Designing and Recording Laboratory Experiments

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Laboratory experiments allow scientists to test hypotheses, observe scientific phenomena, and discover relationships. Most experiments consist of the following steps:

1. Forming a hypothesis that predicts *what* will occur, or that describes *why* or *how* something occurs.
2. Designing an experiment to test the hypothesis
3. Performing the experiment
4. Recording the data and observations
5. Summarizing the results and communicating them to other scientists

Experimental Design

Obviously, the better an experiment is designed, the easier it is to perform the experiment, obtain data, and draw conclusions. Most successful experiments are the result of careful planning, attention to detail, multiple attempts, and learning from past mistakes. The more careful you are about designing and performing your experiments, the more sense your results will make, and the easier it will be to describe your experiment in a report.

Chemistry experiments generally involve the use of specific laboratory techniques applied in a manner that enables the researcher to collect data. Researchers therefore need to understand and be comfortable with techniques before using them in an experiment.

The Goal or Objective

This should be obvious, but you should have a goal or objective in mind before you plan your experiment. Every step of the experiment should take you closer to achieving the goal.

As you are designing your experiment, you may think of extra steps or measurements you can perform along the way that will give you additional useful data, even if those data don't meet the primary goal of the experiment. When this happens, you have two options:

1. Add secondary goals to the experiment. If you do this, you will need to re-visit your experimental plan to make sure all of the necessary elements are there to meet your secondary goals, as well as the primary goal.
2. Use the secondary goals to design future experiments. If the secondary goals end up making the experiment too large or complex, or make it more difficult to obtain the data you need, it's a sign that you need to turn these secondary goals into a separate experiment.

The Experimental Plan

Before you perform an experiment, you need to have an experimental plan. Your plan is an overview or "scheme" for the experiment—usually in the form of an outline or flow chart that describes what you intend to do. It serves the same purpose as an outline serves for writing—it keeps you organized and oriented toward your goal.

Your plan also serves as a checklist for the main parts of your experiment. It helps to keep you on task and helps you remember where you are in the process. The better you can understand and keep track of the flow of your experiment, the less likely you will be to lose your place and miss an important detail or data point.

Performing the Experiment

The carpenter's adage, "Measure twice; cut once." applies to lab experiments. Because you will be performing your own experiment (and not somebody else's from their detailed write-up), you will not have a step-by-step procedure to make sure you haven't forgotten anything. Before you perform each step, double-check:

1. Have I finished recording the previous step and the necessary data and observations?
2. Am I following my plan?
3. Was there anything I need(ed) to do before this step?
4. What data or observations will I need to record during this step?
5. What will I be doing after this step? Should I do anything special in this step to set myself up for the next step?
6. Am I ready to record the procedure and data?

When you believe you have finished performing your entire experiment, go back and re-read your objective and plan before you clean up, to make sure you haven't left anything out.

Recording the Procedure

By the time you have finished your experiment, you should have a detailed record of everything you did. As you perform each step, be sure that you have recorded all of details you think may be relevant before going on to the next step. (In a closely-timed experiment, you may want to write out the steps for the timed part before performing them, and then make any corrections as you go.)

Read over your procedure while it is still fresh in your mind (between the time you finish your experiment and the end of the day) so that you can add any missing details before you forget them.

Taking Data

The success of your experiment relies on the data and observations that you record. Record *every* detail that you think might possibly be significant in your notebook. After you finish your experiment, glance over your data tables to make sure you haven't missed any data points.

Analysis

After your experiment is complete and you have finished filling in the details of your procedure and data points, you are ready to begin analyzing your data. In general, your analysis will be whatever you need to do to use your data to answer your objective. If the experiment involved measurements, the data analysis will usually involve calculations and error analysis.

Your analysis should consider any possible sources of error (especially any errors that you believe actually occurred), considerations to keep in mind the next time you perform a similar experiment, and suggestions for future related experiments.

Works Cited

Pavia, Donald L., Gary M. Lampman, George S. Kriz, and Randall G. Engel. *Introduction to Organic Laboratory Techniques, A Microscale Approach.* (Philadelphia: Saunders College Publishing, 1990). Pp. 16–22.