Curve Fitting in Microsoft Excel
By William Lee

This document is here to guide you through the steps needed to do curve fitting in Microsoft Excel using the least-squares method.

In mathematical equations you will encounter in this course, there will be a dependent variable and an independent variable. Identifying the dependent and independent variables in a mathematical equation will help you identify what you are solving for in the equation. The ***independent variable*** is a variable whose value determines the value of the ***dependent variables***. Independent variable is plotted on the X-axis, and the dependent variable is plotted on the Y-axis. Other variables may also be present in equations. These may be constants or other variables. They may be given to you or you may be required to obtain them by performing curve fitting. The example below illustrates this point.

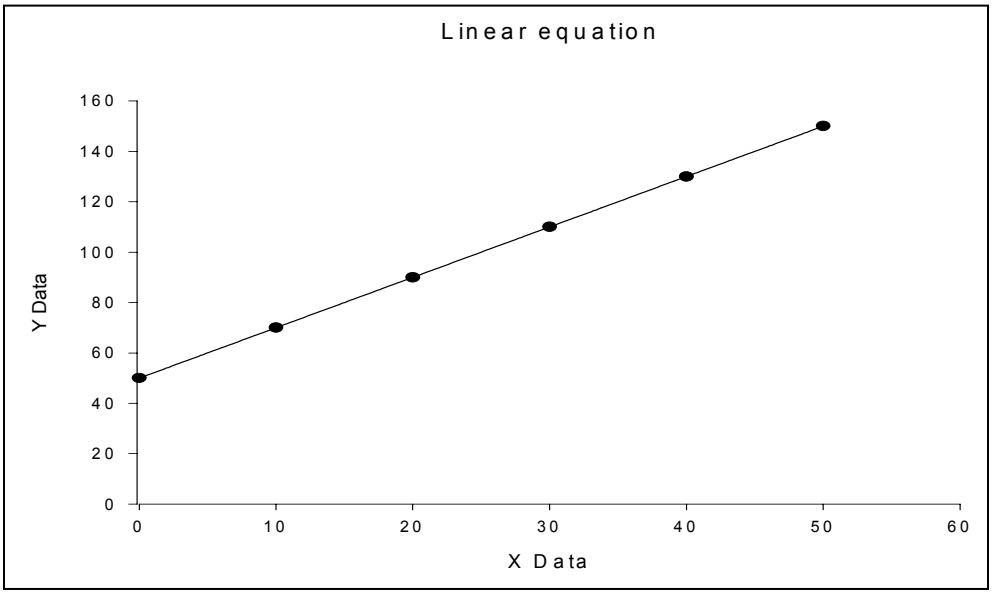
Equation 1:
$y = mx + C$

y = dependent variable
x = independent variable
m and C = constants

Data set:

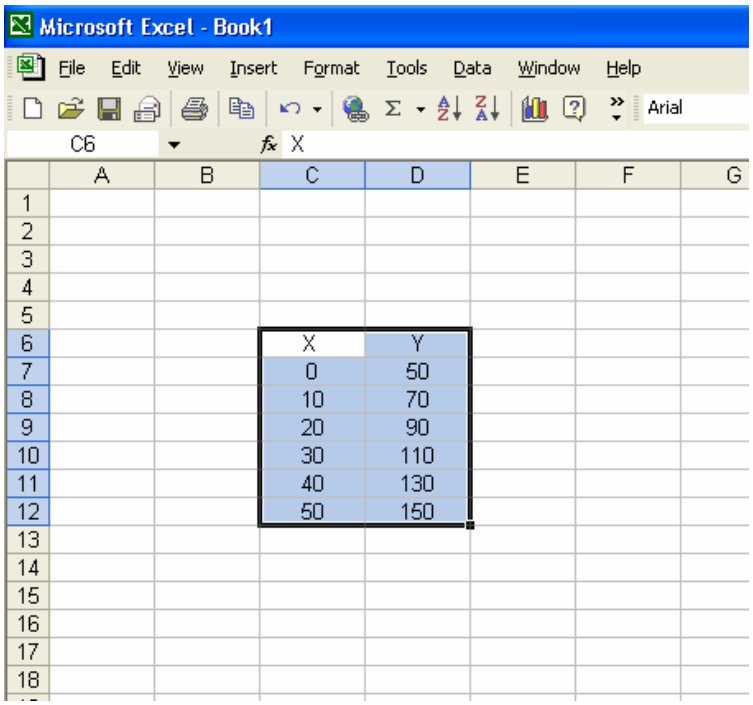
X – independent variable	Y – dependent variable
0	50
10	70
20	90
30	110
40	130
50	150

Graph 1:

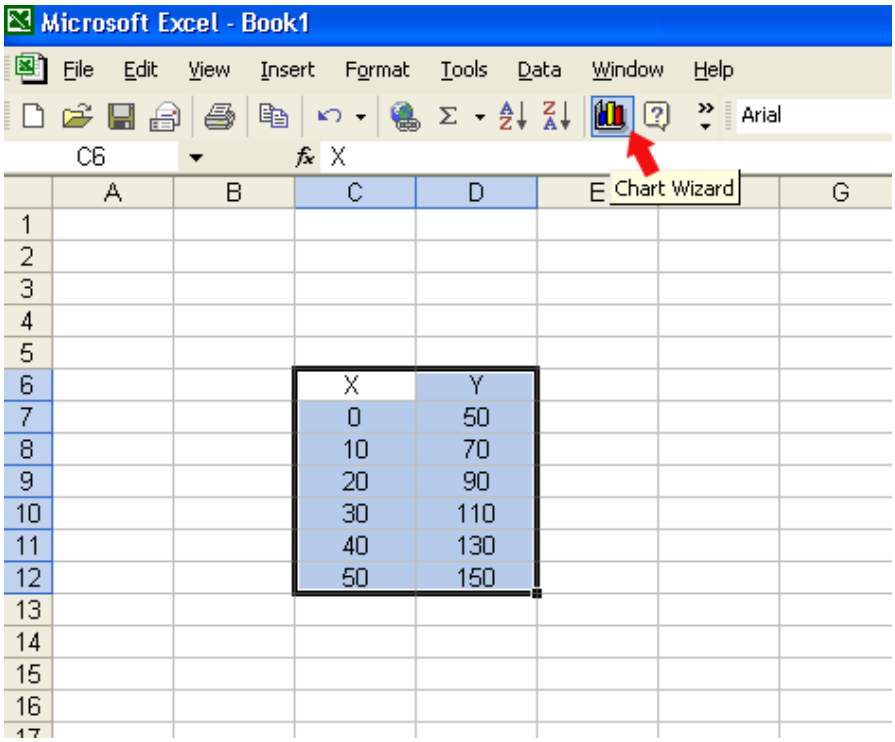


When the dependent and independent variables are plotted as shown in graph 1, m and C values are obtained by adding a best fit line through the data points. m is the slope of the equation, and C is the y-intercept. Adding a best-fit line in Excel can be done by using the Add Trendline.

