Title: F=ma (Fan Cart)

Purpose:

To find the effect on acceleration with different forces and mass

Background:

Materials:

- Computer
- Logger Pro 3.5
- Sonic Ranger
- Fan Cart
- Sail
- Weight (In this case, we used my TI-84 calculator)
- Scale
- Hard, heavy solid object at least 1" thick (We used a textbook)
- At least 2 people

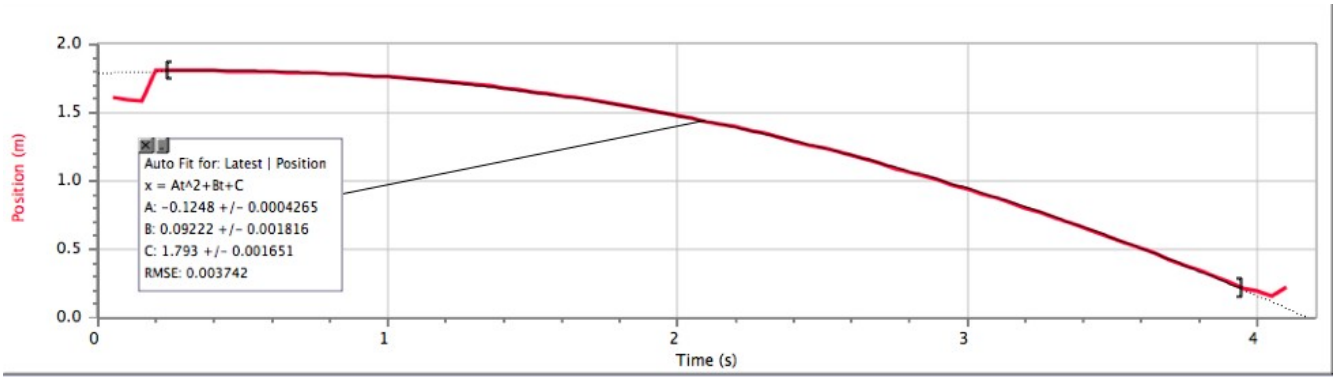
Procedure:

1. Turn on the computer and open Logger Pro 3.5.
2. Connect the sonic ranger to the computer.
3. Set up the sonic so the it is in a straight line with the fan cart and put the sail on the cart.
4. Test drive the fan cart. If the fan cart is low on battery, change it. If the fan cart veers to one side, then make sure it doesn't go too much to the side so that the sonic ranger cannot "find" the cart.
5. Reset the fan cart so it is in line with the ranger and set it to high speed.
6. Press record in Logger Pro 3.5 and release the fan cart.
7. Repeat steps 5 and 6 with different speed with and without weights.
8. Make sure the cart and the weights are measured.

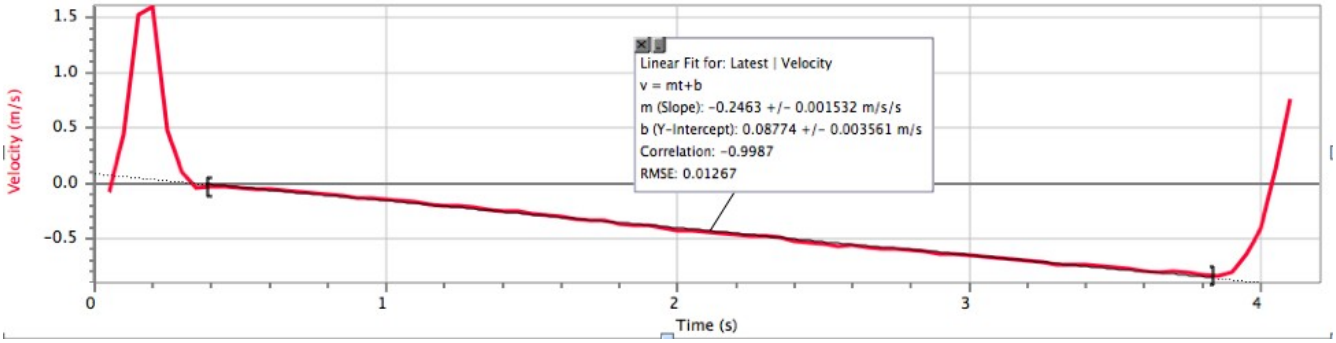
Data:

The follow graphs represents the fan cart on high speed with no extra weight.

Position:



Velocity:



Acceleration:

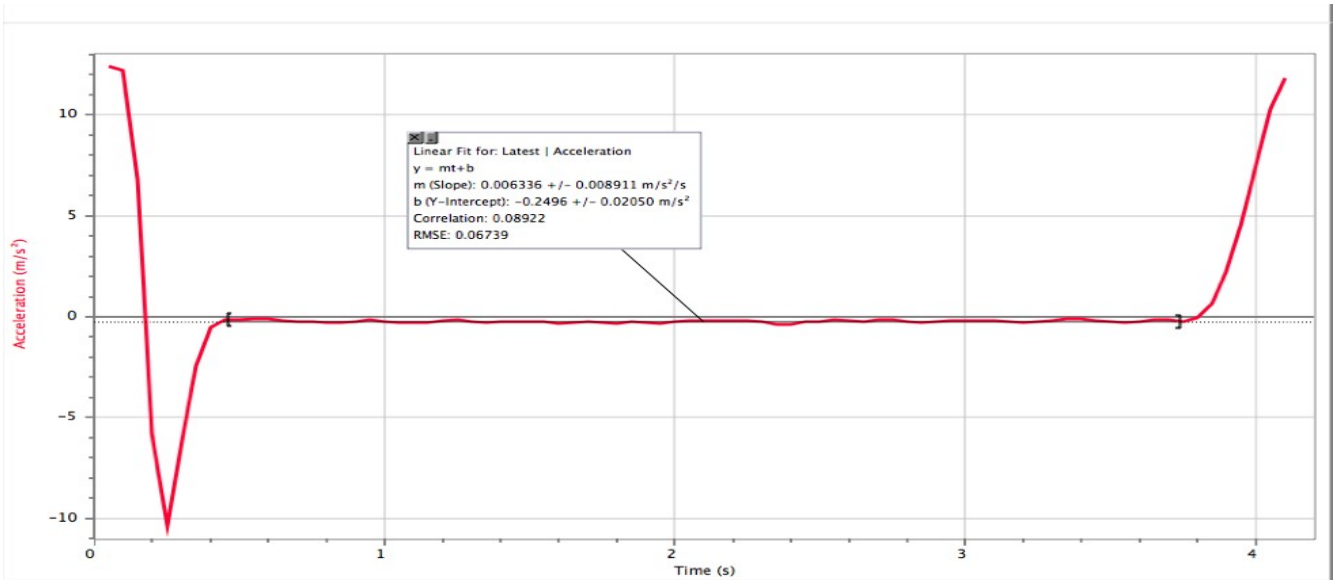
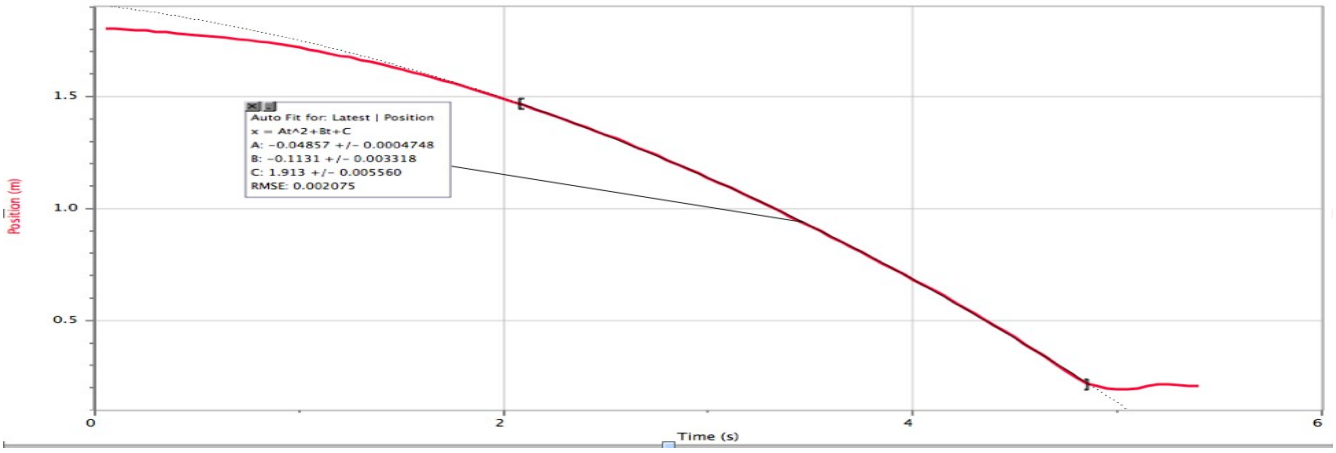


