

Appendix D

GRAPHICAL DISPLAY OF DATA

A graph is a pictorial representation of the relationship between two variables. A graph consists of two axes, a vertical line called the y -axis or ordinate and a horizontal line called the x -axis or abscissa. Along each axis is a numerical scale graduated from bottom to top and left to right.

The dependent variable is the one whose value is the response to the change in the independent variable. The dependent variable is plotted along the y axis. The independent variable is the variable that is changed by the experimenter. The independent variable is plotted along the x axis.

When referring to a graph, the dependent variable (y axis) is always listed first.

When plotting data on a graph manually, use the following steps.

1. Decide how many units each division will represent along the axes. Choose values that make the fullest use of the paper. This makes the graph easier to construct and to read.
2. Decide upon the values to be assigned to the origin (lower left corner of the graph.) These values are often set at (0,0). They must be chosen so that the lowest and highest x and y values are on the scaled part of the graph paper. (Note: The origin (0,0) does not have to be included on all graphs!)
3. Number each major division along the axes.
4. Label the axes to indicate the quantity being plotted. Include both the identity of the variable and the units in which it is expressed.
5. Plot the points; circle each point after it has been plotted to assist in locating points.
6. Draw a smooth curve through the points using a French curve or a straight edge. Do not merely "connect-the-dots" in a disjointed fashion. If the experimental data is theoretically a straight line, draw the best straight line through the points with a straight edge.
7. Title the graph. The title of the graph is written at the top of the graph. The title should be clear, descriptive, and self-explanatory. "Graph #1" is an unacceptable title.

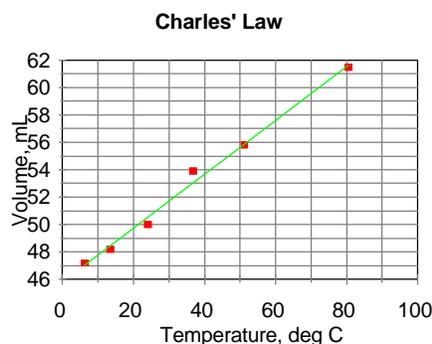
EXAMPLE

Table 1 gives the data that were obtained in a Charles' law experiment. The temperature of the sample of gas was changed by the experimenter and the volume changed in response to the change in temperature. Therefore, the volume is the dependent variable (y axis) and the temperature is the independent variable (x axis). This graph is referred to as a plot of volume versus temperature.

Table 1. Charles' Law data

Volume (mL)	Temperature (°C)
47.2	6.3
48.2	13.5
50.0	24.0
53.9	36.8
55.8	51.2
61.5	80.5

For these data, the major divisions along the y axis are one mL and the major divisions along the x axis are 10°C. In the graph below, the origin was chosen to be (0,46) and all of the data points lie on the scaled part of the graph paper. The numbers for the major divisions are labeled on each axis and each axis is labeled with its variable and the units of the variable. The points are plotted and an appropriate title is given to the graph. Theoretically, the plot is a straight line, so a straight line was drawn through the points with a straight edge.



The general equation for a straight line is $y = mx + b$, where m is the slope $\left(\frac{\Delta y}{\Delta x}\right)$ and b is the y intercept, the value of y when $x = 0$. In this example, using the two points that lie most directly on the line, the slope is:

$$\left(\frac{\Delta y}{\Delta x}\right) = \left(\frac{\Delta \text{volume}}{\Delta \text{temperature}}\right) = \frac{(55.8 - 47.2)\text{mL}}{(51.2 - 6.3)^{\circ}\text{C}} = 0.192\text{mL}/^{\circ}\text{C}$$

The y intercept is not shown on this graph, but could be shown by lengthening the y axis and extrapolating the line to the y axis.

The slope, the y intercept, and the best-fit straight line can also be calculated with a least-squares program on a calculator or with a spreadsheet program such as Quattro®Pro. When a graph is generated with a computer program, the final graph should show the experimental points and best-fit line. Using Quattro®Pro, the line connecting the experimental points should be erased and the dots corresponding to the best-fit line should be erased.