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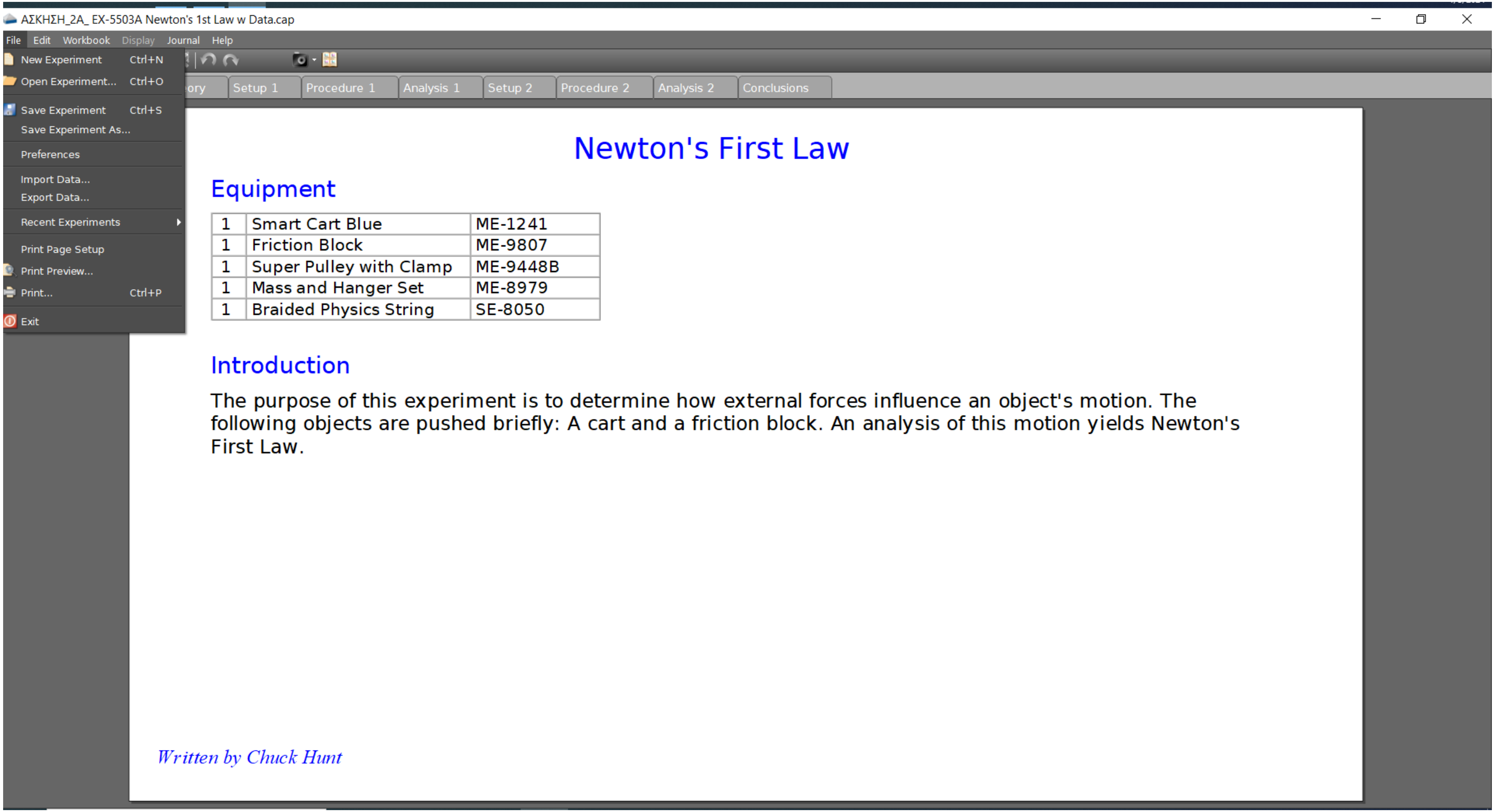
ΑΣΚΗΣΗ_2Α_ EX-5503A Newton's 1st Law w Data.cap
File
Edit
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New Experiment Ctrl+N
Open Experiment... Ctrl+O
Save Experiment Ctrl+S
Save Experiment As...
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Recent Experiments
Print Page Setup
Print Preview...
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Exit
Setup 1
Procedure 1
Analysis 1
Setup 2
Procedure 2
Analysis 2
Conclusions
Newton's First Law
Equipment
1 Smart Cart Blue ME-1241
1 Friction Block ME-9807
1 Super Pulley with Clamp ME-9448B
1 Mass and Hanger Set ME-8979
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Introduction
The purpose of this experiment is to determine how external forces influence an object's motion. The following objects are pushed briefly: A cart and a friction block. An analysis of this motion yields Newton's First Law.
Written by Chuck Hunt

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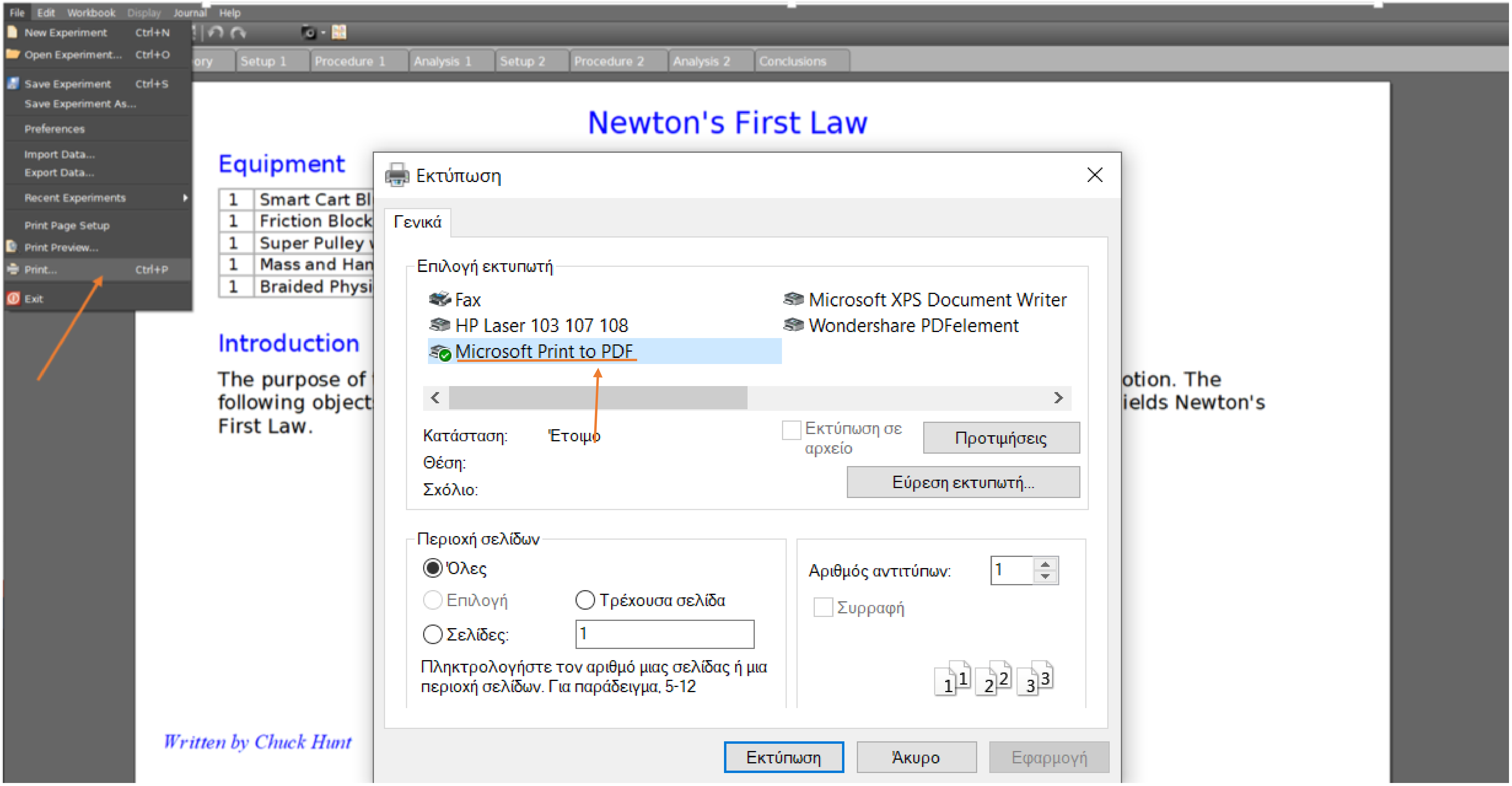

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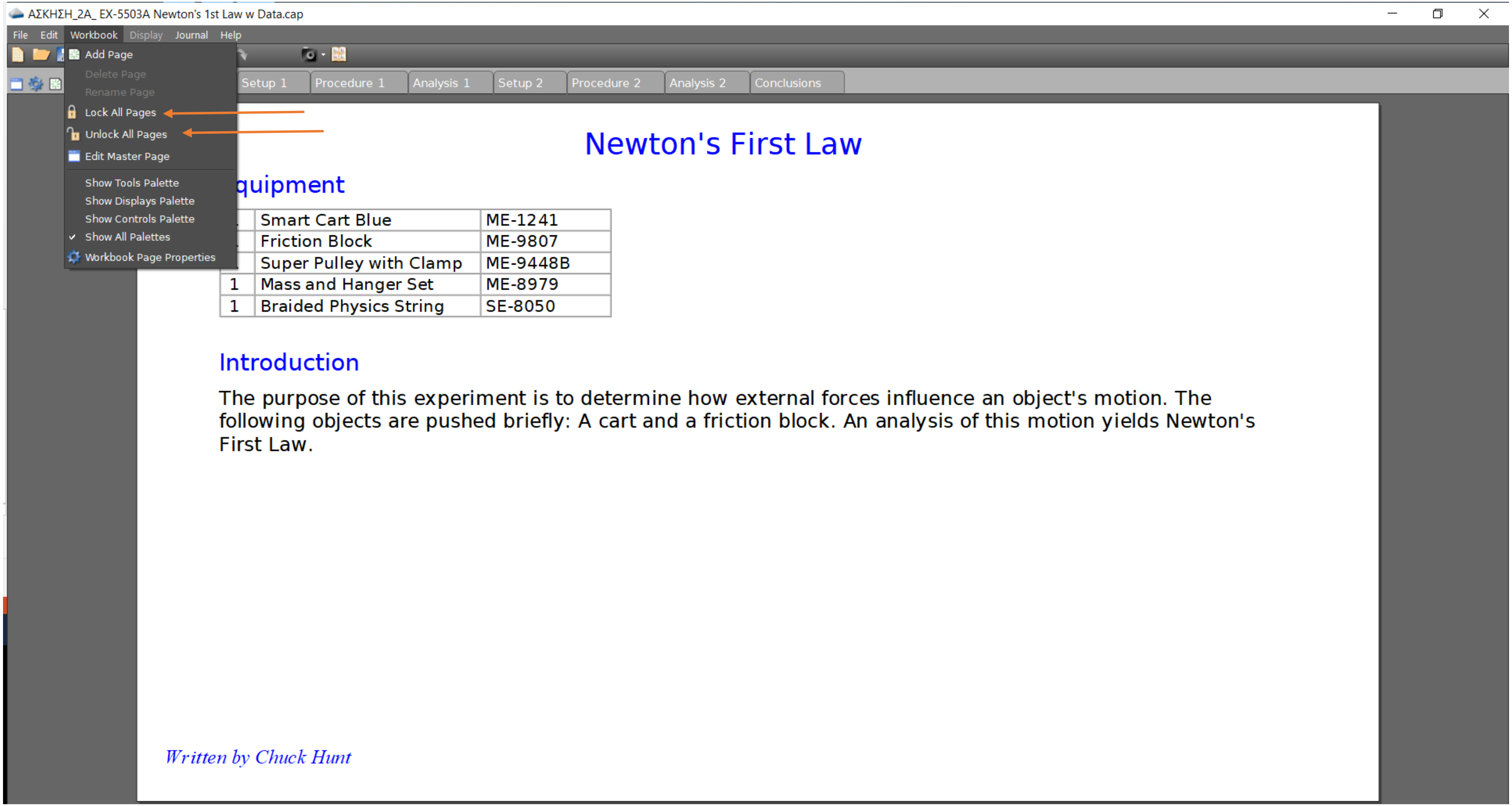

