WORKING WITH DATA

Experimenting in science usually involves collecting data and / or making observations. The type of data that we collect can be described as **quantitative** or **qualitative**.

Quantitative Data

Quantitative data includes numbers (with units) which you normally measure during an experiment.

Examples:

- Temperature (degrees Celsius)
- Length (centimeters)
- Mass (grams)

Qualitative Data

Qualitative data includes descriptions of things that you observe.

Examples:

- The color of a rock
- The smell of a flower
- The movement of an animal or insect

Data Tables

Data tables should be created before you collect data. A well-designed data table will allow you to collect and record data in a neat and timely fashion.

The following data table is an example of a well-designed **quantitative** data table.

TIME THAT IT TAKES A MARBLE TO ROLL DOWN A RAMP

Distance (meters)	Time (seconds)			Average
	Trial 1	Trial 2	Trial 3	
0				
1				
2				
3				
4				
5				

Things that make this data table a good one:

- It is neat an organized in a way that makes sense.
- It has a title.
- Each column has a label with units.
- It is designed in such a way that data can be recorded quickly during an experiment.

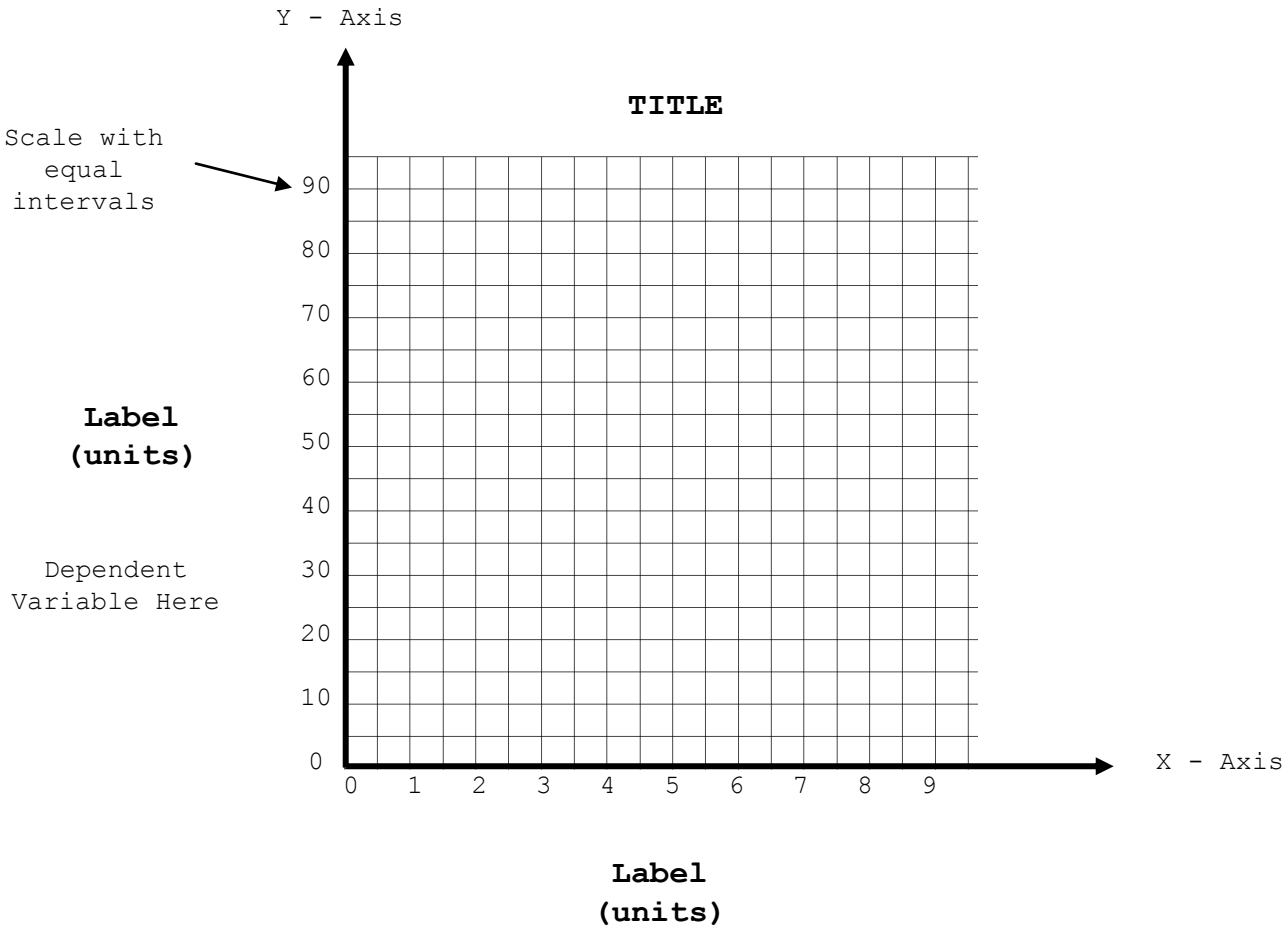
The following data table is an example of a well-designed **qualitative** data table.

