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Period F
Honors Physics

Newton's Second Law (F=ma)

Purpose-to analyze force through graphical analysis and re-prove Newton's theory.

Background-To move anything with a mass, a force acting upon it is needed. Unlike the olden days (1700's-1800's) it was believed that an internal force acting within an object was used to make it move rather than an external force acting upon it. This lab is to prove newton's second law theory. That, "an outer force is needed to make an object move"

Materials

- Fan cart
- Empty cart
- Logger pro application on Mac OSX
- 1lb weight
- "go" motion radar
- ramp
- books (to change the height of the ramp)

Procedure

1. turn on the logger pro application and connect the "go" motion radar to the computer.
2. Make sure it is connected before you try anything. Place the Low powered fan cart on a flat surface and face the "go" motion radar a little over a meter away from the cart.
3. Release the fan cart as you press the play button on logger pro (triggering the motion sensing)
4. Catch the fan cart as it passes a distance of 100 m and stop the "go" motion sensor.
5. When you look at the data you will see two graphs a distance graph and a velocity graph. Go to "additional graphs" in the menu and a smaller graph will appear (acceleration) then press (apple button+r) to organize the graphs automatically.
6. Click on the distance graph and push the A button with meter-sticks on the side to fit the graph correctly, do this to both the distance graph and the velocity graph.
7. Next, click on the distance graph and go to "curve fit" in the menu. Then, click the quadratic equation and highlight the most significant area in the graph to get an accurate curve fit and press "try fit", then "ok"
8. Then, click on the velocity graph and go to "curve fit" in the menu. Then, click the linear equation and highlight the area where a line of best fit should be and press "try fit", then "ok"

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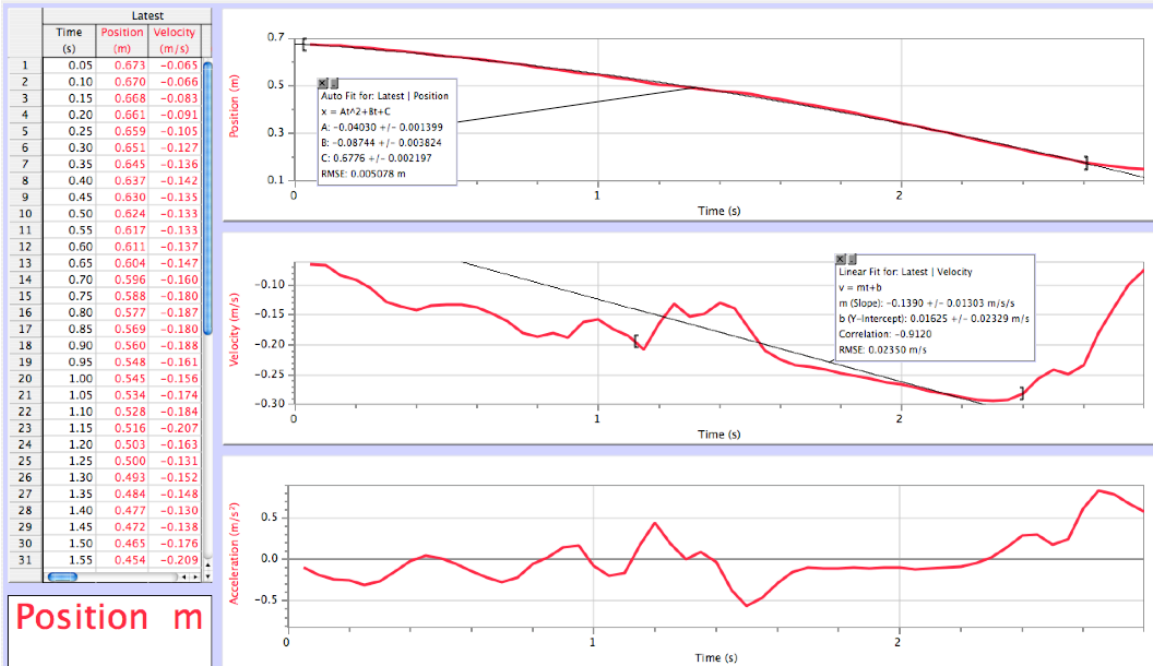
9. Repeat these steps with a fan cart at low power with a weight on it, a fan cart at high power without a weight, and a fan cart at high power with a weight. Also, continue these steps with an empty cart on a 30 degree angle with and without a weight, and an empty cart on a 45 degree angle with and without a weight.
10. Don’t forget to save every graph.

