

How to Linearize Curved Data

Introduction: If your data is curved, the variables you have plotted have a non-linear relationship or mathematical form. Non-linear data is mathematically difficult to analyze. However, if we can convert the data to a linear (straight) form we can use our knowledge of straight lines to learn about the actual physics involved in our experiment. So, if we are confronted with non-linear (curved) data then our goal is to convert the data to a linear (straight) form that can be easily analyzed. This process is called **linearization**.

1. There are four possibilities for graph shapes that we will deal with this year. Each shape represents data that exhibits a different mathematical form.



Linear – Our Goal!

Mathematical form: $y = mx + b$
or $y = kx$

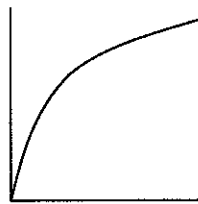
Data is already linear.
Draw a best fit line and calculate the slope.



Over-achiever

Mathematical form: $y = x^2$

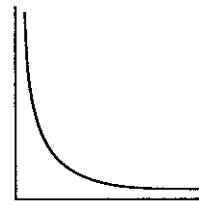
Make a new calculated column with the x-axis variable squared.
($X = x^2$).
Then plot y vs. X



Under-achiever

Mathematical form: $y = \sqrt{x}$

Make a new calculated column with the y-axis variable squared:
($Y = y^2$).
Then plot Y vs. x



Non-conformist

Mathematical form: $y = 1/x$ or
 $y = 1/x^2$

Make a new calculated column with the x-axis variable as $1/x$ or $1/x^2$ ($X = 1/x$ or $X = 1/x^2$).
Then plot y vs. X

2. Make a new calculated column based on the mathematical form (shape) of your data.
3. Plot a new graph using your new calculated column of data on one of your axes.
4. If the new graph (using the calculated column) is straight, you have succeeded in linearizing your data.
5. Draw a best fit line **USING A RULER! DO NOT CONNECT DOTS!!**
6. Calculate the slope of your best fit line (with units) by selecting two points from the best fit line. Pick two points that are reasonably spaced (one near the beginning of the line and one near the end). **Do not use data points.**
7. Write the equation of the best fit line using the real physical variables from your experiment. We call this equation the **physics equation** since it is written in the real variables from our experiment.

IMPORTANT POINT: The slope of the physics equation will have an important physical meaning.

8. Make sure your graph is drawn according to all the steps in the handout **Rules for Graphing By Hand**.