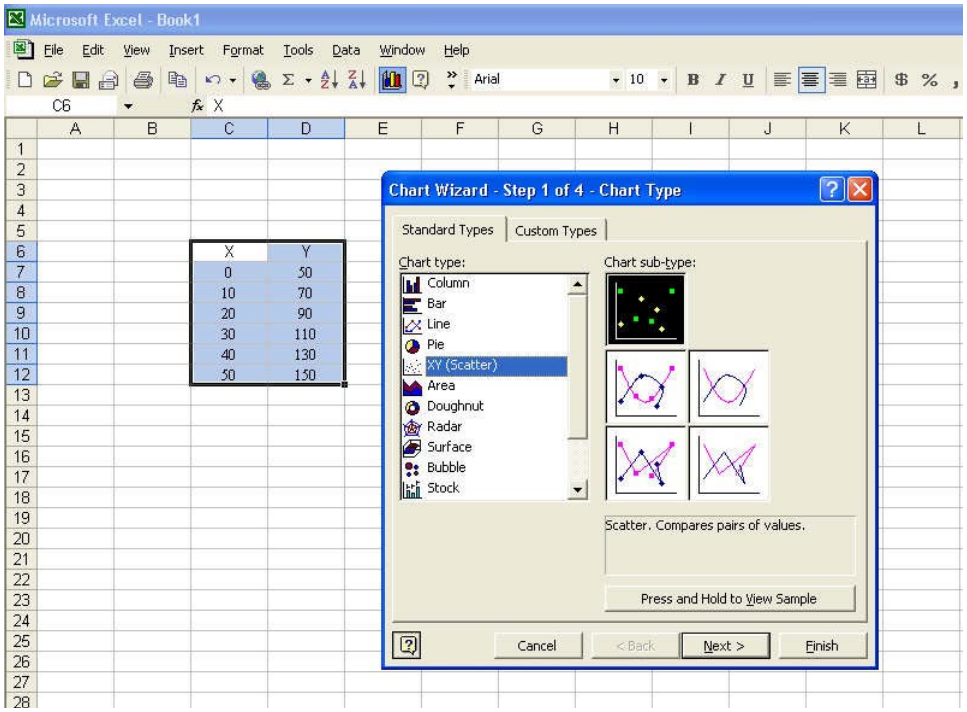
1. Add Data Set in Excel



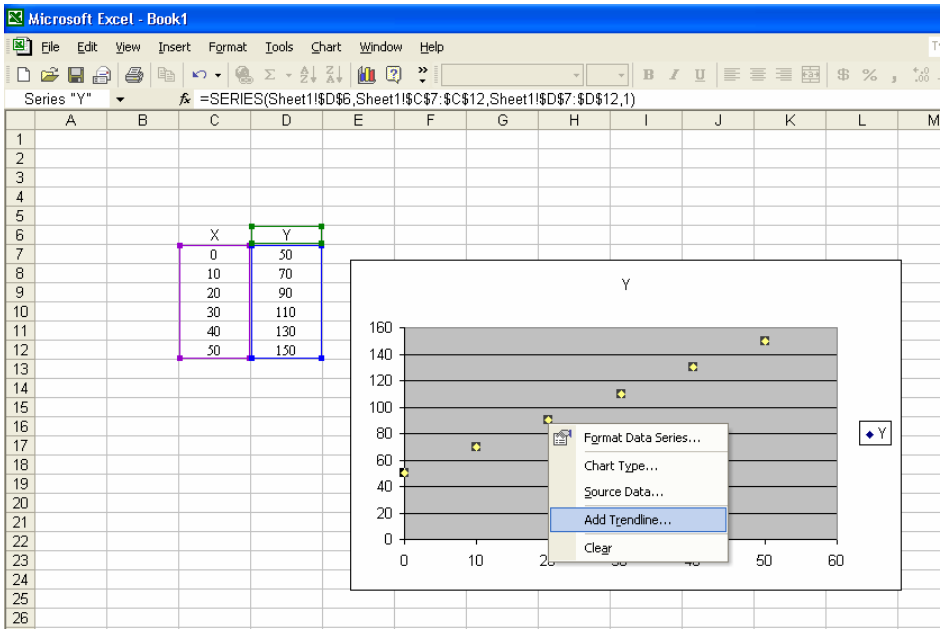
2. To graph it click on **Chart Wizard button.**



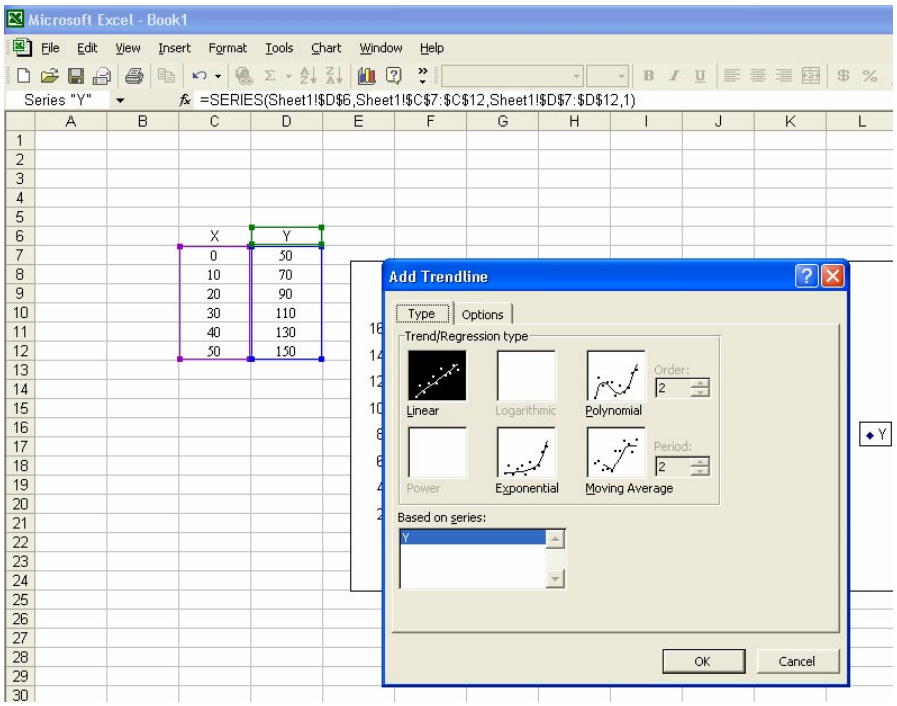
3. Plot the graph as **XY (Scatter)** with data points only. Click Finish when done.



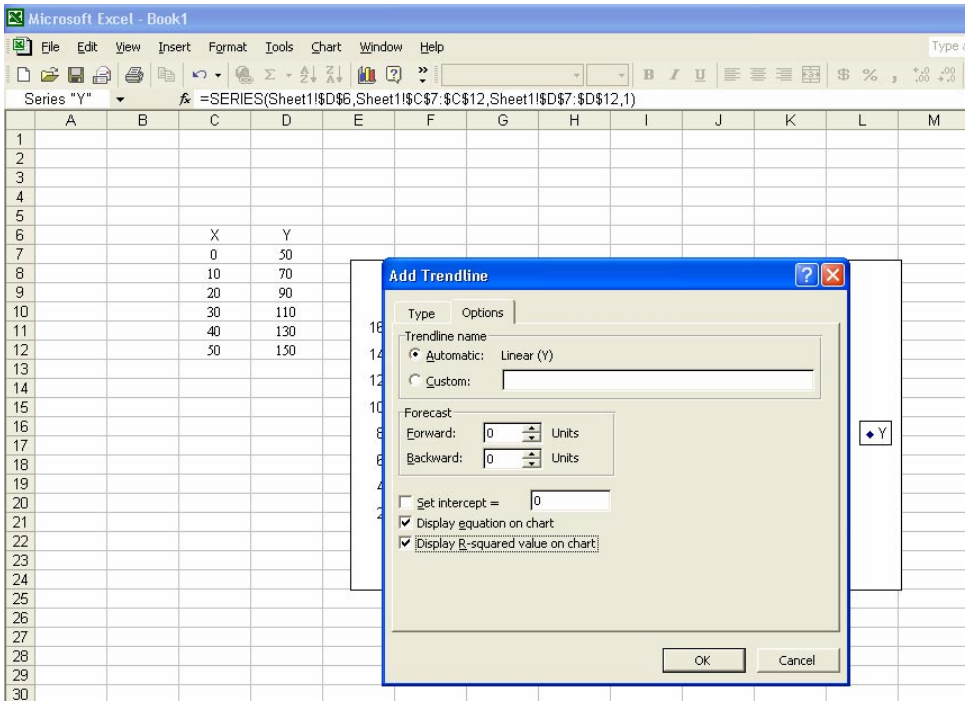
4. To add a trendline, right-click on one of the data points, then select **Add Trendline…**