Data

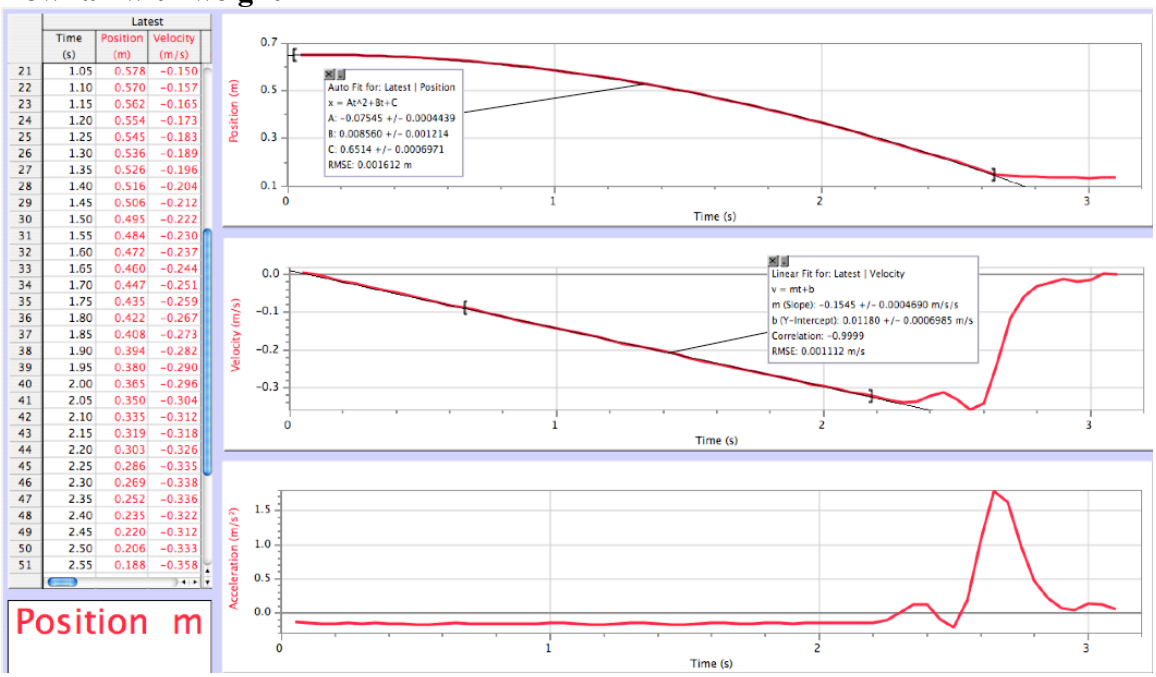
Low fan without weight



	Time (s)	Position (m)	Velocity (m/s)
1	0.05	0.673	−0.065
2	0.10	0.670	−0.066
3	0.15	0.668	−0.083
4	0.20	0.661	−0.091
5	0.25	0.659	−0.105
6	0.30	0.651	−0.127
7	0.35	0.645	−0.136
8	0.40	0.637	−0.142
9	0.45	0.630	−0.135
10	0.50	0.624	−0.133
11	0.55	0.617	−0.133
12	0.60	0.611	−0.137
13	0.65	0.604	−0.147
14	0.70	0.596	−0.160
15	0.75	0.588	−0.180
16	0.80	0.577	−0.187
17	0.85	0.569	−0.180
18	0.90	0.560	−0.188
19	0.95	0.548	−0.161
20	1.00	0.545	−0.156
21	1.05	0.534	−0.174
22	1.10	0.528	−0.184
23	1.15	0.516	−0.207
24	1.20	0.503	−0.163
25	1.25	0.500	−0.131
26	1.30	0.493	−0.152
27	1.35	0.484	−0.148
28	1.40	0.477	−0.130
29	1.45	0.472	−0.138
30	1.50	0.465	−0.176
31	1.55	0.454	−0.209