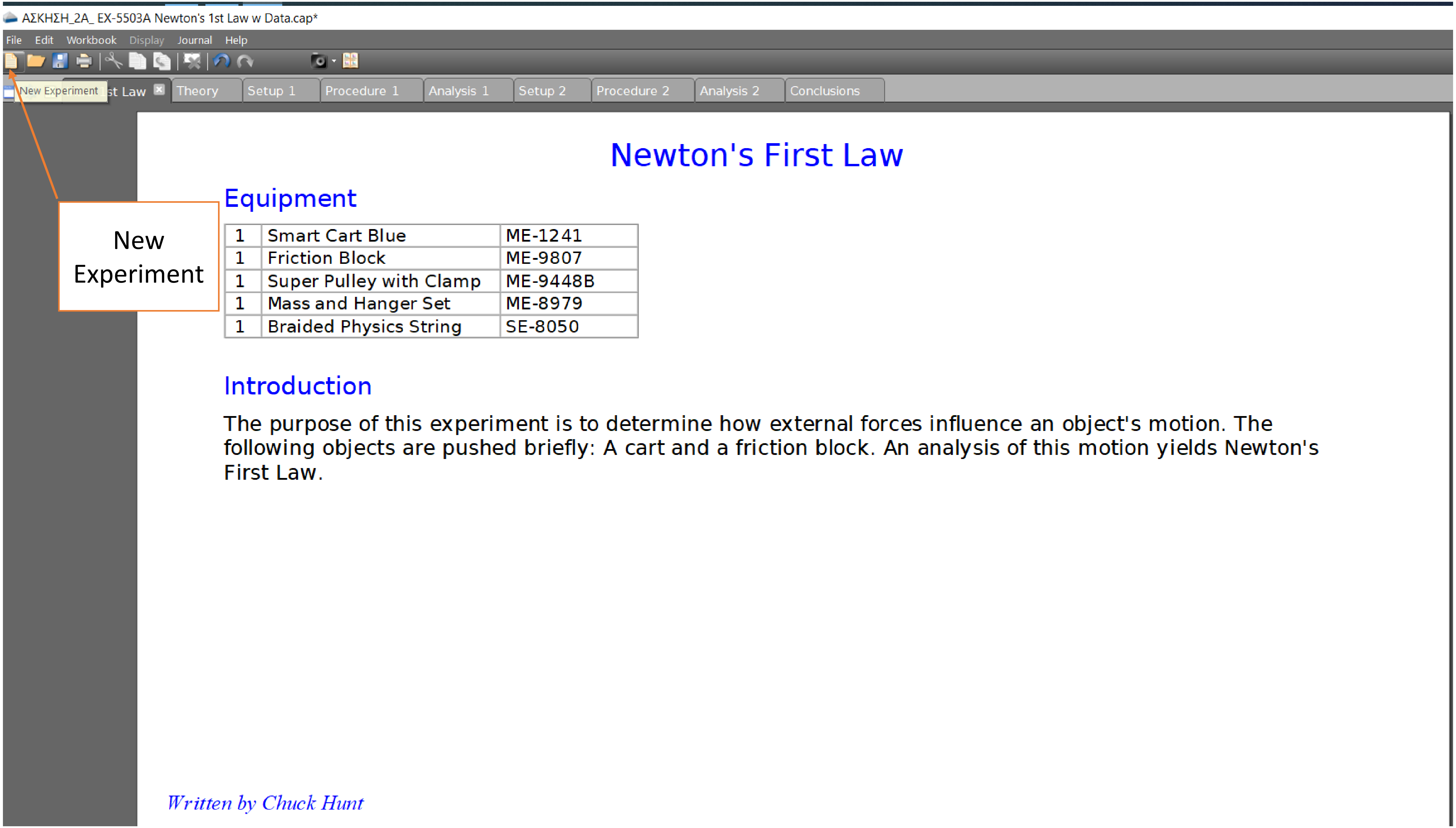

Newton's First Law

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ΑΣΚΗΣΗ_2Α_ EX-5503A Newton's 1st Law w Data.cap*

File Edit Workbook Display Journal Help

Open Experiment

Theory | Setup 1 | Procedure 1 | Analysis 1 | Setup 2 | Procedure 2 | Analysis 2 | Conclusions

Open Experiment

Newton's First Law

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File Edit Workbook Display Journal Help

Save Experiment

Intro 1st Law | Theory | Setup 1 | Procedure 1 | Analysis 1 | Setup 2 | Procedure 2 | Analysis 2 | Conclusions

Save Experiment

Newton's First Law

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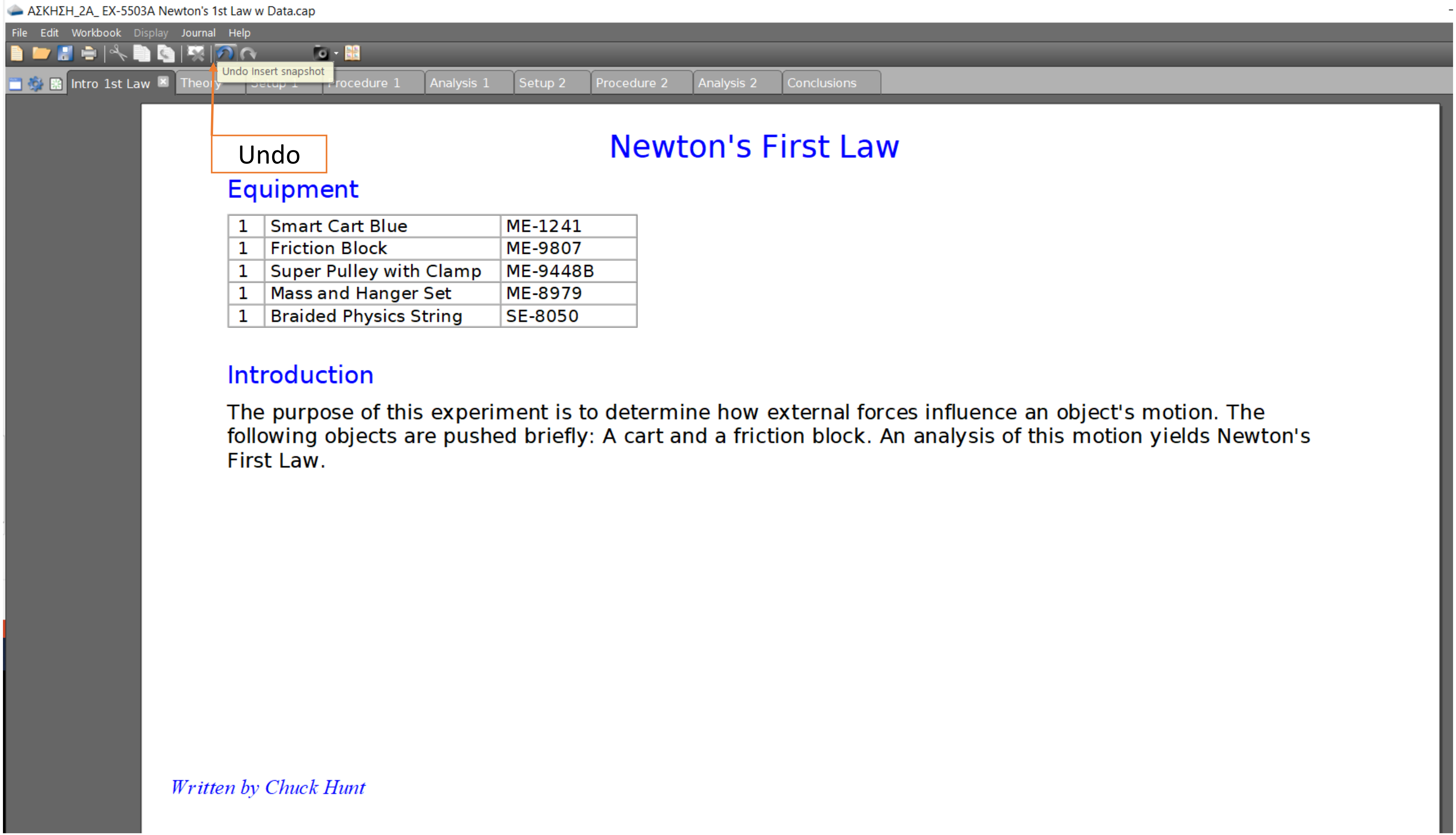