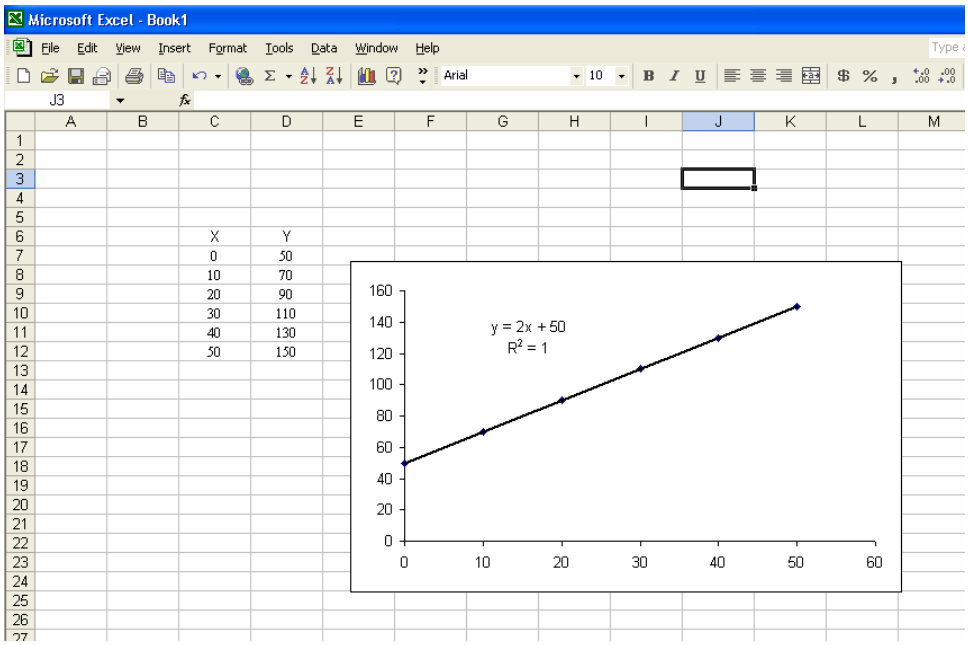
5. Select **Linear** Trend\Regression type.



6. Click on the Options tab. Put a check on **Display equation on chart** and **Display R-squared value on chart boxes.** Click **OK** when done.



7. The equation for the function will be displayed on the chart as shown below.



The equation displayed for the best-fit line shows m (slope) to be 2 and C (y-intercept) to be 50. The method shown here works well when Excel already has the built-in function, such as the function for a linear regression shown above. When the function to be used is not present in Excel (as is the case for most functions you will encounter in the sciences), the method shown below should be used.

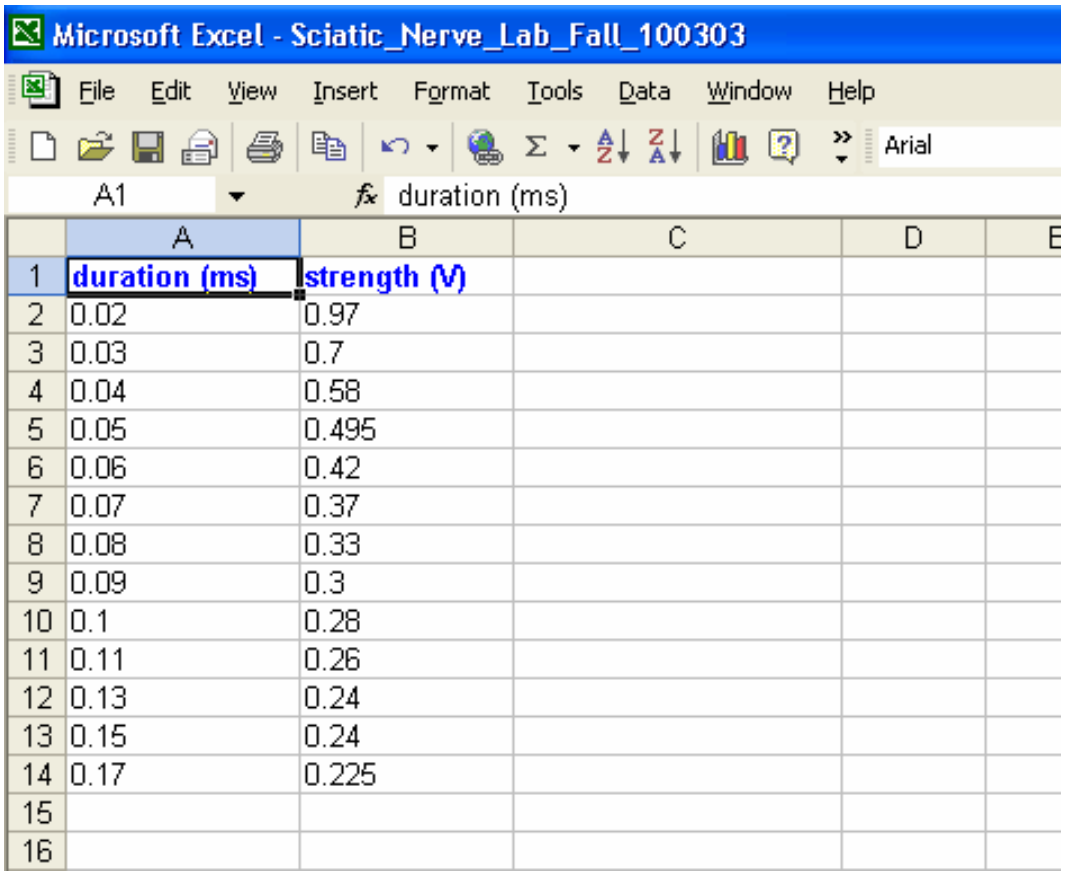
Curve fitting for the Strength-Duration Data

The equation used to fit the strength-duration data is shown below:

$$V = V_{Rh}\left(\frac{1}{1-e^{\frac{-t}{k}}}\right)$$

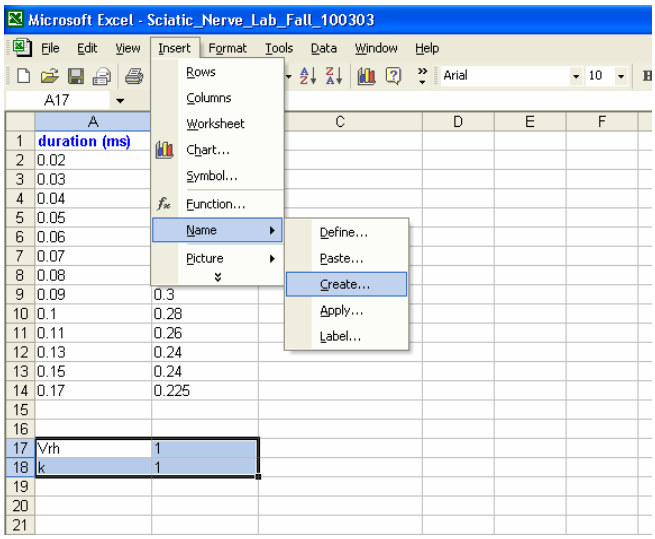
- V = stimulus strength (dependent variable). Plot the stimulus strength on the y-axis.
- V_{Rh} = Rheobase. The rheobase is a constant, whose value depends on the nerve studied. You will obtain this parameter from the fit.
- t = duration (independent variable). Plot the duration on the x-axis.
- k = constant. This is also a constant. You will obtain this parameter from the fit as well.