ORCA BEHAVIOR IN BETWEEN SHOWS AT SEA WORLD

Date / Time	Whales Seen	Observations
9/15 – 10:00 am	2 total – "Willy", "Shamu"	Very playful, breaching out of the water several times.
9/16 – 10:00 am	1 total – "Shamu"	Very quiet and not swimming around very much at all.

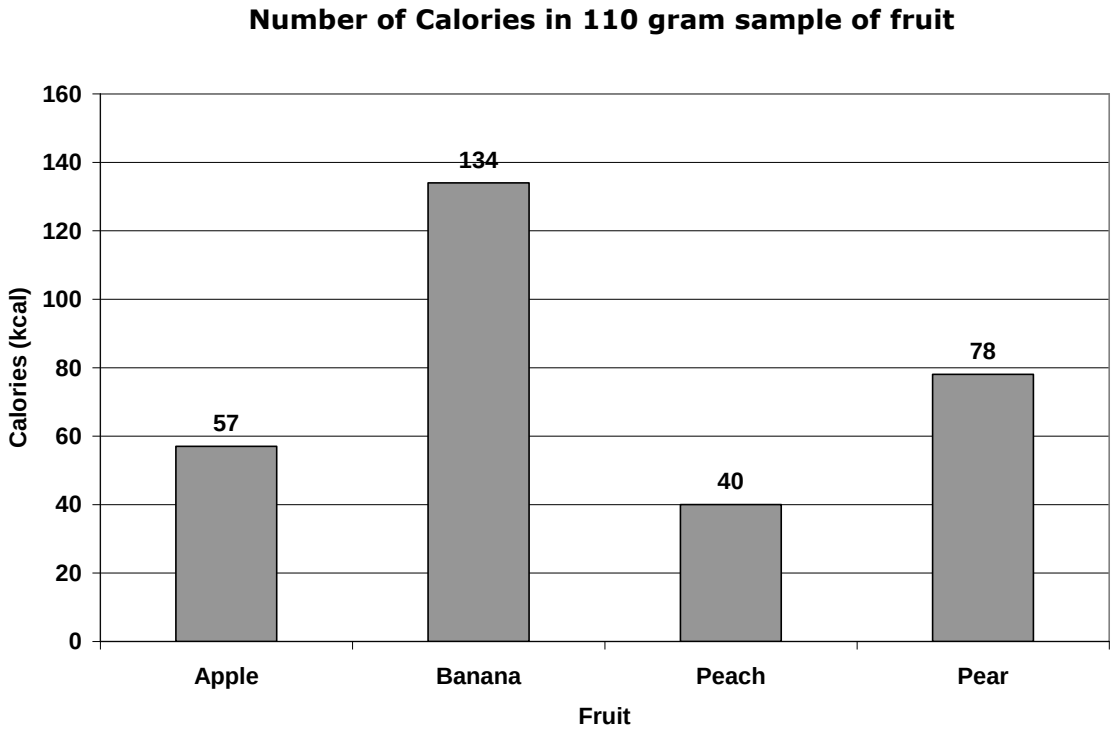
GRAPHING DATA

A graph is a *visual representation of the data.* It helps put your data into a picture that helps you and other people to understand your data. The following diagram illustrates the parts of a graph with some basic properties of a well-constructed graph.