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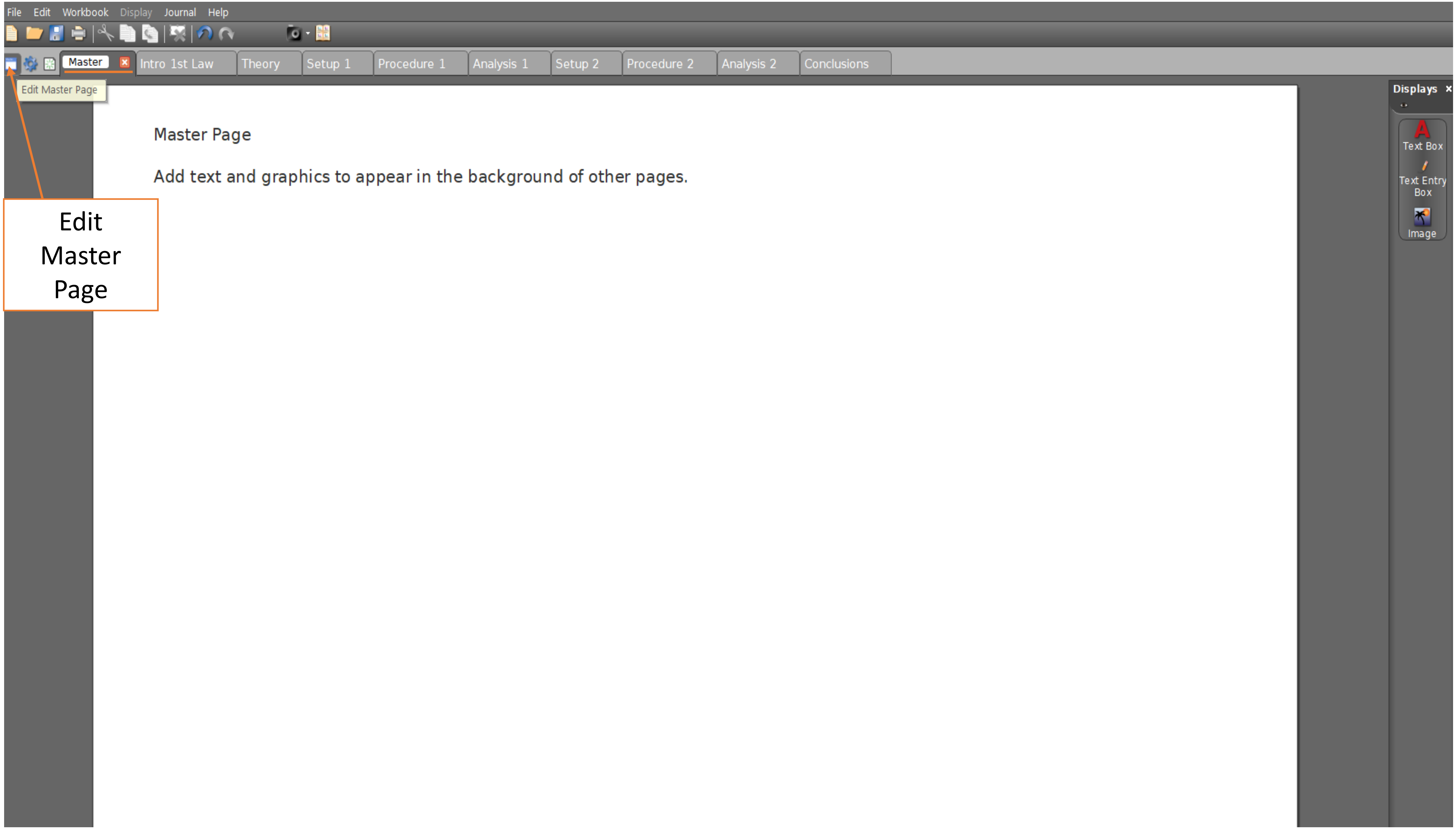
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Intro 1st Law
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Conclusions
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Master Page
Add text and graphics to appear in the background of other pages.
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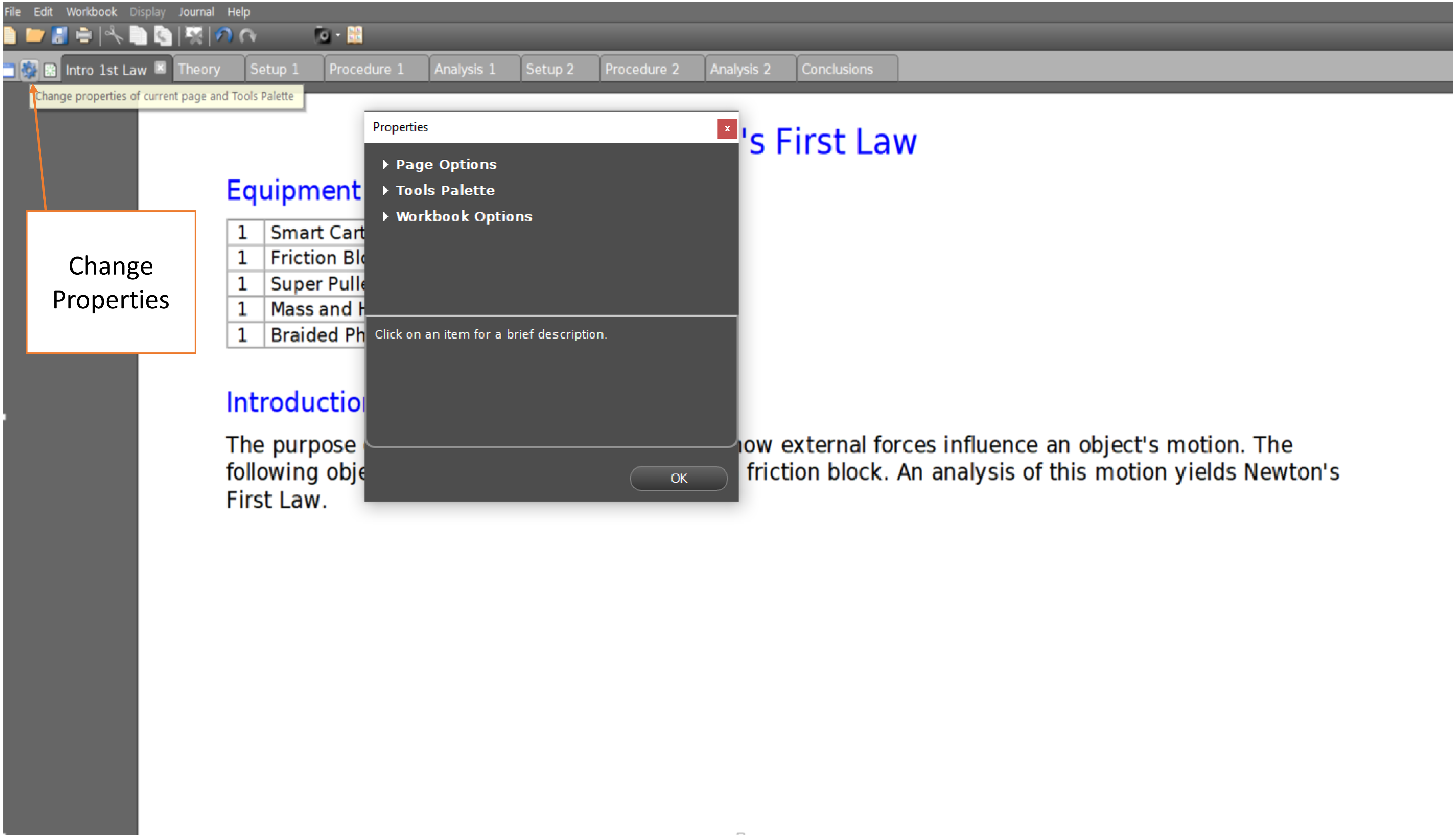
Text Box
Text Entry Box
Image
Edit Master Page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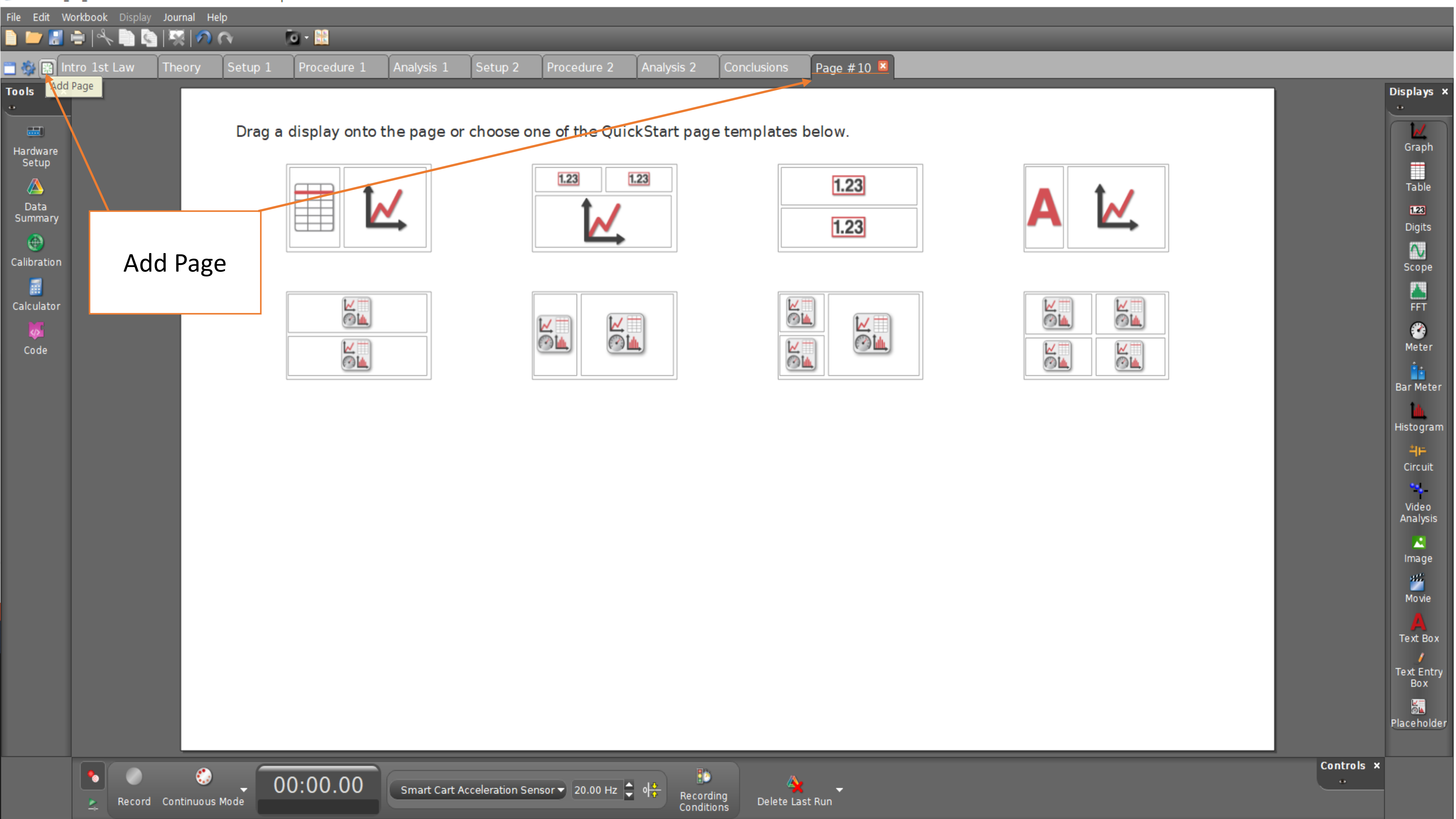
File Edit Workbook Display Journal Help
Intro 1st Law
Theory
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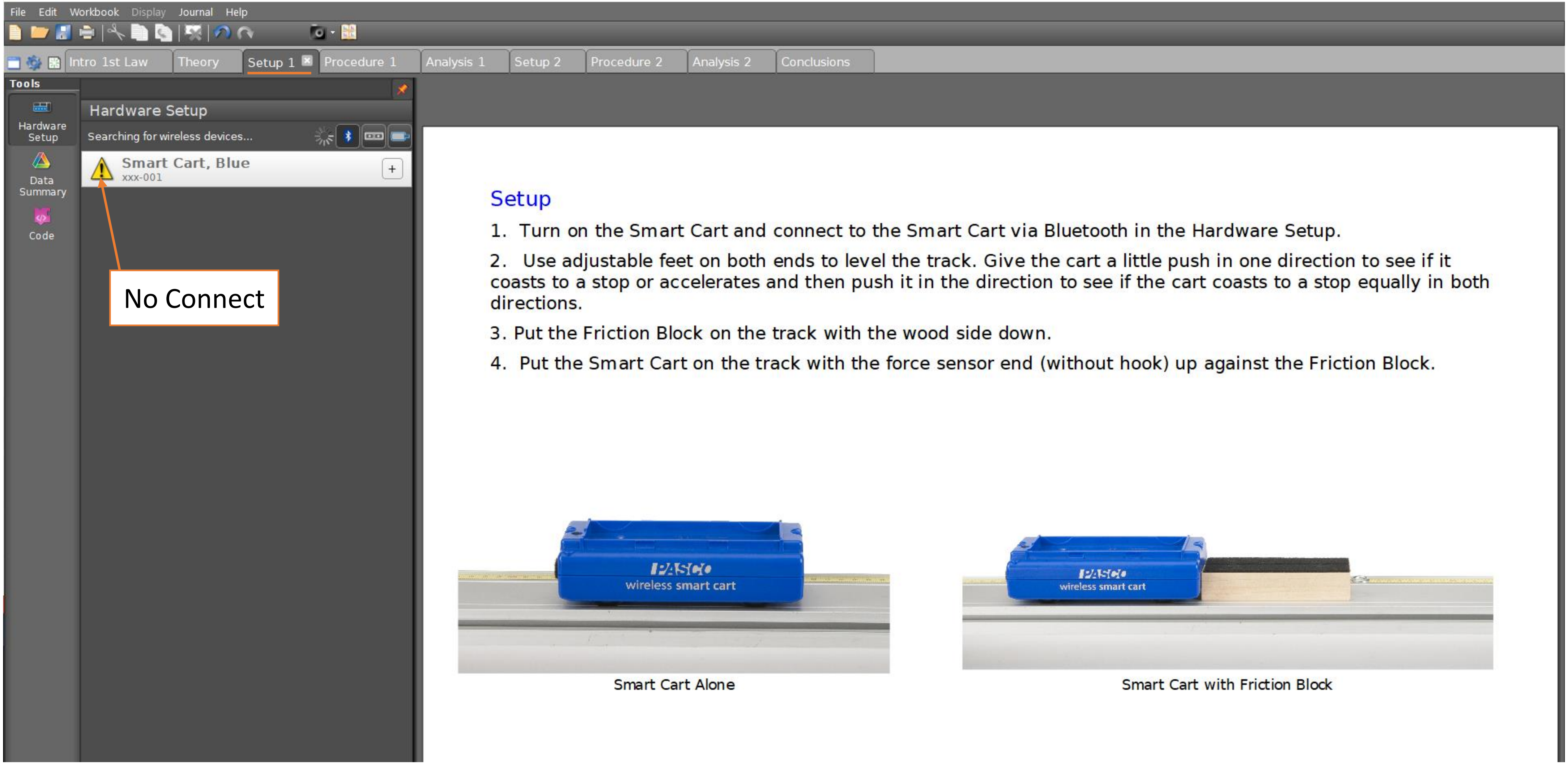
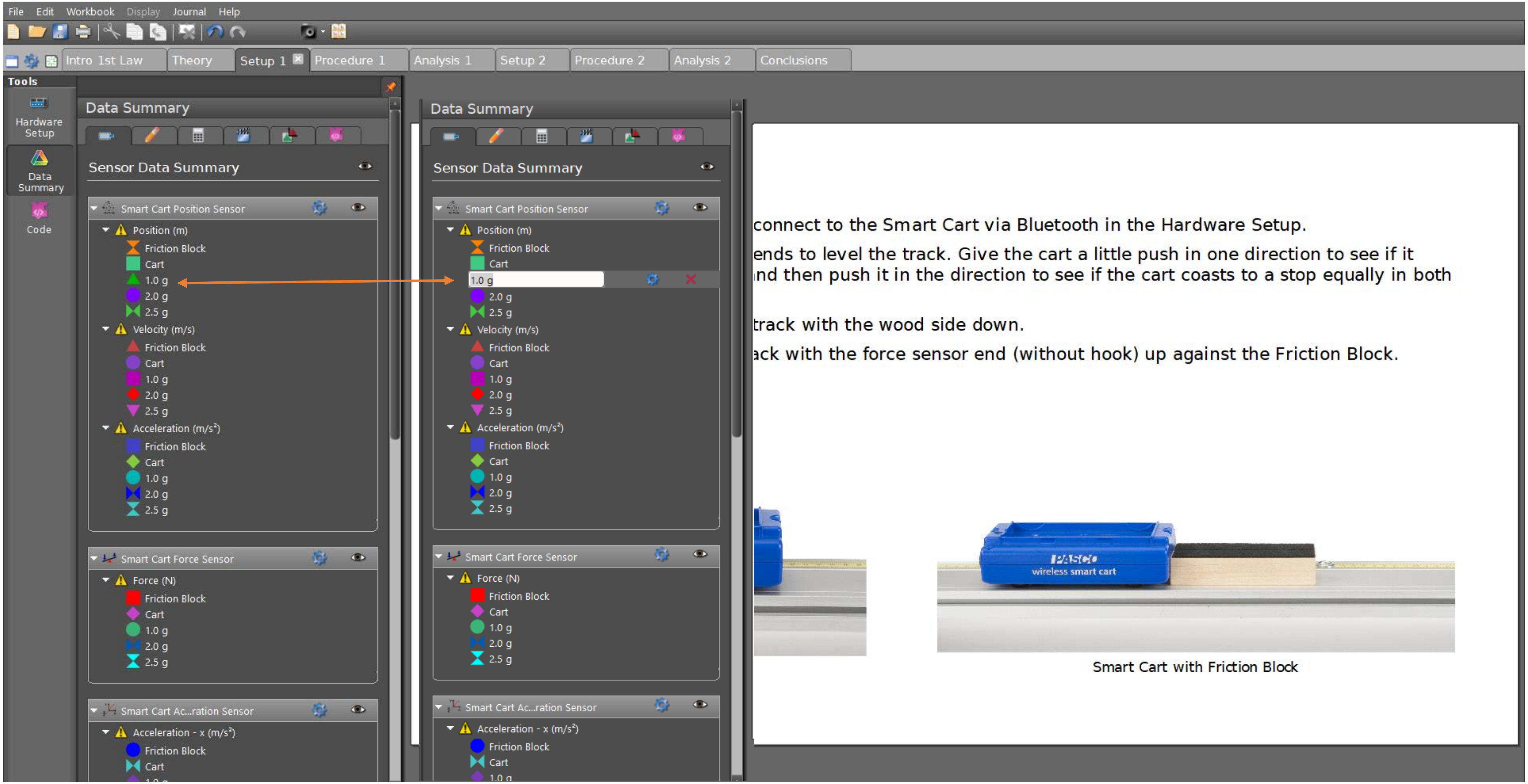
Procedure 2
Analysis 2
Conclusions
Page #10
Add Page
Tools
Hardware Setup
Data Summary
Calibration
Calculator
Code
Add Page
Drag a display onto the page or choose one of the QuickStart page templates below.
Displays
Graph
Table
Digits
Scope
FFT
Meter
Bar Meter
Histogram
Circuit
Video Analysis
Image
Movie
Text Box
Text Entry Box
Placeholder
Record
Continuous Mode
00:00.00
Smart Cart Acceleration Sensor
20.00 Hz
Recording Conditions
Delete Last Run
Controls

