Scientific Method

How can we determine if something is a fact or an opinion? How can we determine an answer to a problem? The answer is use the scientific method.

What is the Scientific Method? It is a series of steps used to help solve a problem.

- **Step 1. Make an Observation.** After making an observation of the natural world, define the problem and make sure only one problem is being studied. **ALL** scientific experimentation starts with observation.
  - **Direct observations** are made by the researcher. The individual is present and witnesses the event, organism, or material that is being observed.
    
    Ex) For instance, if there are 10 ants walking on a table, and you count the ten ants, you can say that you have directly observed 10 ants.
  
  - **Indirect observations**, on the other hand, involve information obtained from another source, such as a survey or witness account. The researcher is not present throughout the observed occurrence.
    
    Ex) You may see, for instance, animal tracks in the sand. You did not see the dog that made those tracks, but you know he was there because the tracks are there. In this case you have indirectly observed the dog.

- **Step 2. Research the problem (question).** Use all available resources to collect data on the subject being covered. Libraries, Internet, books, magazines, personal interviews, etc.

- **Step 3. Develop a hypothesis (educated guess).** Make it a short definitive statement. It may be an "if" then" statement. The "if" part will become the hypothesis and the then part should be the results received at the end of the controlled experiment. Remember your hypothesis can be changed if the results do not support it.
• **Step 4. Develop a controlled experiment.** A controlled experiment is an experiment that contains only one experimental variable. **An experimental or independent variable is the thing being tested (what the scientist changes).** Everything else in the experiment or all other variables must be the same. These variables are also called the **controlled variables.** Keeping these variables the same allows the experimenter to show that it was the experimental variable that caused the results. The **dependent variable** is what changes when the independent variable changes - the dependent variable *depends* on the outcome of the independent variable. **Data** should be organized into charts, tables, or graphs.

• **Step 5. Analyze the data and come up with a conclusion.** Data may be **quantitative** (numbers) or **qualitative** (appearance, properties, etc.). The conclusion may or may not support the hypothesis. Additional experimentation must then take place to build documentation concerning the problem. If the hypothesis is not supported by the data, change the hypothesis, not the data. **Scientists must be unbiased.**

• **WHAT FOLLOWS:** **Scientific research must be published**, but first it must be **reviewed by peers** (other scientists) and **verified for accuracy**. **Research may result in a scientific theory or law.**