1. Input your data set as shown below.

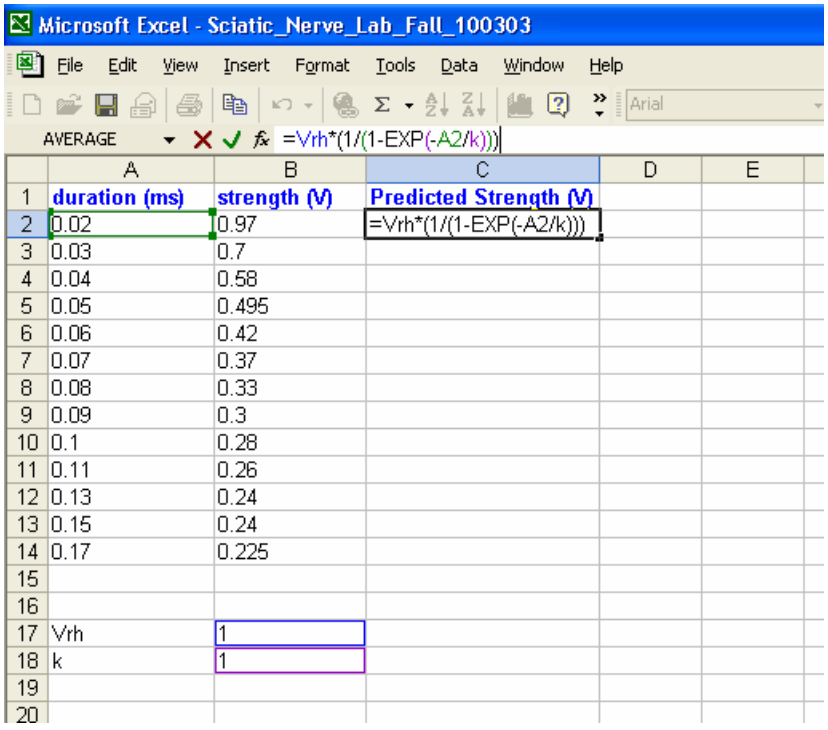


	A	B	C	D	E
1	duration (ms)	strength (V)			
2	0.02	0.97			
3	0.03	0.7			
4	0.04	0.58			
5	0.05	0.495			
6	0.06	0.42			
7	0.07	0.37			
8	0.08	0.33			
9	0.09	0.3			
10	0.1	0.28			
11	0.11	0.26			
12	0.13	0.24			
13	0.15	0.24			
14	0.17	0.225			
15					
16					

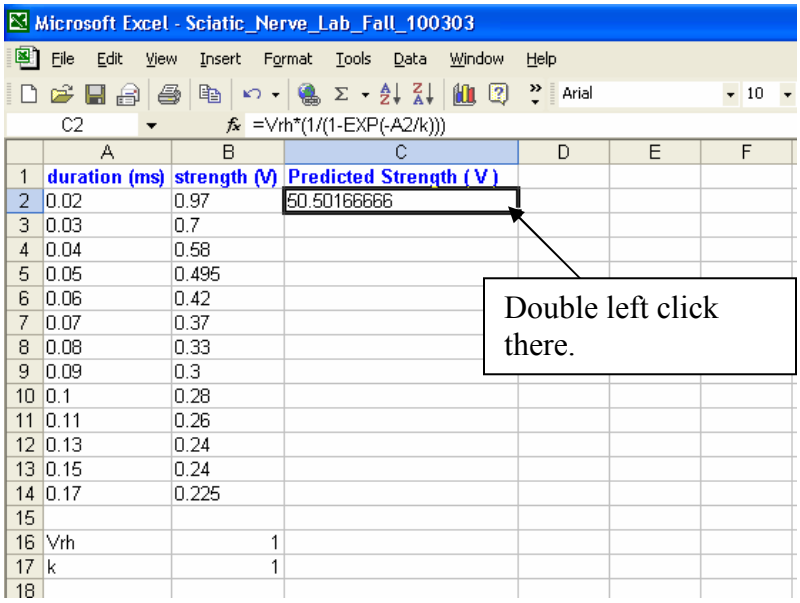
2. Create names for k and V_{Rh}. Input the initial values for V_{Rh} and k (e.g., 1 for both Vrh and k). Then click on **Insert**, **Name**, **Create**. Then a new window will pop up and just click ok.

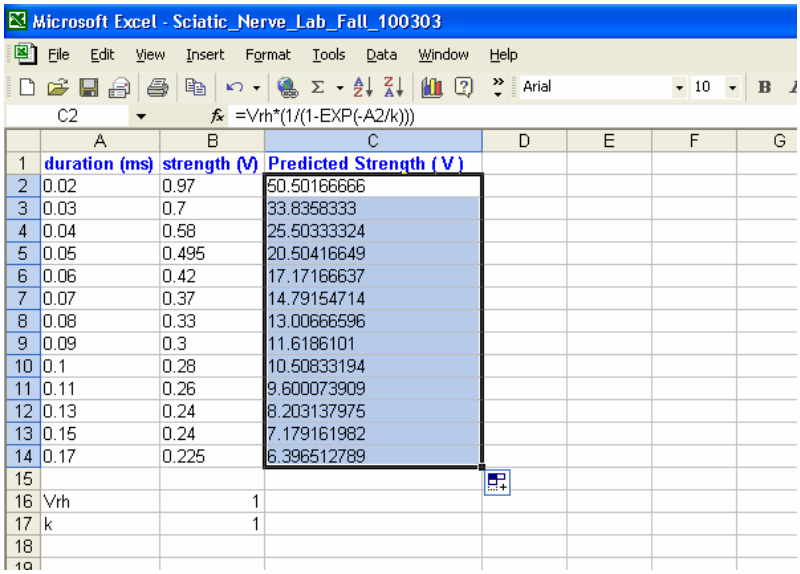


3. Now you have created names for k and V_{Rh}. You can predict the strength using these constants in the equation shown below.

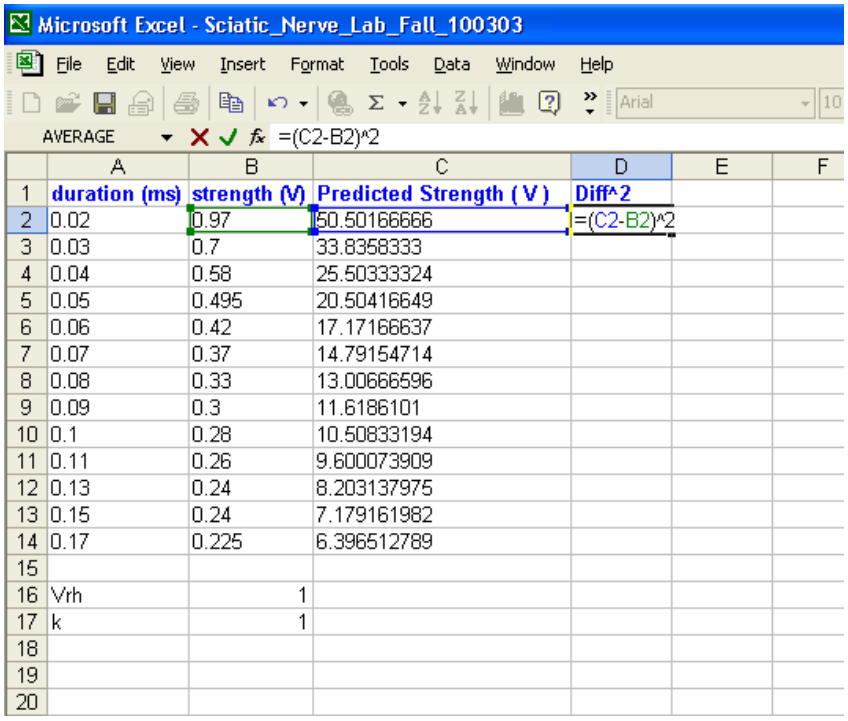


4. Once you have one predicted value for the first duration, double left click on the bottom right corner of your first predicted strength cell as shown below. This will predict the strength for all the durations. See the two figures shown below for what to expect before and after.





5. Now we have predicted the strength for all the durations. We can take the difference between the actual data and the predicted value, and calculate the square of the differenced all the predicted data points (e.g., strengths).



