Linearizing Graphs

Many times in Physics, it is the role of the experimenter to determine the mathematical relationship that exists between two variables.

For example, you may wish to find out how increasing the magnitude of an electric shock to your cat will affect how high it jumps.

In this example, there are two variables: 1) the size of the shock and 2) the height that the cat jumps in response to the shock.

In order to successfully determine the relationship between the two variables, you must determine which is the *independent variable* and which is the *dependent variable*.

The *independent variable* is the variable that you adjust/change throughout the course of the experiment. In the above example, this is the: size of the shock.

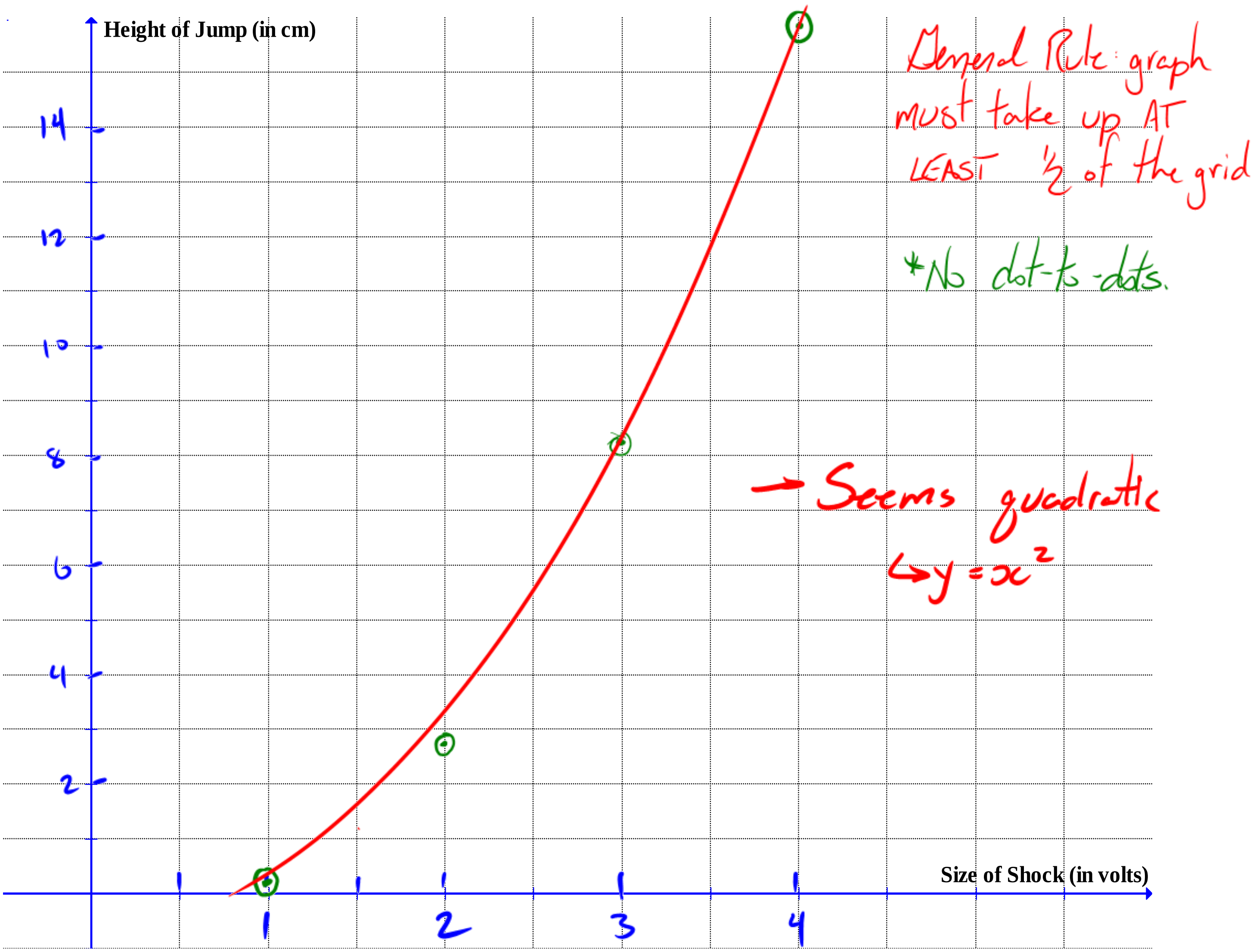
The *dependent variable* is the variable that changes in response to the independent variable; this is the quantity that you measure after adjusting/changing the independent variable. In the above example, the dependent variable is the: height of the jump.

Suppose that after carrying out the necessary lab work, the following data was obtained:

Size of Shock (in volts) (x)	Height of Jump (± 0.5) cm (y)
1	0.1
2	2.8
3	8.2
4	14.9

due to the uncertainty in the measurement. It is estimated by the experimentor.
• Should have the same number of decimal places as the recorded data.

To determine the mathematical relationship, plot a graph with the independent variable on the *x*-axis and the dependent variable on the *y*-axis.