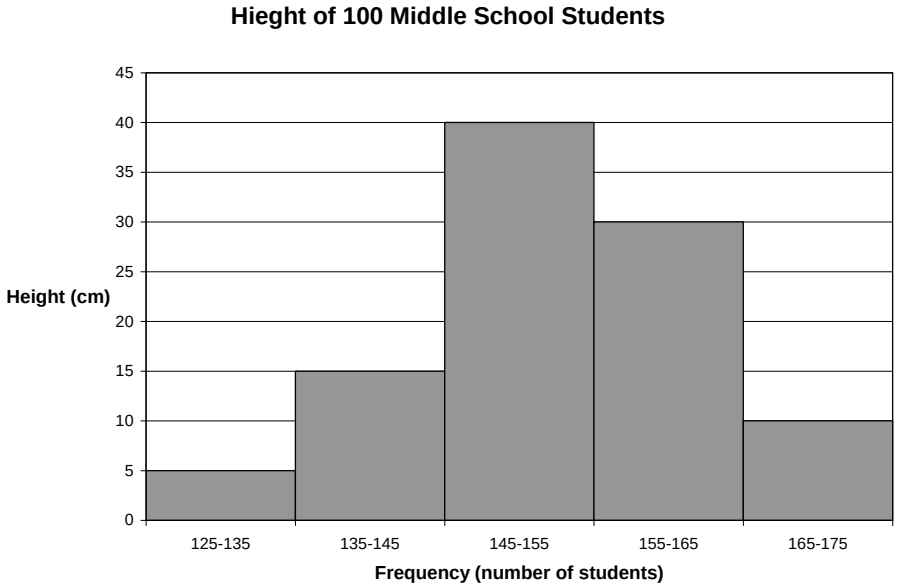
BAR GRAPHS

Use bar graphs to compare quantitative data and qualitative data. The quantitative data goes on the Y-Axis while the qualitative data goes on the X-Axis.



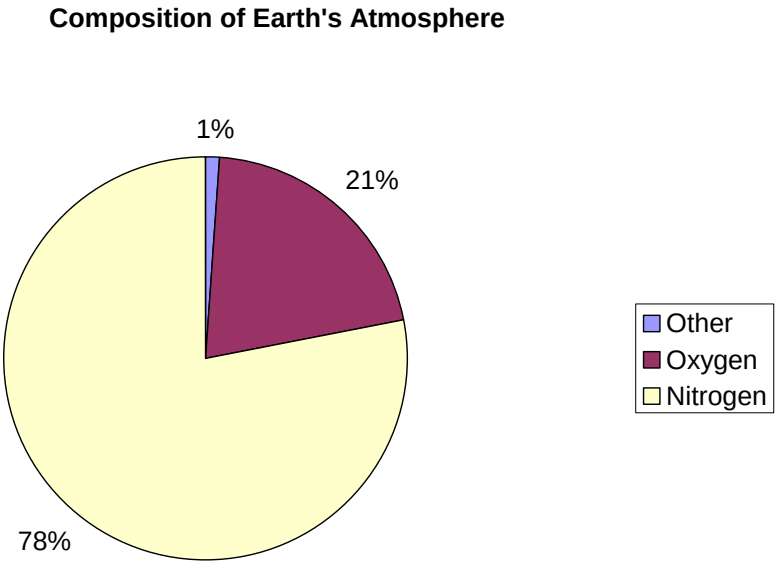
HISTOGRAMS

Use a histogram to display large amounts of data. Histograms are usually used to present "continuous data" where the numbers that we measure take on any value in a certain range. The following graph represents the height of 100 middle school students. The number of students whose height fell in a certain range was counted and then graphed. The following data table contains 100 data points.