Microsoft Excel - Sciatic_Nerve_Lab_Fall_100303

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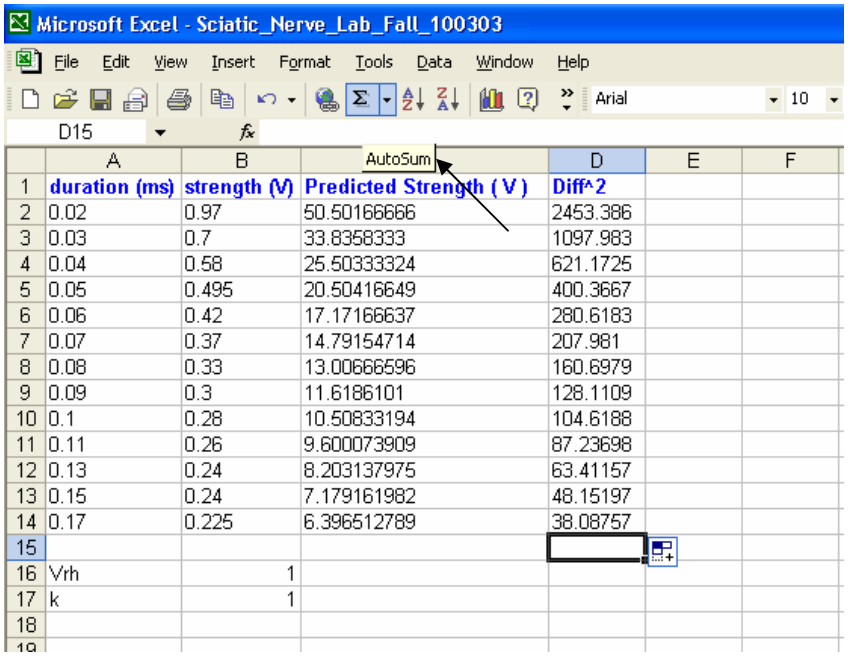
AVERAGE =(C2-B2)^2

	A	B	C	D	E	F
1	duration (ms)	strength (V)	Predicted Strength (V)	Diff^2		
2	0.02	0.97	50.50166666	=(C2-B2)^2		
3	0.03	0.7	33.8358333			
4	0.04	0.58	25.50333324			
5	0.05	0.495	20.50416649			
6	0.06	0.42	17.17166637			
7	0.07	0.37	14.79154714			
8	0.08	0.33	13.00666596			
9	0.09	0.3	11.6186101			
10	0.1	0.28	10.50833194			
11	0.11	0.26	9.600073909			
12	0.13	0.24	8.203137975			
13	0.15	0.24	7.179161982			
14	0.17	0.225	6.396512789			
15						
16	Vrh	1				
17	k	1				
18						
19						
20						

6. Now we have calculated the square of the differences. We can then sum the square of the differences by using the **AutoSum** button as shown below.



Microsoft Excel - Sciatic_Nerve_Lab_Fall_100303

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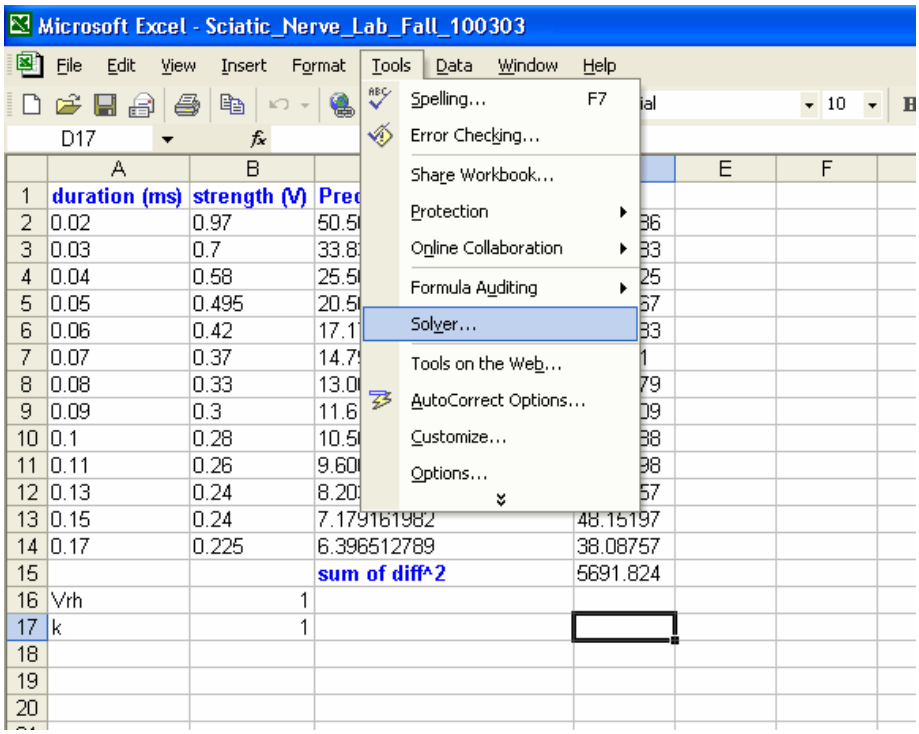
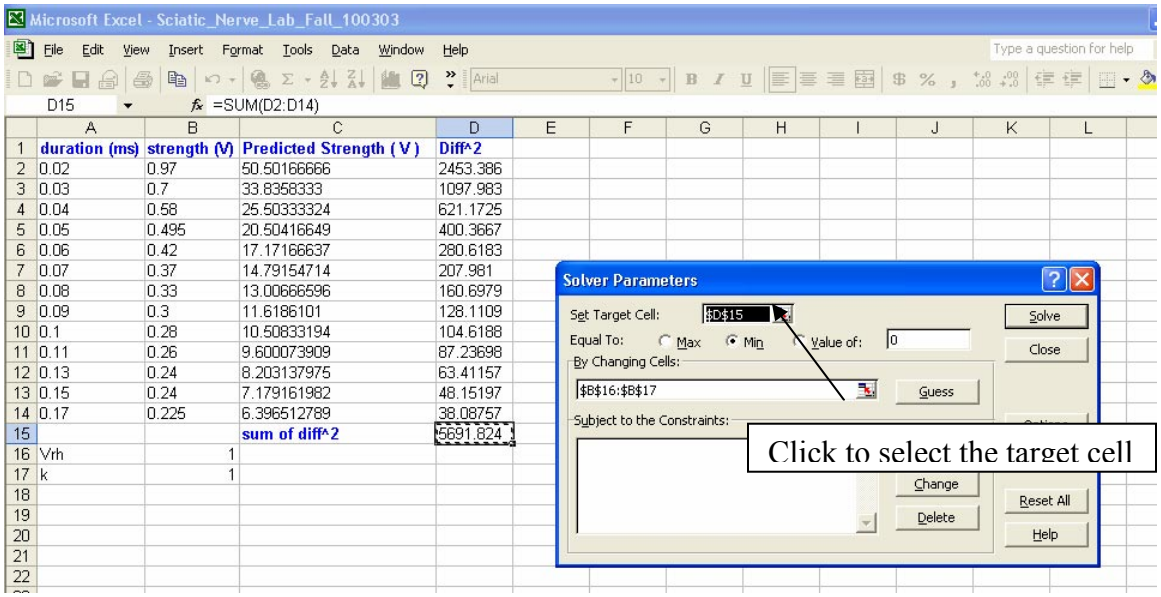
AutoSum

