# <u>Basketball Throw Lab</u>

**Purpose:** To determine the mathematical models for x-position, y-position, x-component of velocity and y-component of velocity versus time for a basketball thrown at an angle and the value of the vertical acceleration.

**Hypothesis:**

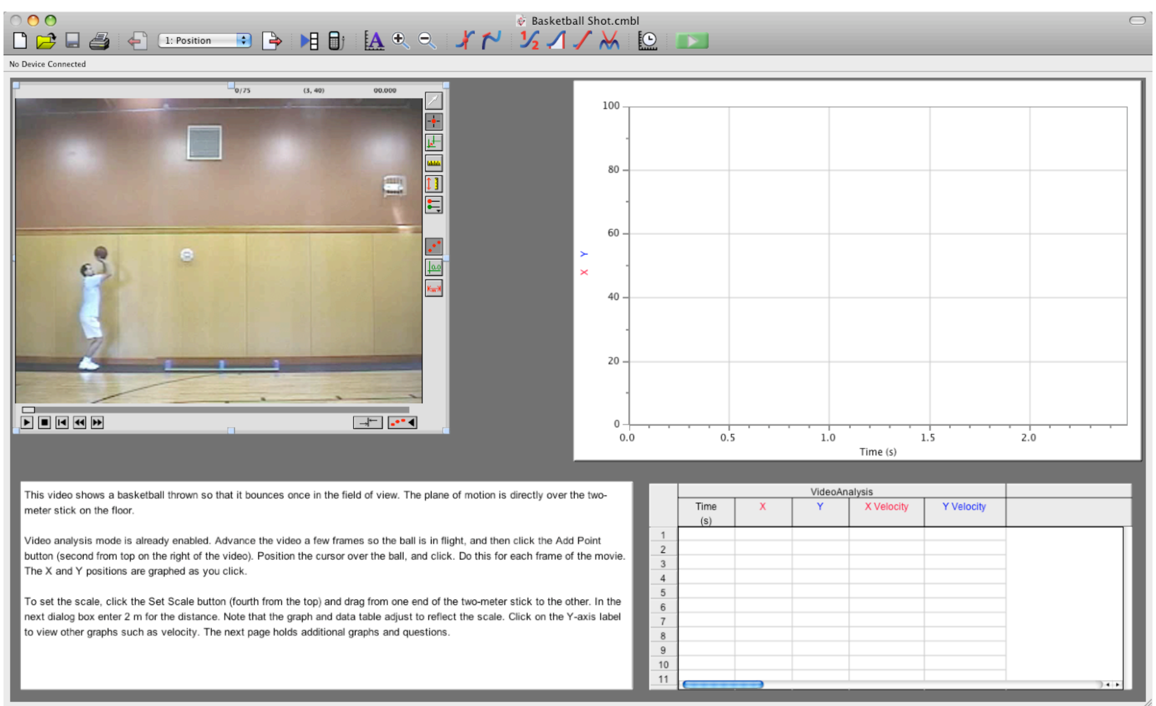
The position graph for x will show a diagonal line in a positive direction because the ball is always traveling forward.

Y position graph - This graph will show a graph that is similar to an upside-down parabola because the ball goes up into the air and then falls to the ground because gravityh has a negative acceleration on the ball.

X velocity graph - This graph will show a horizontal line because the x-velocity is constant.

Y velocity graph - This graph will show a line with a negative slope because gravity is putting a negative constant acceleration on the ball.

