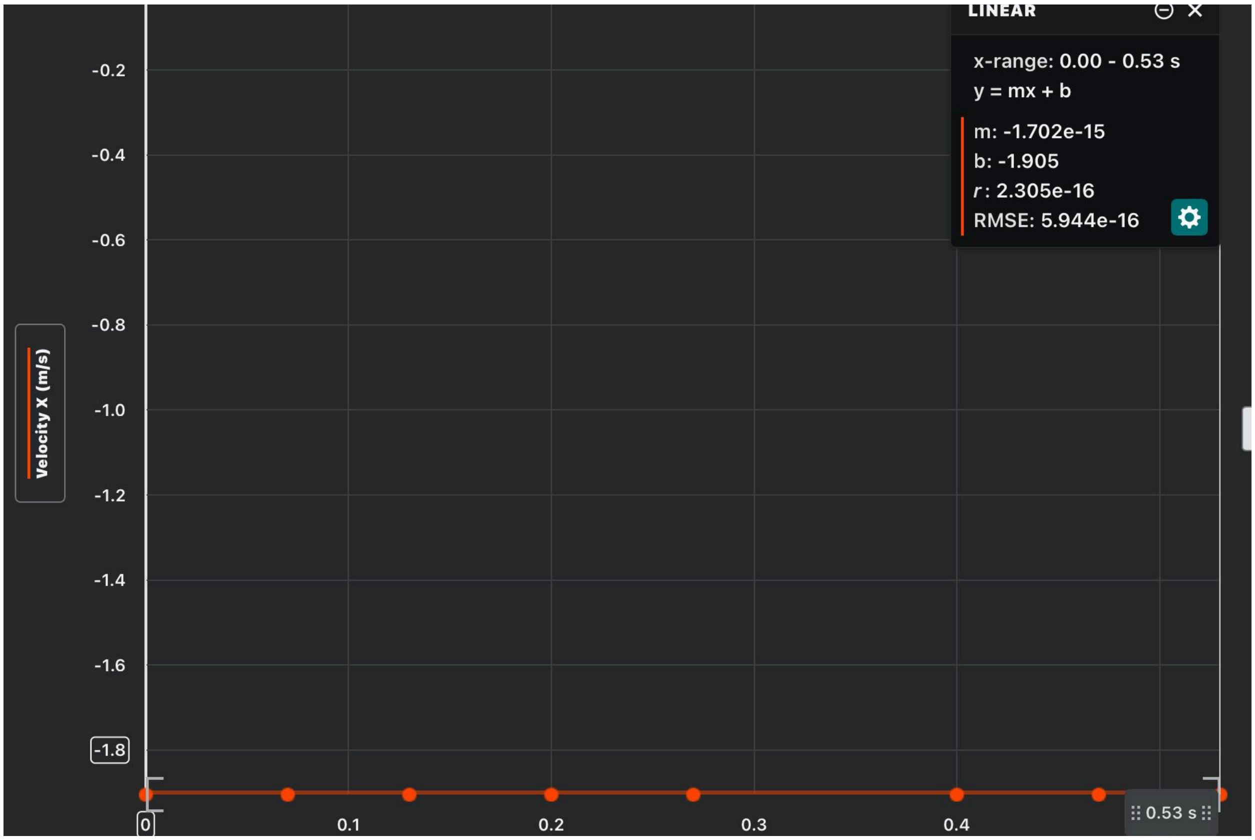
Graphs:



$x(t) = -1.905t + (-0.108)$

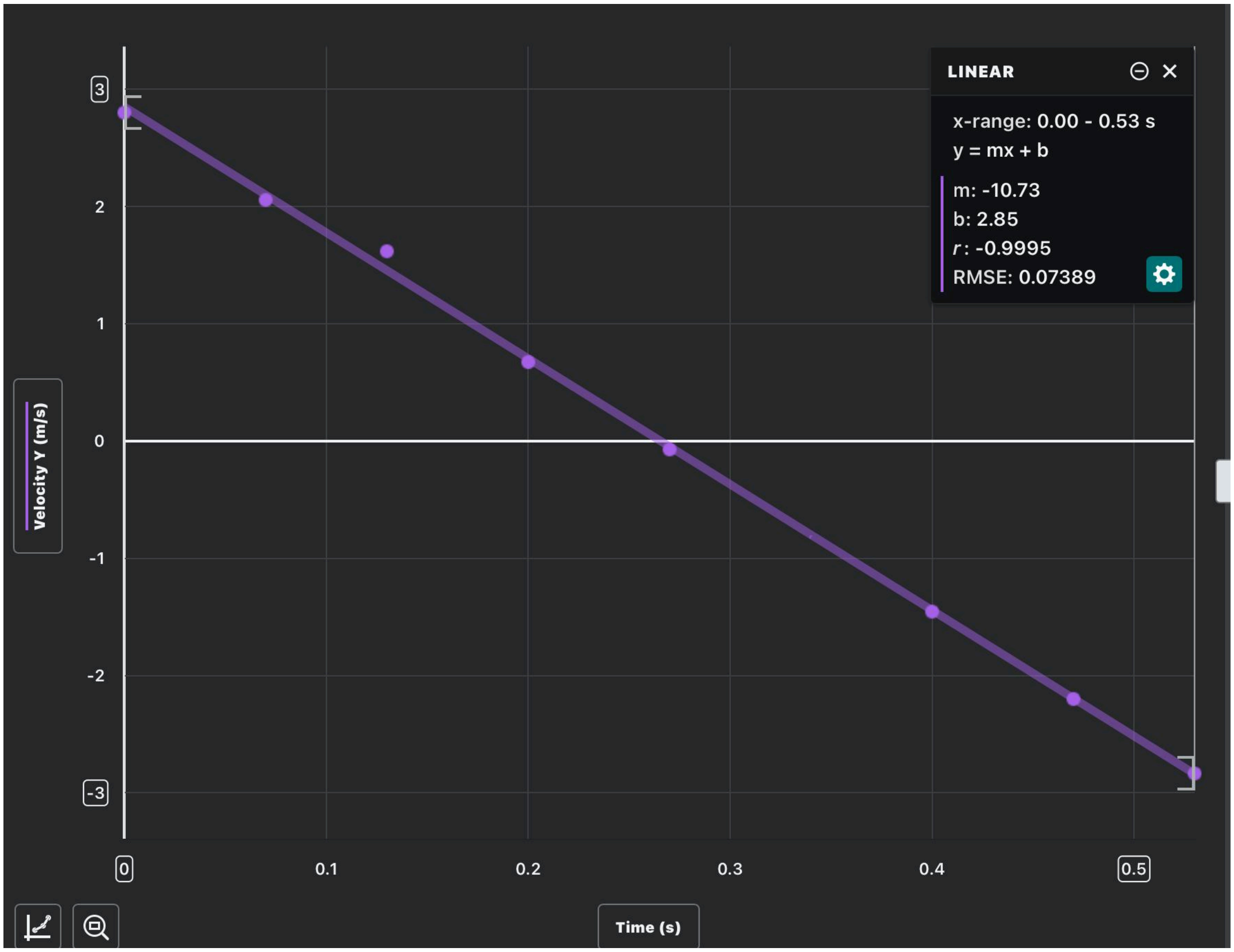


$$y(t) = -5.319t^2 + 2.8t + 0.167$$



Sample Calculations: dx/dt= -1.905t-0.108= -1.905

vx(t)=-1.905



Sample Calculation: dy/dt= -10.73+2.85 vy(0.27)= -10.73(0.27) +2.85=-0.072

vy(t)=−10.73t+2.85

Analysis and Conclusion:

This experiment was meant to facilitate the research of the ball's motion in two dimensions using video analysis in an attempt to model it mathematically using the projectile motion. This allows us to find out the relationship between acceleration, velocity, and position whenever there is gravity and direction involved. The x-position graph was linear, x(t)=−1.905t−1.008, with constant velocity in the x-direction, while the y-position graph was quadratic, y(t)=−5.319t2+2.8t+0.167, as one would expect for projectile motion under gravity.

Differentiation of these position equations to provide velocity yielded $v_x(t)=-1.905$ m/s, a constant velocity in the x-direction, while $v_y(t)=-10.73t+2.85$ was a linear decreasing velocity in the y-direction, confirming constant downward acceleration. The slope of the vertical velocity plots is proportional to the gravity acceleration that is applied to the ball, which is also the constant of the vertical position equation. Experimental values of the velocities were found using the centered differences and plugging in the times into the deviated equations. But there were inconsistencies that made the data less than perfect, this is due to the fact that there could have been scaling issues, frame limitations, and warping of the camera. It resulted in a slight curvature of the computed graphs that may not have been present in the ideal setting. Overall, the lab can adequately demonstrate how derivatives connect velocity and position.