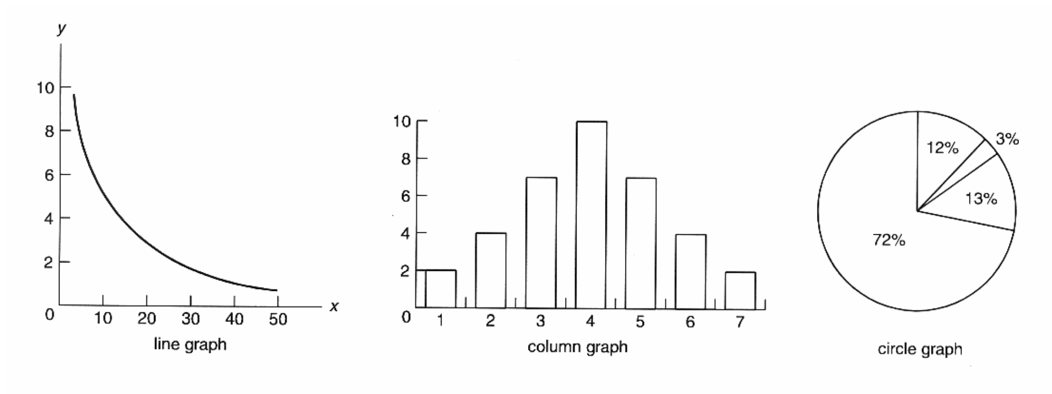
GRAPHING DATA

Introduction:

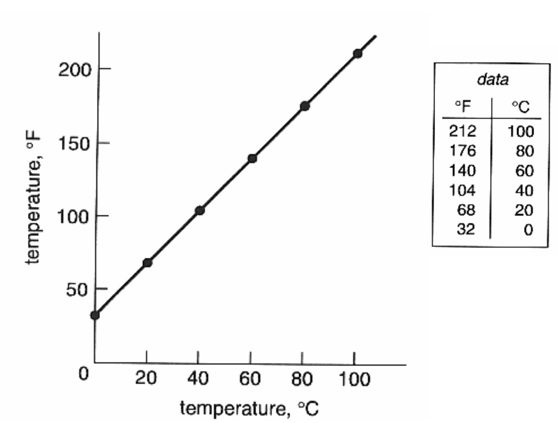
A graph is a diagram that represents the variation of one data set in relation to the resulting variation of one or more other data sets. Scientists use graphs to display and correlate data more easily, and derive fundamental relationships from them. Three common types of graphs are shown in the diagram below.

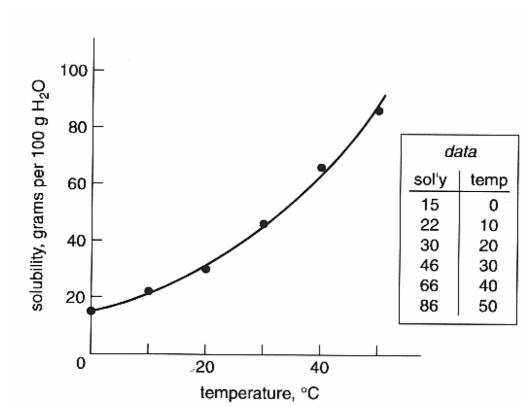


A ***line graph*** is used to compare the values of two variables. The ***independent*** variable is plotted along the ***x-axis***, while the ***dependent*** variable is plotted along the ***y-axis***. The independent variable is the property that is varied by the experimenter, and the dependent variable is the property that is measured in the experiment.

A ***bar or column graph*** is used to compare the values of several individually collected data, such as number of students in a class with a particular grade, or the tear-strength of various plastic materials. A ***pie or circle graph*** is used to show the relationship of a part to the whole, such as percent composition of elements in a compound, or percent of monthly budget used for various expenditures.

The most common type of graph used in scientific work is a line graph. Shown below are two examples of data plotted as line graphs. Note that not all line graphs are straight lines, and not all data points intersect the graph.



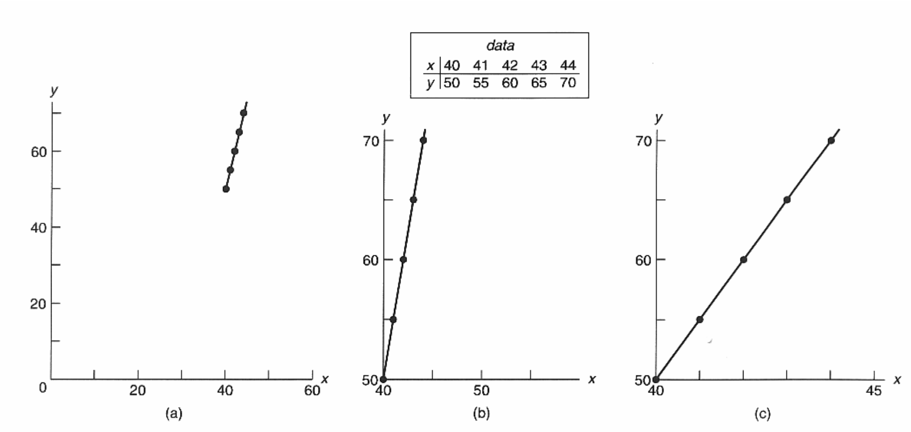


Preparing a Line Graph:

Follow these general rules when preparing a line graph:

1. ***Allow plenty of space for plotting data.***

   Larger graphs are easier to prepare and interpret than smaller ones. Use an entire 8.5 x 11" sheet of graph paper for each graph so that the graph is large. Scale the graph so that the line or curve extends throughout the entire page, instead of being confined to a small portion of the paper. Which graph below is plotted correctly with respect to spacing?