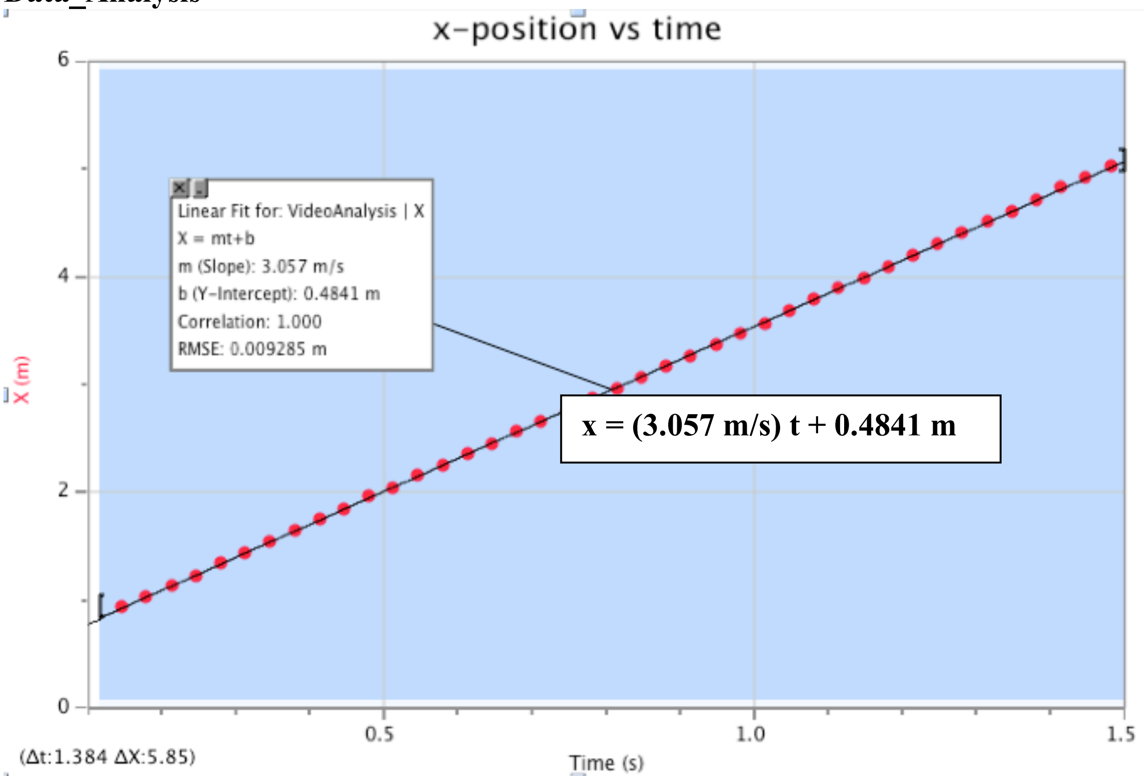
The value of the vertical acceleration would be the acceleration due to gravity. It would be -9.81.

