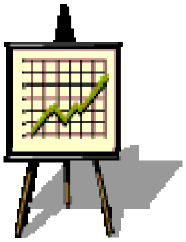
Physics



REQUIRED SKILL

Graphing Data Points

Graphs give instant ability to see trends and relationships between variables.

The variable that is controlled is the independent variable (x-value); the variable, which changes as a result of the independent variable, is called the dependent variable (y-value).

Obtaining information from locations between data points is called interpolation; predicting information from locations beyond your data points is called extrapolation and should be considered carefully for reliability. Also, the shape plotted is referred to in general as a curve, no matter its shape. (i.e., we can still call a straight line a curve; it is just a very special curve)

When plotting a graph, you should:

1. Use graph paper**.**
2. The rule of thumb that plots the independent variable on the x-axis and the dependent variable on the y-axis is NOT necessarily applicable in physics. Your graph should provide a meaningful interpretation of the data. Identify which variable goes on which axis such that the slope, area, and/or y-intercept provide meaningful information.
3. Not all curves go through the origin. You must consider your experiment and decide if (0,0) is valid for your data.
4. Determine a scale such that the maximum area of the graph paper is used to form the curve. Try to use practical divisions for your scale! (1,2 or 5) Complete the scaling chart on your piece of graph paper.

   Zero – Does zero need to be included on the graph.

   DR (Data Range) - Calculate the Data Range (DR), if 0 is included, DR = maximum value else DR = maximum value – minimum value.

   GR (Graph Range) – The number of division (squares) along the axis.

   ISF (Ideal Scale Factor) – ISF = **DR/GR**, This scale factor would utilize the entire graph but in all likelihood requires an unacceptable scale factor.

   NSF (Nice Scale Factor) – NSF = Round the ISF such that NSF ≥ ISF. Round such that the NSF is a practical scale such as 1,2 or 5.

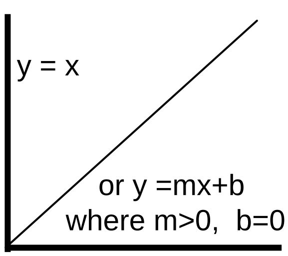
	x-axis	*y*-axis
Zero		
DR		
GR	30	40
ISF		
NSF		

5. Label each axis with the name of the variable and its unit.
6. Plot each data point and draw a box ½ square by ½ square around each point. This box represents the uncertainty in the data point.
7. If the data points appear to lie roughly in a straight line, draw the best-fit line with a ruler. Have the line go through as many point as possible, but if points are not on the line, adjust so that approximately as many lie above the line as below. Do not simply draw a line between (0,0) and the last data point! Never ever draw dot-to-dot! HINT: If you don't have a ruler, your student BADGE provides a pretty good straight edge.

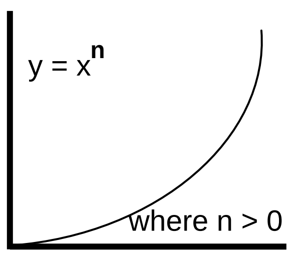
8. If the best-fit curve is a line, calculate the slope. Pick two points along the line (neither can be original data points) that are at least half the length of the line apart. Record the coordinates of these points in the chart at the top of your graph paper and show your slope calculation. Draw two pairs of dashed lines parallel to the axes that intersect at each data point selected for the slope calculation. This shows rise and run.
9. If the data points form a curve, consider various known shapes (parabola, hyperbola, inverse-square, etc). Then draw the appropriate **smooth curve** that goes through as many data points as possible. Adjust your curve such that there are as many missed points above the curve as below it.
10. If a data point is obviously in error, circle it, think back to your lab, and explain what happened in your conclusion. This means that you have the option of throwing away a bad data point as long as you can explain (correctly) why it is bad.
11. Include a **title** for your graph that includes the purpose of the graph, most likely in terms of its variables. “Motion Lab Graph” is not sufficient however; “Velocity vs. Time” would be acceptable.

Four relationships are observed frequently in physics. A simplistic view is provided here.

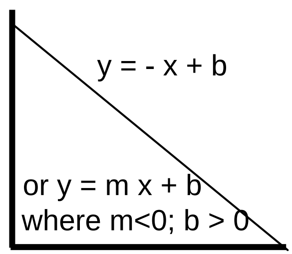
1. When (x) and (y) are directly proportional (or said to have direct variation) the function generates a line with a positive slope when (y) varies with (x). This is shown in Graph A.
2. When (x) and (y) are directly proportional (or said to have direct variation) the function generates a curve opening upward and left when (y) varies with (x^n). This is shown in Graph B.
3. When (x) and (y) are inversely proportional (or said to have inverse variation) the function generates a line with a negative slope when (y) varies with (-x). This is shown in Graph C.
4. When (x) and (y) are inversely proportional (or said to have inverse variation) the function generates a curve opening upward when (y) varies with ($1/x^n$). This is shown in Graph D.



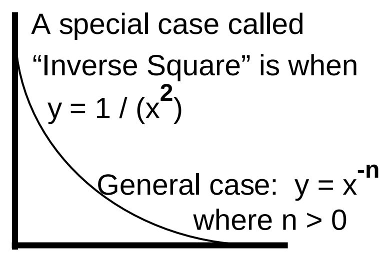
Graph A



Graph B



Graph C



Graph D

Reviewing some Terms

- Directly proportional - As *x* becomes greater so does *y*. Graphs A and B are directly proportional.
- Inversely proportional - As *x* becomes greater, *y* becomes smaller. Graphs C and D are inversely proportional.
- Linear – y changes just as much as does x. Graphs A and C are linear.