What is an Experiment

Experiments are one way to answer questions. If someone asks you "How long does it take for an ice cube to melt?", the two of you can do an experiment to find out. Take an ice cube out the freezer, put it in a bowl on the counter and time how long it takes to melt. That's the simplest type of experiment where you are watching a phenomenon.

That basic experiment can lead to more questions and more advanced experiments. After watching the ice cube melt you can think of more questions. What could we have done to make the ice cube melt faster? What would make it melt slower?

One option at this point is to take a moment and create a hypothesis about ice cubes and melting. Another is to set up a series of tests.

Let's define a few of the terms.

Independent variable - something that is changed in the experiment.

Dependent variable - something that responds to the Independent variable.

Constant Variable - something that is kept the same throughout the series of experiments.

Control - similar test where the independent variable is left unchanged to provide a comparison.

To continue with our ice cube melting experiment, the next question might be "Would the ice cube melt faster if it was in little pieces?" You could set-up a test where you have one ice cube that is broken into little pieces on one plate, and a whole ice cube on a plate beside it. Then you would time how long it takes each ice cube to turn into water.

The independent variable is the size of the pieces of ice, it changed between the two tests. One of the constant variables would be the temperature in the room, it stays the same for both tests. The control would be the whole ice cube that is melting. The dependent variable would be the time it takes the ice cube to melt. That variable is dependent on the size of the pieces of ice.

What if you had just taken out one ice cube, broken it into small pieces and timed how long it took to melt? Couldn't you have just compared it to the time it took the first ice cube to melt? Maybe. But the temperature in the room might have changed between the two experiments. By having a control (the whole ice cube) you are trying to control for other variables that aren't part of the experiment (temperature) but that could change your results.

If you are planning a series of experiments, the constant variable could become the independent variable in the next experiment. It just depends on the question you are trying to answer and the design of the experiment.

A control is often the most interesting part of the experiment. Often they will surprise the scientist by behaving different from what was expected.

What is a hypothesis?

A guess?

No. A hypothesis is sometimes described as an educated guess. That's not the same thing as a guess and not really a good description of a hypothesis either. Let's try working through an example.

If you put an ice cube on a plate and place it on the table, what will happen? Most people would agree with the hypothesis that:

An ice cube will melt in less than 30 minutes.

You could put sit and watch the ice cube melt and think you've proved a hypothesis. But you will have missed some important steps.

For a good science project you need to do quite a bit of research before any experimenting. Start by finding some information about how and why water melts. You could read a book, do a bit of Google searching, or even ask an expert. For our example, you could learn about how temperature and air pressure can change the state of water. Don't forget that elevation above sea level changes air pressure too.

Now, using all your research, try to restate that hypothesis.

An ice cube will melt in less than 30 minutes in a room at sea level with a temperature of 20C or 68F.

But wait a minute. What is the ice made from? What if the ice cube was made from salt water, or you sprinkled salt on a regular ice cube? Time for some more research. Would adding salt make a difference? Turns out it does. Would other chemicals change the melting time?

Using this new information, let's try that hypothesis again.

An ice cube made with tap water will melt in less than 30 minutes in a room at sea level with a temperature of 20C or 68F.

Does that seem like an educated guess? No, it sounds like you are stating the obvious.

At this point, it is obvious only because of your research. You haven't actually done the experiment. Now it's time to run the experiment to prove the hypothesis.

A hypothesis isn't an educated guess. It is a tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation.

Once you do the experiment and prove the hypothesis, it becomes part of scientific theory.

Experiment Design

Start by describing exactly what you want to find out. Your design should include three main parts.

1. Problem
2. Hypothesis
3. Procedure

Keep it simple. Don't try to design one experiment that answers every possible question.

When designing an experiment, be sure to describe exactly what you want to find out.

When you are designing the experiment, be sure to describe all the constant variables. In this experiment, room temperature is a constant variable.

Next you need to describe how you will conduct the experiment.

"I will take two ice cubes the same size out of the freezer. One will be put in a bowl on the counter. One will be broken into smaller pieces and put in a matching bowl. I will time how long it takes them to melt"

Problem

The question should have:

1. the purpose of the experiment
2. the items to be studied (independent variables)
3. how the dependent variables will be studied or observed
4. the conditions of the experiment (constant variables)

For the ice cube: "Do small pieces of ice melt in a shorter time than a whole ice cube if the are both exposed to room temperature air?"

The independent variables the size of the pieces of ice. The constant variable is the temperature of the room. The dependent variable is the time it takes the ice to melt. The control is the whole ice cube.

Procedure

A procedure should be easy to follow, with step-by-step directions and diagrams may be included.

1. Put two identical bowls on the counter.
2. Take two ice cubes out of the freezer and place one in each bowl.
3. Break one of the ice cubes into smaller pieces that are no larger than 1/4 the size of the whole ice cube.
4. Time how long it takes for all the ice to melt.

A good way to check the procedure is to ask someone else to read it.