Name
General Physics (period *1*)
Mrs. Ciustea
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Partner(s): *Partner 1, Partner 2*

UNIFORM ACCELERATION LAB: CAR AND RAMP

DATA COLLECTION:

Table 1: Time Measurements based on Position of a Car Rolling Down an Inclined Ramp

Position of Gate B (± 0.1 cm)	Time through Gate A (± 0.0005 s)			Time through Gate B (± 0.0005 s)			Time from Gate A to Gate B (± 0.0005 s)		
	Trial 1	*Trial 2*	*Trial 3*	*Trial 1*	*Trial 2*	*Trial 3*	*Trial 1*	*Trial 2*	*Trial 3*
10.0	0.1242	0.1249	0.1256	0.0859	0.0871	0.0864	0.1197	0.1232	0.1268
15.0	0.1245	0.1246	0.1244	0.0700	0.0700	0.0706	0.2130	0.2112	0.2141
…	…	…	…	…	…	…	…	…	…

Position of Gate A = 5.0 ±0.1 cm

Length of Car "Wing"= 5.00 cm ±0.05 cm = 0.0500 ±0.0005 m

Table 2: Average Time and Velocities for a Car on an Inclined Ramp

Position of Gate B (m)	Average Time through Gate A (s)	Average Time through Gate B (s)	Average Time from Gate A to Gate B (s)	Initial Velocity ($^{m}/_{s}$)	Final Velocity ($^{m}/_{s}$)
0.100	0.1249	0.0865	0.1245	0.400	0.580
0.150	0.1245	0.0702	0.2119		0.710
…	…	…	…		…

SAMPLE CALCULATIONS:

Average Time through Photogate A at Position = 0.10 m:

$$t_{A\,(average)} = \frac{t_{A1} + t_{A2} + t_{A3}}{3} = \frac{0.1242\text{ s} + 0.1249\text{ s} + 0.1256\text{ s}}{3}$$

$$\boldsymbol{t_{A\,(average)} = 0.1249\text{ s}}$$

Average Time through Photogate B at Position = 0.10 m:

$$t_{B\,(average)} = \frac{t_{B1} + t_{B2} + t_{B3}}{3} = \frac{0.0859\text{ s} + 0.0871\text{ s} + 0.0864\text{ s}}{3}$$

$$\boldsymbol{t_{B\,(average)} = 0.0865\text{ s}}$$

Average Time from Photogate A to Photogate B at Position = 0.10 m:

$$t_{A\to B\,(average)} = \frac{t_{A\to B1} + t_{A\to B2} + t_{A\to B3}}{3} = \frac{0.1197\text{ s} + 0.1232\text{ s} + 0.1268\text{ s}}{3}$$

$$\boldsymbol{t_{A\to B\,(average)} = 0.1245\text{ s}}$$

Initial Velocity (at Photogate A) at Position = 0.10 m:

$$v_{initial} = \frac{length\ of\ wing}{t_{A\,(average)}} = \frac{0.0500\text{ m}}{0.1249\text{ s}}$$