Setup_1 → Hardware Setup → Bluetooth → Smart cart



Setup_1 → Data Summary → Double click → Change Name



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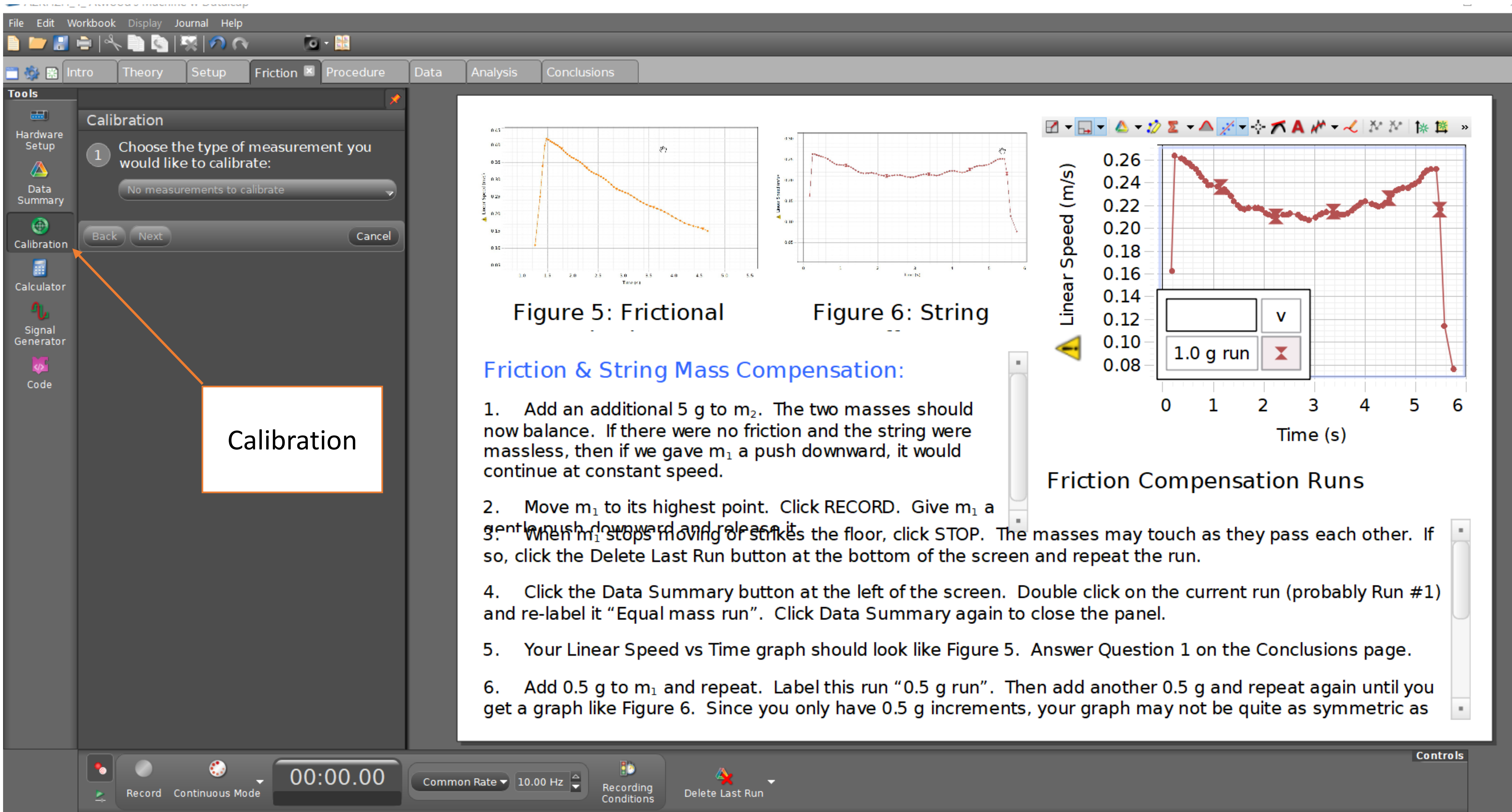

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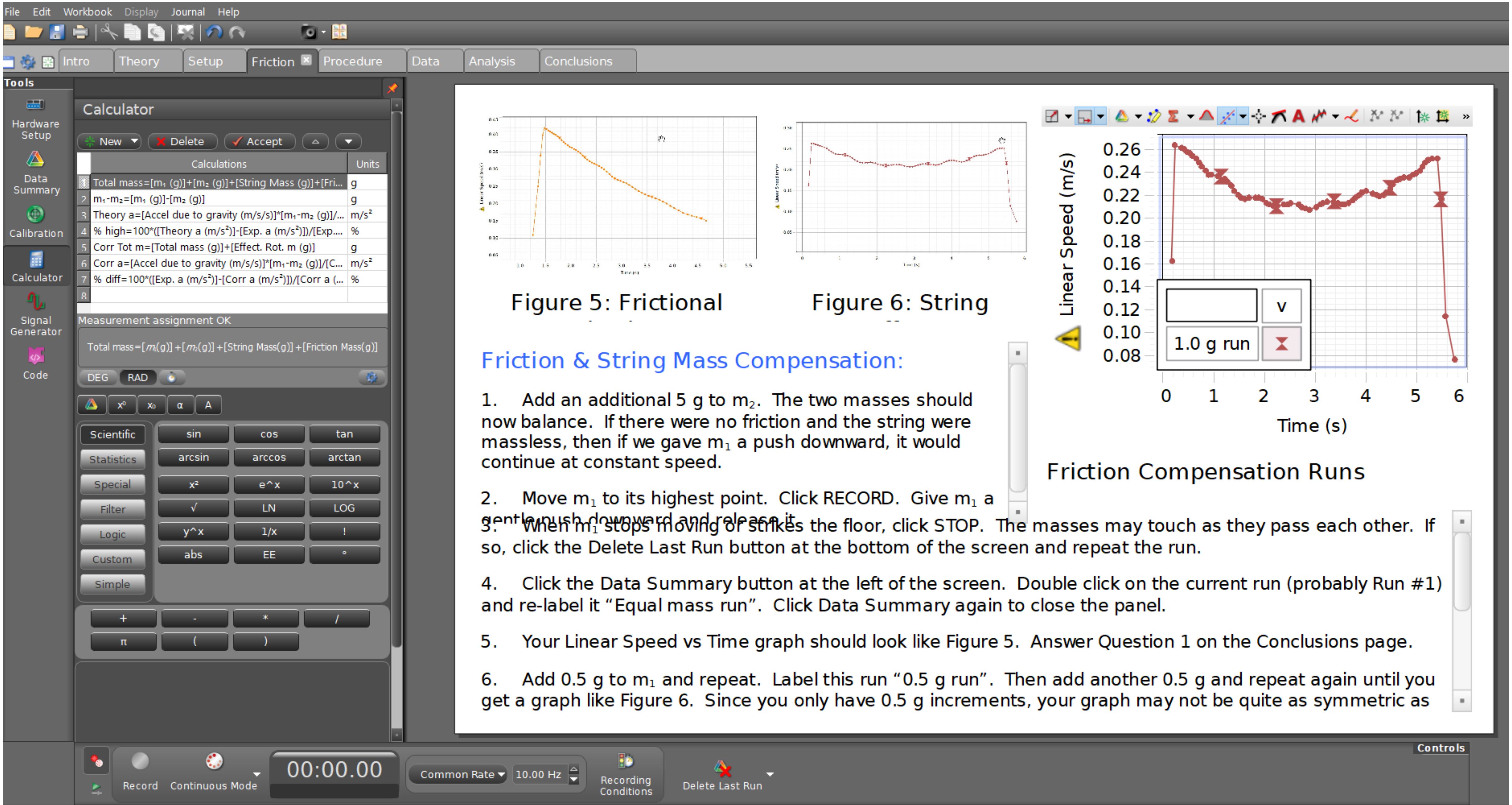

File Edit Workbook Display Journal Help

Intro | Theory A | Setup A | Procedure A | Analysis A | v Graph | Conclusions A

Tools: Hardware Setup, Data Summary, Calculator, Curve Fit Editor, Code

Procedure A: Stretching the Spring

1. Start with the spring unstretched and slack in the string. Your hand should be on the end of the cart away from the Motion Sensor (so the sensor will not measure the position of your hand).

2. Click RECORD at the bottom left of the screen.

3. Push the cart until it is about 15 cm away from the Motion Sensor, then slowly back until it is back where it started from. Click STOP. The data on the Hooke's Law Graph should be very linear and the force should be zero at the right side.

4. Click open Data Summary at the left of the screen. Double-click on this run (probably Run #1) and re-label it "Weak Spring". Note that you can delete bad runs by using the Delete Last Run button at the bottom right of the screen, or … the right of the button to delete specific runs. Click Data Summary a…

5. Push the car until the spring is stretched … RD. Hold the car still for a few seconds.

6. Release the car. Press STOP after the car hits the bumper. The spring may come unhooked. If it does, try to prevent the car from striking the Motion Sensor.

7. Verify that you have good data for the speed of the car after the spring stops pulling on it and its speed is constant.

- Open the "v Graph" tab.
- Verify that the speed becomes constant before the car hits the bumper (speed rapidly becomes negative at the bumper). If you don't see a flat plateau (like the region between 1.70 s and 1.83 s in Figure 3) due to noise, delete the run, and do it again. If noise is a problem, make sure there are no objects near the track to reflect the signal. You may need to change the angle on the Motion Sensor.

