A LIST OF ELEMENTARY QUANTITATIVE EXPERIMENTS IN PHYSICS; PP. 5-52

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Trieste

MICHIGAN STATE NORMAL COLLEGE.

A LIST OF ELEMENTARY

QUANTITATIVE EXPERIMENTS

IN

PHYSICS.

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Prefatory Note.

The Physical Laboratory Practice of this institution is mainly a course in the measurement of *particular quantities*, and in general rests upon and reënforces the principles and laws of physics established by demonstration or class experiment. It is given in four courses.

1. The first course consists of simple dictated exercises accompanying our *Elementary* (or Grammar-School) *Physics*. For this work no manual is used.

2. The table work accompanying and forming an integral part of *Physics I* and *Physics II* for which *Part I* of this pamphlet is used as a manual. It is based on the "collective" system, so called.

3. A special laboratory course, called *Physical Laboratory Practice*, established especially for the benefit of those who have had a year of work in physics in some good high school but with inadequate practical application. Such students take a portion of the work in *Part I* and such additional experiments in *Part II* as they are able to perform in the assigned time. Students who have had *Physics I* and *Physics II* with us will pass directly to *Part II* and work an assigned selection of these exercises according to their needs. *Part II* follows the "separate" system. It is essentially a teachers' course and has to do with the *laboratory method* in science, or how to select, set up, test, repair, care for and use apparatus.

4. A course in *Advanced Laboratory Practice*, accompanying or following *Advanced Physics*. For this course a separate manual is used.

The *Exercises* at the end of *Part I* are carried forward along with the table work.

Hints and Cautions.

1. Make these hints a part of the directions for every experiment. Because they are not repeated continually do not the less have them in mind and observe them.

2. In general with every experiment you are to *observe, and record what you observe.* Make this formula a part of the directions in all your work. Observe accurately, under the most favorable conditions, and, if necessary, observe repeatedly. Press the piece that you are using up to the highest limit of its performance. Make the record at the time of observation; record each observation separately, and not a mere average; and carry out upon your notes all calculations required to give the result called for.

3. With regard to notes, the teacher should see *those taken at the time of performing the experiment.* Let them be legible, complete in themselves so as to need no explanation, and thoroughly good examples of punctuation, paragraphing, and of manuscript work in general. Where possible, record your observations *in a tabular form*, with proper title, and headings for the columns.

4. While a full written description of the piece is in general unnecessary, there should always be a *figure* of the piece with *descriptive list.* Usually it is best to add *dimensions* of the piece, so that as a teacher you can procure or construct the piece from your notes. In general a perspective view is not the most useful, but rather a plan, section, or simple *sketch* of the piece, *showing working parts.* Begin by reading the experiment and all hints and cautions referred to. Write the *number* of the experiment and leave a space for a *title*, which you should *fill in after the experiment is performed.* Perform the steps, as numbered in the exercise, in succession, recording the results as you go forward and numbering the steps of the work as in the exercise. Often a step as numbered simply calls for some adjustment of a piece, or some work not yielding a numerical result. Then record, "Did as required;" "See figure;" "See table below," etc. These notes if written in ink and in good literary form are all you need to make, though they may be copied at your rooms for greater excellence of form, provided the teacher confirms them at the time. Calculations may also be performed outside the laboratory hour. Reduce all fractions to decimals before recording and retain in the record and in all calculations founded upon it only so many places as you have a right to. See Sabine.

5. Work *separately and without consultation or communication* with other members of the class. The teacher is there on purpose to assist you and he wishes to know where you have difficulty and how you yourself do the work. In some cases pupils will be purposely set to assist each other, but do not carry this habit into other problems.

6. In *reading scales* secure a good light and favorable conditions. Use a hand magnifier if necessary. You should always have one with you. See Worthington, p. 15–20, or Allen, p. 60–64.

7. In using wire, thread, silk, etc., be careful about entangling or snarling it. *Work from the free end*, and *leave only one free end* in all material wound on bobbins, spools, etc. Be careful to fasten the free end so that the coils will not loosen or unwind.

8. There is no excuse for *wasting or fouling mercury*. Wipe out with a clean cloth or thin paper all vessels before pouring mercury into them. Avoid spilling by special care at critical points, but work over the mercury tray or mercury table so that if any is spilled it may be saved. The stock of mercury should not diminish much during the year. A special stock will be kept for amalgamating zinc; use this for no other purpose. In amalgamating avoid excess; a single drop will usually suffice for one operation if it is properly done. See Shaw, p. 237.—You will be taught how to clean mercury; or see P. Ahrendt, etc.—Avoid using mercury in the presence of articles of gold, as rings, watches, etc.