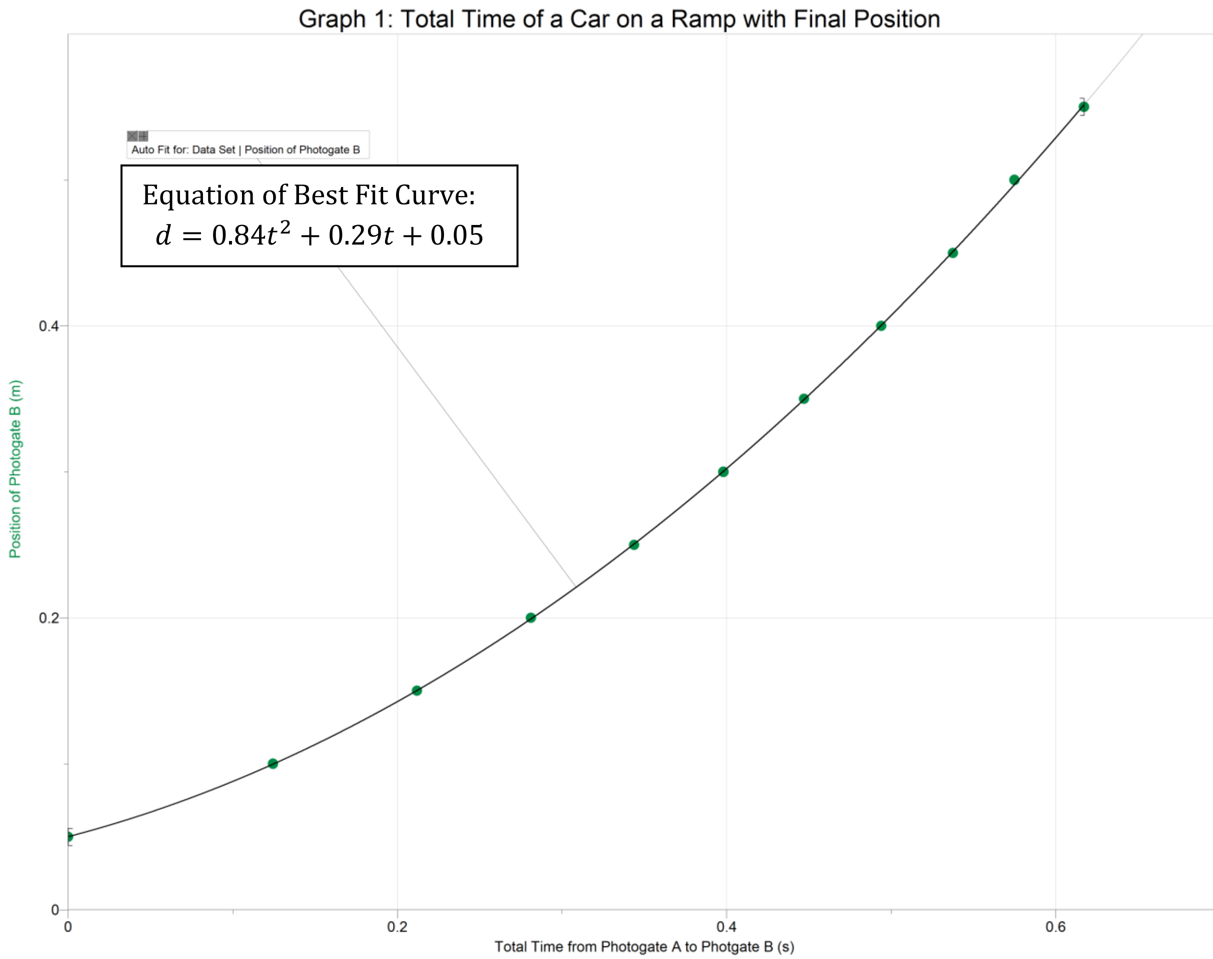
$$\boldsymbol{v_{initial} = 0.400\ {}^{\text{m}}/_{\text{s}}}$$

Final Velocity (at Photogate B) at Position = 0.10 m:

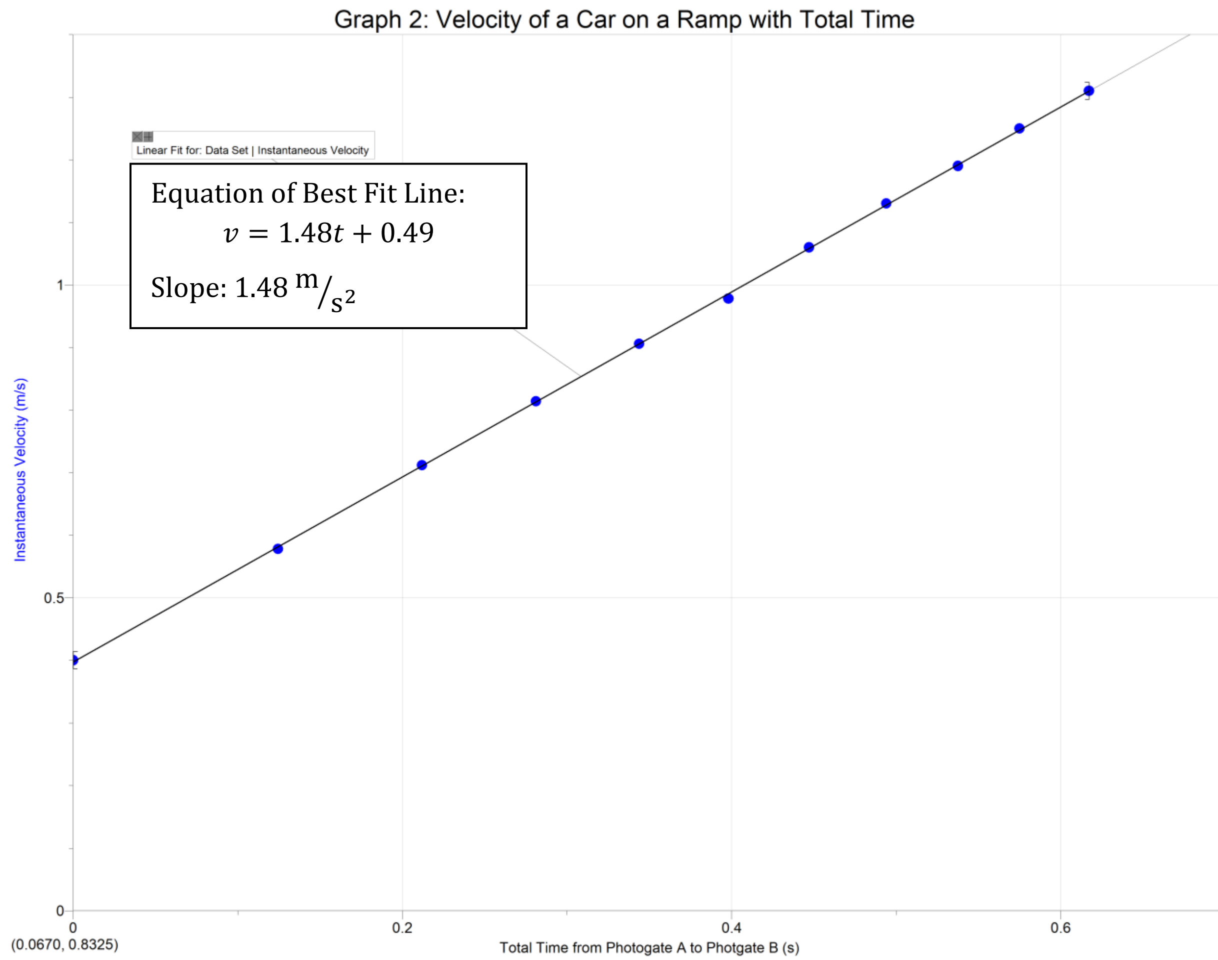
$$v_{final} = \frac{length\ of\ wing}{t_{B\,(average)}} = \frac{0.0500\text{ m}}{0.0865\text{ s}}$$