acceleration-.0806

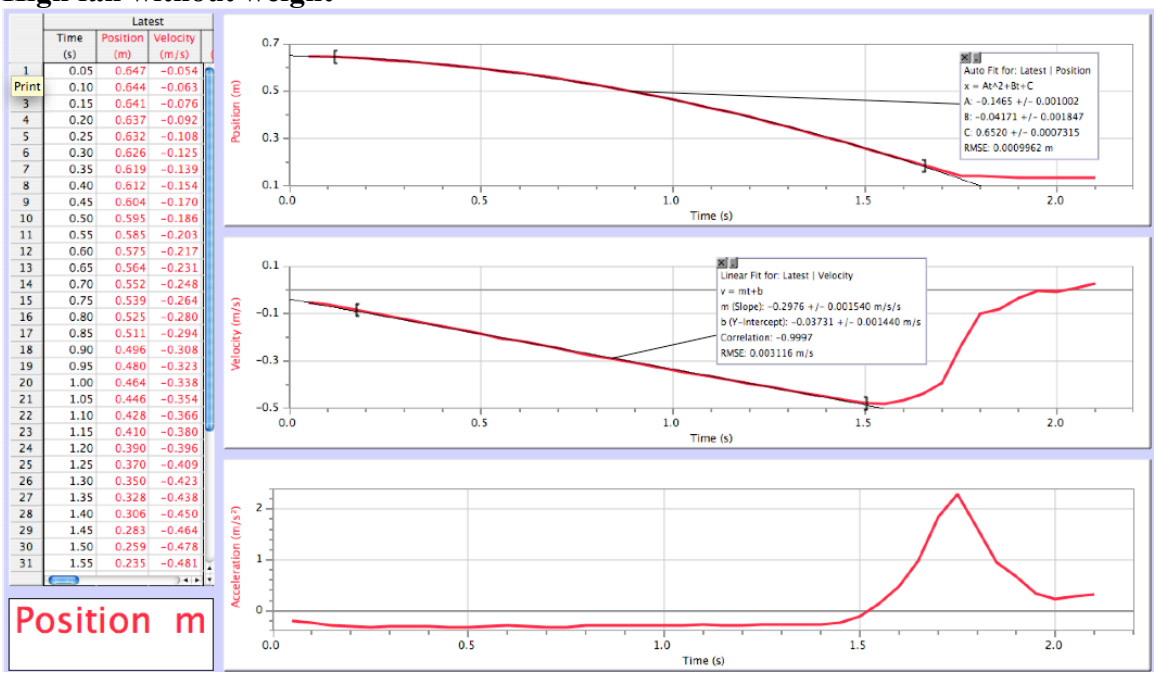
Low fan with weight



	Time (s)	Position (m)	Velocity (m/s)
21	1.05	0.578	−0.150
22	1.10	0.570	−0.157
23	1.15	0.562	−0.165
24	1.20	0.554	−0.173
25	1.25	0.545	−0.183
26	1.30	0.536	−0.189
27	1.35	0.526	−0.196
28	1.40	0.516	−0.204
29	1.45	0.506	−0.212
30	1.50	0.495	−0.222
31	1.55	0.484	−0.230
32	1.60	0.472	−0.237
33	1.65	0.460	−0.244
34	1.70	0.447	−0.251
35	1.75	0.435	−0.259
36	1.80	0.422	−0.267
37	1.85	0.408	−0.273
38	1.90	0.394	−0.282
39	1.95	0.380	−0.290
40	2.00	0.365	−0.296
41	2.05	0.350	−0.304
42	2.10	0.335	−0.312
43	2.15	0.319	−0.318
44	2.20	0.303	−0.326
45	2.25	0.286	−0.335
46	2.30	0.269	−0.338
47	2.35	0.252	−0.336
48	2.40	0.235	−0.322
49	2.45	0.220	−0.312
50	2.50	0.206	−0.333
51	2.55	0.188	−0.358

