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PHY 201 Lab
10 June 2024
Lab Assignment #2

1. Collect three group data by measuring the distance vs time of a ball free fall motion by the motion detector & LabPro

2. Verify that the gravity acceleration is constant from above experiment

3. Collect three group data to verify the motion of a ball upward throwing shown on the lecture handouts for distance vs time/velocity vs time/acceleration vs time by the motion detector & LabPro

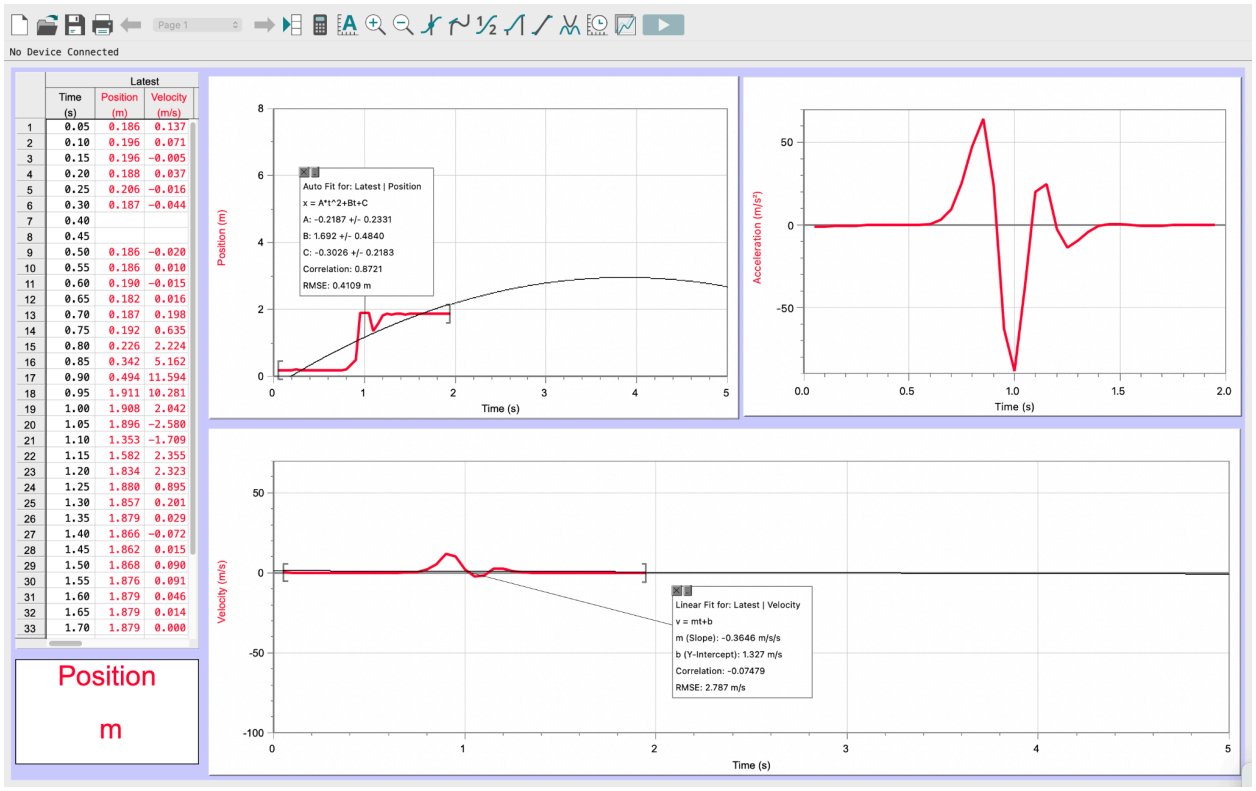
4. Write the lab report including screenshots for data analysis in Logger Pro.