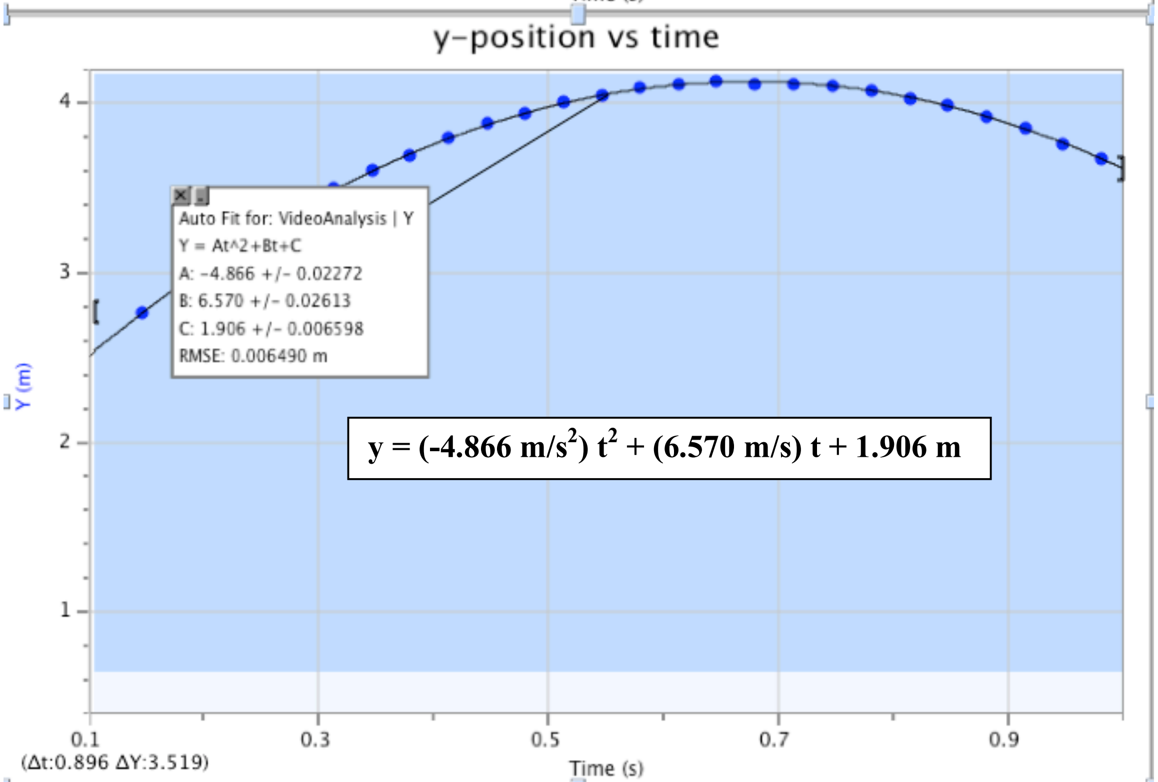


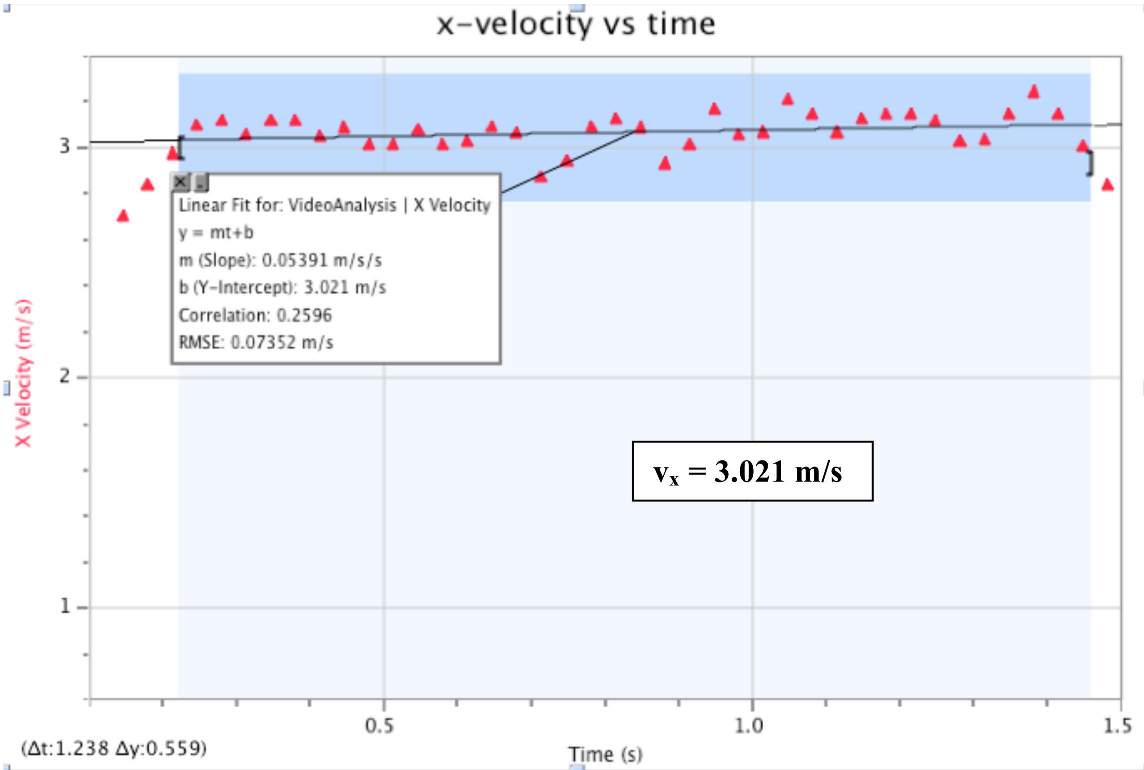
**Data:**

| | VideoAnalysis | | | | |
|---|---|---|---|---|---|
| | Time (s) | X (m) | Y (m) | X Velocity (m/s) | Y Velocity (m/s) |
| 1 | 0.1467 | 0.9506 | 2.765 | 2.695 | 4.959 |
| 2 | 0.1800 | 1.037 | 2.938 | 2.829 | 4.671 |
| 3 | 0.2133 | 1.136 | 3.086 | 2.963 | 4.340 |
| 4 | 0.2467 | 1.235 | 3.222 | 3.086 | 4.126 |
| 5 | 0.2800 | 1.346 | 3.358 | 3.107 | 3.961 |
| 6 | 0.3133 | 1.444 | 3.494 | 3.045 | 3.611 |
| 7 | 0.3467 | 1.543 | 3.605 | 3.107 | 3.107 |
| 8 | 0.3800 | 1.654 | 3.691 | 3.107 | 2.829 |
| 9 | 0.4133 | 1.753 | 3.790 | 3.035 | 2.644 |
| 10 | 0.4467 | 1.852 | 3.877 | 3.076 | 2.243 |
| 11 | 0.4800 | 1.963 | 3.938 | 3.004 | 1.872 |
| 12 | 0.5133 | 2.049 | 4.000 | 3.004 | 1.533 |
| 13 | 0.5467 | 2.160 | 4.037 | 3.066 | 1.286 |
| 14 | 0.5800 | 2.259 | 4.086 | 3.004 | 1.008 |
| 15 | 0.6133 | 2.358 | 4.111 | 3.014 | 0.556 |
| 16 | 0.6467 | 2.457 | 4.123 | 3.082 | 0.113 |
| 17 | 0.6800 | 2.568 | 4.111 | 3.049 | -0.133 |