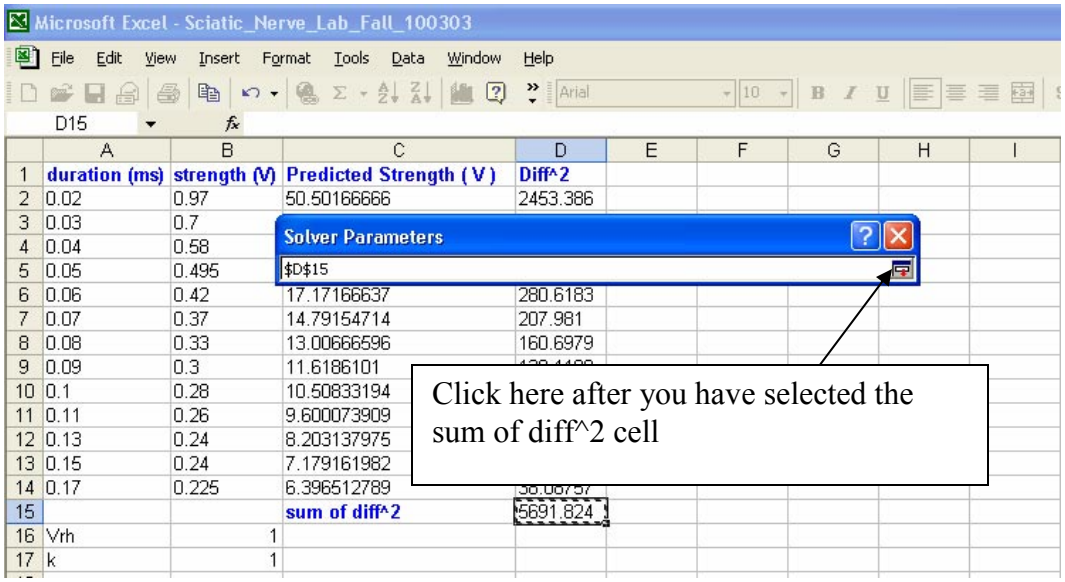
	A	B	C	D	E	F
1	duration (ms)	strength (V)	Predicted Strength (V)	Diff^2		
2	0.02	0.97	50.50166666	2453.386		
3	0.03	0.7	33.8358333	1097.983		
4	0.04	0.58	25.50333324	621.1725		
5	0.05	0.495	20.50416649	400.3667		
6	0.06	0.42	17.17166637	280.6183		
7	0.07	0.37	14.79154714	207.981		
8	0.08	0.33	13.00666596	160.6979		
9	0.09	0.3	11.6186101	128.1109		
10	0.1	0.28	10.50833194	104.6188		
11	0.11	0.26	9.600073909	87.23698		
12	0.13	0.24	8.203137975	63.41157		
13	0.15	0.24	7.179161982	48.15197		
14	0.17	0.225	6.396512789	38.08757		
15						
16	Vrh	1				
17	k	1				
18						

7. Now you have all the data for the analysis. Now click on **Tools**, **Solver**.



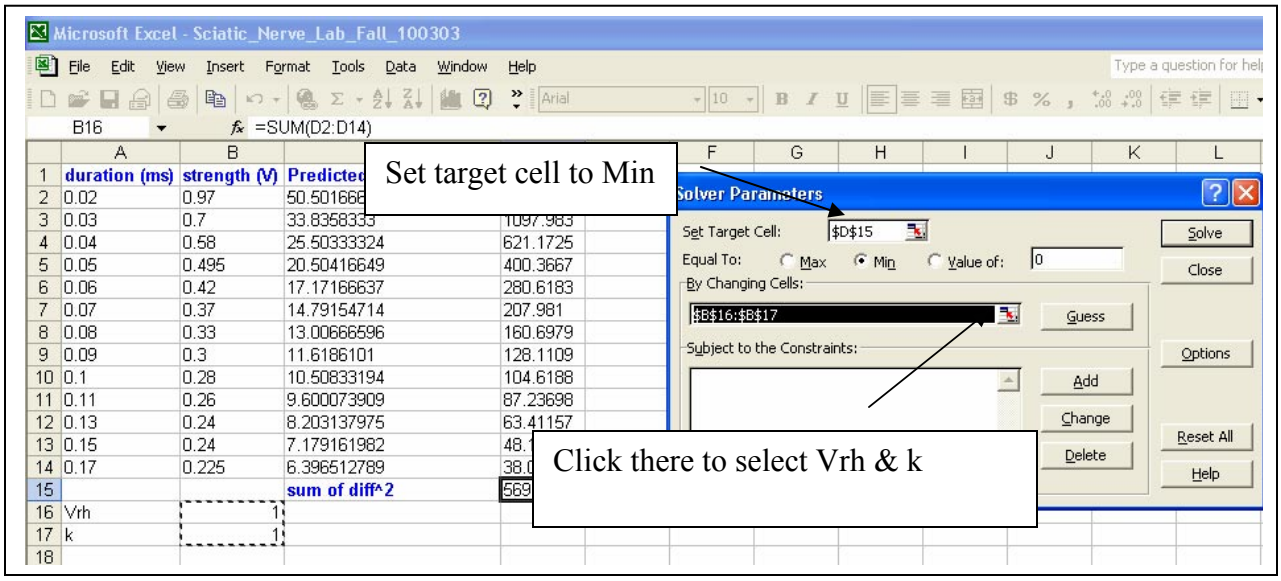
8. A new window will open as shown below. Set the sum of diff^2 cell as your Target Cell.





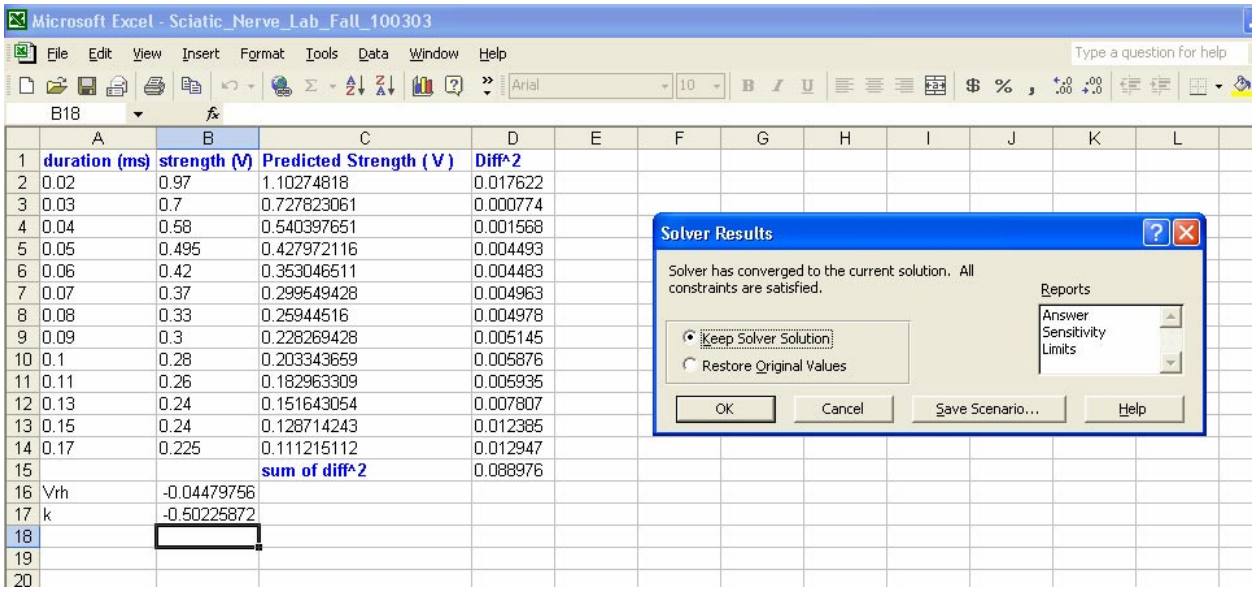
	A	B	C	D
1	duration (ms)	strength (V)	Predicted Strength (V)	Diff^2
2	0.02	0.97	50.50166666	2453.386
3	0.03	0.7		
4	0.04	0.58		
5	0.05	0.495		
6	0.06	0.42	17.17166637	280.6183
7	0.07	0.37	14.79154714	207.981
8	0.08	0.33	13.00666596	160.6979
9	0.09	0.3	11.6186101	
10	0.1	0.28	10.50833194	
11	0.11	0.26	9.600073909	
12	0.13	0.24	8.203137975	
13	0.15	0.24	7.179161982	
14	0.17	0.225	6.396512789	
15			sum of diff^2	5691.824
16	Vrh	1		
17	k	1		

9. Now make the target cell Equal to **Min**. Under **By Changing Cells**, select the cells where the numeric values of V_{Rh} and k are located as shown below.