Q1, 2

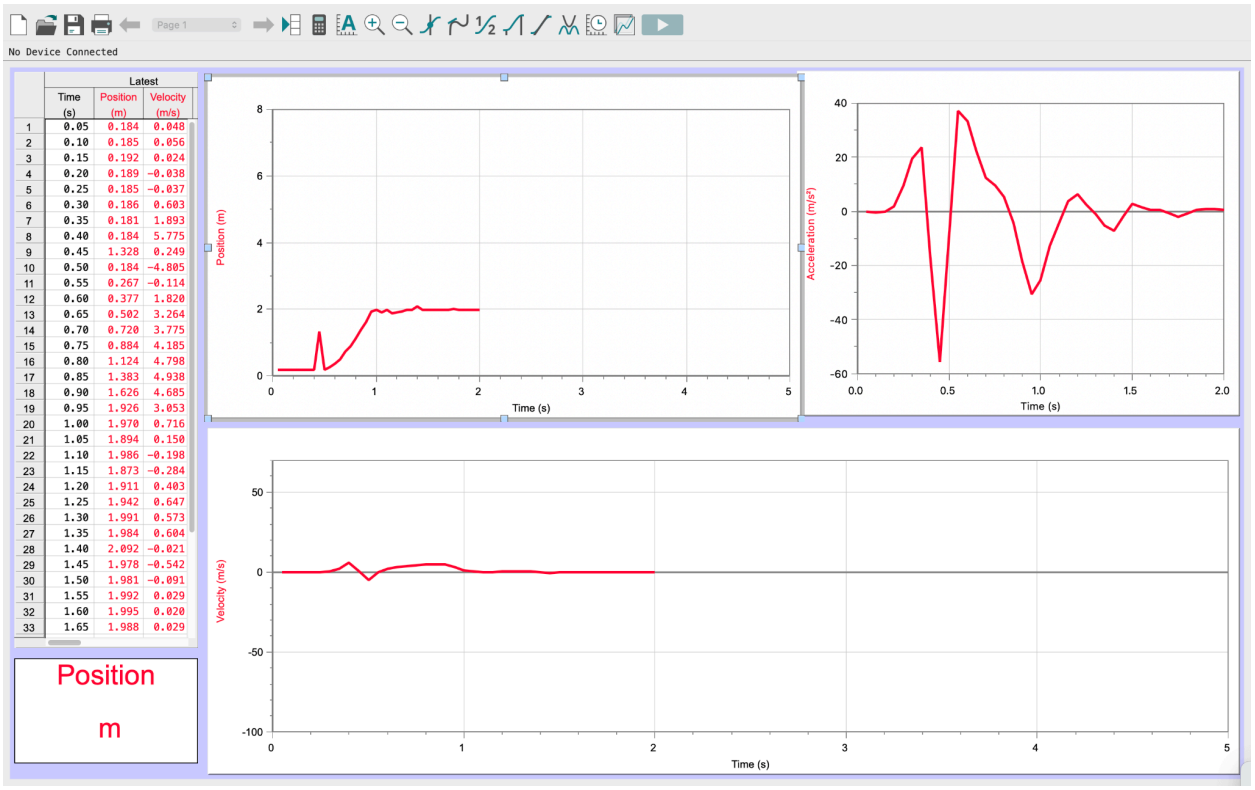
Following criteria has to be met for an ideal free fall:

- The object is dropped in a vacuum, eliminating air resistance.
- Gravity is the sole force acting on the object.
- Gravitational acceleration (g) is constant and uniform over the fall.
- The object starts from rest, ensuring initial velocity is zero.
- The distance vs. time graph forms a parabolic curve, described by $d(t)=12gt$, showing distance increases with the square of time.
- The velocity vs. time graph is a straight line with a slope of g, expressed by $v(t)=gt$.
- Fitting distance-time data to a quadratic curve and velocity-time data to a linear line confirms constant gravitational acceleration, approximately 9.81 m/s2.