8. Click open Data Summary and label this run as "15 cm".

9. Repeat steps 5-9 for initial stretches of 30 cm and 45 cm. Label them "30 cm" and '45 cm".

10. Replace the weak spring with one of the strong springs and repeat steps 1-4. Label the run "Strong Spring".

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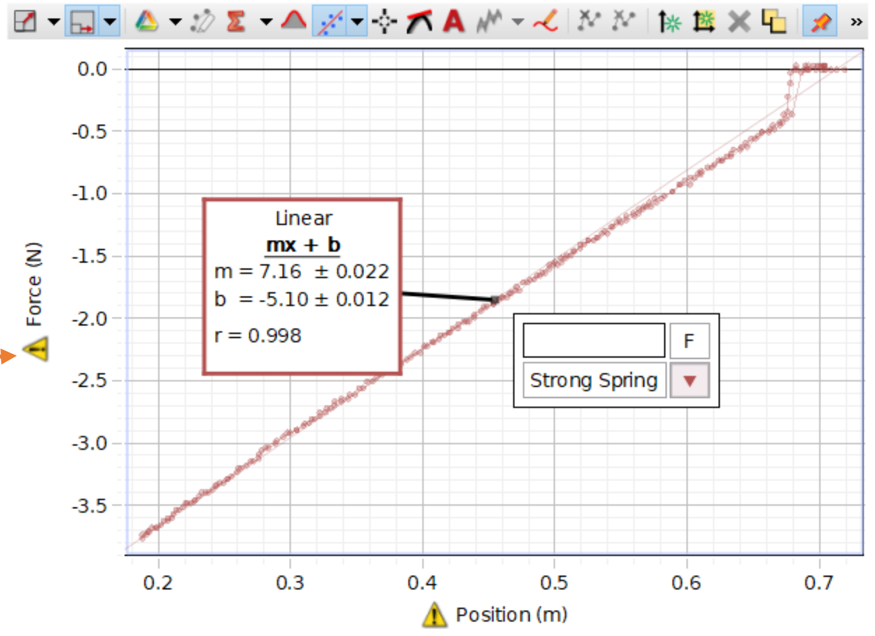

Hooke's Law

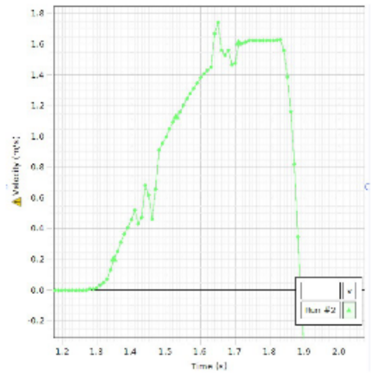

Figure 3: Constant Speed Plateau

Record

Select Sensor

Zero Sensor

Delete Last Run

Record | Continuous Mode | 00:00.00 | Motion Sensor | 100.00 Hz | Recording Conditions | Delete Last Run

Analysis A

1. Click on the black triangle by the Run Select icon on the graph toolbar and select "Weak Spring".

2. Click the Scale-to-Fit icon at the left of the graph toolbar.

3. Click on the Selection icon on the graph toolbar and when the selection box appears, drag the box handles to highlight all the data except the region where the force is zero because the spring is unstretched.

4. Click on the black triangle by the Curve Fit icon and select Linear.

5. From Equation 2 in Theory, the slope of the F vs. x plot is the Spring Constant, k. Enter the v uncertainty in the Spring Constant table on the Weak Spring line for k and δk.

6. We need to determine the exact position where the spring is first unstretched, x_o. Click on th the coordinates crosshairs box that appears and drag it until the vertical crosshair intersects th line (Linear) that you added with the Curve Fit tool crosses the F = 0 horizontal line. Read the v coordinates box and enter it in the first line of the Spring Constant Table. Estimate the uncertainty in x_o by moving the vertical crosshairs a little bit (use the spread of the data to estimate how much is reasonable) left and right of the crossing point and see how much x changes in the coordinates box. Enter the value as δx_o in the Spring Constants table.

7. Right click in the Coordinates tool box and select Delete Tool. Click on the black triangle by the Curve Fit icon and turn off "Linear". Click anywhere in the Selection box to highlight it and click the Remove Active Element icon.

8. Repeat steps 1-5 and 7 for "Strong Spring".

9. We need the start position, x_1, for each of the accelerated runs. Click the black triangle by the Run Select icon and select "15 cm". Click the Scale to Fit icon.

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Table I: Spring Constants

	Spring	k (N/m)	δk (N/m)	x_o (m)	δx_o (m)	x_1 15 (m)	x_1 30 (m)	x_1 45 (m)
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2	Strong	6.86	0.01					
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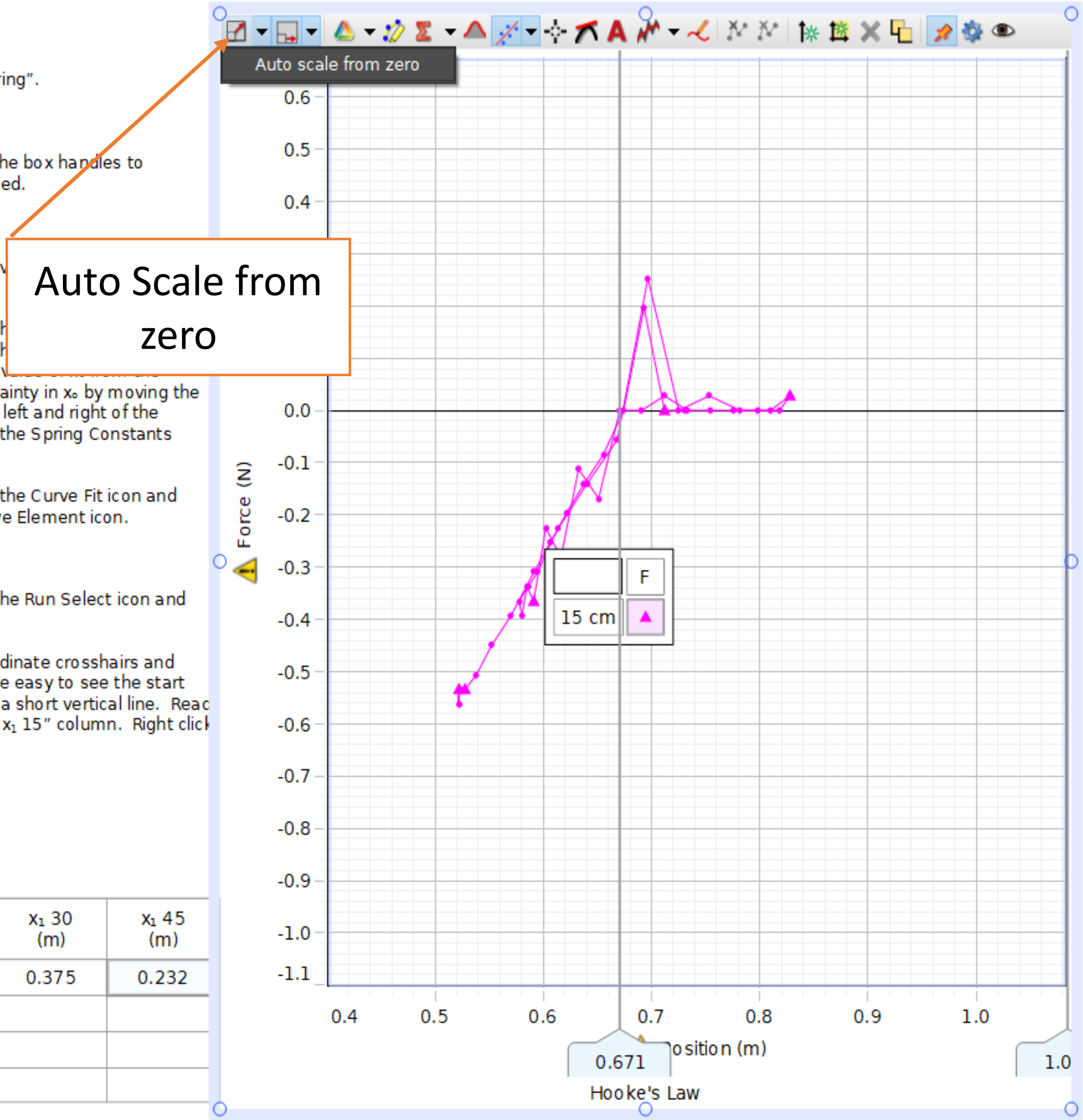
4								



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Scale Axes

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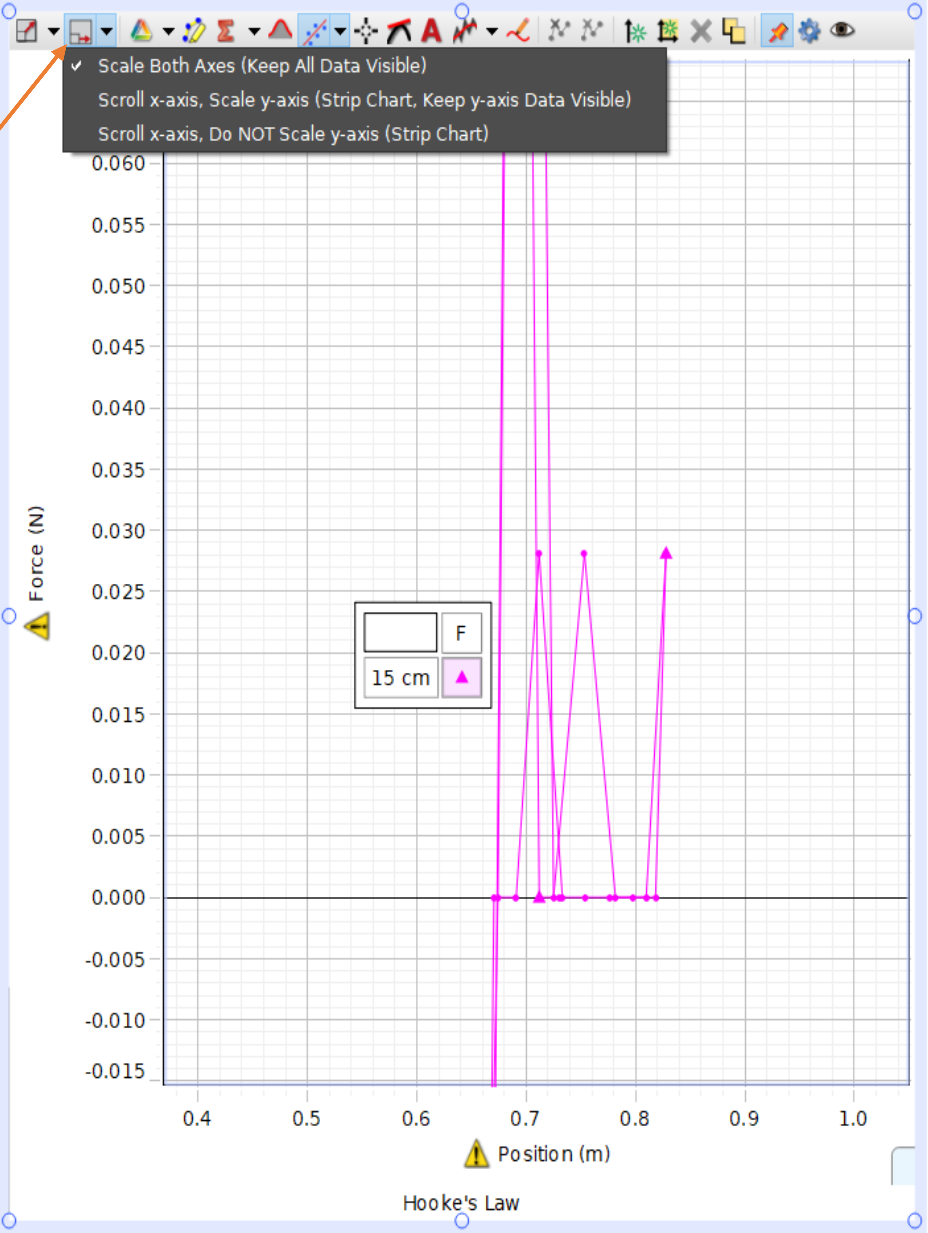