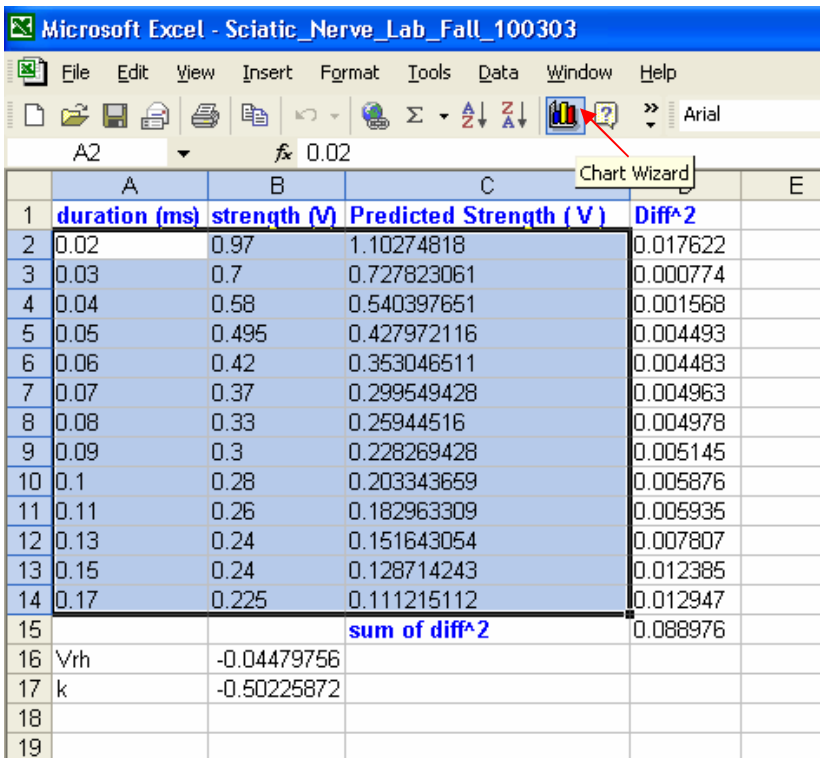
	A	B	C
1	duration (ms)	strength (V)	Predicted
2	0.02	0.97	50.50166
3	0.03	0.7	33.8358333
4	0.04	0.58	25.50333324
5	0.05	0.495	20.50416649
6	0.06	0.42	17.17166637
7	0.07	0.37	14.79154714
8	0.08	0.33	13.00666596
9	0.09	0.3	11.6186101
10	0.1	0.28	10.50833194
11	0.11	0.26	9.600073909
12	0.13	0.24	8.203137975
13	0.15	0.24	7.179161982
14	0.17	0.225	6.396512789
15			sum of diff^2
16	Vrh	1	
17	k	1	
18			

10. Now you can click on **Solve** and Excel will minimize the difference between the predicted strength and actual strength by changing the values of V_{Rh} and k. A new window will popup after you click solve, just click **OK**.



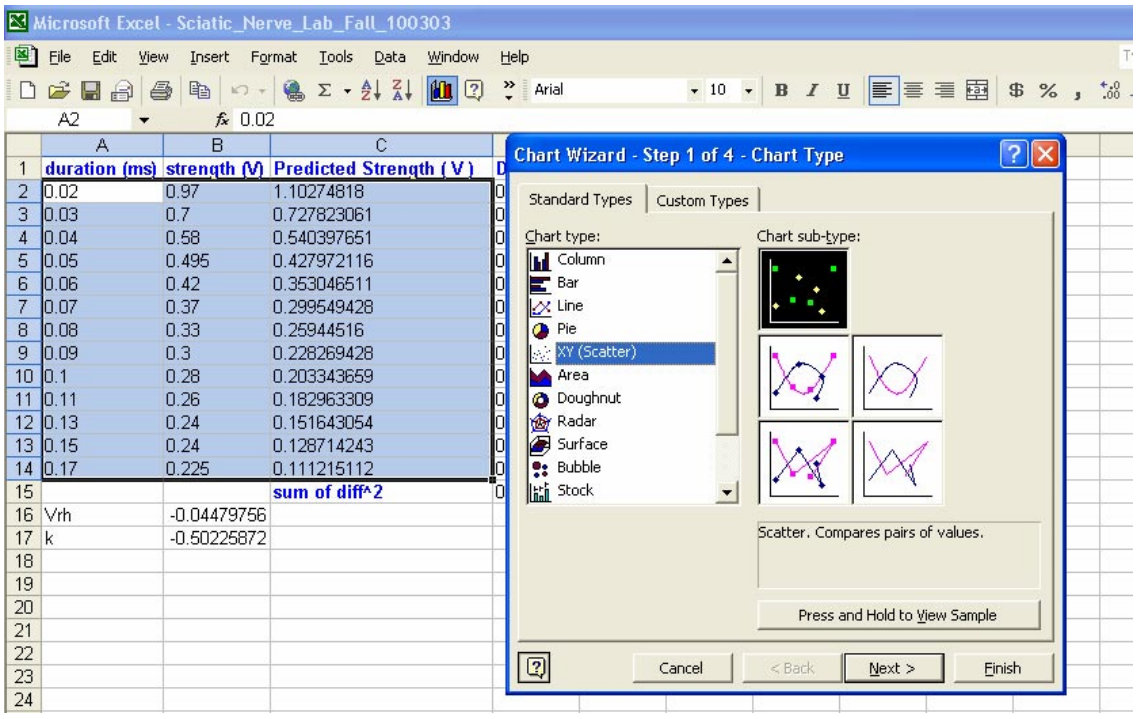
	A	B	C	D
1	duration (ms)	strength (V)	Predicted Strength (V)	Diff^2
2	0.02	0.97	1.10274818	0.017622
3	0.03	0.7	0.727823061	0.000774
4	0.04	0.58	0.540397651	0.001568
5	0.05	0.495	0.427972116	0.004493
6	0.06	0.42	0.353046511	0.004483
7	0.07	0.37	0.299549428	0.004963
8	0.08	0.33	0.25944516	0.004978
9	0.09	0.3	0.228269428	0.005145
10	0.1	0.28	0.203343659	0.005876
11	0.11	0.26	0.182963309	0.005935
12	0.13	0.24	0.151643054	0.007807
13	0.15	0.24	0.128714243	0.012385
14	0.17	0.225	0.111215112	0.012947
15			sum of diff^2	0.088976
16	Vrh	-0.04479756		
17	k	-0.50225872		
18				
19				
20				

11. Now plot both the actual and predicted values in Excel. You can do this by highlighting the duration, strength and predicted strength columns as shown below. Then click on the **Chart Wizard** button.