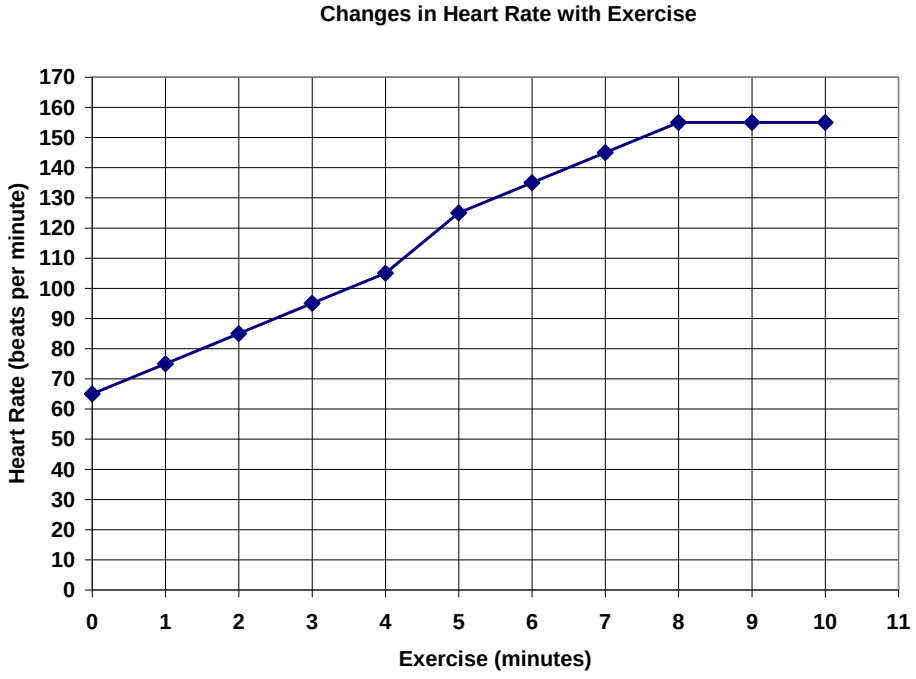
PIE CHARTS / CIRCLE GRAPHS

Use these to give a quick view of the relationship among the parts of a whole. The numbers or values in a circle graph always add up to 100 percent.



LINE GRAPHS

Line graphs show the relationship between two variables. It describes what happens to one variable as the other changes or visa versa.



MAKING A GRAPH

The following checklist will help you in making a graph that is complete and accurate.

BMS GRAPHING YEST TEST

1. Does your graph have a TITLE?
2. Did you properly label each axis including units?
3. Did you use uniform intervals on each axis?
4. Did you show the independent variable on the horizontal axis(x-axis)?
5. Did you show the dependent variable on the vertical axis (y-axis)?
6. Did you plot your data accurately on your graph?

Let's look at the following temperature data for water that is heated.

Temperature as water is heated.

Temperature (° Celsius)	10	15	20	25	30	35	40
Time (sec)	0	30	60	90	120	150	180

STEP ONE – DETERMINE WHAT TYPE OF GRAPH YOU SHOULD MAKE

The data shows the relationship between two variables - so a line graph would make the most sense.

STEP TWO – DETERMINE HOW TO DRAW AND LABEL YOUR AXES

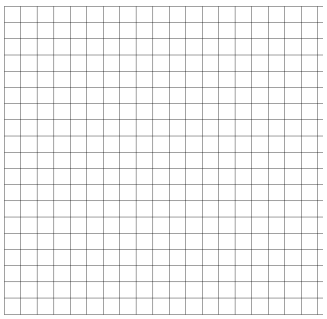
In this step, you need to determine which axis will represent each variable.

The **independent variable** is the variable **that you control** during your experiment.

The **dependent variable** is the variable **that you measured** during your experiment.

In the example of the water being heated, you would measure the temperature at pre-determined time intervals. So, temperature is the dependent variable and time is the independent variable.

Temperature as water was heated.



STEP THREE – DETERMINE THE SCALE FOR EACH AXIS

Probably the most difficult part of graphing is in determining what scale you will use on each of your axes. A scale is a series of equally spaced marks that you will use to plot your data.