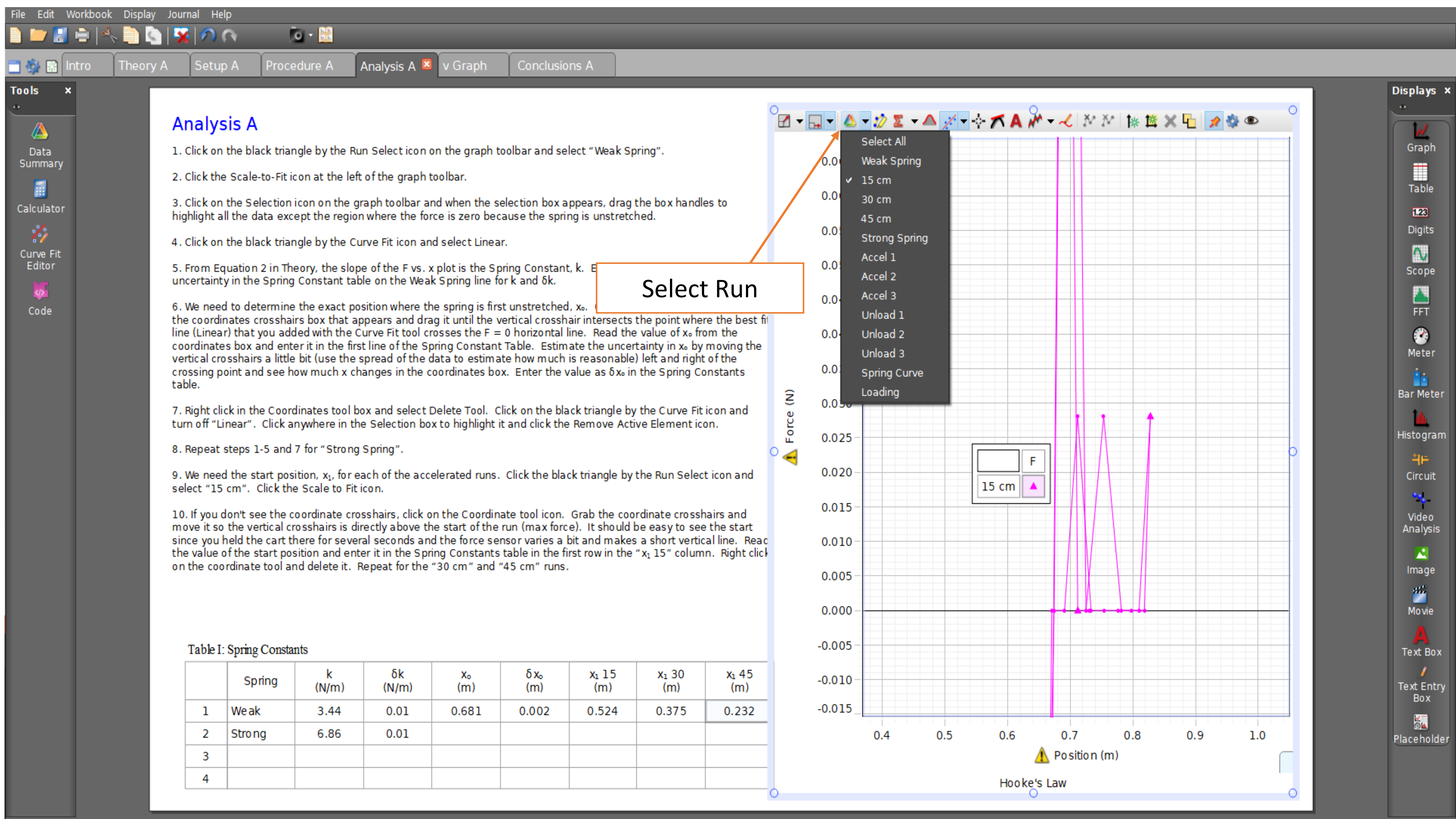

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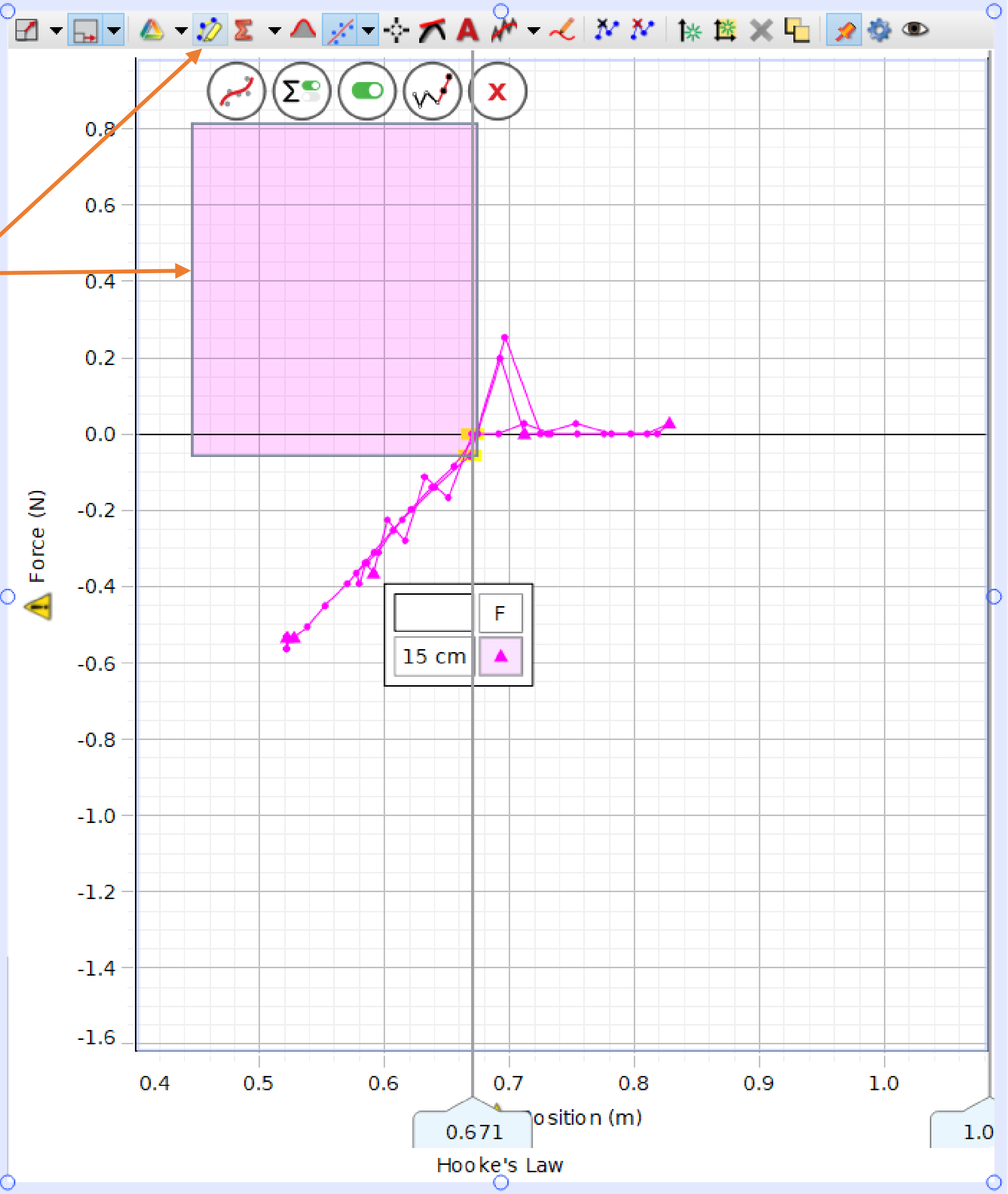

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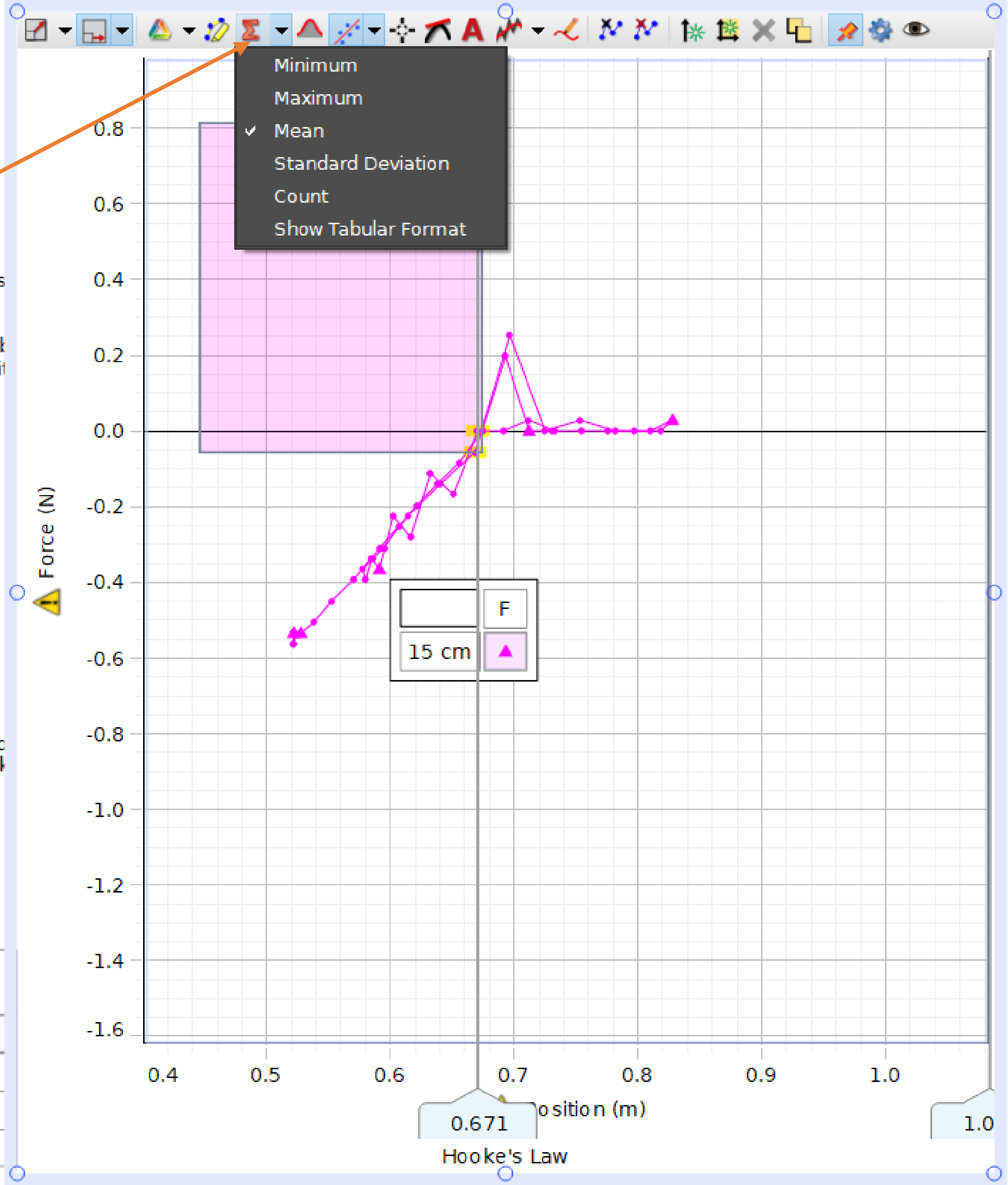