| 18 | 0.7133 | 2.667 | 4.111 | 2.861 | -0.284 |
| 19 | 0.7483 | 2.753 | 4.099 | 2.931 | -0.597 |
| 20 | 0.7817 | 2.864 | 4.074 | 3.080 | -1.024 |
| 21 | 0.8150 | 2.963 | 4.025 | 3.113 | -1.325 |
| 22 | 0.8483 | 3.074 | 3.988 | 3.076 | -1.677 |
| 23 | 0.8817 | 3.173 | 3.914 | 2.922 | -2.037 |
| 24 | 0.9150 | 3.259 | 3.852 | 3.004 | -2.387 |
| 25 | 0.9483 | 3.370 | 3.753 | 3.158 | -2.706 |
| 26 | 0.9817 | 3.481 | 3.667 | 3.045 | -2.901 |
| 27 | 1.015 | 3.568 | 3.568 | 3.056 | -3.313 |
| 28 | 1.048 | 3.679 | 3.444 | 3.200 | -3.693 |
| 29 | 1.082 | 3.790 | 3.321 | 3.138 | -4.064 |
| 30 | 1.115 | 3.889 | 3.173 | 3.056 | -4.414 |
| 31 | 1.148 | 3.988 | 3.025 | 3.117 | -4.691 |
| 32 | 1.182 | 4.099 | 2.864 | 3.138 | -5.062 |
| 33 | 1.215 | 4.198 | 2.679 | 3.138 | -5.237 |
| 34 | 1.248 | 4.309 | 2.519 | 3.107 | -5.514 |
| 35 | 1.282 | 4.407 | 2.321 | 3.014 | -6.029 |
| 36 | 1.315 | 4.506 | 2.111 | 3.025 | -6.409 |
| 37 | 1.348 | 4.605 | 1.889 | 3.138 | -6.667 |
| 38 | 1.382 | 4.716 | 1.667 | 3.230 | -6.914 |
| 39 | 1.415 | 4.827 | 1.432 | 3.138 | -7.263 |