The key here is to choose a scale that takes advantage of as much of your graph paper as possible while at the same time keeping the space between those marks.

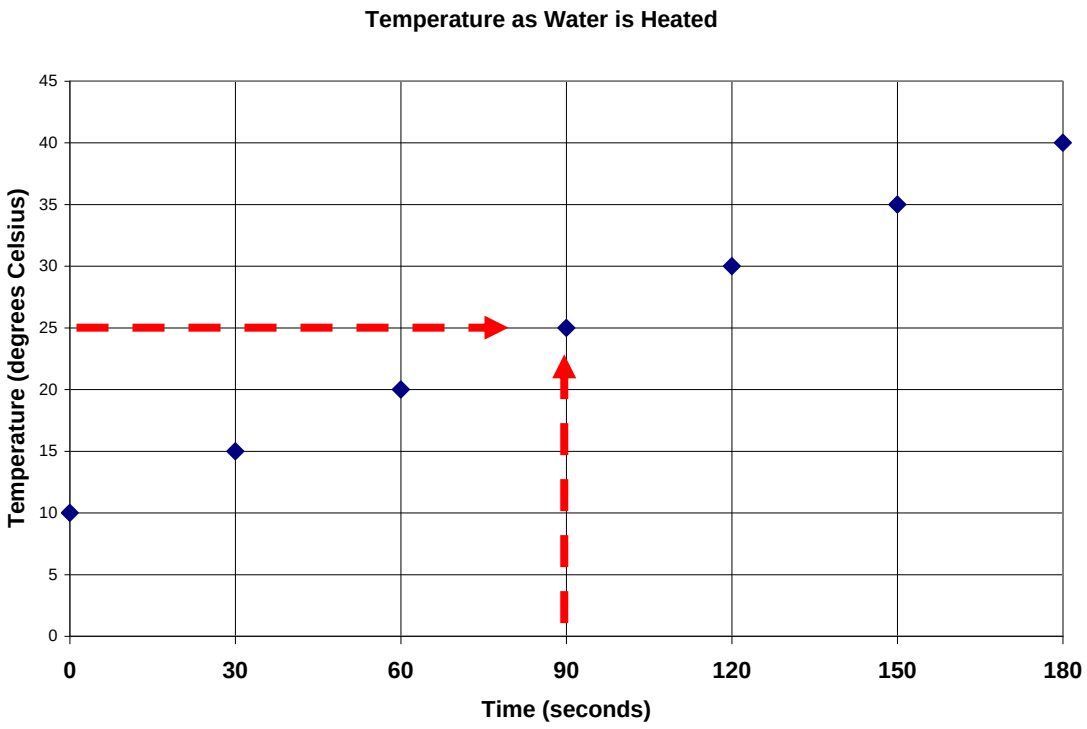
In this case, our data makes it easy for us to select a scale. Each temperature interval measured over each time interval is equal.

Temperature as water is heated.

Temperature (° Celsius)	10	15	20	25	30	35	40
Time (sec)	0	30	60	90	120	150	180

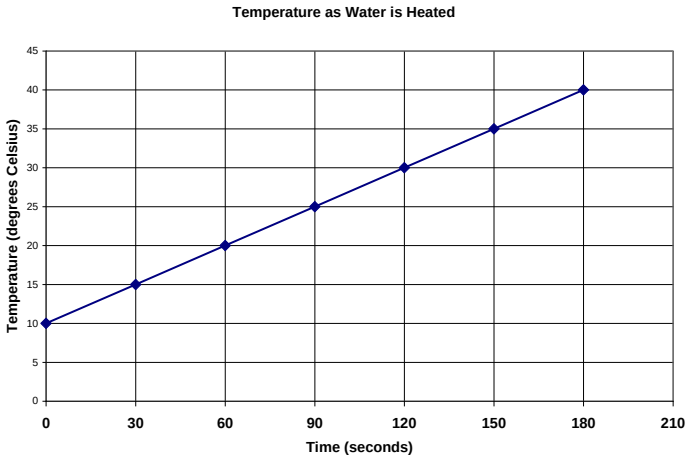
STEP FOUR – PLOTTING THE DATA

In a line graph, each data point has two values – one for the x-axis and one for the y-axis. In the example below, the temperature is 25 degrees Celsius at a time of 90 seconds. Where the two values intersect is where you will plot your point.