Table:

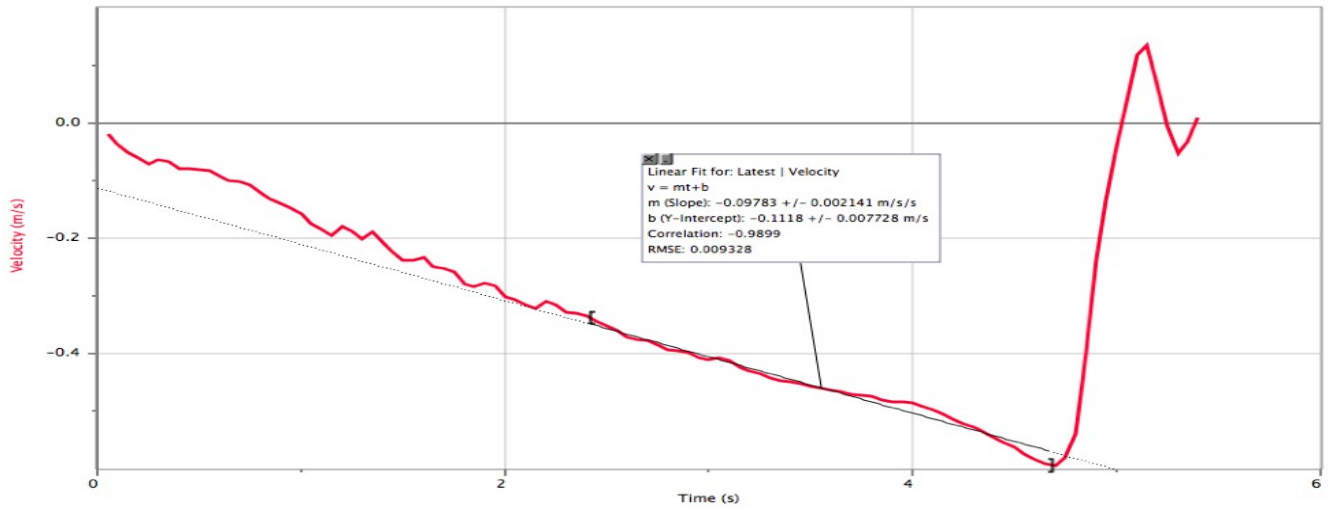
	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	1.617	−0.079	12.406
2	0.10	1.598	0.440	12.222
3	0.15	1.585	1.528	6.828
4	0.20	1.812	1.595	−5.777
5	0.25	1.812	0.481	−10.354
6	0.30	1.811	0.097	−6.164
7	0.35	1.809	−0.035	−2.428
8	0.40	1.807	−0.034	−0.527
9	0.45	1.806	−0.034	−0.160
10	0.50	1.804	−0.044	−0.138
11	0.55	1.801	−0.053	−0.106
12	0.60	1.798	−0.052	−0.106
13	0.65	1.796	−0.059	−0.187
14	0.70	1.793	−0.074	−0.225
15	0.75	1.788	−0.083	−0.234
16	0.80	1.785	−0.094	−0.285
17	0.85	1.780	−0.112	−0.312
18	0.90	1.774	−0.131	−0.238
19	0.95	1.765	−0.136	−0.170
20	1.00	1.760	−0.141	−0.227
21	1.05	1.752	−0.158	−0.302
22	1.10	1.744	−0.175	−0.316
23	1.15	1.735	−0.191	−0.289
24	1.20	1.725	−0.207	−0.210
25	1.25	1.713	−0.211	−0.166

The following graphs will show the fan cart on high speed with my calculator.

Position:



Velocity:



Acceleration:

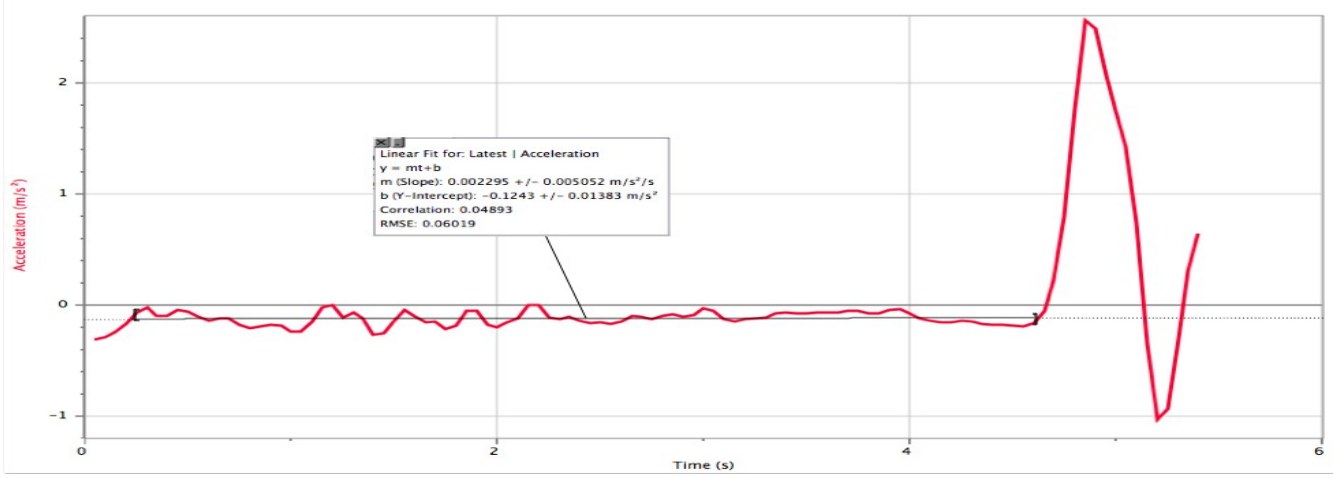
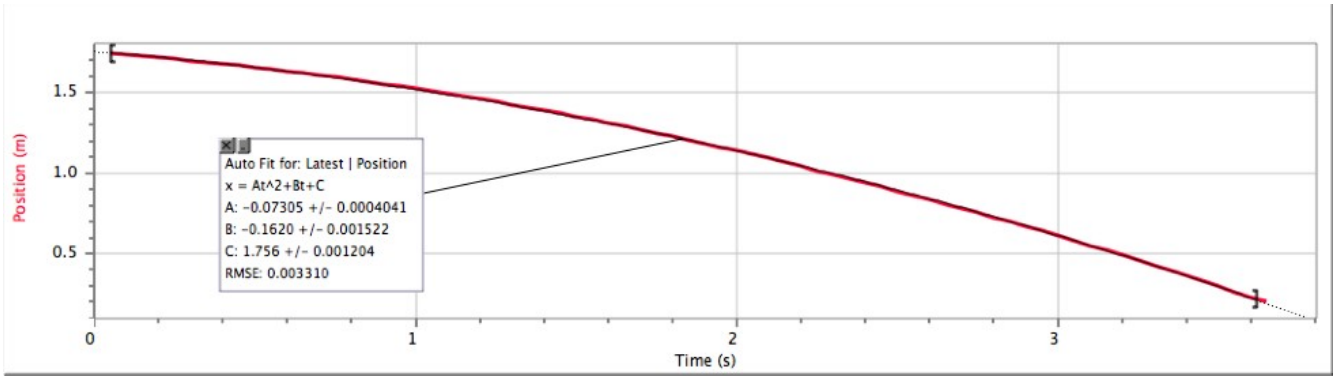


