

## Examples of Variables

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
<b>How much water flows through a faucet at different openings?</b>	Water faucet opening (closed, half open, fully open)	Amount of water flowing measured in liters per minute	<ul style="list-style-type: none"> <li>The Faucet</li> <li>Water pressure, or how much the water is "pushing"</li> </ul> <p>"Different water pressure might also cause different amounts of water to flow and different faucets may behave differently, so to insure a fair test I want to keep the water pressure and the faucet the same for each faucet opening that I test."</p>
<b>Does heating a cup of water allow it to dissolve more sugar?</b>	Temperature of the water measured in degrees Centigrade	Amount of sugar that dissolves completely measured in grams	<ul style="list-style-type: none"> <li>Stirring</li> <li>Type of sugar</li> </ul> <p>"More stirring might also increase the amount of sugar that dissolves and different sugars might dissolve in different amounts, so to insure a fair test I want to keep these variables the same for each cup of water."</p>
<b>Does fertilizer make a plant grow bigger?</b>	Amount of fertilizer measured in grams	<ul style="list-style-type: none"> <li>Growth of the plant measured by its height</li> <li>Growth of the plant measured by the number of leaves</li> <li>See Measuring Plant Growth for more ways to measure plant growth</li> </ul>	<ul style="list-style-type: none"> <li>Same type of fertilizer</li> <li>Same size pot for each plant</li> <li>Same type of plant in each pot</li> <li>Same type and amount of soil in each pot</li> <li>Same amount of water and light</li> <li>Make measurements of growth for each plant at the same time</li> </ul> <p>"The many variables above can</p>

			each change how fast a plant grows, so to insure a fair test of the fertilizer, each of them must be kept the same for every pot."
<b>Does an electric motor turn faster if you increase the voltage?</b>	Voltage of the electricity measured in volts	Speed of rotation measured in revolutions per minute (RPMs)	<ul style="list-style-type: none"> <li>• Same motor for every test</li> <li>• The motor should be doing the same work for each test (turning the same wheel, propeller or whatever)</li> </ul> <p>"The work that a motor performs has a big impact on its speed, so to insure a fair test I must keep that variable the same."</p>

### Time as an Example of an Independent Variable

In some experiments, time is what causes the dependent variable to change. The scientist simply starts the process, then observes and records data at regular intervals.

<b>Question</b>	<b>Independent Variable (What I change)</b>	<b>Dependent Variables (What I observe)</b>	<b>Controlled Variables (What I keep the same)</b>
<b>How fast does a candle burn?</b>	Time measured in minutes	Height of candle measured in centimeters at regular intervals of time (for example, every five minutes)	<ul style="list-style-type: none"> <li>• Use same type of candle for every test</li> <li>• Wind--make sure there is none</li> </ul>

### The Independent Variable for Surveys and Tests of Different Groups

When a scientist performs a test or survey on different groups of people or things, those groups define the independent variable. For example:

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
Who listens to music the most: teenagers or their parents?	The groups receiving the survey: teenagers or parents	The amount of time that each person listens to music per day measured in hours	Ask the question in exactly the same way to each individual

### Either/Or (Binary) Variables

Sometimes a variable simply represents an either/or (binary) condition. For example, something might be either present or not present during an experiment.

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
Is a classroom noisier when the teacher leaves the room?	Teacher location: The teacher is either in the room or not in the room.  "The teacher's location is an either/or situation"	Loudness measured in decibels	<ul style="list-style-type: none"> <li>• Same classroom</li> <li>• Same students</li> <li>• Same time of day</li> </ul>
Do bicycle fenders keep the rider dry when riding through a puddle?	Fenders: The bicycle either has fenders or it does not  "Many engineering projects have alternative designs with independent variables like this one (with and without fenders)."	The rider either gets wet or does not  "Dependent variables can represent either/or situations, too."	<ul style="list-style-type: none"> <li>• Same type of bike and tires (except for the fenders!)</li> <li>• Riding at the same speed</li> <li>• Same size and depth of puddle</li> </ul>

## What Makes for Good Variables?

You will know your variables are good if you can answer yes to each of the following questions:

1. Is the independent variable measurable?
2. Can you change the independent variable during the experiment?
3. Have you identified all relevant dependent variables, and are they all caused by and dependent on the independent variable?
4. Are all dependent variable(s) measurable?
5. Have you identified all relevant controlled variables?
6. Can all controlled variables be held at a steady value during the experiment?