

PRACTICAL PHYSICS

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Practical physics by J. A. Crowther

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J. A. CROWTHER

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PHYSICS**

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BY

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P R E F A C E

THE importance of experimental work in the teaching of Natural Science is now well recognised. Some experimental acquaintance with the phenomena which are being studied is almost indispensable to their proper understanding, and no one would now attempt to teach Physics as a mere "book-work" subject. Practical Physics, however, has a value apart from its function of providing a basis for theoretical teaching. It provides one of the best means of educating the student's powers of accurate observation and accurate reasoning.

For the training to be of real value, however, the observation must be accurate, and the reasoning correct. This accuracy is of greatest importance, just where it is most difficult to obtain it, namely, in the first year's course in the subject. Beginners are only too apt to assume that accuracy is bound up with elaborate and costly apparatus, and is not to be expected from the simple means at their disposal. They thus form habits of slovenly and inaccurate working which it is exceedingly difficult to eradicate afterwards. In Practical Physics as in other things "well begun is half done," and the student who has worked conscientiously and intelligently through the course outlined in the following pages will find few difficulties to be overcome in the remainder of his work in Practical Physics.

The course has been designed to cover the practical work in Physics which is usually demanded of a student in the first medical examination, or in an examination for a school certificate. The book thus forms, in some measure, a companion

volume to the author's *Manual of Physics*. It is, however, except in scope, quite independent of the latter, and I have not hesitated to vary both the order and the treatment of the different subjects where it seemed advantageous from a laboratory point of view.

I had not thought it possible, when I undertook the writing of this volume, that so many words would be required to describe the simple experiments contained in it. Accuracy in Practical Physics, however, is largely a matter of careful attention to small details, and even small details may take long to describe. Much experience as a teacher and an examiner has taught me that no precautions are obvious to the average student. It is only by training and by experience that the arts of practical measurement in Physics are acquired. I have, therefore, described at least one experiment of each class in very minute detail, and have attempted at the same time to explain the why and the wherefore of each of the precautions described. Some attempt has also been made to indicate the order of accuracy to be expected from the different kind of measurements made in the course of the experiment, and to impress upon the student the importance of adjusting the various factors involved so as to make the final result as accurate as possible. All these considerations form an integral part of the art of experimenting, and cannot be introduced too early into the course, but they undoubtedly take up space in describing. From considerations of space, however, these details are not usually repeated when a second experiment of a similar type is described; the student is simply referred back to the previous experiment in which they have been described in detail. In this way it is hoped that the volume will supply all the information the student needs, without at the same time eliminating all necessity for active thought on his part. Students often acquire a considerable mechanical and unintelligent facility in carrying out detailed printed instructions—a facility which, though it may have its uses, is of little educational value.

The various divisions of the subject are arranged in the

usual order, but it is not necessary, or perhaps even advisable, that they should be taught in this order. Practical Mechanics and Practical Electricity are usually found to present more difficulties to the beginner than Heat and Optics. To whichever section is taken first, however, the preliminary chapter on Practical Measurements forms a suitable and almost indispensable introduction.

The range of the experiments has been limited by the schedules of the examinations for which the volume has been primarily prepared. Even so, the selection of experiments from the large number which might have been described, has been one of no little difficulty. With a few exceptions, experiments of a merely qualitative kind have been omitted. The great majority of the experiments included are capable of giving results which are accurate to two or three per cent. As the volume is intended for the use of the student, I have also ruled out experiments which, either from the manipulative skill required, or from the complexity or cost of the necessary apparatus, seemed more suitable for the lecture table than the elementary laboratory.

The apparatus required is usually of a simple and fairly inexpensive type. Elaborate and expensive apparatus is neither necessary nor desirable for students beginning the subject, and much of the apparatus described in the book could well be made by the students themselves with a little assistance.

The student should not leave any experiment until it has been carried to a successful conclusion. One experiment thoroughly mastered is of more value than a large number carried out in an inaccurate or slovenly manner. In my own classes I have always insisted on seeing a correctly written up account of the previous experiment before allotting a fresh one. As a result, however, it is almost inevitable that students will progress at very different rates. In order that the class may be kept more or less together, which is often desirable, I have added some additional exercises at the end of each chapter. These have mainly been selected from examination papers

and may be used as tests of the previous work. A student who has mastered the previous experiments in the section should have no difficulty in working them through successfully without further instruction.

Many of the diagrams have been drawn especially for this book to illustrate the principle of the apparatus rather than its appearance. A few diagrams have been reprinted from the author's *Manual of Physics*. I am indebted to Messrs. F. E. Becker & Co. (London) and Messrs. W. G. Pye & Co. (Cambridge) for their kindness in supplying illustrations of some of their apparatus.

J. A. C.

CAMBRIDGE,
October 1922.

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