Table:

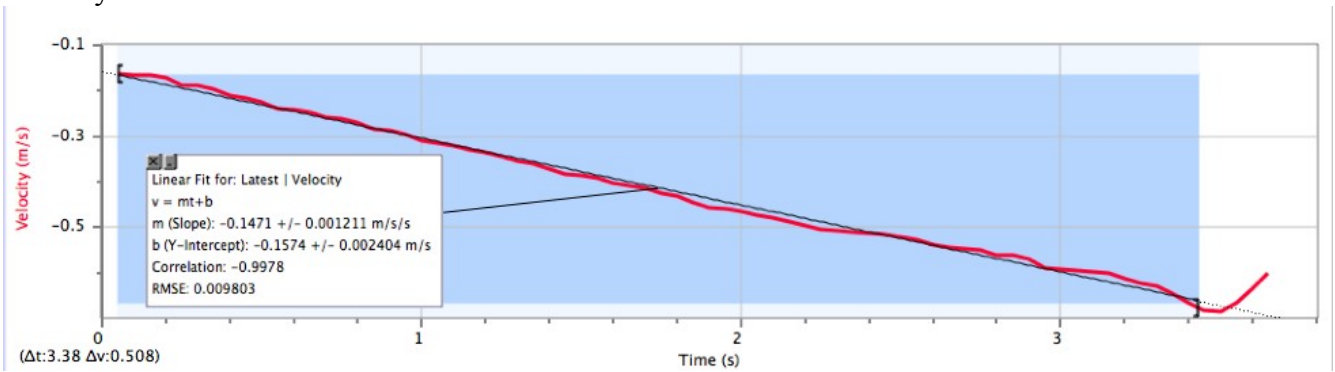
	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	1.803	−0.019	−0.315
2	0.10	1.802	−0.036	−0.293
3	0.15	1.799	−0.051	−0.239
4	0.20	1.797	−0.060	−0.175
5	0.25	1.794	−0.072	−0.066
6	0.30	1.789	−0.063	−0.020
7	0.35	1.788	−0.066	−0.101
8	0.40	1.783	−0.079	−0.095
9	0.45	1.779	−0.078	−0.047
10	0.50	1.775	−0.080	−0.057
11	0.55	1.771	−0.082	−0.104
12	0.60	1.767	−0.092	−0.140
13	0.65	1.762	−0.099	−0.117
14	0.70	1.757	−0.102	−0.121
15	0.75	1.752	−0.108	−0.176
16	0.80	1.746	−0.121	−0.210
17	0.85	1.740	−0.132	−0.195
18	0.90	1.733	−0.140	−0.176
19	0.95	1.726	−0.148	−0.190
20	1.00	1.718	−0.157	−0.239
21	1.05	1.711	−0.174	−0.237
22	1.10	1.700	−0.185	−0.159
23	1.15	1.692	−0.194	−0.021
24	1.20	1.680	−0.180	0.002
25	1.25	1.675	−0.187	−0.112
26	1.30	1.661	−0.202	−0.070
27	1.35	1.653	−0.188	−0.121
28	1.40	1.644	−0.207	−0.265
29	1.45	1.633	−0.224	−0.251

Pictures below will show the fan cart on low speed with no extra weights.

Position:



Velocity:



Acceleration:

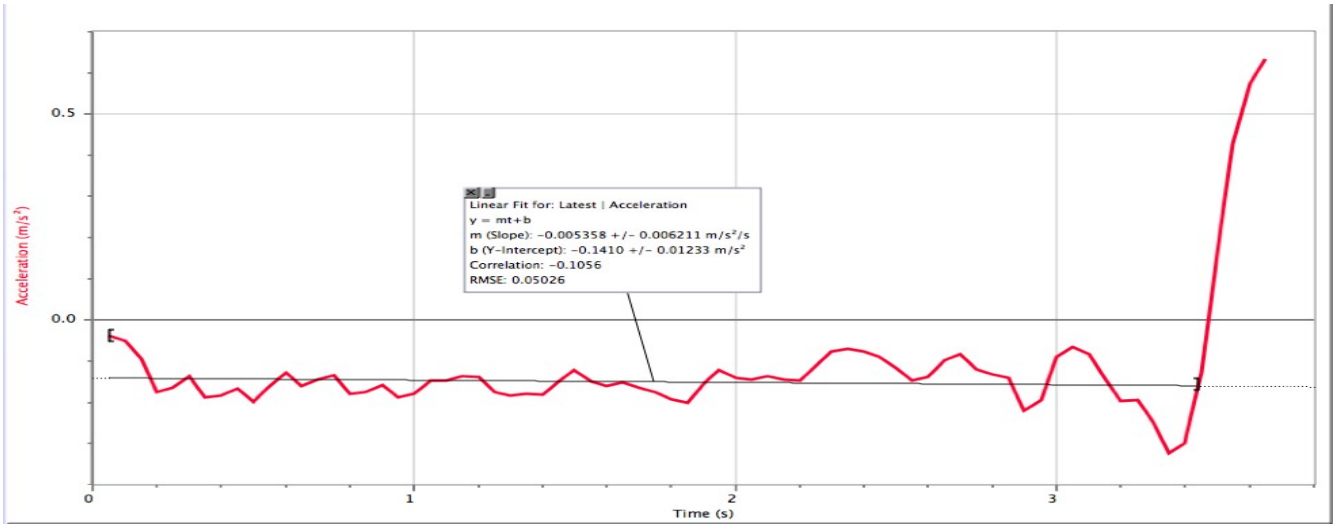
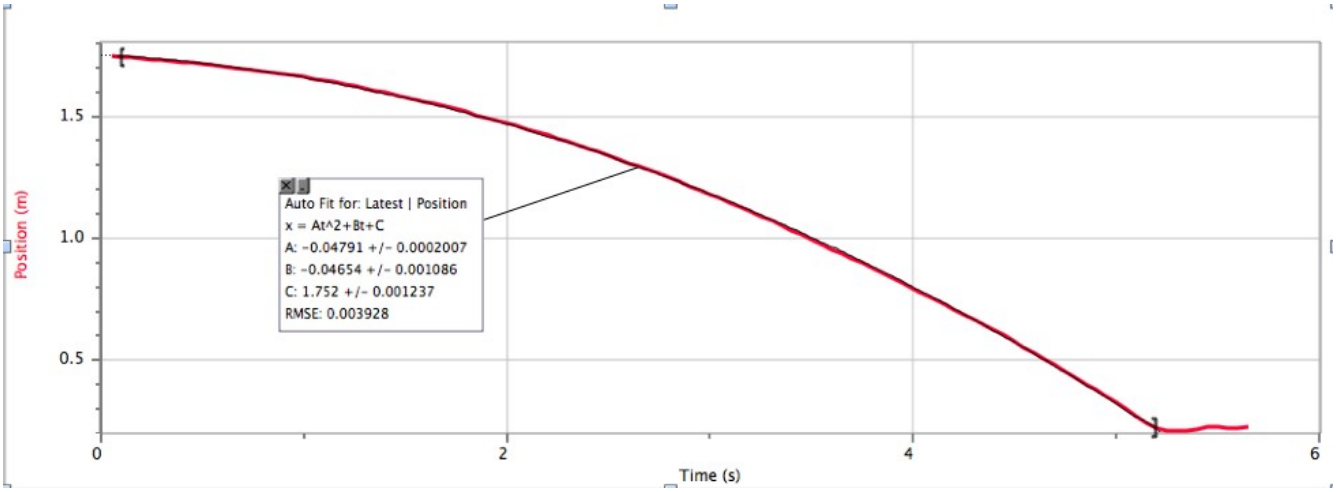


