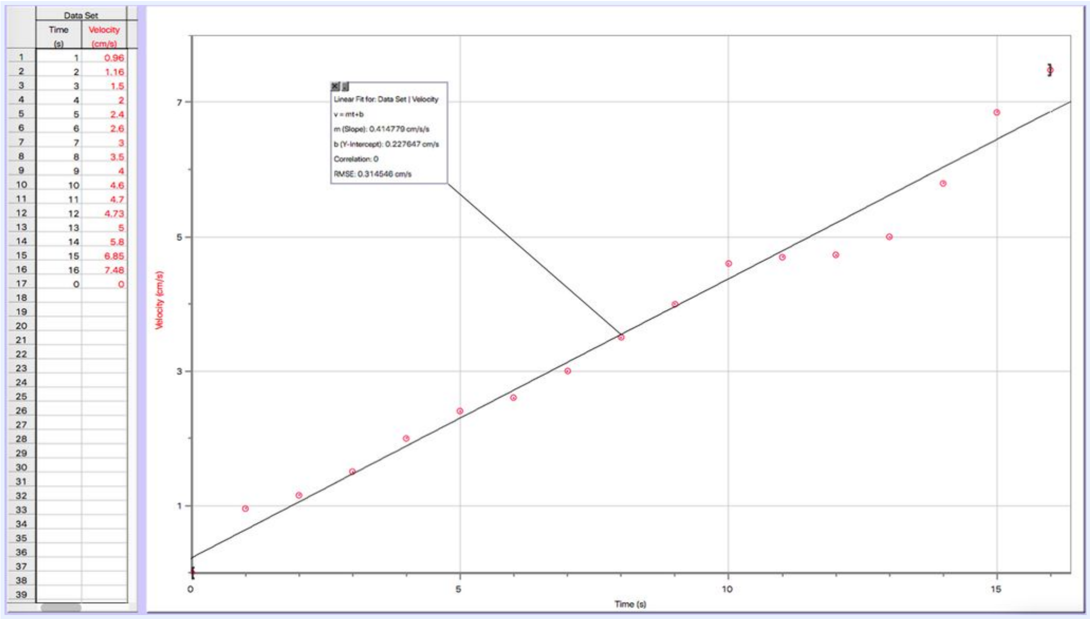
Developing a Non-Constant Velocity Model of a Slow Roller

In the Slow Roller lab, our group's goal was to examine the data of a moving object that does not have a constant velocity and to develop a model to predict the position of such an object. In the lab, a disc with a rod through it (the slow roller) was placed on a handcrafted ramp and rolled down, gaining speed along its path. The slow roller's distance was recorded once every second, and recorded into a graphing program (Logger Pro), creating both position-time and velocity-time graphs.

Analyzing both the velocity-time graph and the position-time graph proves the velocity is not constant as the slow roller travels down the ramp. In the velocity-time graph, the velocity increases as time increases. For example, at five seconds, the velocity is 2.4cm/s while at ten seconds, the velocity has increased to be 4.6. In fact, every point appears to increase by approximately the same value every second. As modeled by the best fit line, for every second of time, the velocity increases by roughly 0.4cm/s consistently. However, we should note that the actual data does not always follow the best fit line. There is a dip in the calculated velocity starting at 12 seconds. After 12 seconds the velocity appears to decrease then sharply increase to about 0.65cm/s/s, which is a larger change than the previously calculated value of 0.4cm/s. Since these graphs are from data solely from one trial (trial 3), there is a high chance outlier points that would be most likely smoothed out by an average of all the trials. As mentioned above, the velocity-time graph can be modeled by a best-fit line that is defined by $v_f = \frac{\frac{0.4cm}{s}}{s}(t) + \frac{0.2cm}{s}$ Since this is a linear graph, the best fit line has a slope of 0.4cm/s/s For this velocity-time graph, the slope would be the $\frac{\Delta v}{\Delta t}$, which is the average acceleration, suggesting that the accelerations stays the same and velocity is increasing. The line of best fit also determines the initial velocity or y-intercept of the slow roller graph 0.2cm/s. Additionally, the position-time graph also suggests that the velocity of the slow roller is not constant. For example, the change in displacement from five to six seconds is 2.5cm while the change in displacement from ten to eleven seconds is 4.9, almost twice the difference in displacement. Because these are two different values and the equation for velocity is ($\frac{\Delta x}{\Delta t}$), the velocity must have different values at 5 and 10 seconds. The slope of the position-time graph is not a straight line like we had seen with graphs that represent the position of constant velocity models. As the slow roller moved down the ramp, the position graph's slope became steeper and steeper, causing a curve, or half U shape. The slow roller started off slow and gradually gained speed as time went by, and every second, there was more of a displacement of position every second, causing the curve of the graph. Both the position-time graph and the velocity-time graph curves show that the velocity of the slow roller was not constant as it rolled down the ramp.