acceleration-.1590

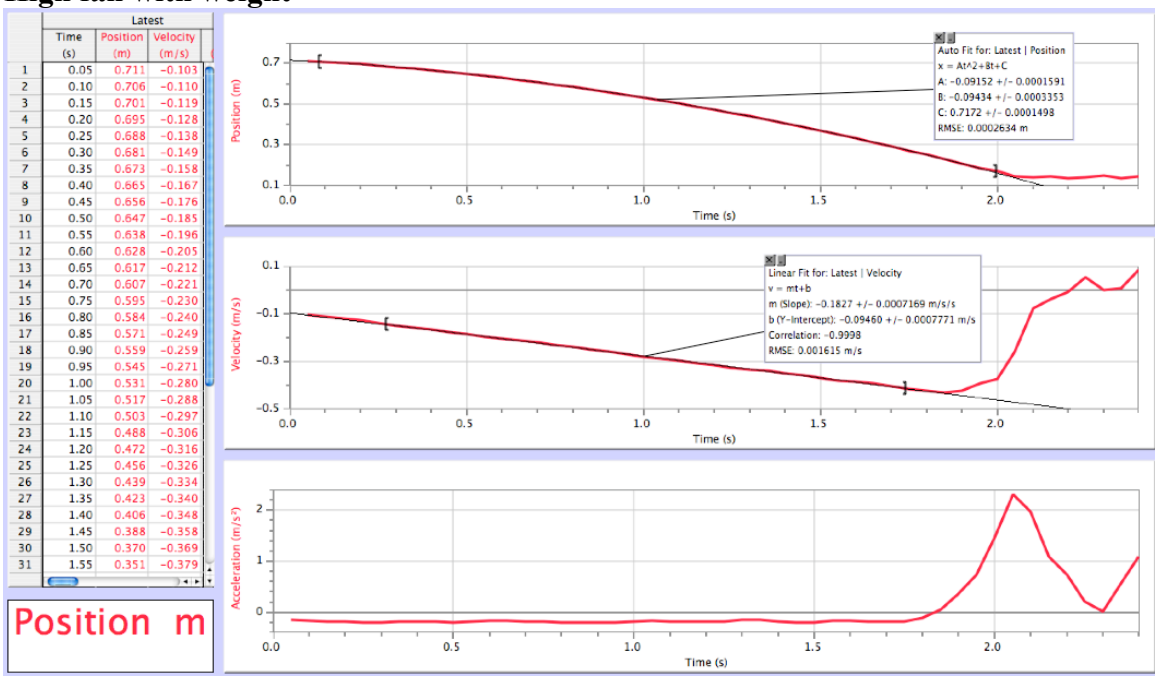
High fan without weight



	Time (s)	Position (m)	Velocity (m/s)
1	0.05	0.647	-0.054
2	0.10	0.644	-0.063
3	0.15	0.641	-0.076
4	0.20	0.637	-0.092
5	0.25	0.632	-0.108
6	0.30	0.626	-0.125
7	0.35	0.619	-0.139
8	0.40	0.612	-0.154
9	0.45	0.604	-0.170
10	0.50	0.595	-0.186
11	0.55	0.585	-0.203
12	0.60	0.575	-0.217
13	0.65	0.564	-0.231
14	0.70	0.552	-0.248
15	0.75	0.539	-0.264
16	0.80	0.525	-0.280
17	0.85	0.511	-0.294
18	0.90	0.496	-0.308
19	0.95	0.480	-0.323
20	1.00	0.464	-0.338
21	1.05	0.446	-0.354
22	1.10	0.428	-0.366
23	1.15	0.410	-0.380
24	1.20	0.390	-0.396
25	1.25	0.370	-0.409
26	1.30	0.350	-0.423
27	1.35	0.328	-0.438
28	1.40	0.306	-0.450
29	1.45	0.283	-0.464
30	1.50	0.259	-0.478
31	1.55	0.235	-0.481