Table:

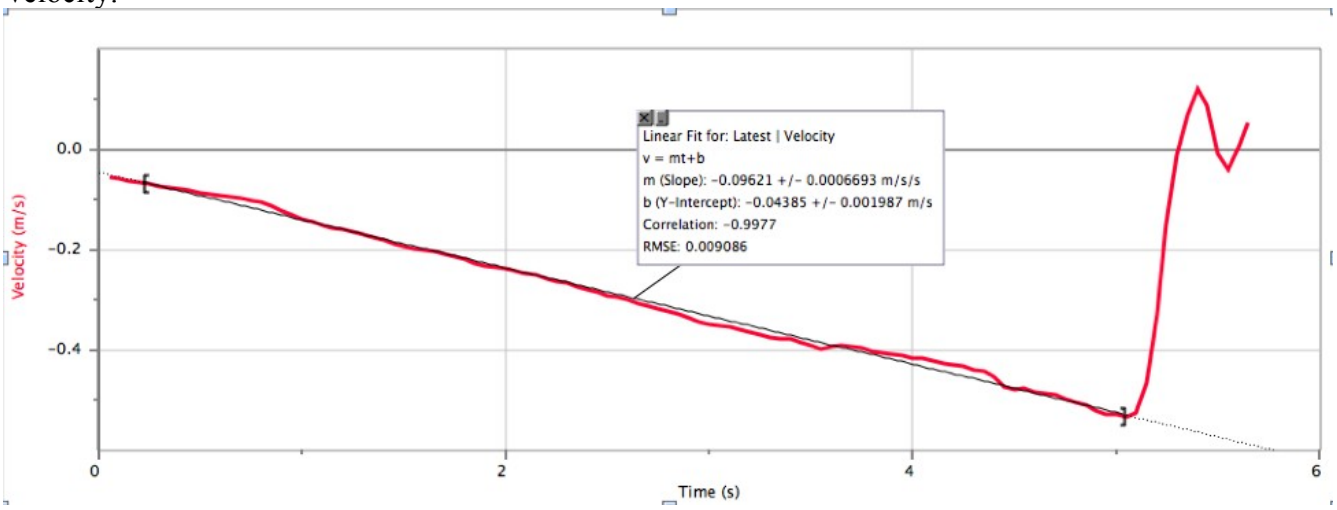
	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	1.741	−0.162	−0.038
2	0.10	1.733	−0.165	−0.050
3	0.15	1.725	−0.164	−0.094
4	0.20	1.717	−0.172	−0.175
5	0.25	1.708	−0.187	−0.165
6	0.30	1.698	−0.189	−0.137
7	0.35	1.689	−0.196	−0.188
8	0.40	1.679	−0.211	−0.184
9	0.45	1.667	−0.215	−0.166
10	0.50	1.657	−0.224	−0.198
11	0.55	1.645	−0.239	−0.163
12	0.60	1.633	−0.241	−0.128
13	0.65	1.622	−0.248	−0.159
14	0.70	1.608	−0.260	−0.146
15	0.75	1.595	−0.262	−0.134
16	0.80	1.582	−0.269	−0.179
17	0.85	1.568	−0.283	−0.176
18	0.90	1.553	−0.288	−0.159
19	0.95	1.540	−0.296	−0.189
20	1.00	1.524	−0.309	−0.179
21	1.05	1.508	−0.315	−0.146
22	1.10	1.493	−0.322	−0.147
23	1.15	1.476	−0.331	−0.137
24	1.20	1.459	−0.335	−0.138
25	1.25	1.443	−0.342	−0.175

Pictures below will show the fan cart on low speed with my calculator.

Position:



Velocity:



Acceleration:

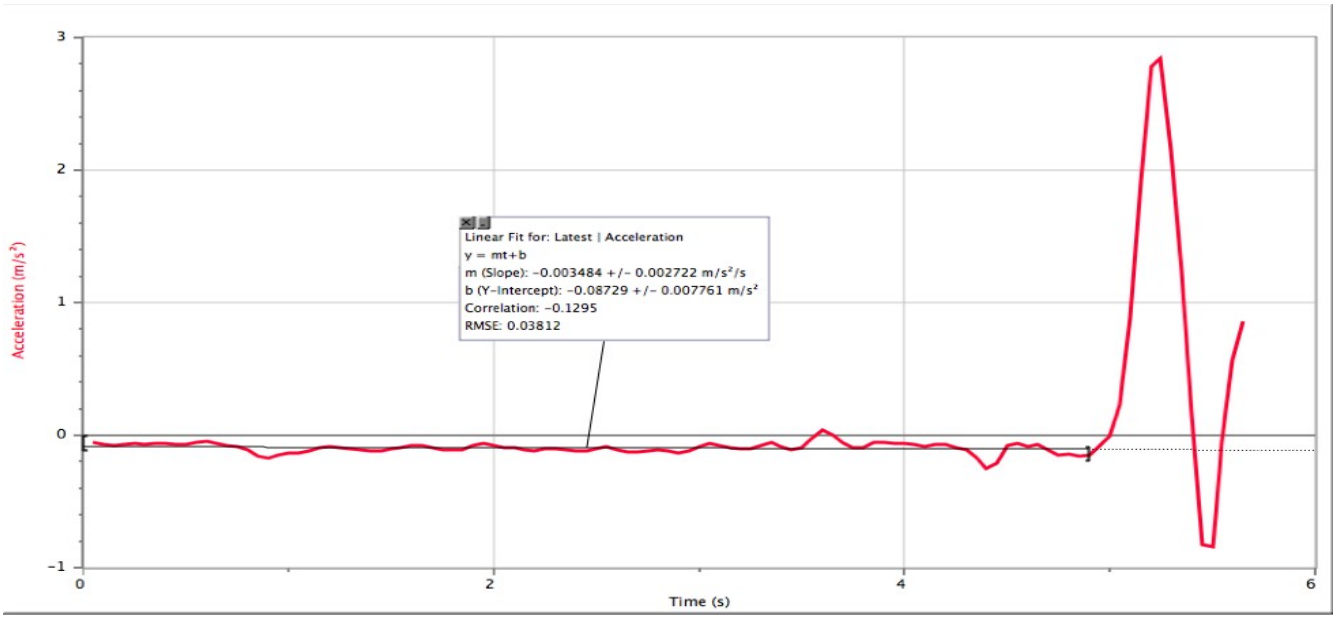


Table:

	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	1.745	−0.056	−0.058
2	0.10	1.742	−0.058	−0.069
3	0.15	1.739	−0.062	−0.078
4	0.20	1.736	−0.067	−0.070
5	0.25	1.733	−0.069	−0.063
6	0.30	1.729	−0.072	−0.069
7	0.35	1.725	−0.077	−0.066
8	0.40	1.721	−0.079	−0.062
9	0.45	1.718	−0.082	−0.069
10	0.50	1.713	−0.086	−0.068
11	0.55	1.709	−0.090	−0.057
12	0.60	1.704	−0.092	−0.050
13	0.65	1.700	−0.094	−0.062
14	0.70	1.695	−0.098	−0.079
15	0.75	1.690	−0.102	−0.086
16	0.80	1.685	−0.105	−0.111
17	0.85	1.680	−0.112	−0.155
18	0.90	1.674	−0.123	−0.169
19	0.95	1.667	−0.131	−0.151
20	1.00	1.660	−0.137	−0.136
21	1.05	1.653	−0.144	−0.130
22	1.10	1.646	−0.151	−0.116
23	1.15	1.638	−0.156	−0.096
24	1.20	1.630	−0.160	−0.090
25	1.25	1.622	−0.164	−0.093

General:

	Position: A	Position: RMSE	Velocity: m	Velocity: RMSE	Acceleration : RMSE	Mass	Force
High empty	-0.1248	0.003	-0.246	0.01267	0.067	586g	144.156
High Calculator	-0.04857	0.002075	-0.09783	0.009	0.06009	Calculator: 290	85.699
Low empty	-0.07305	0.003310	-0.1471	0.0098	0.05		86.2
Low Calculator	-0.0479	0.003928	-0.096	0.009086	0.03812		84.096

Observations:

On the most part, the slope of the acceleration graph is twice the A value of the position graph, due to the formula ½ at^2. Our RMSE value was pretty low too, but that could also be from my excellent skill of only curve fitting the graph so we get the lowest RMSE numbers. Also, our graphs have a negative slope because the cart was headed towards the sonic ranger thus decreasing in distance over time. Then in the first position graph of the fan cart on high speed with no extra weight, there was a stutter on the start because Sammy J wasn't being careful when she released the cart. And, as it can be noticed, there is always a big jump at the end of all the velocity and acceleration graph due to the fan cart crashing into the textbook, coming into a sudden stop and a big hassle. Our calculated forces are all pretty similar except for the cart on high when it is empty. I remember seeing something similar in last years labs, but I don't remember why.

Analysis

This lab would have been much better if we had fan carts that does not go off path and a smoother surface. Also, it would be nice if we could figure out what is the deal with the off the chart force for the fan cart on high speed with no weights.

Title: F=ma (Vernier Cart and Ramp)

Purpose: To find the force acted on the cart at different angle.

Background:

Materials:

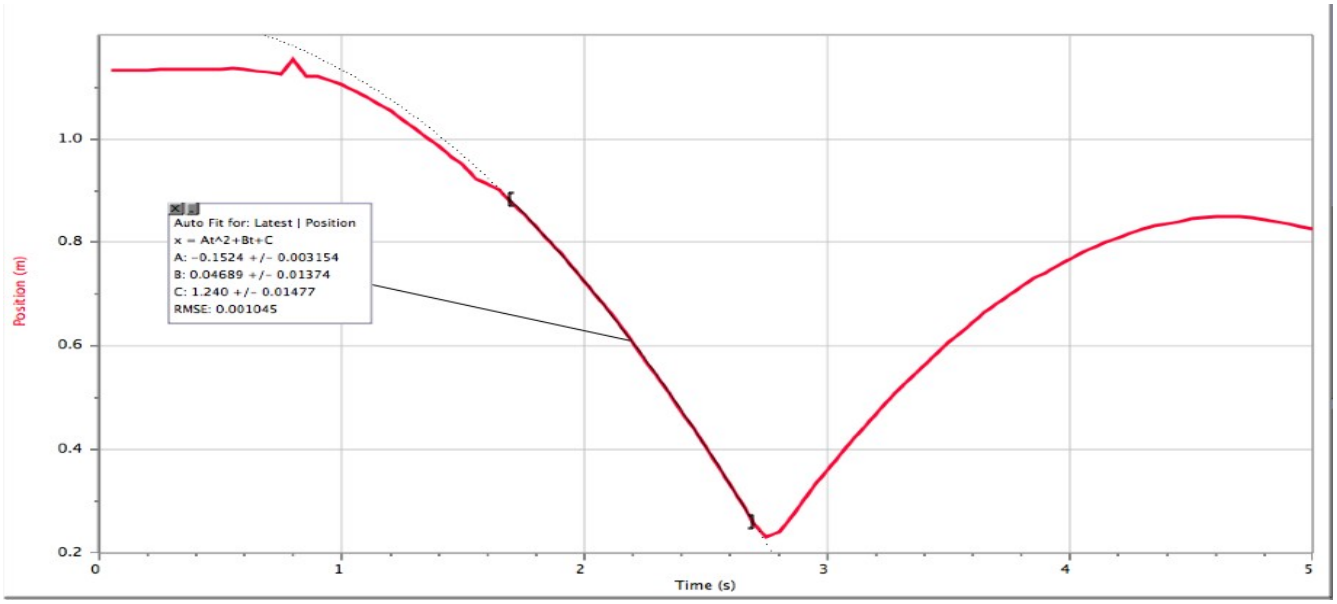
- Computer
- Logger Pro 3.5
- Vernier ramp
- Vernier cart
- Ruler
- Sonic ranger
- Books

Procedures:

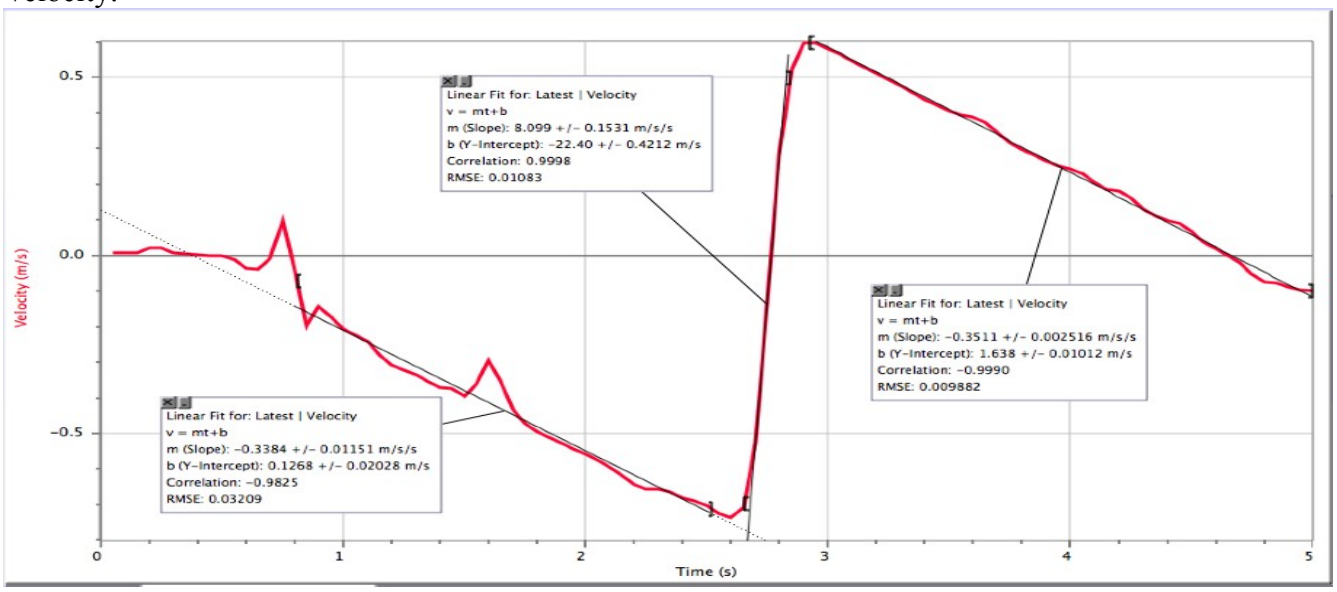
1. Turn on the computer and open Logger Pro 3.5.
2. Connect the sonic ranger to the computer.
3. Set up the sonic ranger at the end of the Vernier ramp.
4. Lift the end of the ramp with the pulley and set it on top of some books for different angles.
5. Measure the angle of the ramp and record it.
6. Place the cart at the lifted end of the ramp and hold it there.
7. Press record in Logger Pro 3.5 and release the cart at the same time.
8. Repeat steps 4 to 7 with different angles.