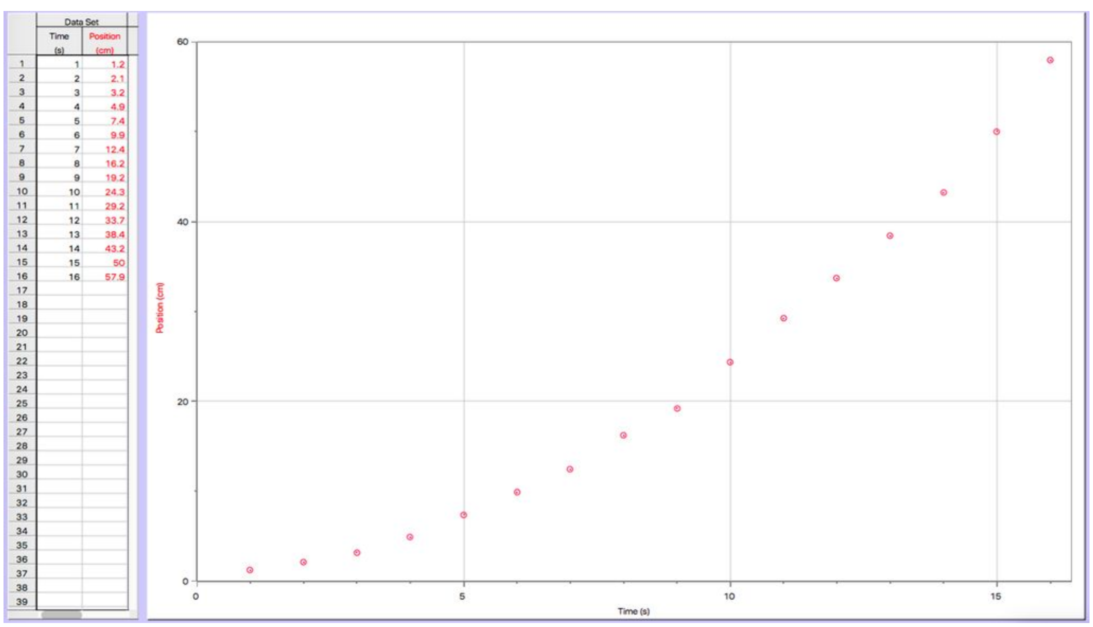
VELOCITY TIME GRAPH AND EQUATION *(trial 3)*:



	Data Set	
	Time (s)	Velocity (cm/s)
1	1	0.96
2	2	1.16
3	3	1.5
4	4	2
5	5	2.4
6	6	2.6
7	7	3
8	8	3.5
9	9	4
10	10	4.6
11	11	4.7
12	12	4.73
13	13	5
14	14	5.8
15	15	6.85
16	16	7.48
17	0	0

LINE OF BEST FIT: $v_f = \frac{\frac{0.4cm}{s}}{s}(t) + \frac{0.2cm}{s}$

POSITION TIME GRAPH *(trial 3)*:



	Data Set	
	Time (s)	Position (cm)
1	1	1.2
2	2	2.1
3	3	3.2
4	4	4.9
5	5	7.4
6	6	9.9
7	7	12.4
8	8	16.2
9	9	19.2
10	10	24.3
11	11	29.2
12	12	33.7
13	13	38.4
14	14	43.2
15	15	50
16	16	57.9