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Display Area Data

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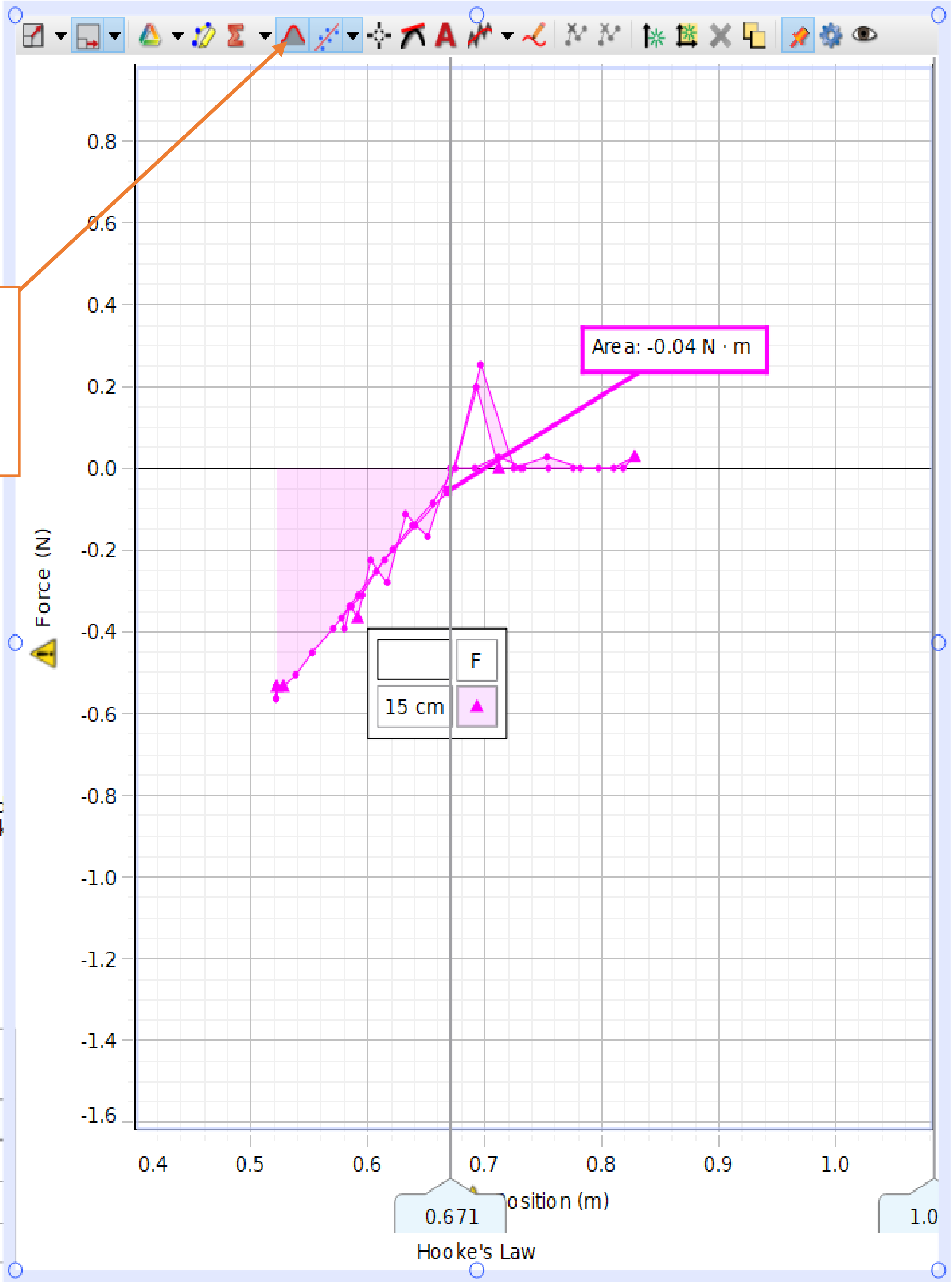
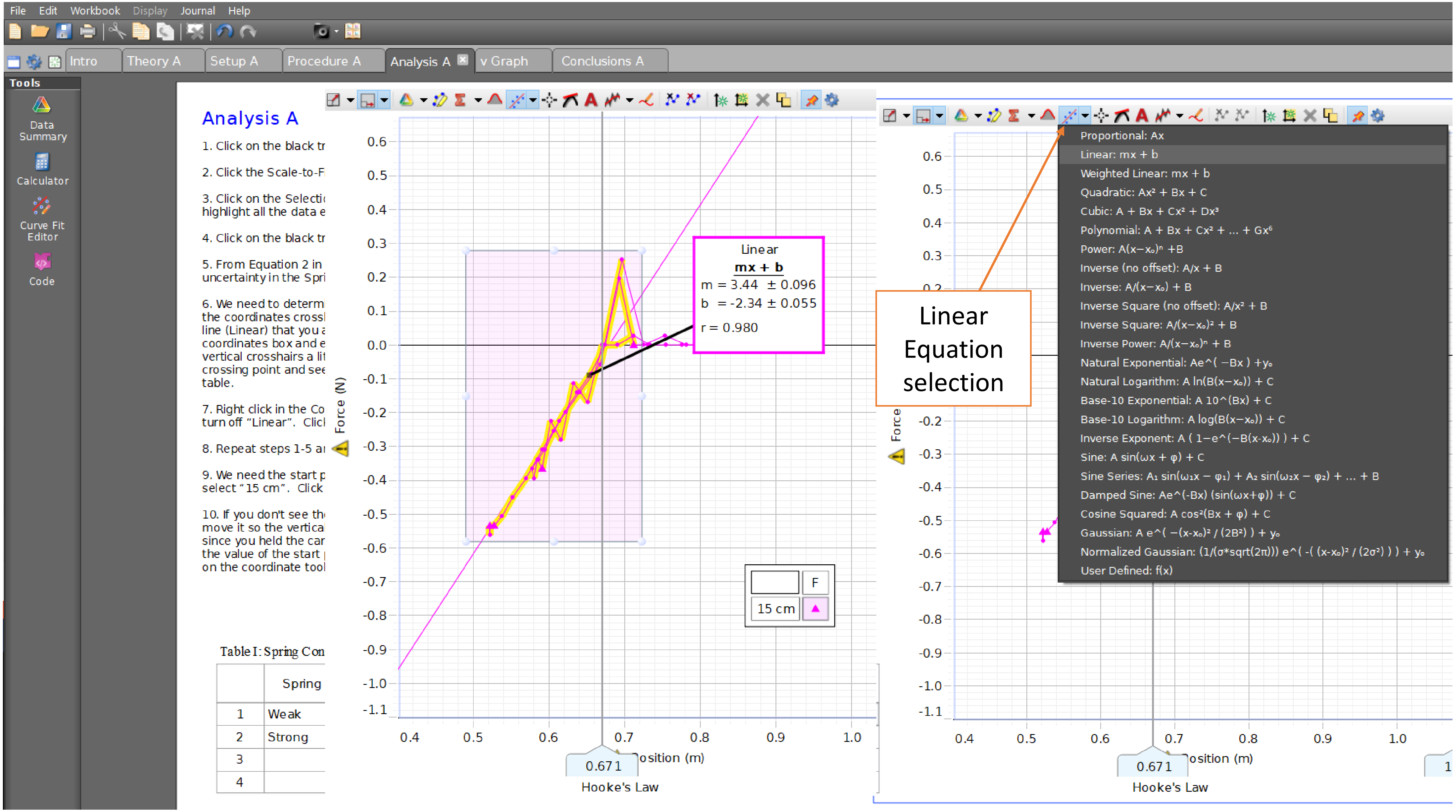


Table I: Spring Constants

	Spring	k (N/m)	δk (N/m)	x_o (m)	δx_o (m)	x_1 15 (m)	x_1 30 (m)	x_1 45 (m)
1	Weak	3.44	0.01	0.681	0.002	0.524	0.375	0.232
2	Strong	6.86	0.01					
3								
4								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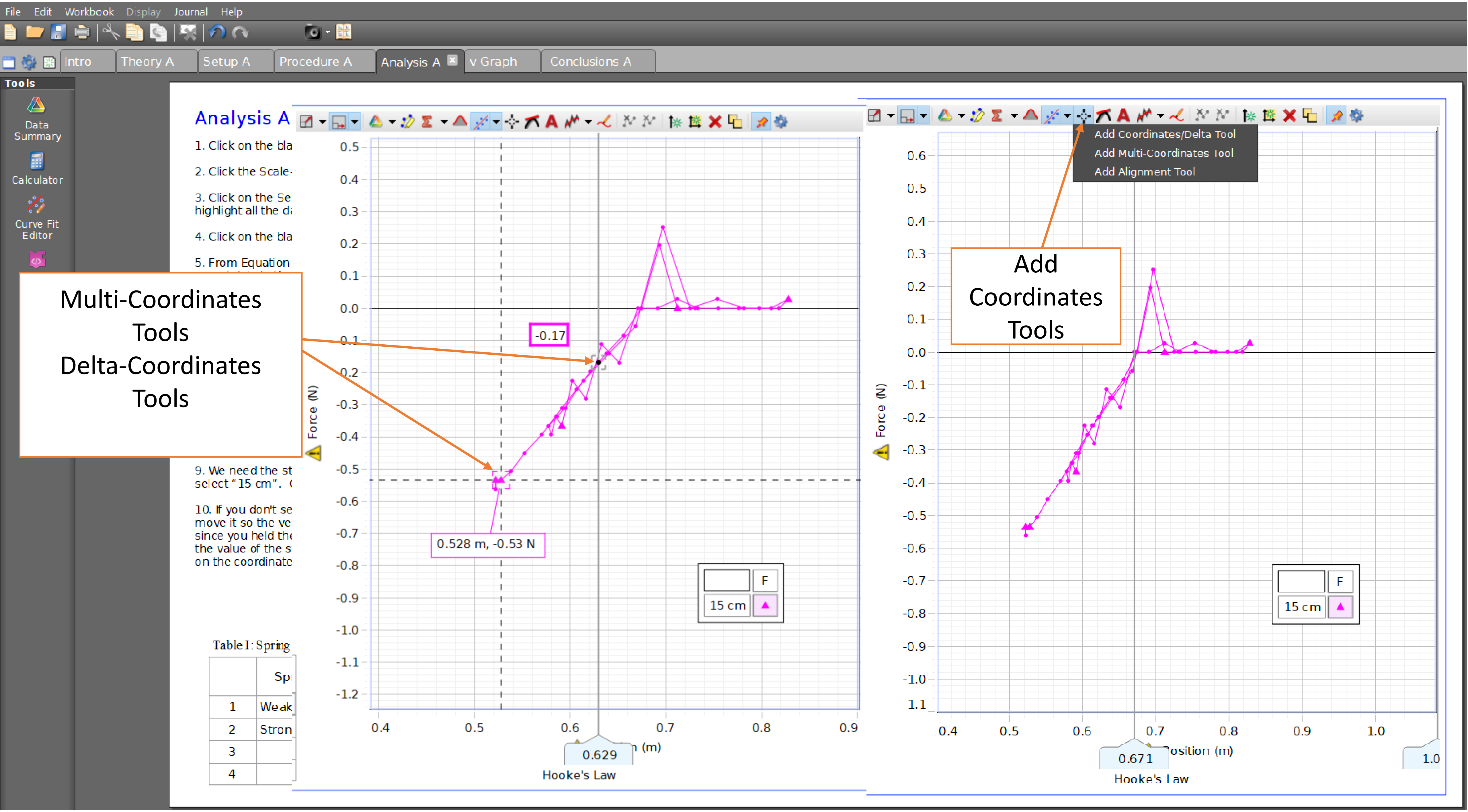
1. Click on the black tr
2. Click the Scale-to-F
3. Click on the Selecti highlight all the data e
4. Click on the black tr
5. From Equation 2 in uncertainty in the Spri
6. We need to determ the coordinates crossi line (Linear) that you a coordinates box and e vertical crosshairs a li crossing point and see table.
7. Right click in the Co turn off "Linear". Clic
8. Repeat steps 1-5 a
9. We need the start p select "15 cm". Click
10. If you don't see th move it so the vertica since you held the car the value of the start on the coordinate tool
Table I: Spring Con
Spring
1 Weak
2 Strong
3
4
Linear
mx + b
m = 3.44 ± 0.096
b = -2.34 ± 0.055
r = 0.980
F
15 cm
Force (N)
Position (m)
0.671
Hooke's Law
Linear Equation selection
Proportional: Ax
Linear: mx + b
Weighted Linear: mx + b
Quadratic: Ax² + Bx + C
Cubic: A + Bx + Cx² + Dx³
Polynomial: A + Bx + Cx² + ... + Gx⁶
Power: A(x−x₀)ⁿ +B
Inverse (no offset): A/x + B
Inverse: A/(x−x₀) + B
Inverse Square (no offset): A/x² + B
Inverse Square: A/(x−x₀)² + B
Inverse Power: A/(x−x₀)ⁿ + B
Natural Exponential: Ae^(−Bx) +y₀
Natural Logarithm: A ln(B(x−x₀)) + C
Base-10 Exponential: A 10^(Bx) + C
Base-10 Logarithm: A log(B(x−x₀)) + C
Inverse Exponent: A (1−e^(−B(x-x₀))) + C
Sine: A sin(ωx + φ) + C
Sine Series: A₁ sin(ω₁x − φ₁) + A₂ sin(ω₂x − φ₂) + ... + B
Damped Sine: Ae^(-Bx) (sin(ωx+φ)) + C
Cosine Squared: A cos²(Bx + φ) + C
Gaussian: A e^(−(x-x₀)² / (2B²)) + y₀
Normalized Gaussian: (1/(σ*sqrt(2π))) e^(-((x-x₀)² / (2σ²))) + y₀
User Defined: f(x)
Force
Position (m)
0.671
Hooke's Law



