The <u>independent variable</u> is the factor that is changed in order to test the effect of the change on other variables. The <u>dependent </u>variable changes as result of changes to the independent variable.

Scientific investigations include many different steps. After the "**analyze data**" step in a scientific Investigation, a scientist might use results to reject an existing hypothesis and form a new hypothesis.

Students compete in a short race at a track meet. An example of a <u>quantitative</u> observation is the time passed from start to finish in seconds.

The **curved** graph below shows the temperature of an object as it cools at a changing rate. A **straight** line would indicate a constant rate of cooling.
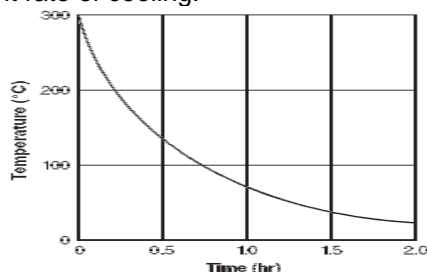

To scientifically compare dish detergents, you could set up an experiment in which the dishes, food, and water are controlled and the only variable is the brand of detergent.

The school physician performed a experiment to investigate the effects of aerobic exercise on high school freshmen. He examined 25 student volunteers, and then he had each student perform aerobic exercises, such as jogging, swimming, and bicycling. The doctor recorded the students' pulse rates before each activity, during each activity, and after each activity. The **dependent variable** in this experiment is the pulse rates.

A biomedical company uses a certain type of bacteria to manufacture a new medicine. A researcher for the company studies how temperature affects the rate at which the bacteria reproduce. She records her results in a graph. Currently, a company grows the bacteria in a lab maintained at 18 °C. If the company wants to grow the bacteria as **quickly** as possible, the lab temperature should be increased to between 20 °C and 30 °C.
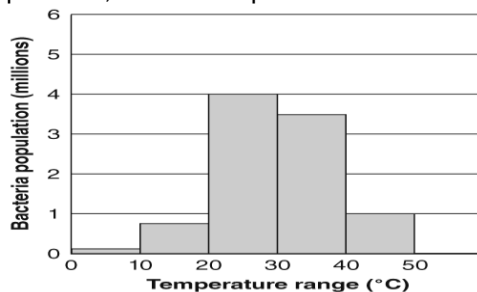
Renee rolls a steel ball down a ramp. She conducts multiple trials by releasing the ball from varying heights on the ramp. For each trial, she measures and records the release height of the ball and the distance the ball travels away from the ramp before falling to the ground. The figure below shows the experiment. In this experiment, the **independent variable** is the height from which the ball is released.
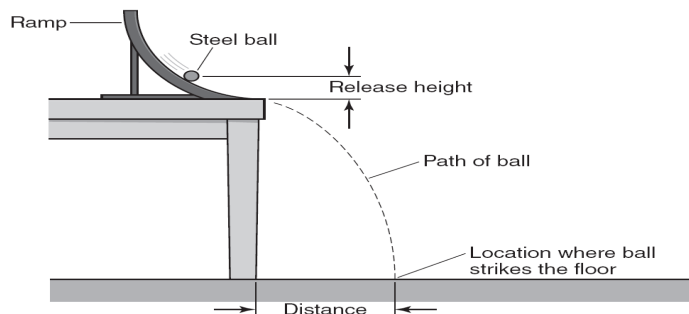
Marissa is conducting an experiment in which she is testing a substance she believes will turn green when put into different acid solutions. She finds that sometimes the substance turns green, but at other times it turns red. A logical hypothesis for her to develop for a new experiment with the substance is, "The substance will turn green when it is put into an acid solution with a pH between 3 and 4. Not all acids have the same ph level.

A non-numerical observation describes a **qualitative** observation. For example, "The soil feels spongy."

Using the chart below, Clara is helping another student analyze the results of an investigation. Her classmate wanted to see how long drinks would stay cold in different insulated cups. Clara does not know what the hypothesis was, but does know the data that the other student collected. She reviews the results of the other student's investigation, which are shown in the chart below. Her classmate asks Clara to summarize the results and offer her conclusion. A good answer Clara could give is, "The plastic cup insulates better than the ceramic cup."

Material	Time for beverage to warm to room temperature (hours)
plastic foam	3.25
ceramic	2.50

In chemistry, scientists classify some elements as metals. Copper is an example of a metal. Copper is often used in electrical wiring. Some properties can be identified through **observation** alone. For example, one property of copper is its' metallic, golden-brown color.

A spring scale can be used to measure certain properties of an object, such as its **weight**.

A student is exploring a salt water solution in science lab pictures below. She measures the mass of the salt water solution, then boils off the water, and then measures the mass of the salt remaining in the flask. One **quantitative** change the student observed is the mass of the flask decreased from 145g to 13g.
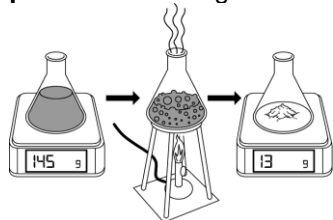
These three measurements are actually all the same length: 1,000 meters, 1 kilometer, 1,000,000 millimeters.

Ella paints two identical pieces of metal different colors. She places them near each other in direct sunlight for 30 minutes and records her data in a table. Because each color absorbs a different amount of heat energy, the temperature are all different.

Color of metal	Temperature of metal (°C)
white	40
green	66
black	70

The SI base unit abbreviation for temperature is (K), which stands for the Kelvin.

An example of a **qualitative** observation is the texture of an object

A microscope is one scientific tool that would be good to be used to study your cheek cells.

An electronic balance is one scientific tool would good to be used to compare the masses of two rocks.

ESSAY TOPIC:
You conduct an investigation to determine how long it takes for a rock, dropped from a height of 1 m, to hit the ground. Describe how you would incorporate multiple trials in the experiment, and explain why this practice is a good one.

SAMPLE ANSWER:
I could incorporate multiple trials by repeating the experiment and adding the new data to previous data. Multiple trials are beneficial because they increase the sample size of the data. The increase in sample size decreases the risk of experimental error. It also increases the number of trials and so allows the experimenter to average the time of the drops. If an unknown variable creeps into one on the trials and skews the data, repetition will lessen the effect on the data as a whole.