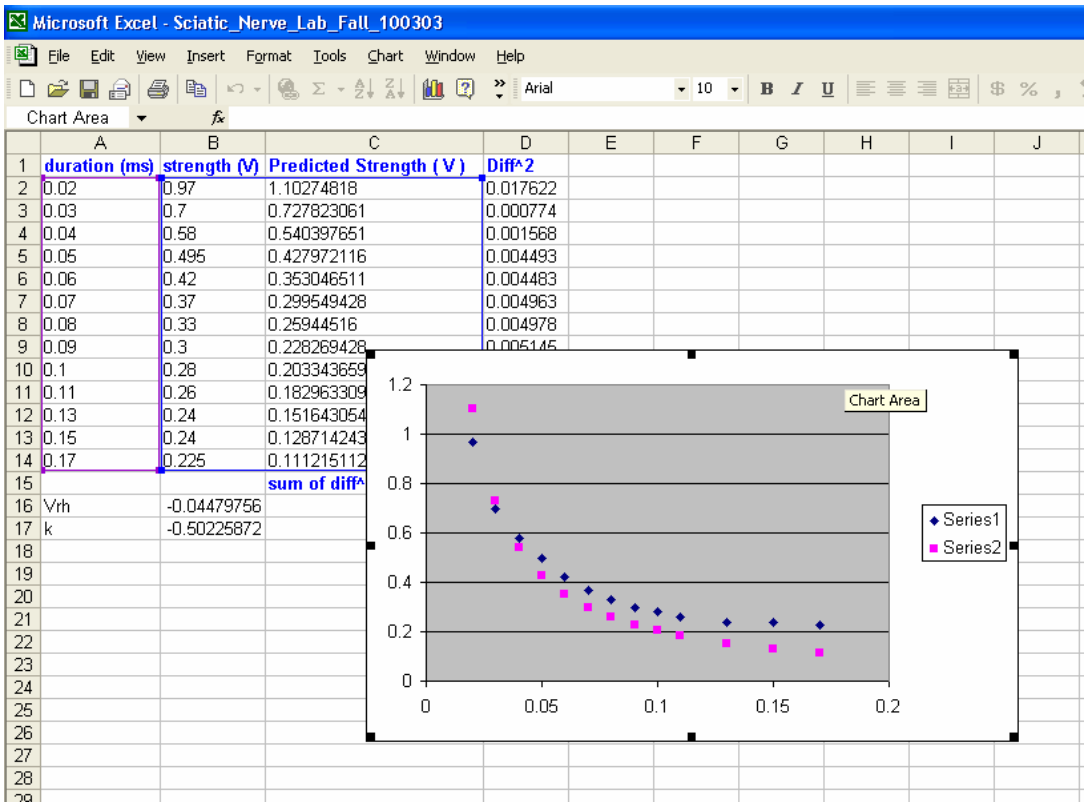


	A	B	C	D	E
1	duration (ms)	strength (V)	Predicted Strength (V)	Diff^2	
2	0.02	0.97	1.10274818	0.017622	
3	0.03	0.7	0.727823061	0.000774	
4	0.04	0.58	0.540397651	0.001568	
5	0.05	0.495	0.427972116	0.004493	
6	0.06	0.42	0.353046511	0.004483	
7	0.07	0.37	0.299549428	0.004963	
8	0.08	0.33	0.25944516	0.004978	
9	0.09	0.3	0.228269428	0.005145	
10	0.1	0.28	0.203343659	0.005876	
11	0.11	0.26	0.182963309	0.005935	
12	0.13	0.24	0.151643054	0.007807	
13	0.15	0.24	0.128714243	0.012385	
14	0.17	0.225	0.111215112	0.012947	
15			sum of diff^2	0.088976	
16	Vrh	-0.04479756			
17	k	-0.50225872			
18					
19					

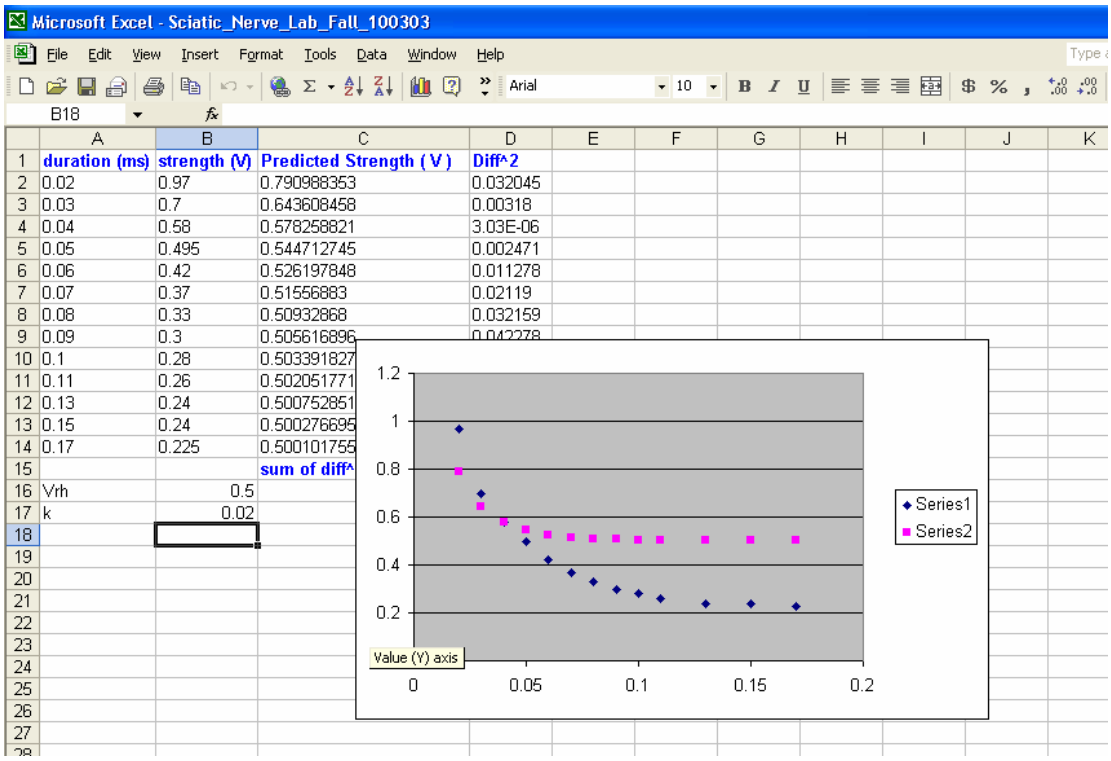
12. Select XY scatter as the chart type and click finish.



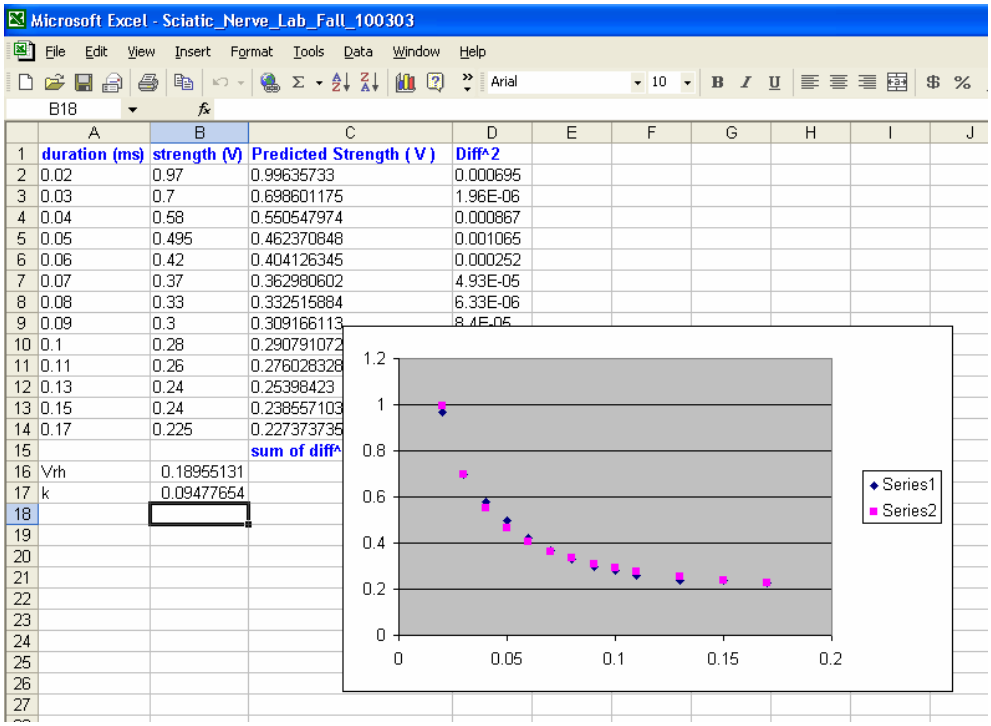
13. Now your predicted points are shown in pink and your actual values are shown in blue. Notice the predicted values do not fall exactly on top of the actual strength. This means the predicted values are not good.



14. To allow solver to minimize the sum of square of differences, the initial values for V_{Rh} and k have to be close to the final predicted values. So change V_{Rh} to 0.5 and k to 0.02.



15. Use solver again to solve. This is what you will get.



Now you can use the predicted values to calculate the Chronaxie. This is the end of the tutorial.