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9. We need the st
select "15 cm".
10. If you don't se
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since you held the
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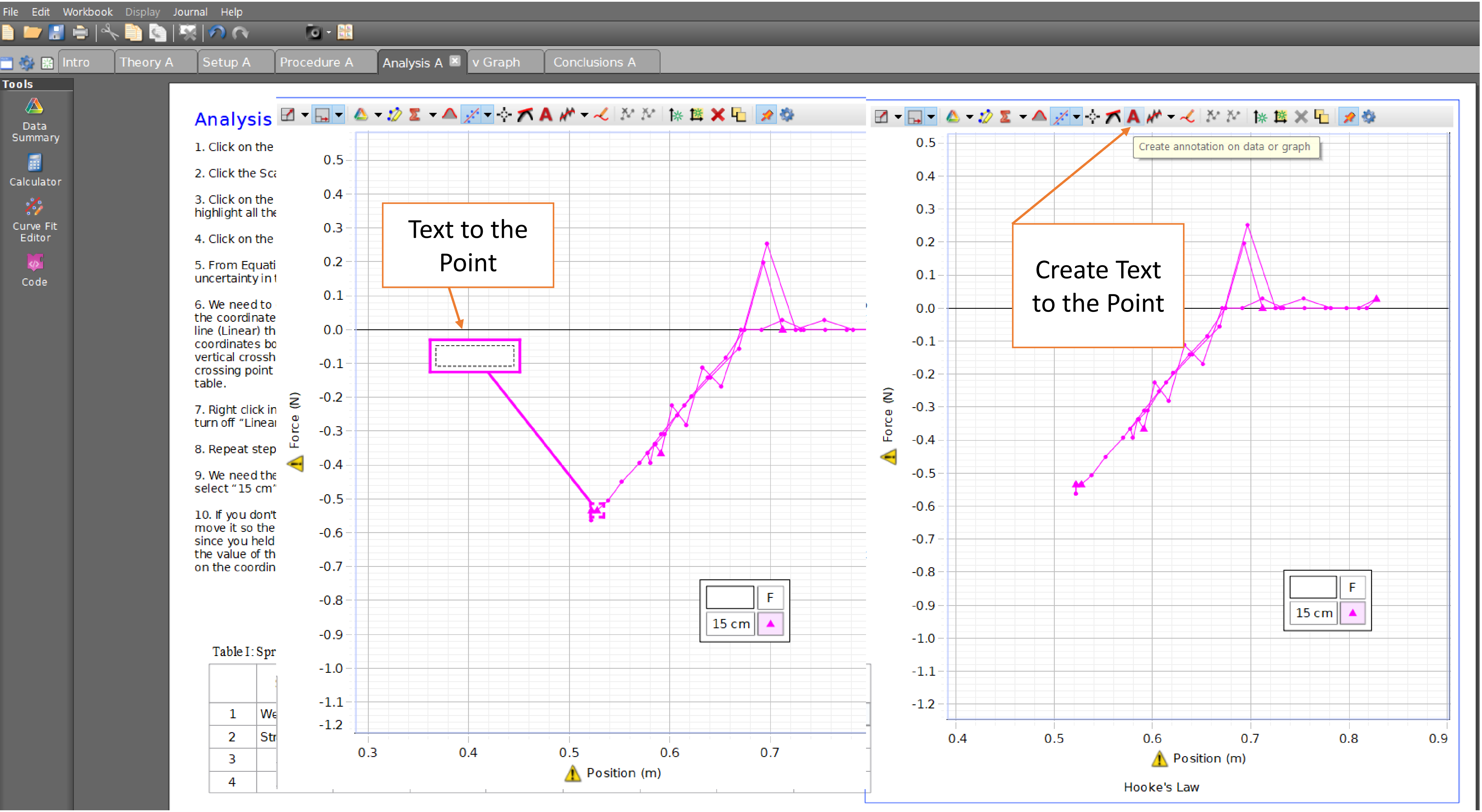
on the coordinate
Table I: Spring
Sp
1 Weak
2 Stron
3
4
Multi-Coordinates Tools
Delta-Coordinates Tools
-0.17
0.528 m, -0.53 N
Force (N)
F
15 cm
0.629
Hooke's Law
Add Coordinates/Delta Tool
Add Multi-Coordinates Tool
Add Alignment Tool
Add Coordinates Tools
Force (N)
F
15 cm
0.671
Position (m)
Hooke's Law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8. Repeat step
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Table I: Spr
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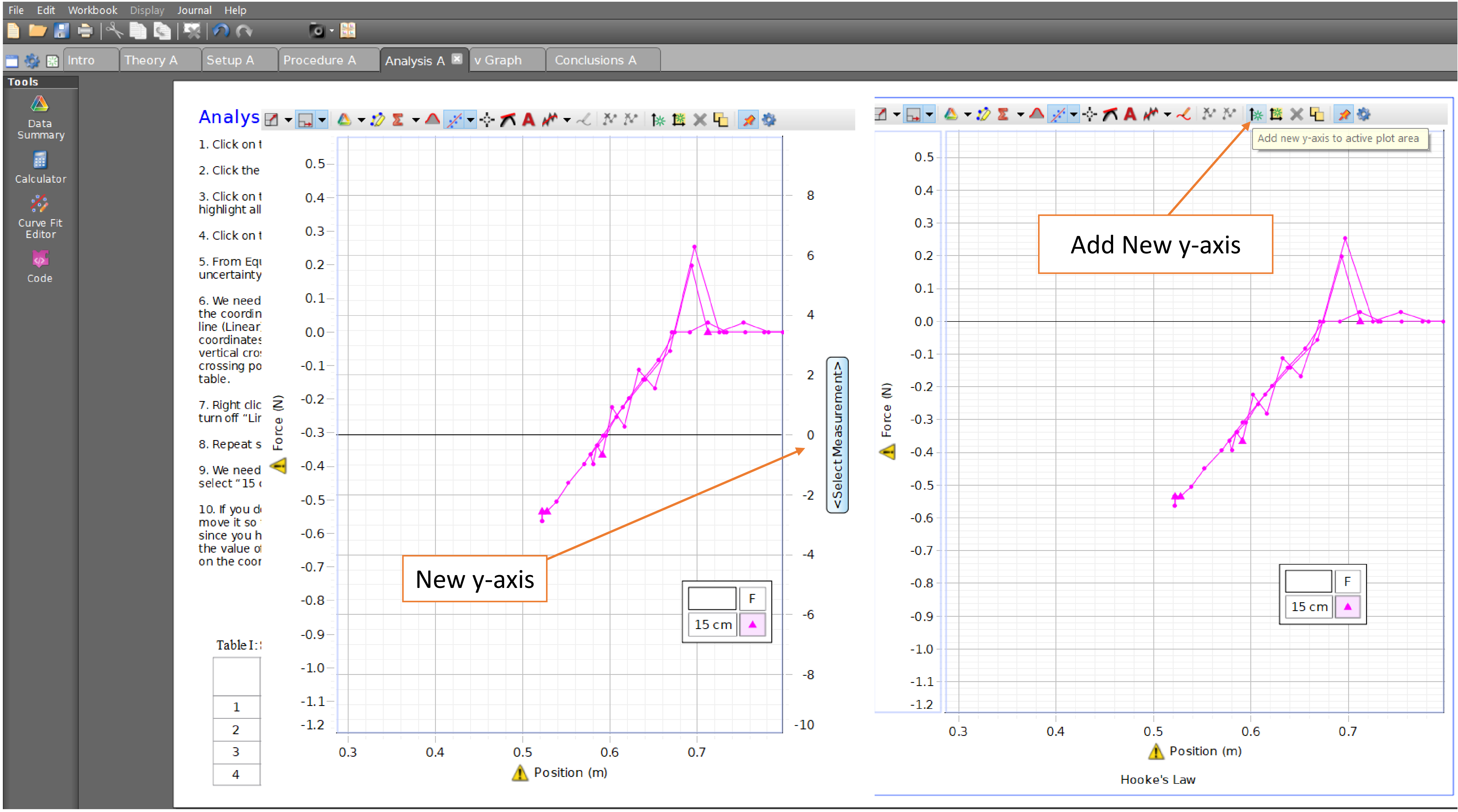
Text to the Point
Create Text to the Point
Create annotation on data or graph
Force (N)
Position (m)
F
15 cm
Hooke's Law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9. We need
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10. If you d
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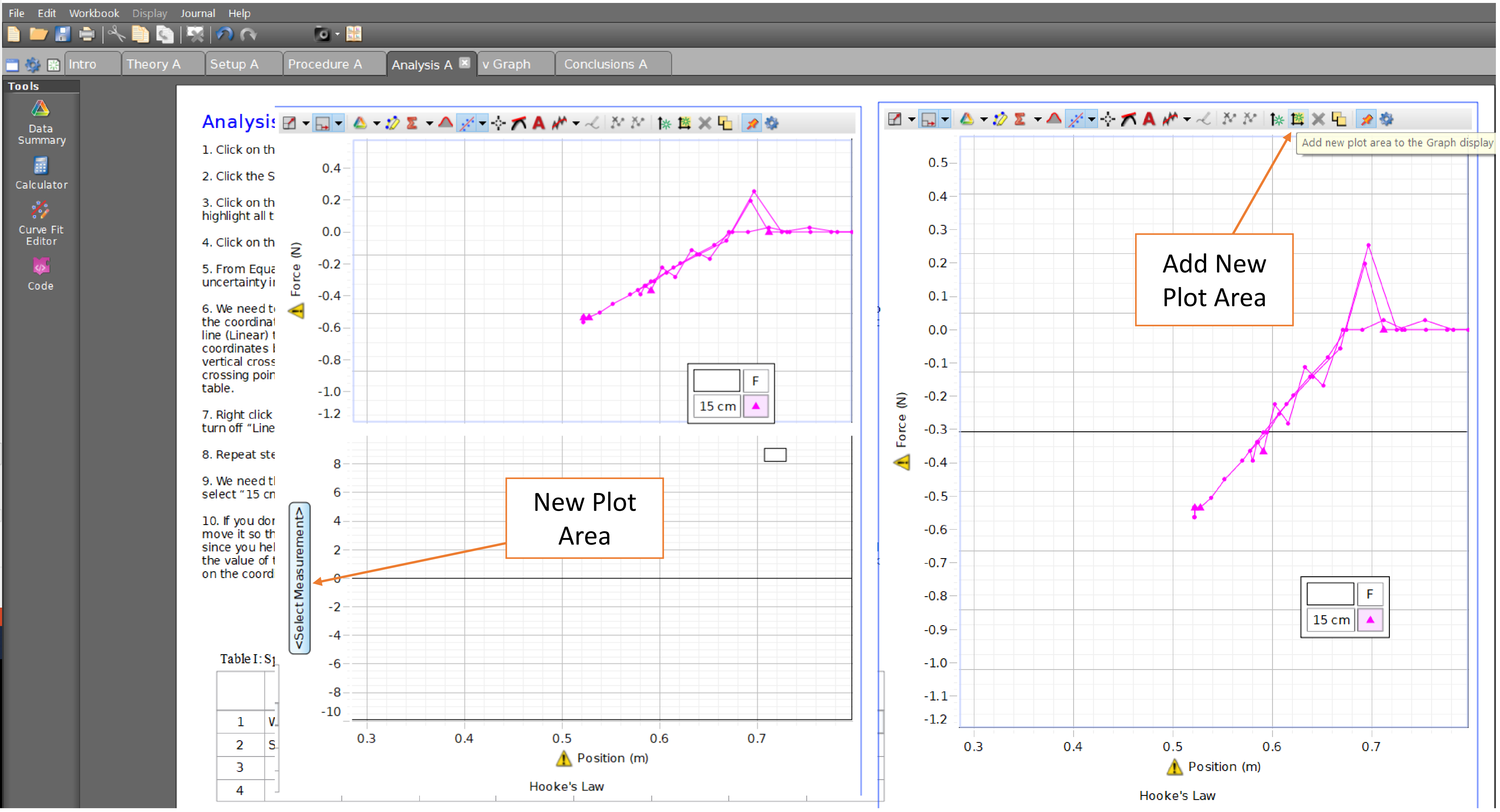
the value o
on the coor
Table I:
1
2
3
4
Force (N)
Position (m)
<Select Measurement>
New y-axis
F
15 cm
Add new y-axis to active plot area
Add New y-axis
Hooke's Law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8. Repeat ste
9. We need tl select "15 cn
10. If you do move it so th since you hel the value of t on the coord
Table I: S
New Plot Area
Add New Plot Area
Add new plot area to the Graph display
Force (N)
<Select Measurement>
Position (m)
Hooke's Law
F
15 cm