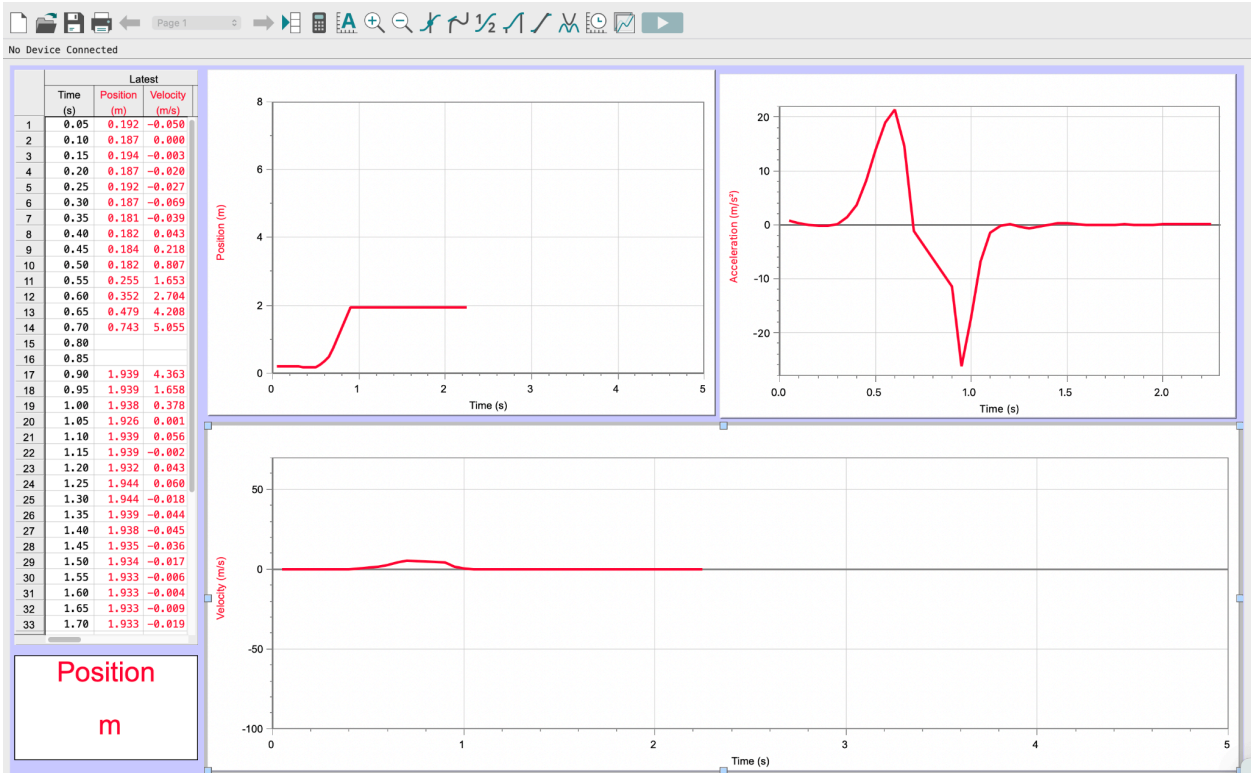
DATA1:


No Device Connected
Latest
Time (s)
Position (m)
Velocity (m/s)
1 0.05 0.186 0.137
2 0.10 0.196 0.071
3 0.15 0.196 −0.005
4 0.20 0.188 0.037
5 0.25 0.206 −0.016
6 0.30 0.187 −0.044
7 0.40
8 0.45
9 0.50 0.186 −0.020
10 0.55 0.186 0.010
11 0.60 0.190 −0.015
12 0.65 0.182 0.016
13 0.70 0.187 0.198
14 0.75 0.192 0.635
15 0.80 0.226 2.224
16 0.85 0.342 5.162
17 0.90 0.494 11.594
18 0.95 1.911 10.281
19 1.00 1.908 2.042
20 1.05 1.896 −2.580
21 1.10 1.353 −1.709
22 1.15 1.582 2.355
23 1.20 1.834 2.323
24 1.25 1.880 0.895
25 1.30 1.857 0.201
26 1.35 1.879 0.029
27 1.40 1.866 −0.072
28 1.45 1.862 0.015
29 1.50 1.868 0.090
30 1.55 1.876 0.091
31 1.60 1.879 0.046
32 1.65 1.879 0.014
33 1.70 1.879 0.000
Position
m
Position (m)
Time (s)
Auto Fit for: Latest | Position
x = A*t^2+Bt+C
A: -0.2187 +/- 0.2331
B: 1.692 +/- 0.4840
C: -0.3026 +/- 0.2183
Correlation: 0.8721
RMSE: 0.4109 m
Acceleration (m/s²)
Time (s)
Velocity (m/s)
Time (s)
Linear Fit for: Latest | Velocity
v = mt+b
m (Slope): -0.3646 m/s/s
b (Y-Intercept): 1.327 m/s
Correlation: -0.07479
RMSE: 2.787 m/s

DATA2:


No Device Connected
Latest
Time (s) | Position (m) | Velocity (m/s)
1 0.05 0.184 0.048
2 0.10 0.185 0.056
3 0.15 0.192 0.024
4 0.20 0.189 −0.038
5 0.25 0.185 −0.037
6 0.30 0.186 0.603
7 0.35 0.181 1.893
8 0.40 0.184 5.775
9 0.45 1.328 0.249
10 0.50 0.184 −4.805
11 0.55 0.267 −0.114
12 0.60 0.377 1.820
13 0.65 0.502 3.264
14 0.70 0.720 3.775
15 0.75 0.884 4.185
16 0.80 1.124 4.798
17 0.85 1.383 4.938
18 0.90 1.626 4.685
19 0.95 1.926 3.053
20 1.00 1.970 0.716
21 1.05 1.894 0.150
22 1.10 1.986 −0.198
23 1.15 1.873 −0.284
24 1.20 1.911 0.403
25 1.25 1.942 0.647
26 1.30 1.991 0.573
27 1.35 1.984 0.604
28 1.40 2.092 −0.021
29 1.45 1.978 −0.542
30 1.50 1.981 −0.091
31 1.55 1.992 0.029
32 1.60 1.995 0.020
33 1.65 1.988 0.029
Position
m
Position (m)
Time (s)
Acceleration (m/s²)
Time (s)
Velocity (m/s)
Time (s)

DATA3:


No Device Connected
Latest
Time (s) | Position (m) | Velocity (m/s)
1 0.05 0.192 −0.050
2 0.10 0.187 0.000
3 0.15 0.194 −0.003
4 0.20 0.187 −0.020
5 0.25 0.192 −0.027
6 0.30 0.187 −0.069
7 0.35 0.181 −0.039
8 0.40 0.182 0.043
9 0.45 0.184 0.218
10 0.50 0.182 0.807
11 0.55 0.255 1.653
12 0.60 0.352 2.704
13 0.65 0.479 4.208
14 0.70 0.743 5.055
15 0.80
16 0.85
17 0.90 1.939 4.363
18 0.95 1.939 1.658
19 1.00 1.938 0.378
20 1.05 1.926 0.001
21 1.10 1.939 0.056
22 1.15 1.939 −0.002
23 1.20 1.932 0.043
24 1.25 1.944 0.060
25 1.30 1.944 −0.018
26 1.35 1.939 −0.044
27 1.40 1.938 −0.045
28 1.45 1.935 −0.036
29 1.50 1.934 −0.017
30 1.55 1.933 −0.006
31 1.60 1.933 −0.004
32 1.65 1.933 −0.009
33 1.70 1.933 −0.019
Position
m
Position (m)
Time (s)
Acceleration (m/s²)
Time (s)
Velocity (m/s)
Time (s)

The figures above do not necessarily match the ideal situation explained below, this could be because of possible air upthrust, external force applied when dropping the ball etc.
However, at some point of time the acceleration remains constant at round 9.8 during which we can consider the moving object was experiencing free fall. For instance for fig 1 at t= 0.78sec, for fig 2 at approx t = 0.185 sec and for fig3 approx at t = 0.45

Q3:
Motion of the ball directly thrown upward is ideally is described below:

Distance vs. Time:

- Initially increases as the ball moves upward.
- Reaches a maximum at the peak height.
- Decreases as the ball descends back to the starting point.
- Forms a parabolic curve.

Velocity vs. Time:

