**THE SCIENTIFIC METHOD                                       Laboratory Exercise # 1**

**LABORATORY  OBJECTIVES**

Upon completion of this laboratory exercise the student will be able to:

1.  Identify the components of the scientific method and explain each.

2.  Perform and evaluate a simple scientific experiment.

3.  Design a simple scientific experiment.

**MATERIALS  NEEDED**

None

**PREPARATION**

Read Chapter 1, pages 12 through 15 of your textbook.

**INTRODUCTION**

Science has been described as a way of knowing.  It emerges from man's curiosity about ourselves and the world around us.  Seeking to understand seems to be one of our basic drives.  We ask questions that arise from our observations of natural things; and we seek discovery of answers.  Striving to reveal the secrets of nature, scientists have devised a method of getting at the truth or solving problems.  This is called the scientific method.  Actually, there are many methods but they all bear common features or rules.

Is the scientific method something that only scientists can use?  Certainly not; its usefulness extends  to all of us, even in our daily lives.  For example, I can use it to find why my car will not start.  Or, I can find out what foods give me a stomachache.

Despite what the scientist wants to find out and the exact procedure used, certain features of the scientific method are common. Scientists make observations that lead them to ask questions. They make educated guesses about possible answers, then devise ways to test their guesses. In its classical form the scientific method involves the following steps:

1.   ***Observation and Stating of a Problem*** - Scientific investigations usually begin with an observation that stimulates a desire to know or understand.  The scientist then states the problem as clearly and concisely as possible.

2.***Collection of Pertinent Information*** - An attempt should be made to assemble the pertinent facts concerning the problem.  The scientist seeks to tap into as much available information about the problem  as possible. This information may come from the library, the worldwide web, colleagues, or from other available sources.

3.***Formulation of a Hypothesis***- Based on information assembled in step two above, a tentative explanation or hypothesis is advanced.  Some call this an educated guess.  This is a trial idea, a possible solution to the problem.  A key feature of the hypothesis is that it can be tested or validated.

4.***Testing of the Hypothesis*** - In this step the scientist designs and executes an experiment to test the validity of the hypothesis.  The exact design of this test can vary greatly and depends           upon the nature of the study and the creativity of the investigator.  The experiment must be carefully planned and conducted with great precision. Scientists strive to eliminate all human and instrumental bias.  Accurate records as quantifiable data must be kept of every phase of the experiment.  Results of the experiment are gathered and analyzed.  Many experiments consist of a control group and an experimental group.  The experimental group is identical to the control group in every respect except one, called the variable.  The one substance, situation, etc. that is being tested is varied.  All other factors are kept constant in both the experimental group and the control group.  Therefore, the control serves as the basis or standard by which it is determined if the one variable is responsible for any differences in results.  A key feature of the experiment is that it must be repeatable.  That is, other researchers must be able to repeat the experiment under the same conditions and achieve the same results.

5.   ***Conclusion***- When the experiment is complete, the researcher must evaluate the results in an effort to reach a conclusion.  The conclusion either supports or fails to support the original hypothesis.  In either case, knowledge is gained and the researcher moves on.

6.***Publication of Results***- While your personal use of the scientific method does not involve this step, it is vital to the scientist.  This requires publication, in appropriate scientific literature, of a detailed report of the problem, the hypothesis, all experimental methods and results, and the conclusions reached by the investigator.  This allows other scientists to repeat the investigation if they choose, as a way of confirming the validity of the study.

**LABORATORY EXERCISE PROCEDURE**

Use the indicated steps of the scientific method with each of the following three (3) exercises.  These exercises are designed to provide some experience using the scientific method as a way to acquire knowledge.  Carefully complete each exercise recording the required information on the report sheets beginning on page 4.  When complete, submit the reports sheets to the instructor to be graded.

**Activity:**

I.    You have noticed that your heart rate seems to race when you physically exert yourself.  You wonder if the human heart rate increases as the intensity of exercise increases.  You can hypothesize that this is indeed the case.

A.  State the observation.

B.  What problem or question has been identified?

      C.  The hypothesis is

      D.  Experimentation:  To obtain the necessary data, you must determine your heart rate at varying levels of physical exertion.  You will first monitor your heart rate at rest to establish a base line.  Lie down for at least five minutes,  then determine your heart rate by monitoring your pulse rate.  (Blood surges through arteries each time your heart beats.)  On your report sheet, record your resting pulse rate in beats per minute.  The step  exercise will be used at varying levels of intensity.  In this exercise you will step up one step, then step back down.  Do this ten times in a one minute period. (Once every six seconds.)  Quickly monitor your pulse in beats per minute.  Record your pulse rate on the grid (graph) on the Report Sheet.  Rest until your pulse rate nears your resting rate.  Repeat the step exercise and pulse reading for:  fifteen steps, twenty steps, twenty-five steps, thirty steps, thirty-five steps, and forty steps per minute. (*If you are physically unable to perform the step exercise,* *substitute another mode of exertion which is measurable.  Or let another person do the step test.)*  Summarize your results by plotting your heart rate against your exercise intensity on the graph provided.

       E.  Conclusion

      Answer all the follow-up questions concerning this experiment.

      This exercise should be reported on Report Sheets 1-2.

II.   You have observed that you and your friend sometime have similar thoughts simultaneously.  You suspect that thoughts can be transmitted by "Extra Sensory Perception -ESP".

      A.  State the observation.

      B.  What problem or question has been identified?

      C.  The hypothesis is

      D.  Experimentation:  Sit back-to-back with a friend.  Choose and record a number between  one and five.  Concentrate and try to "send" the chosen number to your friend.  Give no  hints.  After a few seconds of concentration have your friend guess the number.  Record  the success or failure of the transmission.  Repeat the previous procedure fifty times. Summarize your results.

      E.  Conclusion

      Answer all the follow-up questions for this experiment.

      This exercise should be reported on Report Sheets 3-4 .

III. The scientific method is nothing more than a logical and reliable method used to determine  the truth or solve problems.  You can use it in your daily life to answer questions.  Suppose your father has always maintained that nitrogen fertilizer, properly applied, will consistently  make your grass grow greener.  Design a simple, controlled experiment to determine  whether  or not his assertion is true.

      Complete the exercise on report sheet 4.