acceleration - .2920

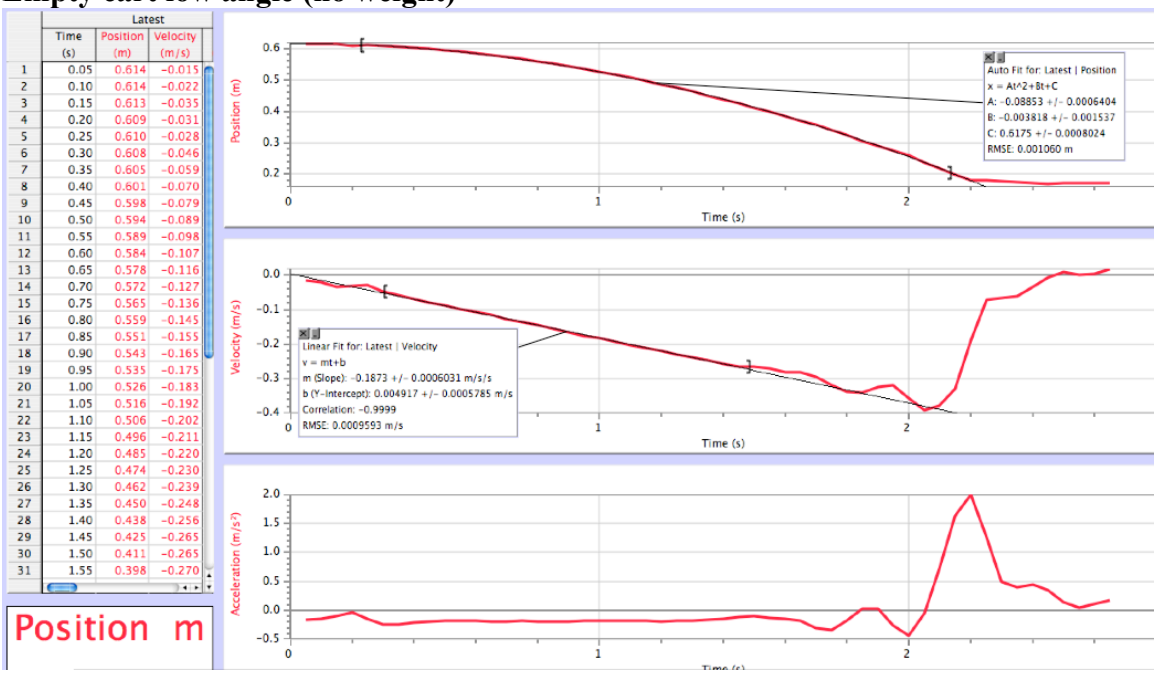
High fan with weight



	Time (s)	Position (m)	Velocity (m/s)
1	0.05	0.711	-0.103
2	0.10	0.706	-0.110
3	0.15	0.701	-0.119
4	0.20	0.695	-0.128
5	0.25	0.688	-0.138
6	0.30	0.681	-0.149
7	0.35	0.673	-0.158
8	0.40	0.665	-0.167
9	0.45	0.656	-0.176
10	0.50	0.647	-0.185
11	0.55	0.638	-0.196
12	0.60	0.628	-0.205
13	0.65	0.617	-0.212
14	0.70	0.607	-0.221
15	0.75	0.595	-0.230
16	0.80	0.584	-0.240
17	0.85	0.571	-0.249
18	0.90	0.559	-0.259
19	0.95	0.545	-0.271
20	1.00	0.531	-0.280
21	1.05	0.517	-0.288
22	1.10	0.503	-0.297
23	1.15	0.488	-0.306
24	1.20	0.472	-0.316
25	1.25	0.456	-0.326
26	1.30	0.439	-0.334
27	1.35	0.423	-0.340
28	1.40	0.406	-0.348
29	1.45	0.388	-0.358
30	1.50	0.370	-0.369
31	1.55	0.351	-0.379