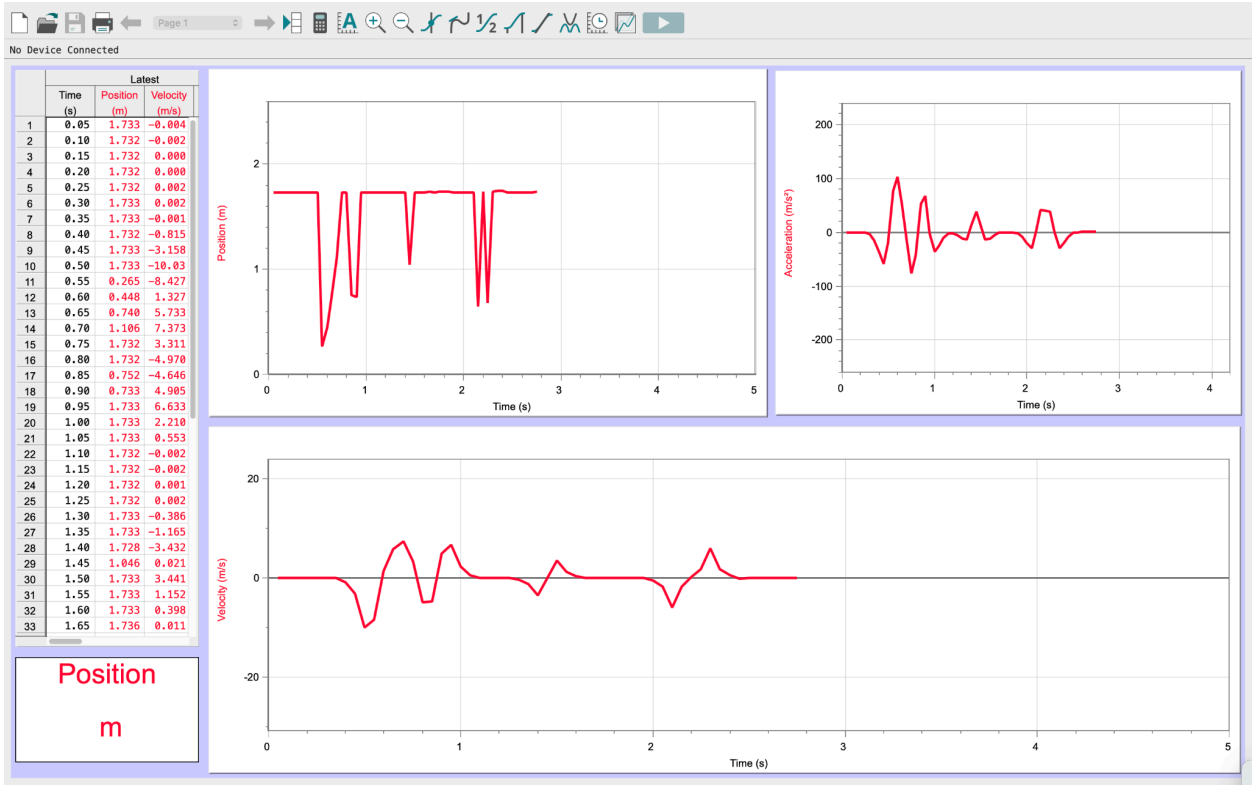
- Starts at an initial positive value.
- Decreases linearly to zero at the peak height.
- Becomes negative as the ball descends.
- Forms a straight line sloping downwards.

Acceleration vs. Time:

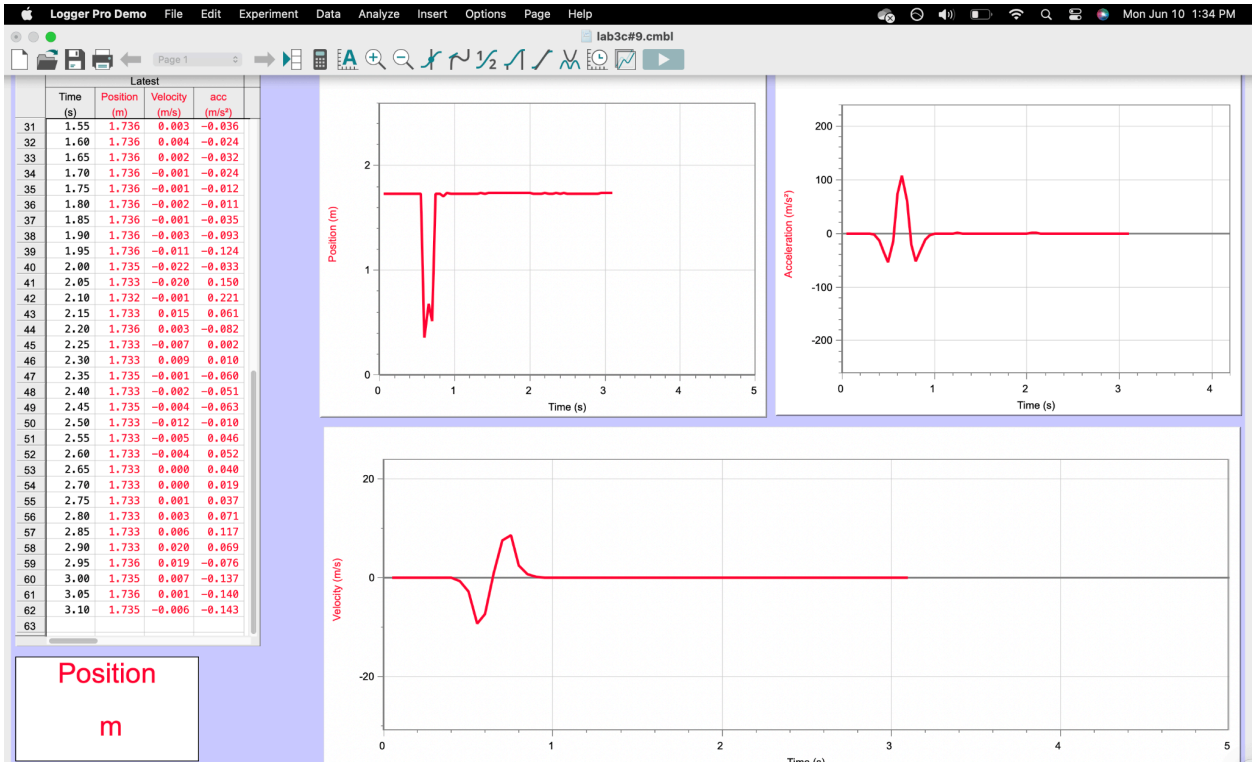
- Constant throughout the motion.
- Equal to the acceleration due to gravity (9.81 m/s2 downward).
- Indicated by a horizontal line at -9.81 m/s^2.

