A LABORATORY MANUAL IN PHYSICS: TO ACCOMPANY BLACK AND DAVIS' "PRACTICAL PHYSICS FOR SECONDARY SCHOOLS"

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TO ACCOMPANY

BLACK AND DAVIS' "PRACTICAL PHYSICS FOR SECONDARY SCHOOLS"

BY

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INTRODUCTION

It is now more than twenty years since we began to teach elementary physics in the laboratory and we already have many laboratory manuals. Why add another to the list? Every teacher of physics undoubtedly takes up the task of organizing his laboratory with great enthusiasm and high hopes. But sooner or later he finds that this business of teaching young people physics by means of laboratory exercises is a very difficult problem. No amount of costly apparatus or elaborate laboratory directions will produce that mental activity about physical phenomena that we all want to stimulate in our students.

Doubtless the ideal method would be for each teacher to make his own laboratory manual, and many have done so. This book is the result of one teacher's attempt to get together a set of experiments that represent a well-balanced course. The aim has been to make the directions so clear and concise that the average boy or girl, who already has in mind a general outline of the problem, can not only do the experiment but can also see the point to it. It is assumed that when the class assembles for the laboratory exercise the teacher will first make a few introductory remarks to indicate just what the problem of the day is and how it is related to the previous work and to the practical affairs of life; then he will briefly outline just how the problem is to be attacked in the laboratory. If the student has already mastered the written directions, he ought then to be able to proceed intelligently and expeditiously with the work in hand.

One reason why so much of our laboratory work in elementary physics is ineffective seems to be that the students get lost in the multitude of details and forget the point or purpose of the experiment. Sometimes the directions are given with such minuteness that the work is purely mechanical. This is reflected in the notebooks, which show no individuality and seem to indicate that the work has consisted merely in filling in certain blank spaces in a tabular form. It is, of course, expected that at first the student will need much help in arranging his notes in an orderly way, but these suggestions should be made less and less necessary as time goes on. The great danger in notebook work is artificiality. The student should write down in his own words such notes that when he reviews his work six months or a year later they will recall to his mind just what he did and what were his results.

In the early days of student laboratory work a very large fraction of the time devoted to physics was spent in the laboratory, but in recent years we have come to believe that most subjects can be presented in their *qualitative* aspects best by the teacher in clean-cut lecture-table demonstrations, while the work of the student in the laboratory should be to perform a few well-selected experiments involving simple measurements. It is, of course, always to be remembered that this elementary work is not primarily physical *measurements*, but *physics*. Therefore it is hardly worth while at this stage of the work to spend much time in discussing percentage errors which are to be reckoned in tenths of one per cent. The engineer often has to be satisfied with results which check within 5%. Why should we seek for such a high degree of accuracy as can only be attained by complicating the apparatus and the manipulation?

So it has come about that the suggested apparatus is very

simple and often crude. It is also suggested that the student do on an average only about one experiment per week. Frequent quizzes and reviews of the laboratory work have been found of great value. In this connection it is urged that the colleges provide for a *practical laboratory examination* as a part of the admission examination in physics, and that the schools use such practical examinations as a part of the routine work to test the student's achievements in physics. This laboratory examination should not be simply a repetition of experiments already performed, but should also to some extent test the student's originality and power to apply the methods of the laboratory to new problems.

In his search for the best experiments, each teacher gathers ideas from so many sources that he hardly knows to whom he is indebted for the result. In this case, the author owes a great deal to his fellow members of the Eastern Association of Physics Teachers, whose meetings have been so fruitful and suggestive. American teachers of elementary laboratory physics are under great obligations to Professor E. H. Hall of Harvard University for his persistent pioneer work in this field, and the author is under special obligations to him as his teacher, adviser, and friend. Professor J. M. Jameson of Pratt Institute has given a practical or engineering aspect to several of the experiments (Nos. 17, 32, and 33) in mechanics and electricity. Finally, it is a great pleasure to acknowledge the help of Professor Hermann Hahn of Berlin, Germany, whose "Handbuch für Physikalische Schülerübungen" is a mine of suggestions and information about laboratory experiments in physics.

N. H. B.