acceleration - .1804

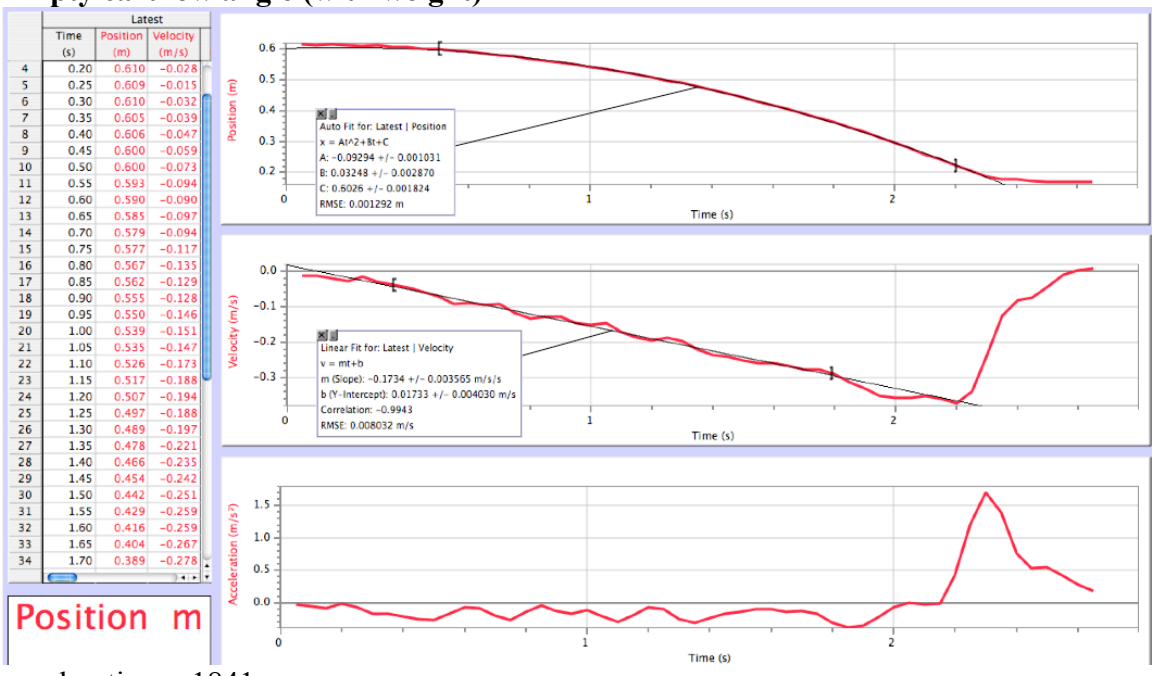
Empty cart low angle (no weight)



	Latest		
	Time (s)	Position (m)	Velocity (m/s)
1	0.05	0.614	−0.015
2	0.10	0.614	−0.022
3	0.15	0.613	−0.035
4	0.20	0.609	−0.031
5	0.25	0.610	−0.028
6	0.30	0.608	−0.046
7	0.35	0.605	−0.059
8	0.40	0.601	−0.070
9	0.45	0.598	−0.079
10	0.50	0.594	−0.089
11	0.55	0.589	−0.098
12	0.60	0.584	−0.107
13	0.65	0.578	−0.116
14	0.70	0.572	−0.127
15	0.75	0.565	−0.136
16	0.80	0.559	−0.145
17	0.85	0.551	−0.155
18	0.90	0.543	−0.165
19	0.95	0.535	−0.175
20	1.00	0.526	−0.183
21	1.05	0.516	−0.192
22	1.10	0.506	−0.202
23	1.15	0.496	−0.211
24	1.20	0.485	−0.220
25	1.25	0.474	−0.230
26	1.30	0.462	−0.239
27	1.35	0.450	−0.248
28	1.40	0.438	−0.256
29	1.45	0.425	−0.265
30	1.50	0.411	−0.265
31	1.55	0.398	−0.270

acceleration - .1610

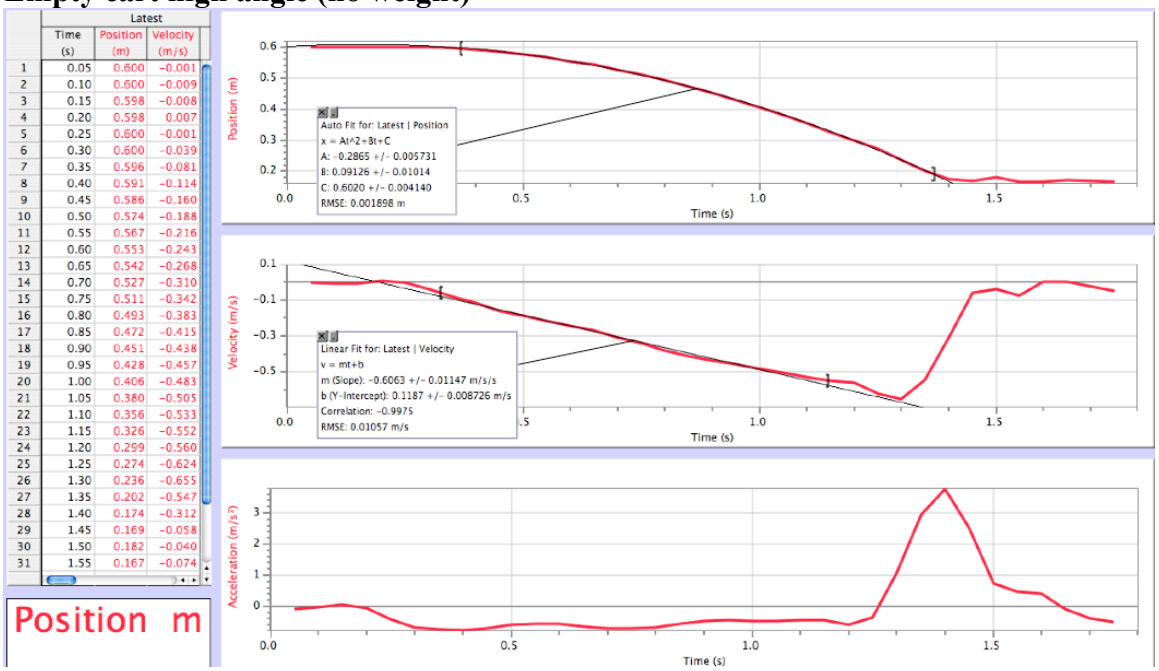
Empty cart low angle (with weight)



