Science

Learning Lists for Science 5

The Recording of Experimental Work

Contents Updated: Wednesday, 03 December 2003

Introduction

Through his experiments, Henry Cavendish, the eighteenth century British physicist, came to a deep understanding of electrical phenomena. He had, however, one serious fault—he rarely took the trouble to write up his findings. The result was that for many years people continued to work on problems he had long ago solved. For example, he discovered Ohm's law fifty years before Ohm did. The law is quite rightly ascribed to Ohm though, because the German schoolmaster made the information available to others.

Moral—you may get personal satisfaction from doing good experimental work but, if you wish to get credit for it, you have to develop an ability to communicate your findings to others.

A. Requirements

1. **Science candidates are usually required to pass a practical examination consisting of practical exercises, which usually counts significantly towards the overall grade**
2. **Candidates must submit their practical books or folders at the time of the practical examination. Poor work or insufficient work can lead to failure**
3. **Sometimes a scheme of continous assessment of practical work is operated, in which case students will be assessed on their weekly practical work.**

B. Objectives

1. **Scientific experimental research seeks to:**
    - **discover new facts**
    - **verify or refute new hypotheses (tentative theories)**
    - **establish precise values of physical quantities.**

2. **Experiments in the teaching laboratory seek to:**
    - **train the student in scientific method ty encouraging them to:**
        - **make accurate observations and measurements**
        - **formulate hypotheses**
        - **make logical deductions**
        - **devise further experiments to test deductions**
    - **provide an opportunity of learning how to handle apparatus and instruments**
    - **illustrate the theoretical work studied in lessons and text textbooks**
    - **train the student to analyse experimental results, assess their accuracy, quantify**

errors and suggest improvements in the design of experiments
- foster accurate reporting of experiments.

C. Laboratory Notebook

1. Keep a notebook for practical chemistry:
   - memory is fallible—might need data weeks later
   - numbers without explanatory notes rapidly become meaningless
   - scraps of paper get lost.

2. Keep the notebook carefully:
   - all relevant facts should be included, eg:
     - all direct observations—allows all readings to be checked if necessary
     - explanatory notes and comments
     - checks and precautions
     - faults and corrections
     - unusual occurences
     - calculations (no mental arithmetic)
     - reasons for repeated readings
     - the date of the measurements.
   - some warnings:
     - don't overwrite incorrect numbers (they might be misread)—strike out with a single line and record correctly alongside
     - don't try to economise on space by omitting details or cramping the pages
     - don't mix together notes and data from different experiments.
   - when tabulating results:
     - use headed columns
     - include the units.
   - emphasise important values, eg an average, by:
     - underlining, or
     - putting in a block.

3. When writing up a final report on the experiment—work from your notebook!

D. Format of Scientific Reports

1. Set aside the format you were taught at school.
2. Adopt the following format:
   - title, date and name
   - introduction
   - experimental:
     - apparatus
     - materials
     - procedure.
   - results
   - discussion
   - summary
   - references
   - for projects and extended experiments—an abstract.

3. Experimental details may be omitted provided that:
   - a suitable reference can be quoted
   - a handout is enclosed and referred to.

E. Guiding Principles

1. Presentation—should help the reader:
   - each new report—a new page

- **use main and subsidiary headings**
- **space the sections adequately**
- **use a logical sequence**
- **number tables, and refer to as Table 1, etc**
- **number illustrations and graphs, and refer to as Figure 1, etc.**

2. **Use scientific language:**
   - **impersonal**
   - **passive voice and past tense—something was done (you are following the given procedure)**
   - **"I" is now permissible, notably when you are doing something different, something original, changing a routine or analysis**
   - **concise**
   - **short sentences.**

3. **The Introduction:**
   - **have in mind a colleague of equal ability who needs some background information**
   - **state the purpose of the experiment**
   - **set the scene in general terms**
   - **outline essential theoretical principles—not detailed theory**
   - **don't give details of apparatus and procedure.**

4. **Experimental:**
   - **include all information necessary for repeating the experiment**
   - **describe only special equipment—not flasks, etc**
   - **use labelled diagrams**
   - **omit standard procedures—quote the source (handout?) or reference**
   - **explicitly mention any modifications to a standard procedure**
   - **describe fully any extensively modified procedures and those devised by yourself**
   - **describe any special purification of materials.**

5. **Results:**
   - **record all relevant observations**
   - **give full tables**
   - **plot data whenever possible**
   - **indicate precision by decimal places**
   - **don't quote numbers to an unwarranted accuracy**
   - **include calculations.**

6. **Discussion:**
   - **the most important part of the report—a critical appraisal of the results and possible interpretations**
   - **what is the signifance of the results?**
   - **how do they compare with accepted or theoretical values?**
   - **are the results consistent with each other?**
   - **how large are the errors?**
   - **what assumptions or approximations limit the results?**
   - **did you take any special precautions?**
   - **can the apparatus or procedure be improved?**
   - **were there any abnormal results? What caused them?**
   - **have the objects of the experiment been achieved?**
   - **is any further work possible on the same or related line to extend the investigation?**
   - **<u>don't</u> get into the habit of glibly ascribing poor results to poor technique or faulty apparatus—you should be attempting to improve your technique all the time and the apparatus will only rarely be faulty.**

7. **Summary:**
   - **outline the results and principle conclusions.**

8. **Abstract:**
    - **a rapid review of the report for the reader who wants some idea of what has been done but does not wish to read the whole of it**
    - **needed only for extended reports—eg projects**
    - **20—100 words**
    - **briefly state the object, an indication of the method, important results and the conclusions**
    - **though written last it is intended to precede the report and be read first.**

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