$$\boldsymbol{v_{final} = 0.580\ {}^{\text{m}}/_{\text{s}}}$$

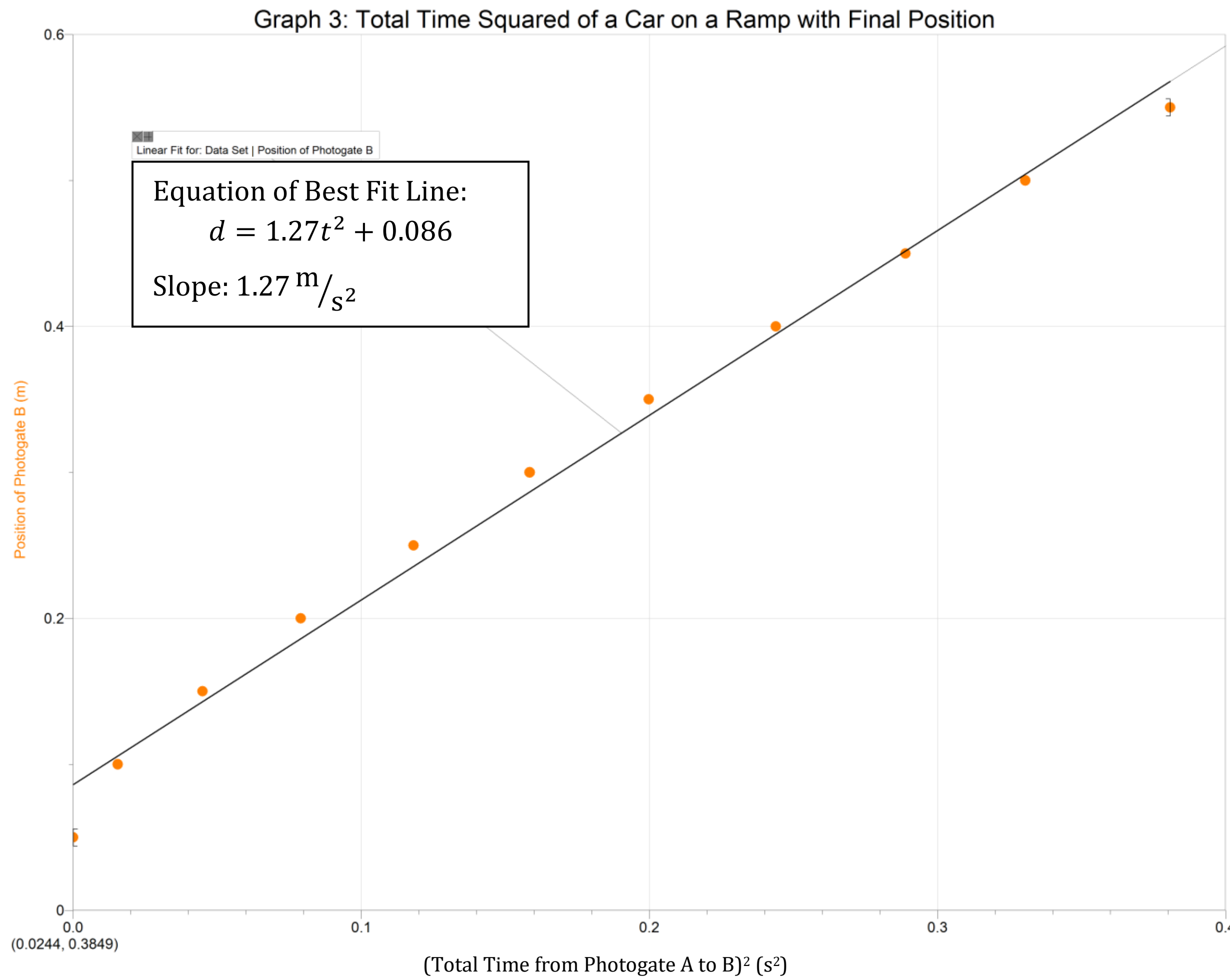
DATA ANALYSIS:



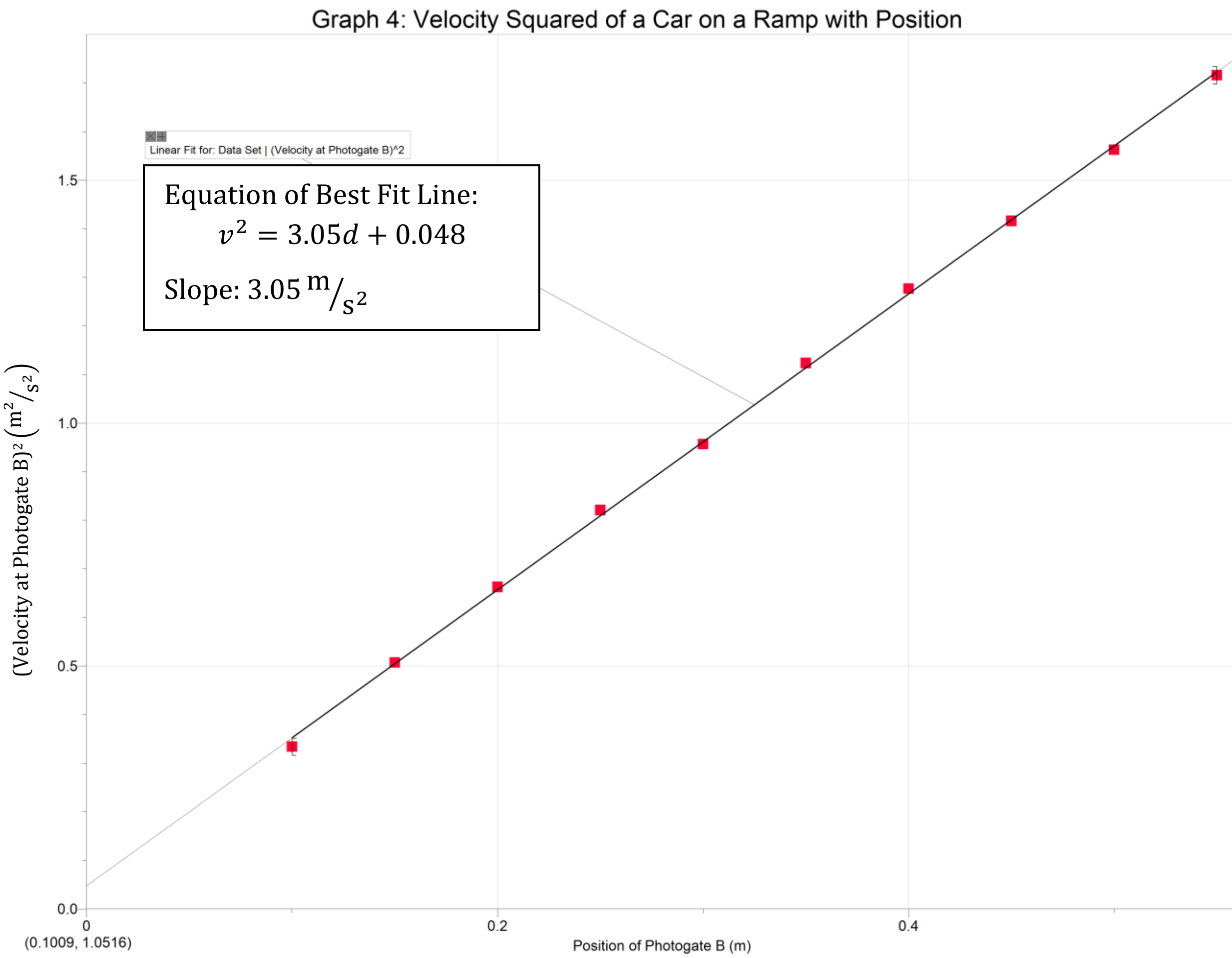
This graph models our equation: $d_2 = d_1 + v_1 t + \frac{1}{2}at^2$



This graph models our equation: $v_2 = v_1 + at$



This graph models a linearized version of our equation: $d = v_1 t + \frac{1}{2}at^2$



This graph models our equation: $v_2{}^2 = v_1{}^2 + 2ad$

ANALYSIS QUESTIONS:

3. It is very easy to find the acceleration from Graph 2. The acceleration can be found from the slope of a velocity-time graph. To find the acceleration from Graph 1 is a bit more difficult. You would have to use tangent lines to create a velocity-time graph. It's easier just to use Graph 2.
5. The slopes of my graphs are as follows:
   - Graph 2: 1.48 $^{m}/_{s^2}$
   - Graph 3: 1.27 $^{m}/_{s^2}$
   - Graph 4: 3.05 $^{m}/_{s^2}$
6. The slope of Graph 4 is about twice the value of the slope of Graph 2. (This is because they're modeling equations that we know! Graph 2 is showing $v_2 = v_1 + at$ and Graph 4 is showing ${v_2}^2 = {v_1}^2 + 2ad$. You can see that the acceleration is multiplied by 2 for Graph 4).
7. My acceleration, from the slope of Graph 2, is 1.48 $^{m}/_{s^2}$. The accepted value is 1.55 $^{m}/_{s^2}$:

$$\% \, Error = \left|\frac{Accepted - Experimental}{Accepted}\right| \times 100\% = \left|\frac{1.55 \, ^{m}/_{s^2} - 1.48 \, ^{m}/_{s^2}}{1.55 \, ^{m}/_{s^2}}\right| \times 100\%$$

$$\% \, \boldsymbol{Error} = \mathbf{4.5}\%$$

CONCULSION:

1. In this lab, I found the acceleration of the car down the ramp to be 1.48 $^{m}/_{s^2}$. This is a fairly accurate answer, being within 4.5% of the accepted value of 1.55 $^{m}/_{s^2}$.
2. Possible sources of error:
   a. Photogates were loose and tightening them caused them to register as blocks, so they moved a little with each trial
   b. The ramp rocked a lot, so our times might have been affected by that near the bottom of the ramp
   c. Giving the car a push when releasing it