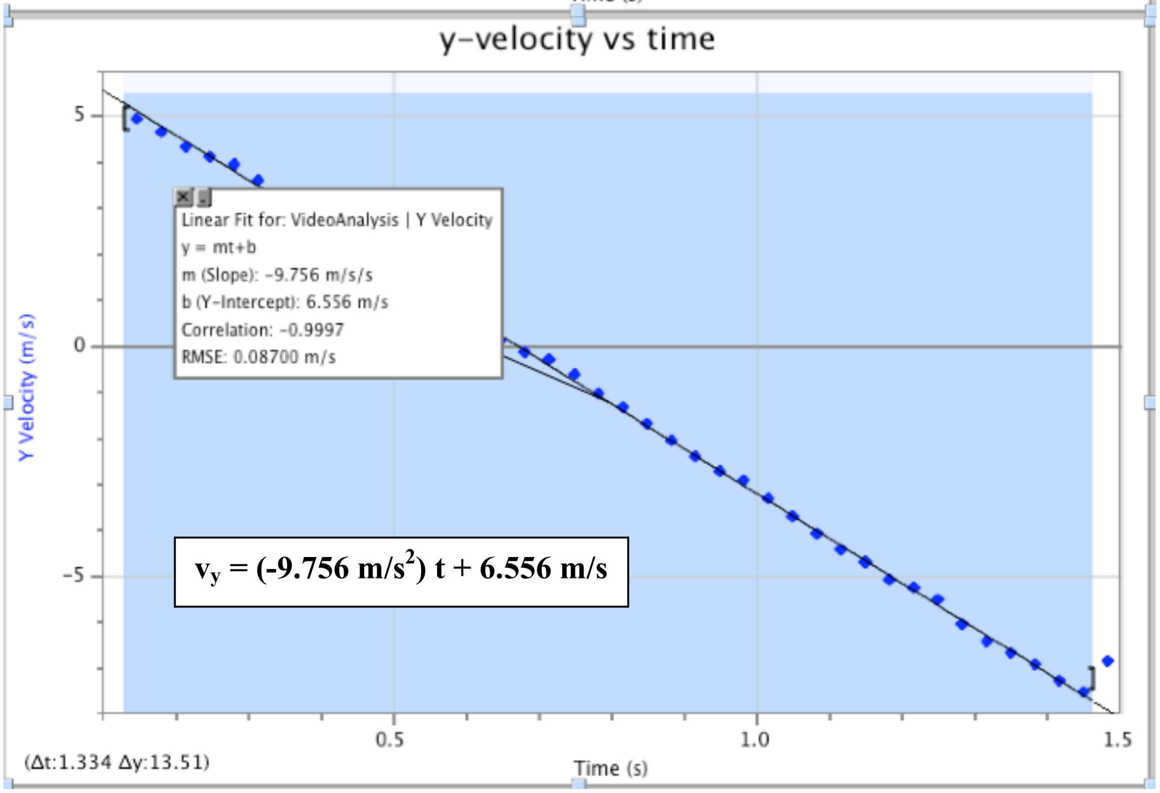
**Data_Analysis**





x–velocity vs time
X Velocity (m/s)
Time (s)
Linear Fit for: VideoAnalysis | X Velocity
y = mt+b
m (Slope): 0.05391 m/s/s
b (Y–Intercept): 3.021 m/s
Correlation: 0.2596
RMSE: 0.07352 m/s
$v_x = 3.021$ m/s
(Δt:1.238 Δy:0.559)

y–velocity vs time
Y Velocity (m/s)
Time (s)
Linear Fit for: VideoAnalysis | Y Velocity
y = mt+b
m (Slope): –9.756 m/s/s
b (Y–Intercept): 6.556 m/s
Correlation: –0.9997
RMSE: 0.08700 m/s
$v_y = (-9.756\ m/s^2)\ t + 6.556\ m/s$
(Δt:1.334 Δy:13.51)

**Finding vertical acceleration:**

a = 2 (-4.866 m/s$^2$)

a = **9.732 m/s$^2$**

To get this we took the first coefficient from the y position graph equation and set it equal to ½ a. Since we needed to find "a" we took "A" and multiplied it by 2. This gave us 9.732 m/s$^2$, close to -9.81 m/s$^2$.

from the slope of the y-velocity vs time graph:

**a = -9.756 m/s$^2$**

**Conclusion:**

For the x-position graph, our hypothesis proved to be right. The mathematical model of the graph is x = (3.057 m/s) t + 0.4841 m. The slope of the graph is the x-velocity because the x graph is a line, The graph describes the motion of the ball well with its correlation of 1.

The equation of an object moving at constant velocity is x = mt + b. Here, x is the position, m is the velocity of the object, t is the clock reading and b is the starting point.

Our hypothesis for the y-position graph also came out correct. The equation of the graph is y = (-4.866 m/s$^2$) t$^2$ + (6.570 m/s) t + 1.906 m. In the mathematical model y = At$^2$ + Bt + C, y is the position, A is ½ the acceleration, B is the initial velocity and C is the starting point.

The x velocity graph came out to be (almost) a horizontal line. The line isn't perfectly horizontal like it should have been, however. A little bit of error must have come in when doing the experiment (clicking on the ball). We mustn't have clicked directly in the center of the ball. The relative equation for this line is $v_x$ = 3.021 m/s. There isn't a slop to this graph because the x-velocity is constant, the ball is always moving forward.

Our hypothesis for the y velocity also proved to be correct. The equation of the graph is $v_y$ = (-9.756 m/s$^2$) t + 6.556 m/s. The correlation on this graph was also very good at -0.9997. The slope is the acceleration of the ball due to gravity. The "b" of the equation is the initial velocity of the ball.

Because this is a simulation, there wasn't much error in the experiment. The only error that may have occurred, was when we were clicking on the basketball to progress the scene. We may not always have clicked directly in the center of the basketball. Otherwise the graphs were pretty right on.

To improve this experiment, it would have been more hands on by creating your own video of the ball motion. With time though it couldn't happen but it would've been nicer to do it that way. I would also like to test different size balls and also balls with different weight to see the differences if they had any between each other.