

The Scientific Method

- 1. Problem Identification** -- Define an interesting but specific problem that can be accurately and adequately studied in the available amount of time. Repeating an experiment done by someone else does have learning value, but students should be encouraged to study a unique problem/issue or study a common problem in a unique manner. There are three sentences in a problem: *first sentence*-- a statement of what the problem is; *second sentence*--a statement of interest for pursuing the problem; and *third sentence*--a final question to be answered by the project. [i.e., What is the effect of doing A on B?]
 - 2. Literature Review** -- Research available information on the topic, using as many sources as possible. The primary purpose of doing research is to gain information about the topic stated in the problem. This will give a foundation from which the student can plan a useful experiment, provide descriptions of related research, experimental design, types of data collected, and results and conclusions. This may be the most critical phase of the project because it allows the student to fully benefit from the knowledge and experience of experts in the field. The literature review consists of library research--books, magazine and journal articles, news articles, Internet, and possibly interviews of scientists or experts currently involved in the field of study. It is written as a research report that summarizes information learned pertaining to the problem question. (See *BIBLIOGRAPHY below.)
 - 3. Hypothesis** -- The understanding of the problem gained from the literature review allows the researcher to develop a reasonable hypothesis to explain the cause of the problem and/or possible solutions to the problem that can be tested with accuracy; i.e., it is a prediction for the answer to the question posed in the Problem Identification and is based on the research in the LITERATURE REVIEW. The hypothesis is written in the form of a testable statement, in third person, and with reasoning behind the hypothesis.
 - 4. Experimental Design** -- Based on the hypothesis to be tested and the knowledge gained from the literature review, a plan is constructed for carrying out the experiment. Reputable results are the consequence of careful planning of the experiment, taking in to account possible sources of error. A good scientist is careful to control factors (*variables*) that may influence the outcome of the experiment. The two parts of experimental design are: **1) Materials**--a list of items need to conduct the experiment, and **2) Procedures**--a step-by-step (numbered) list of how to use the materials and conduct the experiment. The Materials and Procedures are written much like a recipe without “how to” words.
 - 5. Data Collection** -- Once the procedures are written, students should follow the list of procedures to collect the materials and conduct the experiment. Precise recordings of collected data and observations (both qualitative and quantitative) will make summarizing the results easier. This is best accomplished by dating and recording ALL information concerning the experiment in a logbook or journal. Charts and graphs must be made from this information. Be sure to use **METRIC** measurements and label all charts and graphs appropriately.
 - 6. Results (Data Analysis)** -- Upon completion of the experiment, appropriately titled and labeled tables & graphs are to be constructed followed by a summary of the data collected should be written to explain the observations of the experiment. No opinions are included, only a summary of the facts and calculations including references to the charts and graphs. All qualitative (¶1) and quantitative (¶2) observations should be summarized and discussed. Averages should be calculated and discussed and make comparisons (¶3+) between trials and variables. [% change]
 - 7. Conclusions** -- The Conclusions based on Data are a written explanation of the contributing factors for the results of the experiment. Inferences are included to help explain your reasoning. Well-written conclusions must have 3 parts: Claim, Evidence, and Reasoning. CLAIM → a statement/conclusion about the solution to the problem/hypothesis from observed data; EVIDENCE → the appropriate & sufficient scientific data that supports the claim taken from the data analysis including numerical data with appropriate labels; REASONING → justification that shows why the data counts as evidence to support the claim and includes appropriate scientific principles...links the claim and the evidence.
- * *Bibliography* -- This includes all references, both reading and professional interviews used in researching and conducting the experiment. They should be written in alphabetical order by author according to the proper MLA format and is placed on a separate page after the conclusions.