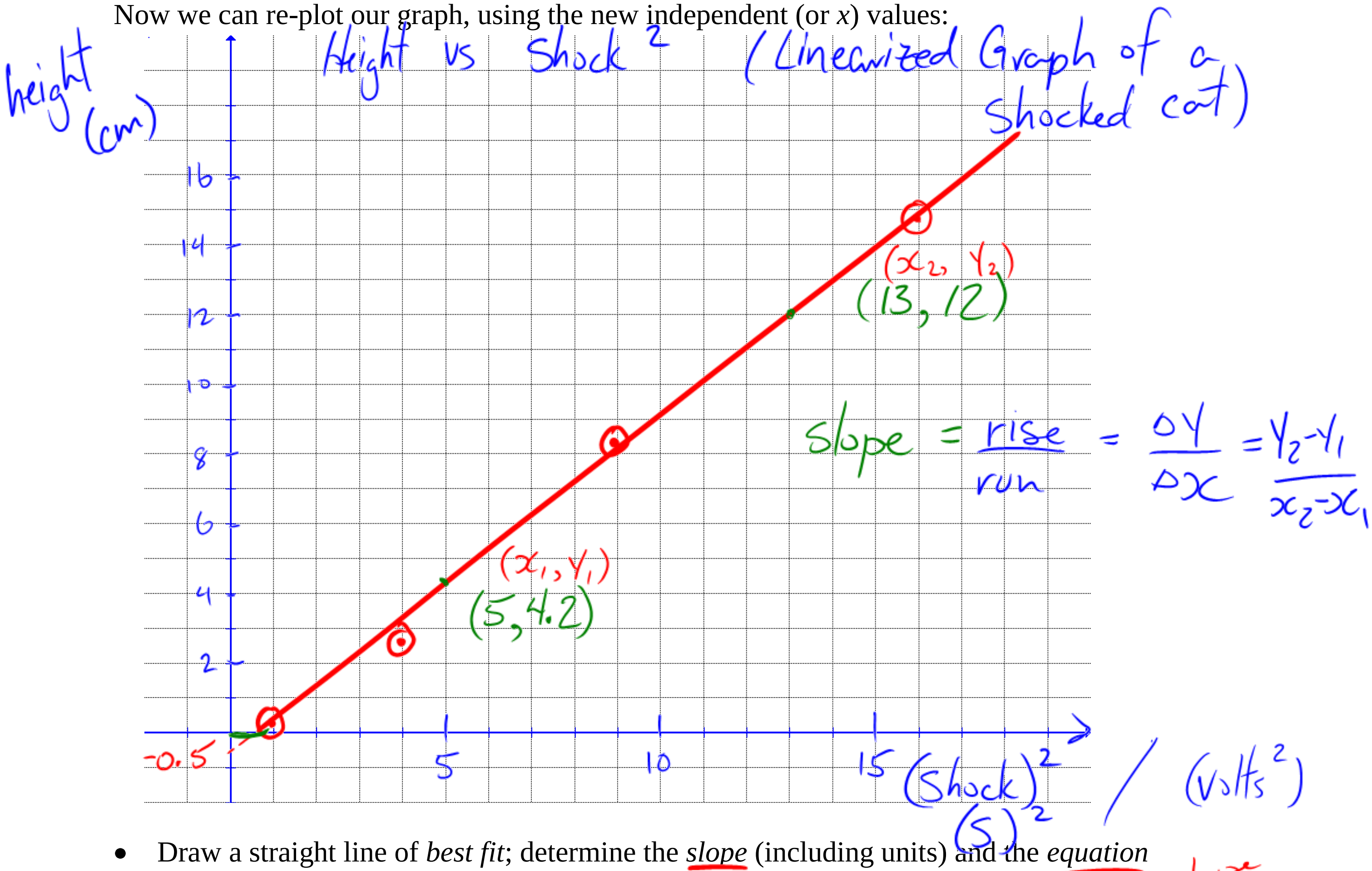
- Include a *title* on all graphs.
- Label the axes—include your scale!
- Plot data points with small dots or x's.
- Draw a *smooth* curve/line of best fit—do not do 'dot-to-dots'!

After making a graph, decide what the general mathematical relationship is (or might be); this will help you decide how to manipulate the *independent variable* in order to get a straight-line graph.

Because our graph from above looks like a parabola, we will 'guess' that the equation that describes the line is of the form: $y = x^s$. In order to linearize this graph, we need to manipulate the independent variable (in this case, by squaring it, as the relationship seems to be x^2.)

Size of Shock (in volts) (x)	(Size of shock)^2 (x^2)	Height of Jump (+ 0.5) cm (y)
1	1	0.1
2	4	2.8
3	9	8.2
4	16	14.9

Now we can re-plot our graph, using the new independent (or x) values:



- Draw a straight line of *best fit*; determine the *slope* (including units) and the *equation* of the line:

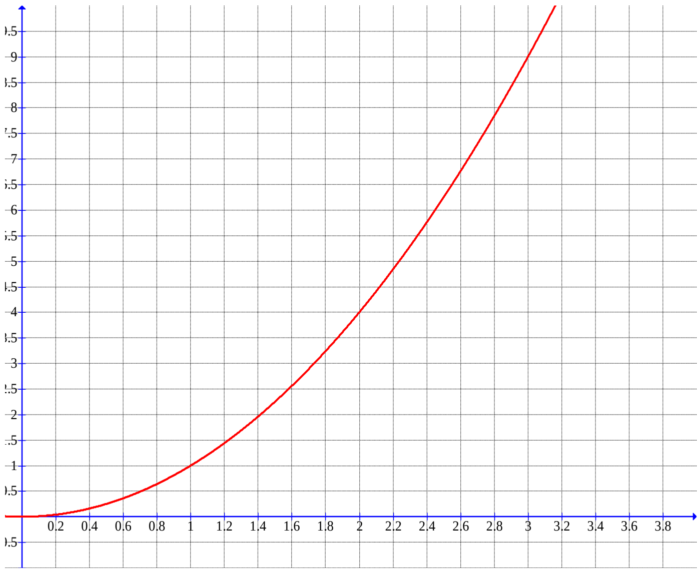
Slope $= \frac{12 - 4.2}{13 - 5} = \frac{7.8}{8} = 0.975 = 0.98 \frac{cm}{volt^2}$

$y = mx + b$ (slope, y-int.)

$$h = 0.98\, s^2 - 0.5$$

Common Functions in Physics

f(x)=x^0.5



f(x)=x^(-2)