2. ***Draw and label the axis.***

   Draw the axis using a ruler, and allow space along each axis for labels and units. Assign the dependent variable to the y-axis and the independent variable to the x-axis.

3. ***Scale the axis.***

   When scaling the axis, consider the minimum and maximum values for each variable. When appropriate, the origin does not have to be labeled as zero (see diagram c above). Be sure your scaling divisions are equal, and easily divisible for marking fractional data points.

4. ***Plot data points and draw best straight line or smooth curve through them.***

   If the data points visually indicate a straight line, draw one using a ruler through as many points as possible, with about as many points on one side of the line as the other. If the data points suggest a curve, draw a smooth curve the best represents the data points, with as many points on one side of the curve as the other. See examples on bottom of page 1.

Interpreting Graphs:

Once you have prepared a graph, you can obtain additional useful information from it. For example, you can determine data points outside the range of data plotted (extrapolation). You may also be able to determine other information based on the shape of the graph.

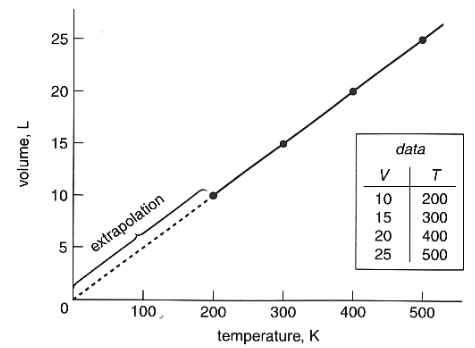
A. *Straight-Line Graphs*

Straight –line graphs can easily be extrapolated by extending the line beyond the last data points (see diagram below). Extrapolation allows us to determine data points other than those determined experimentally. In addition, we can determine the y-intercept for the graph, which can be used to express the equation of the graph.

All straight line graphs can be described by the general equation

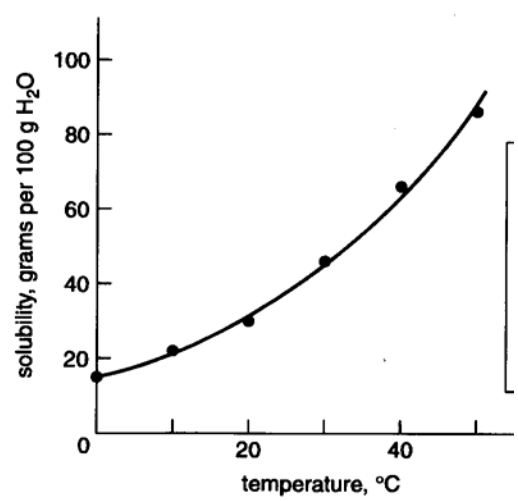
$$y = mx + b$$

where x and y are variables, m is the slope of the line, and b is the y-intercept. The slope of the line can be determined by dividing the change in y by the change in x. Because the line is the best representation of ***all*** the lines, ***values of points on the line***, rather than experimentally determined data points, should be used to determine the slope. Also, in order to ***decrease the error***, ***widely separated points*** on the line should be used for slope determination.



B. *Curved-Line Graphs*

Some relationships are not linear and cannot be represented by a straight-line graph. A plot of data for this kind of relationship gives a curved-line graph. This type of graph is useful in showing an overall relationship, although the slope and the y-intercept cannot be determined as with the straight-line graph. It is difficult to make general statements about the interpretation of a curved-line graph, and various techniques for interpretation of each kind of graph must be learned as each is encountered.



QUESTIONS:

1. Use graph1 to predict the following quantities:

   A) Distance the object traveled in 2.0 seconds: ________________________

   B) Distance the object traveled in 3.0 seconds: ________________________

   C) Distance the object traveled in 4.0 seconds:________________________

2. Use the information above to calculate the following quantities:

   A) Distance the object traveled between 1.0 and 2.0 seconds:______________

   B) Distance the object traveled between 2.0 and 3.0 seconds:______________

   C) Distance the object traveled between 3.0 and 4.0 seconds:______________

3. Complete the following statement by filling in the blanks with the correct choice:

   Within the margin of experimental error, the change in distance between equal time intervals is _____________(equal/unequal) to each other. This relationship between two variables in a graph is called _____________(linear/non-linear).

4. Use graph 2 to calculate the following quantities:

   A) The solubility increase between 20 and 40 °C: _____________________

   B) The solubility increase between 40 and 60 °C: _____________________

   C) The solubility increase between 80 and 100 °C: _____________________

5. Complete the following statement by filling in the blanks with the correct choice:

   Within the margin of experimental error, the change in solubility between equal temperature intervals is _____________(equal/unequal) to each other. This relationship between two variables in a graph is called _________(linear/non-linear).