Below is data collected by logger pro, a ball was used to carry out this experiment and then the motion of the ball was scored by using logger pro sensor.

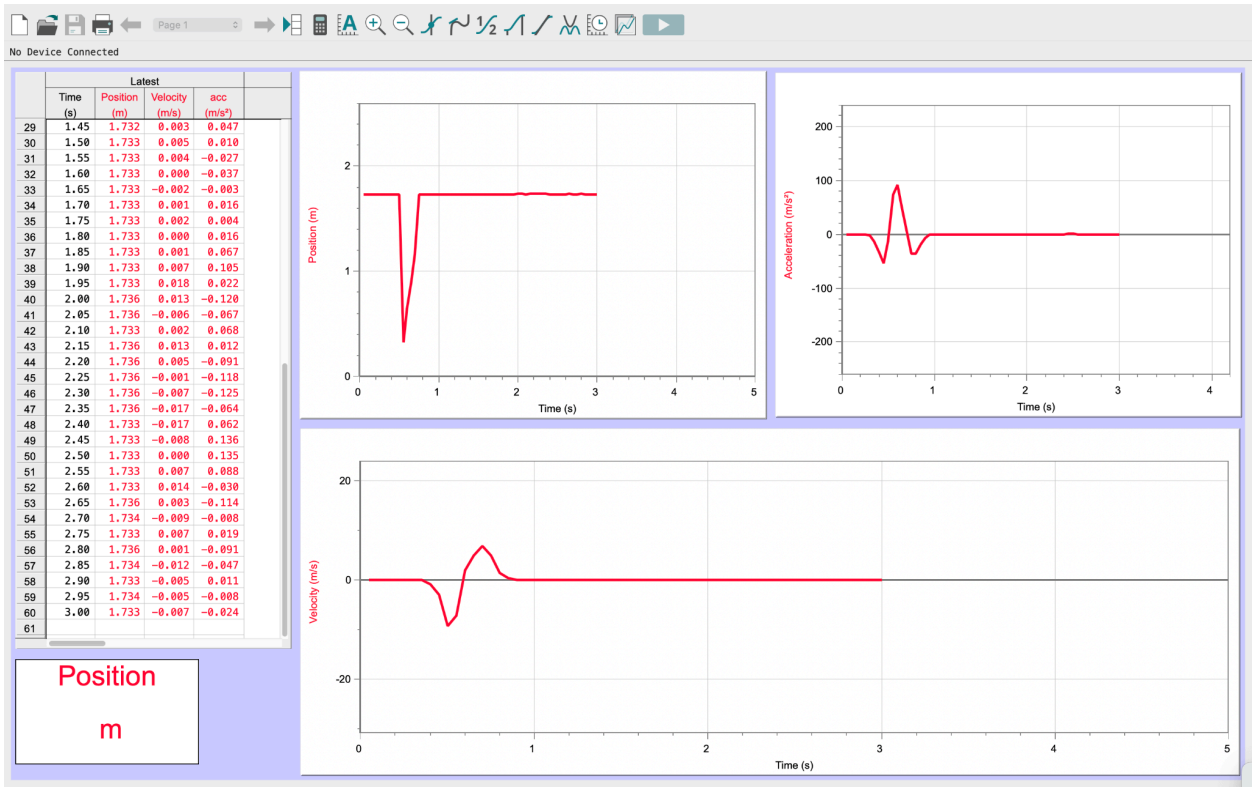
DATA1:



DATA2:


Logger Pro Demo File Edit Experiment Data Analyze Insert Options Page Help
Mon Jun 10 1:34 PM
lab3c#9.cmbl
Page 1
Latest
Time (s) Position (m) Velocity (m/s) acc (m/s²)
31 1.55 1.736 0.003 −0.036
32 1.60 1.736 0.004 −0.024
33 1.65 1.736 0.002 −0.032
34 1.70 1.736 −0.001 −0.024
35 1.75 1.736 −0.001 −0.012
36 1.80 1.736 −0.002 −0.011
37 1.85 1.736 −0.001 −0.035
38 1.90 1.736 −0.003 −0.093
39 1.95 1.736 −0.011 −0.124
40 2.00 1.735 −0.022 −0.033
41 2.05 1.733 −0.020 0.150
42 2.10 1.732 −0.001 0.221
43 2.15 1.733 0.015 0.061
44 2.20 1.736 0.003 −0.082
45 2.25 1.733 −0.007 0.002
46 2.30 1.733 0.009 0.010
47 2.35 1.735 −0.001 −0.060
48 2.40 1.733 −0.002 −0.051
49 2.45 1.735 −0.004 −0.063
50 2.50 1.733 −0.012 −0.010
51 2.55 1.733 −0.005 0.046
52 2.60 1.733 −0.004 0.052
53 2.65 1.733 0.000 0.040
54 2.70 1.733 0.000 0.019
55 2.75 1.733 0.001 0.037
56 2.80 1.733 0.003 0.071
57 2.85 1.733 0.006 0.117
58 2.90 1.733 0.020 0.069
59 2.95 1.736 0.019 −0.076
60 3.00 1.735 0.007 −0.137
61 3.05 1.736 0.001 −0.140
62 3.10 1.735 −0.006 −0.143
63
Position
m
Position (m)
Time (s)
Acceleration (m/s²)
Time (s)
Velocity (m/s)
Time (s)

DATA3:


Page 1
No Device Connected
Latest
Time (s) Position (m) Velocity (m/s) acc (m/s²)
29 1.45 1.732 0.003 0.047
30 1.50 1.733 0.005 0.010
31 1.55 1.733 0.004 −0.027
32 1.60 1.733 0.000 −0.037
33 1.65 1.733 −0.002 −0.003
34 1.70 1.733 0.001 0.016
35 1.75 1.733 0.002 0.004
36 1.80 1.733 0.000 0.016
37 1.85 1.733 0.001 0.067
38 1.90 1.733 0.007 0.105
39 1.95 1.733 0.018 0.022
40 2.00 1.736 0.013 −0.120
41 2.05 1.736 −0.006 −0.067
42 2.10 1.733 0.002 0.068
43 2.15 1.736 0.013 0.012
44 2.20 1.736 0.005 −0.091
45 2.25 1.736 −0.001 −0.118
46 2.30 1.736 −0.007 −0.125
47 2.35 1.736 −0.017 −0.064
48 2.40 1.733 −0.017 0.062
49 2.45 1.733 −0.008 0.136
50 2.50 1.733 0.000 0.135
51 2.55 1.733 0.007 0.088
52 2.60 1.733 0.014 −0.030
53 2.65 1.736 0.003 −0.114
54 2.70 1.734 −0.009 −0.008
55 2.75 1.733 0.007 0.019
56 2.80 1.736 0.001 −0.091
57 2.85 1.734 −0.012 −0.047
58 2.90 1.733 −0.005 0.011
59 2.95 1.734 −0.005 −0.008
60 3.00 1.733 −0.007 −0.024
61
Position
m
Position (m)
Time (s)
Acceleration (m/s²)
Time (s)
Velocity (m/s)
Time (s)

Here is the interpretation of the third data,
a ball is being dropped from a height, bouncing upon impact, and then being picked up or held again. Initially, the position vs. time graph shows the ball held at a constant height of approximately 1.8 meters. Around 0.5 seconds, the ball is dropped, indicated by a sharp decrease in position to about 0.1 meters. This drop is accompanied by a negative spike in velocity and acceleration, showing the ball accelerating downwards due to gravity. Upon impact with the ground, the velocity and acceleration graphs display brief positive spikes, representing the bounce. The position graph shows a slight rise post-impact, confirming the bounce, before returning to the original height.