9. Be careful about *slopping* or spilling liquids, *staining* with acids or corrosive substances, etc. Also about *marring*, *marking*, *scratching*, or otherwise defacing the furniture or apparatus. It would occasion no loss of time or energy if you should manipulate so carefully that you should *never* spill a drop of any liquid or mar any of the pieces. Simply see that the drip-cup is placed under all burettes; mix, pour, and stir corrosive liquids over the sink; hold a zinc or other battery element over an empty tumbler when you raise it from the cell; etc., etc. The accuracy of your work can be very well measured by your habits of manipulation.

10. A special point is made of matches. Take them as needed from the match-safes and in no case have or leave piles of them here and there in the laboratory. See that they are well quenched before throwing into waste boxes.

11. It is very important that the material and apparatus for any experiment or series of experiments be kept together and be properly restored to the box or case designed for them after every use. When an experiment is assigned you, look over the material for the experiment and see that it is all present and in order. If not, report promptly to the teacher in charge. At the close of the hour, or earlier if the experiment is completed, restore in perfect order to the box or case.

12. Report to the teacher at once any injury, breakage, or accident to apparatus or material. No special charge is made for the natural wear of apparatus or for injuries sustained by pieces assigned for use and properly used, *provided such injury is promptly reported.* Do not use a piece if it is evident that such use will be attended with any risk, either to the piece, or yourself, or to any material.

13. This paragraph may be referred to for a large number of special hints and cautions, usually alluded to in the exercise or set forth more fully in the references, and upon the carefnl observance of which the excellence of your work will mainly depend; such as precautions concerning index error, zero error, parallax, "back-lash" of screw, capillarity and refraction in reading liquid columns, and estimating scale-divisions to tenths. Also for precautions concerning straining a screw, using the same part of a screw continually, leaving a pinch-cock on a rubber hose when not in use, leaving the zinc of a simple cell in acid after using, or unnecessarily during use, and concerning heating, drying, and cleaning glass articles, etc., etc.

14. Do not meddle with the adjustment of fine pieces without special directions by the teacher; *e. g.* the adjustments of a balance. Do not take the standard barometers from their hooks, or readjust the prisms of the best spectroscope, or change the reticle of the transit, or dissect the objective of a microscope, etc., etc.

15. References are given to practical manuals concerning care in handling, accuracy in observing, and skill in manipulating: also to tables, formulas, etc. Use the references for these purposes *and not for matter to incorporate into your note books.* In general *copy nothing* from any text or reference book, but hold your notes closely to *records of personal observations* and deductions directly from these observations.

The reference books are not to be taken from the laboratory except in special cases and then by permission. Do not use the books to write on, for blocking, etc., but guard them from injury of all kinds.

Reference is so frequently made to the following books that they may conveniently be known by abbreviations.

Adams, Physical Laboratory Manual, designated by ..... A.
Allen, Laboratory Physics ..... Al.
Ames & Bliss, Laboratory Manual ..... A. & B.
Arey, Experimental Physics ..... Ar.
Ayrton, Practical Electricity ..... Ayr.
Barker, Advanced Course in Physics ..... B.
Chute, Practical Physics ..... C.
Everett, Units and Physical Constants ..... E.
Frick, Physical Technics ..... F.
Glazebrook & Shaw, Practical Physics ..... G. & S.

Gage, Manual and Note-Book ..... G.
Gage, Elements of Physics ..... G.
Hall & Bergen, Text-Book of Physics ..... H. & B.
Kohlrausch, Physical Measurements ..... K.
Loewy, Experimental Physics ..... Lo.
Lupton, Tables ..... L.
Mayer, Sound ..... M.
Mayer and *Barnard*, Light ..... M. & B.
Pickering, Physical Manipulation ..... P.
Stewart & Gee, Practical Physics ..... S. & G.
Stewart & Gee, Practical Physics for Schools ..... S. & G.
Sabine, Laboratory Course in Physics ..... S.
Shaw, Physics by Experiment ..... Sh.
Whiting, Physical Measurement ..... W.
Whiting, Tables ..... W.
Worthington, Physical Laboratory Practice ..... Wor.
Wright, Light and Lantern Work ..... Wr.
Woodhull, First Course in Science ..... Wo.

E. A. S.

NORMAL LABORATORIES, August, 1898.