Data:

The following graphs shows our first cart at a height of 3 centimeters.
Position:



Velocity:



Acceleration:

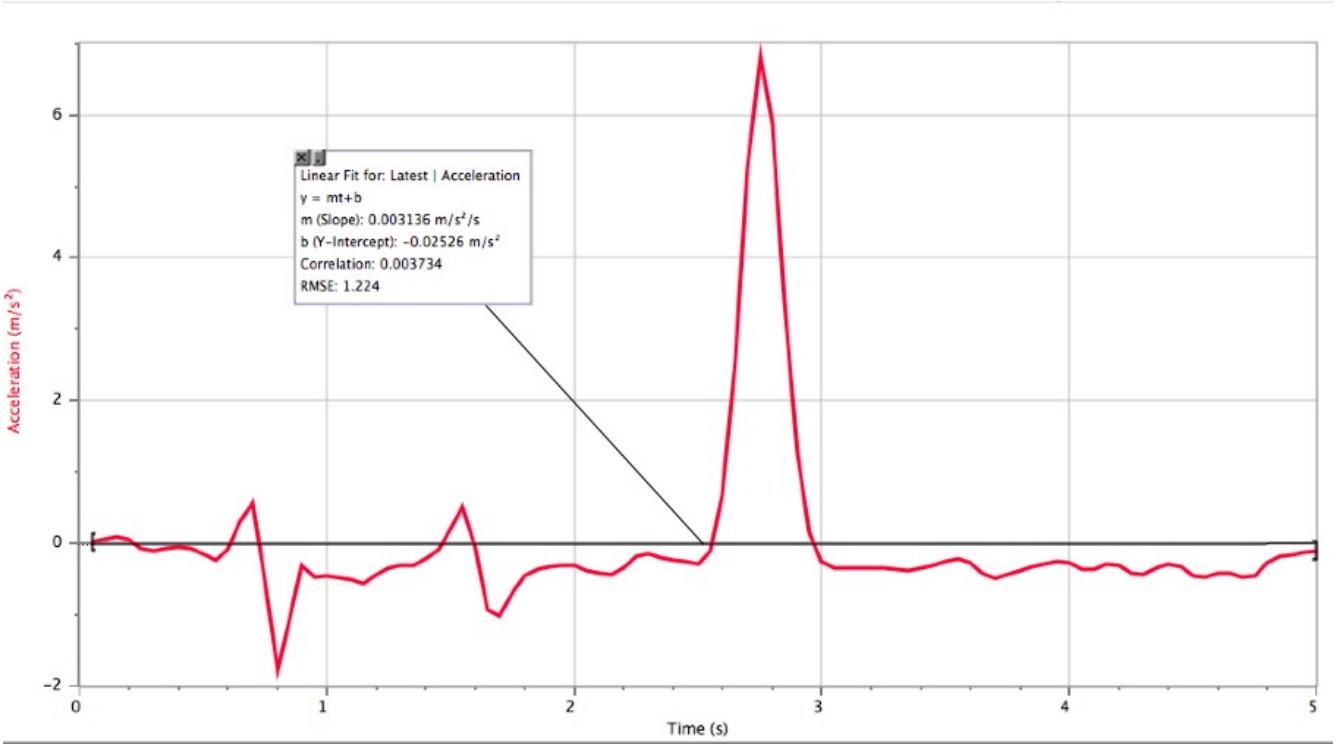
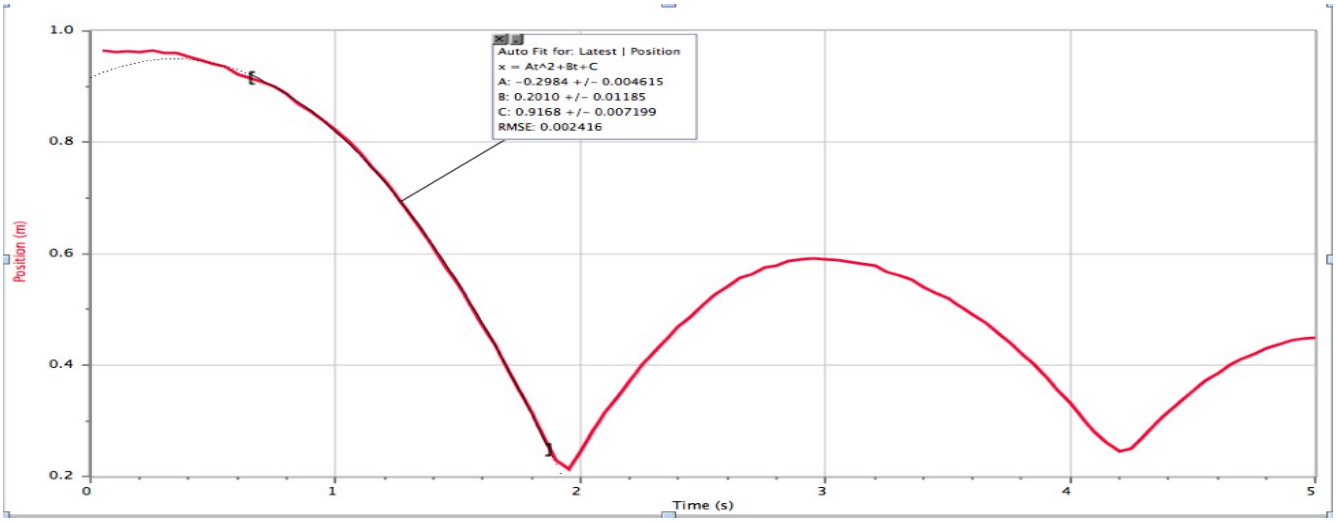


Table:

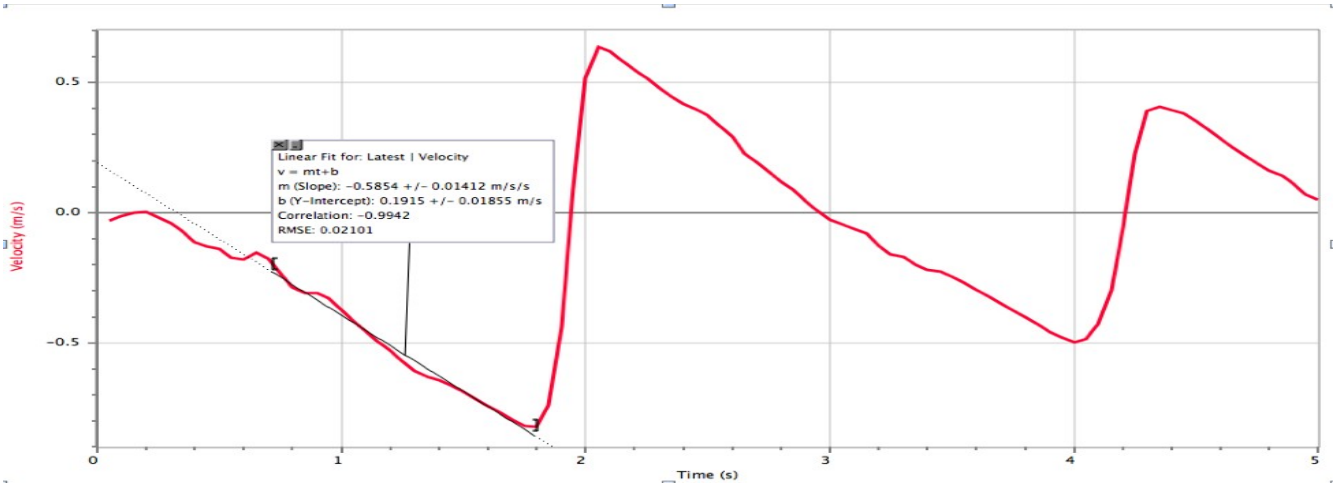
	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	1.132	0.007	0.012
2	0.10	1.133	0.006	0.047
3	0.15	1.133	0.008	0.097
4	0.20	1.133	0.021	0.063
5	0.25	1.136	0.020	−0.076
6	0.30	1.135	0.008	−0.118
7	0.35	1.136	0.004	−0.083
8	0.40	1.136	0.001	−0.060
9	0.45	1.136	−0.001	−0.066
10	0.50	1.136	−0.002	−0.141
11	0.55	1.136	−0.012	−0.240
12	0.60	1.135	−0.037	−0.087
13	0.65	1.132	−0.038	0.299
14	0.70	1.129	−0.009	0.569
15	0.75	1.126	0.099	−0.495
16	0.80	1.154	−0.043	−1.778
17	0.85	1.122	−0.197	−1.064
18	0.90	1.121	−0.143	−0.319
19	0.95	1.113	−0.175	−0.483
20	1.00	1.105	−0.205	−0.456
21	1.05			
22	1.10	1.083	−0.241	−0.510
23	1.15	1.068	−0.280	−0.564
24	1.20	1.053	−0.307	−0.442
25	1.25	1.037	−0.323	−0.339
26	1.30	1.021	−0.336	−0.317
27	1.35	1.004	−0.354	−0.316

Below is cart 2 with the ramp set at 5.7cm above surface.

Position:



Velocity:



Acceleration:

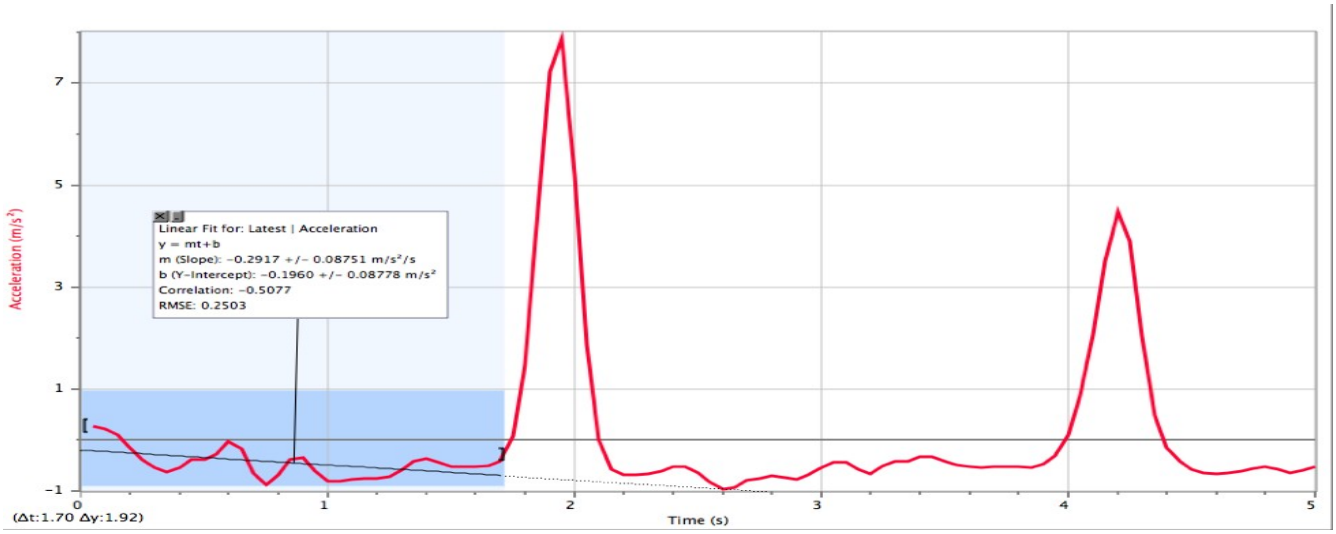
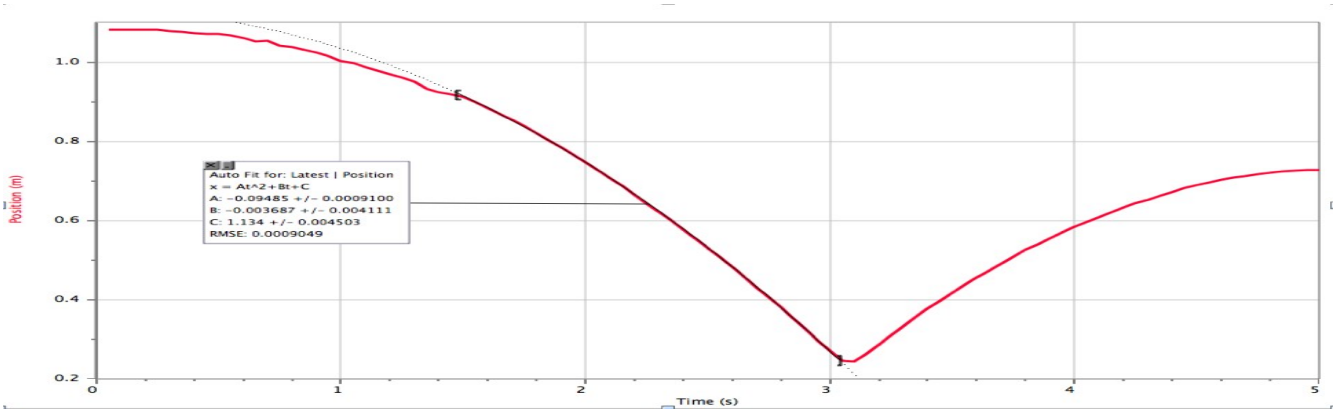


Table:

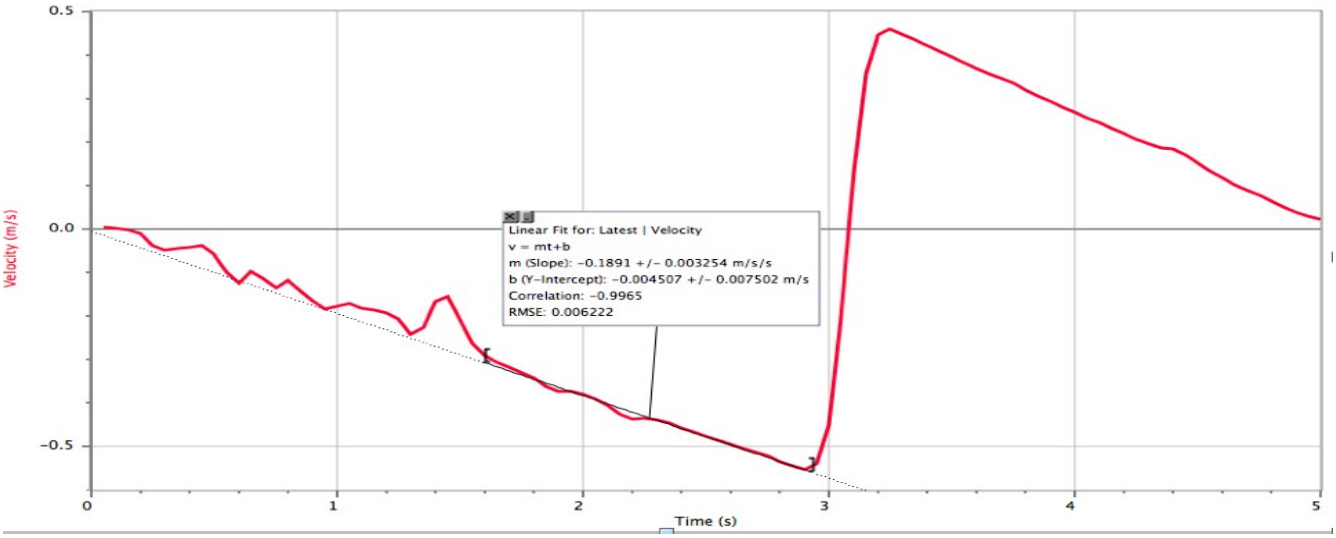
	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	0.964	−0.028	0.281
2	0.10	0.962	−0.013	0.215
3	0.15	0.962	−0.002	0.094
4	0.20	0.962	0.004	−0.145
5	0.25	0.964	−0.017	−0.387
6	0.30	0.960	−0.039	−0.537
7	0.35	0.961	−0.072	−0.626
8	0.40	0.954	−0.112	−0.536
9	0.45	0.948	−0.128	−0.389
10	0.50	0.941	−0.141	−0.376
11	0.55	0.935	−0.172	−0.272
12	0.60	0.922	−0.179	−0.028
13	0.65	0.915	−0.154	−0.169
14	0.70	0.910	−0.176	−0.653
15	0.75	0.900	−0.233	−0.879
16	0.80	0.886	−0.287	−0.685
17	0.85	0.869	−0.307	−0.375
18	0.90	0.854	−0.308	−0.351
19	0.95	0.839	−0.327	−0.617
20	1.00	0.823	−0.376	−0.810
21	1.05	0.801	−0.419	−0.800
22	1.10	0.781	−0.455	−0.769
23	1.15	0.756	−0.494	−0.757
24	1.20	0.731	−0.530	−0.750
25	1.25	0.703	−0.570	−0.725
26	1.30	0.674	−0.609	−0.592
27	1.35	0.642	−0.632	−0.415
28	1.40	0.610	−0.643	−0.367

Cart three shows the ramp set at at height of 2.7cm.

Position:



Velocity:



Acceleration:

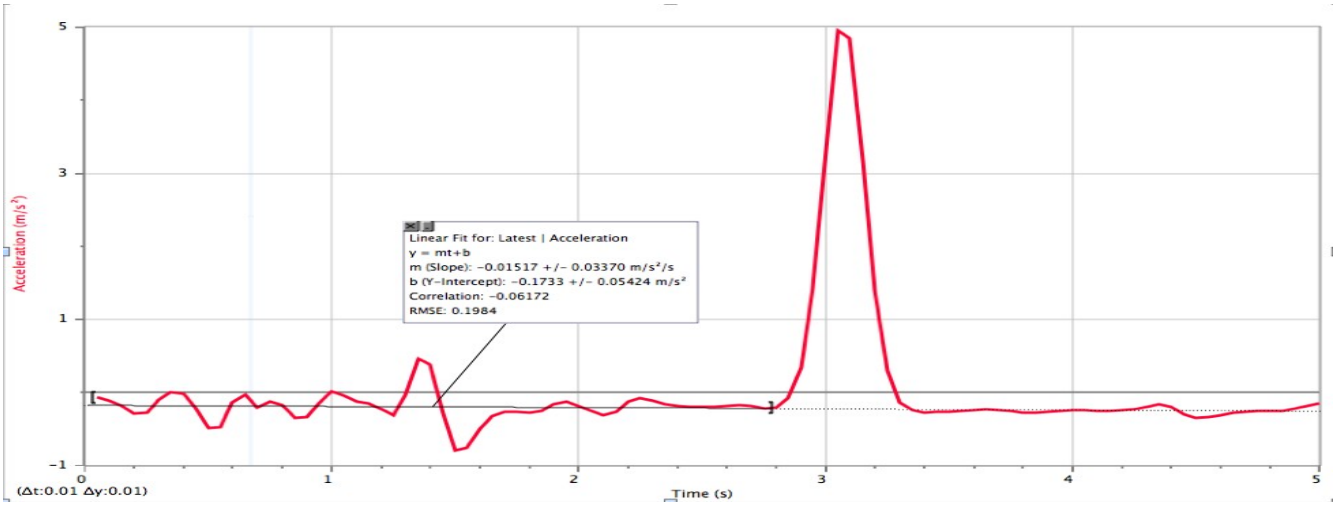


Table:

	Latest			
	Time (s)	Position (m)	Velocity (m/s)	acc (m/s²)
1	0.05	1.082	0.005	−0.062
2	0.10	1.083	0.003	−0.108
3	0.15	1.083	−0.003	−0.177
4	0.20	1.083	−0.012	−0.284
5	0.25	1.083	−0.037	−0.275
6	0.30	1.078	−0.048	−0.099
7	0.35	1.077	−0.043	0.005
8	0.40	1.074	−0.043	−0.016
9	0.45	1.072	−0.036	−0.206
10	0.50	1.072	−0.056	−0.483
11	0.55	1.068	−0.100	−0.481
12	0.60	1.061	−0.125	−0.134
13	0.65	1.053	−0.097	−0.035
14	0.70	1.054	−0.113	−0.200
15	0.75	1.041	−0.134	−0.120
16	0.80	1.038	−0.118	−0.168
17	0.85	1.032	−0.141	−0.345
18	0.90	1.024	−0.163	−0.333
19	0.95	1.015	−0.184	−0.148
20	1.00	1.004	−0.176	0.017
21	1.05	0.998	−0.170	−0.046
22	1.10	0.988	−0.182	−0.123
23	1.15	0.979	−0.187	−0.147
24	1.20	0.969	−0.192	−0.227
25	1.25	0.961	−0.206	−0.308
26	1.30	0.950	−0.242	−0.038
27	1.35	0.934	−0.226	0.458
28	1.40	0.925	−0.166	0.377
29	1.45	0.920	−0.156	−0.289

Observations:

We had a pretty low RMSE value, most likely due to my excellent skills of taking only the best part of the graph to create a value.

Analysis:

I think it would be slightly more accurate if the track was perfectly fitted for the cart and that it is frictionless.