	Latest		
	Time (s)	Position (m)	Velocity (m/s)
4	0.20	0.610	−0.028
5	0.25	0.609	−0.015
6	0.30	0.610	−0.032
7	0.35	0.605	−0.039
8	0.40	0.606	−0.047
9	0.45	0.600	−0.059
10	0.50	0.600	−0.073
11	0.55	0.593	−0.094
12	0.60	0.590	−0.090
13	0.65	0.585	−0.097
14	0.70	0.579	−0.094
15	0.75	0.577	−0.117
16	0.80	0.567	−0.135
17	0.85	0.562	−0.129
18	0.90	0.555	−0.128
19	0.95	0.550	−0.146
20	1.00	0.539	−0.151
21	1.05	0.535	−0.147
22	1.10	0.526	−0.173
23	1.15	0.517	−0.188
24	1.20	0.507	−0.194
25	1.25	0.497	−0.188
26	1.30	0.489	−0.197
27	1.35	0.478	−0.221
28	1.40	0.466	−0.235
29	1.45	0.454	−0.242
30	1.50	0.442	−0.251
31	1.55	0.429	−0.259
32	1.60	0.416	−0.259
33	1.65	0.404	−0.267
34	1.70	0.389	−0.278

acceleration - .1841

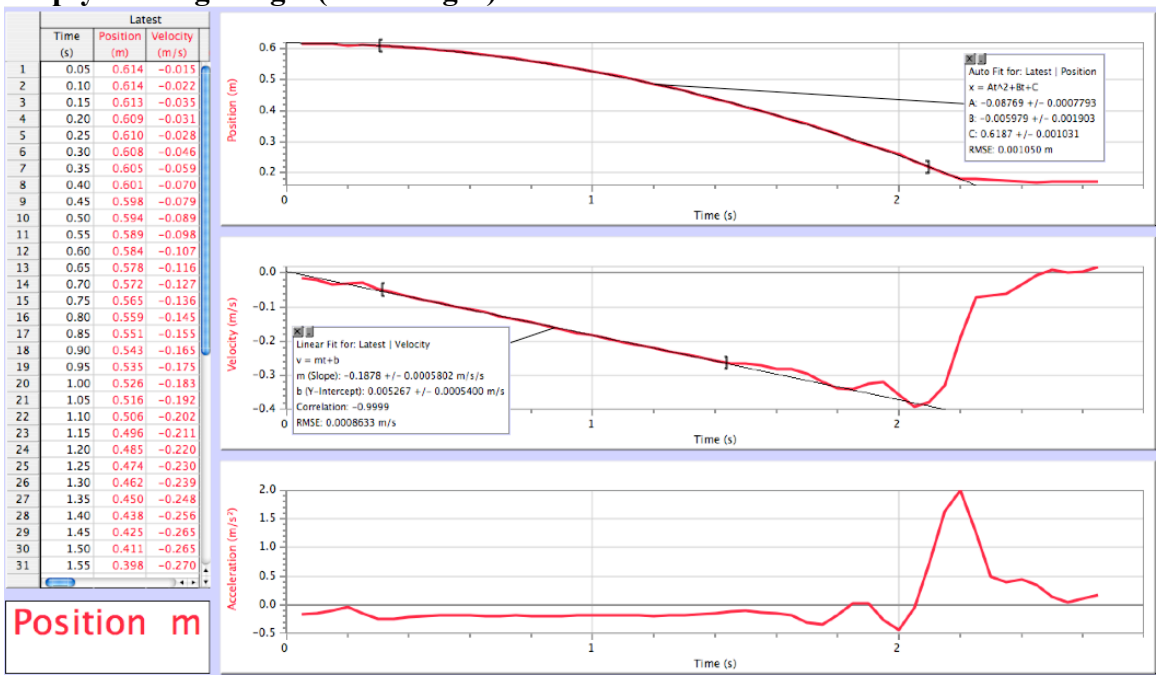
Empty cart high angle (no weight)