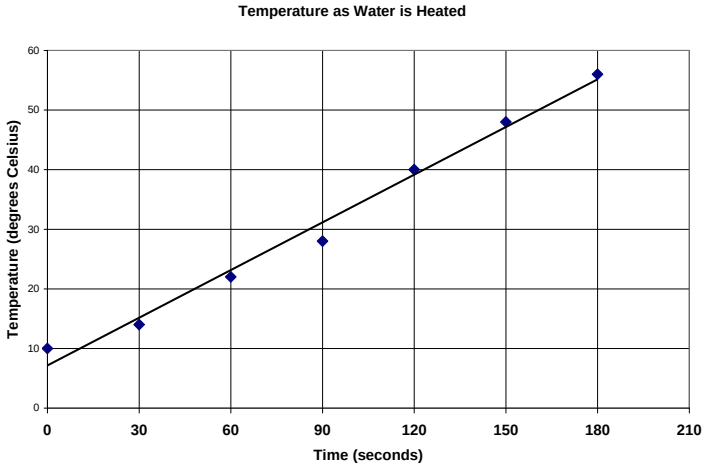
Interpreting Graph Lines

Graphs are useful for interpreting data at a glance. In this graph, you could conclude that the longer the water was heated, the higher the temperature of the water became.



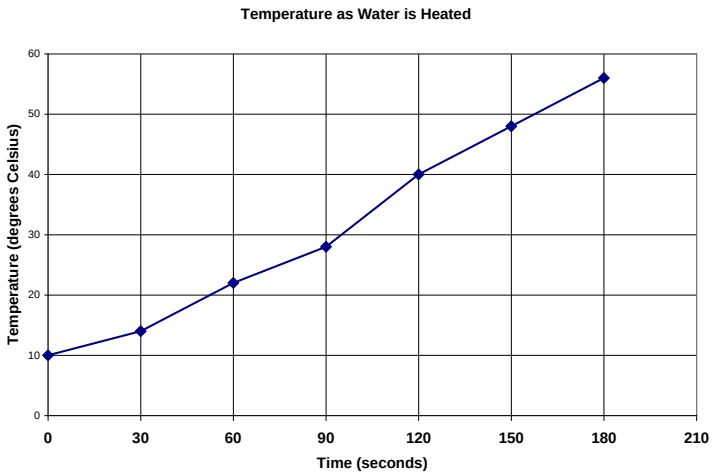
Best-Fit Line Graphs

In the following example, the data points do not lend themselves to drawing a <u>straight</u> line that will touch every data point. In this case, you could use a **<u>best-fit line</u>** to help you show the "trend" or tendency of the data. In this example, you could also conclude that the longer the water was heated, the higher the temperature of the water became.



Broken Line Graphs

In the following example, the data points are connected together using what is called a broken line. It shows in more detail what happened to the temperature over the course of the entire experiment. The changing slope of the line gives us information about what happened. A steeper slope indicates a faster rise in temperature while a lower slope indicates a slower rise in temperature.



INTERPOLATION & EXTRAPOLATION OF DATA

Graph lines can help us to read between data points as well as beyond data points that we have collected.

The graph below demonstrates how **INTERPOLATION** works. In this example, we can tell that at 50 seconds, the temperature of the water was 15 degrees Celsius, even though we never did collect data at exactly 50 seconds.

The graph below also demonstrates how **EXTRAPOLATION** works. In the example below, we can tell that at 140 seconds, the temperature of the water would be close to 24 degrees Celsius, even though we never did collect data at 140 seconds.

Temperature as Water is heated

Temperature (°Celsius)	10	12	14	16	18	20	22
Time (sec)	0	20	40	60	80	100	120