	Latest		
	Time (s)	Position (m)	Velocity (m/s)
1	0.05	0.600	−0.001
2	0.10	0.600	−0.009
3	0.15	0.598	−0.008
4	0.20	0.598	0.007
5	0.25	0.600	−0.001
6	0.30	0.600	−0.039
7	0.35	0.596	−0.081
8	0.40	0.591	−0.114
9	0.45	0.586	−0.160
10	0.50	0.574	−0.188
11	0.55	0.567	−0.216
12	0.60	0.553	−0.243
13	0.65	0.542	−0.268
14	0.70	0.527	−0.310
15	0.75	0.511	−0.342
16	0.80	0.493	−0.383
17	0.85	0.472	−0.415
18	0.90	0.451	−0.438
19	0.95	0.428	−0.457
20	1.00	0.406	−0.483
21	1.05	0.380	−0.505
22	1.10	0.356	−0.533
23	1.15	0.326	−0.552
24	1.20	0.299	−0.560
25	1.25	0.274	−0.624
26	1.30	0.236	−0.655
27	1.35	0.202	−0.547
28	1.40	0.174	−0.312
29	1.45	0.169	−0.058
30	1.50	0.182	−0.040
31	1.55	0.167	−0.074

acceleration - .4180

Empty cart high angle (with weight)



	Latest		
	Time (s)	Position (m)	Velocity (m/s)
1	0.05	0.614	−0.015
2	0.10	0.614	−0.022
3	0.15	0.613	−0.035
4	0.20	0.609	−0.031
5	0.25	0.610	−0.028
6	0.30	0.608	−0.046
7	0.35	0.605	−0.059
8	0.40	0.601	−0.070
9	0.45	0.598	−0.079
10	0.50	0.594	−0.089
11	0.55	0.589	−0.098
12	0.60	0.584	−0.107
13	0.65	0.578	−0.116
14	0.70	0.572	−0.127
15	0.75	0.565	−0.136
16	0.80	0.559	−0.145
17	0.85	0.551	−0.155
18	0.90	0.543	−0.165
19	0.95	0.535	−0.175
20	1.00	0.526	−0.183
21	1.05	0.516	−0.192
22	1.10	0.506	−0.202
23	1.15	0.496	−0.211
24	1.20	0.485	−0.220
25	1.25	0.474	−0.230
26	1.30	0.462	−0.239
27	1.35	0.450	−0.248
28	1.40	0.438	−0.256
29	1.45	0.425	−0.265
30	1.50	0.411	−0.265
31	1.55	0.398	−0.270

acceleration - .1614

Observations – I observed while doing the lab that the carts went faster without the weight, and the heavier ones went slow at first but faster at the end because an object of a higher mass will take more force to move, but once it gets moving it moves faster. I also observed that the high-powered fan really is sharp, but besides that, I learned from watching other people and their mistakes while doing the lab.

Analysis – the lab was hard to understand at first, but once taught how to use the tools correctly it was a lot easier. I took pictures from each of the eight motion detected carts. The lab would have been more successful if we were to have a more accurate scale or a scale that could hold the weight of the carts. It could have also been improved by getting more accurate curve fits for the different graphs.

Conclusion – the lab was a success, we successfully analyzed force through graphical analysis and reproved Newton's theory. We discovered that a force is needed to act upon an object because without a fan it wouldn't have accelerated. Also, we analyzed force through graphical analysis successfully because we now can find the acceleration.