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PRACTICAL PHYSICS

Practical Physics. By R. T. Glazebrook, M.A., F.R.S., and W. N. Shaw, M.A., Demonstrators at the Cavendish Laboratory, Cambridge. (London: Longmans, Green, and Co., 1885.)

THE authors have done a real service to all whose business it is to conduct classes in a physical laboratory by supplying them with a most excellent guide. Not only teachers, but students, will find this book invaluable.

The authors have for some time prepared manuscript notes for use in the laboratory, sufficient to enable a student to make the measurements described without that frequent necessity for supervision which is found when verbal instruction only has been given. Since such well tested notes form the main portion of this work, it is certain that the experiments which are described have been so frequently carried out that the details given are sure to correspond to the best arrangement in each case, and further, that all possibility of an oversight has been removed.

In many cases instruments used for the same purpose are so different in detail that the authors were met by the difficulty of choosing whether to describe several forms or to be content with explaining the particular instrument used for each purpose at the Cavendish Laboratory. They have, in adopting the latter course, found one means of limiting an enormous subject. In another direction they have found a natural boundary—that between a book of theoretical and one of practical physics. The theory of the methods and instruments is not given at length, except in those cases where the text-books are not sufficiently explicit. Again, the whole range of practical physics is so extensive that choice had to be exercised as to what experiments should be included and what unavoidably passed by. The experiments selected in each subject are typical, and are such as “to enable the student to make use of his practical work to obtain a clearer and more real insight into the principles of the subjects; they include those which have formed for the past three years the course of practical physics for the students preparing for the first part of the Natural Sciences Tripos.” It would be impossible to make a selection more exactly suited to meet the wants of an educational laboratory.

In the preface will be found the system employed at the Cavendish Laboratory for making a set of apparatus go as far as possible with a large class. The subject is divided into sections, each requiring its own instruments; sometimes one, sometimes several, experiments belong to one section. When any section is assigned to a student, none of the instruments belonging to it are available elsewhere. The same system of division is employed in the text, no less than eighty-two numbered sections being the result.

The value of the book is much enhanced by the addition, at the end of each section, of the results of an actual experiment. These short statements are valuable in many ways. In the first place, they show how to enter results systematically, so that the meaning of the entry is obvious. Secondly, they show the probable degree of

accuracy attainable, especially when more than one method of making the same determination is given. Thirdly, and this is perhaps the most important to the teacher, the series of numbers to be found enables any one to discover the proportions and sizes of the several parts of each piece of apparatus employed. An example taken from p. 420 will make this clear:—

“*Experiment.*—Determine the difference of potential between the two ends of the given wire through which a current is flowing. Enter results thus:—

Mass of water	...	...	...	...	grms.
Water equivalent of the calorimeter	...	...	...	...	24.2
“	...	...	...	...	4.2
“	...	...	...	...	28.4
<i>M</i> (copper deposited in voltameter)...	...	...	...	...	.222

Total rise of temperature for each two minutes:—

4°.4	4°.4	4°.2	4°.0	3°.8
<i>T</i>	...	...	...	24°.8
$E = 4.36 \times 10^8 = 4.36 \text{ volts.}$				

In this case there is no means of estimating the probable accuracy of the result, but the data are sufficient to enable any one who wishes to do so to reproduce exactly the instrument employed.

The chapter on physical arithmetic, in which errors, corrections, accuracy, and the manipulation of small quantities are treated, is of special value.

The chapter on the balance is very complete. Though perhaps the balance is the most important of all philosophical instruments, it is a question whether so much space as twenty pages should be devoted to it, where so much that is important is necessarily excluded for want of space. Students do certainly use the balance most blindly, and if its theory is not explained in a satisfactory manner in the text-books, this surely is the place to find it. Other subjects of which the usual accounts in the authors' opinions needed supplementing are measurement of fluid pressure, thermometry, calorimetry, and hygrometry.

The chapters on electricity and magnetism are treated in a different manner from the rest of the book, for what reason is not apparent. The precise and quantitative relations between mechanical, magnetic, and electrical units are to be found in almost every modern text-book, and so there would be no occasion to repeat definitions, &c., if the treatment of these last chapters was the same as that employed in the earlier ones. It is here perhaps more than anywhere that the authors had to exercise their choice of the most suitable, out of an almost endless variety of experiments, any one of which might well find a place. No one can find fault with the selection, yet it seems a pity that not a word is said about electrometers or indeed about statical electricity at all. Many will be disappointed in finding no account of the absolute determination of electromotive force by any of the methods of induction. The only method given depends on the measurement of the heat generated by a current, which of course involves a knowledge of the value of J , the mechanical equivalent of heat. This is the more to be regretted, as instructions for determining experimentally the value of J are not to be found in the chapter on heat. It is to be hoped that in another edition a few pages will be devoted to one or both of these essential measurements.

For a first edition the book is remarkably free from

misprints, the only one discovered being the omission of a " π " in the denominator of the expression for the absolute capacity of a condenser (p. 480). C. V. B.

MALAYAN ANTIQUITIES

Alterthümer aus dem Ostindischen Archipel und Angrenzenden Gebieten. Herausgegeben von Dr. A. B. Meyer. (Leipzig, 1884.)

THE present sumptuous volume forms the fourth of the series being issued under the enlightened management of the Curator of the Dresden Zoological and Anthropological Museum. These costly publications, which could scarcely be undertaken without the active co-operation of the general administration of the royal artistic and scientific collections in the Saxon Capital, will, when completed, prove a great boon, especially to students of eastern antiquities, and of the progress of human culture amongst the peoples of Southern Asia.

This fourth part, so far complete in itself, will be found of great value in elucidating the civilising influences both of Brahmanism and Buddhism on the races of Further India and the Malay Archipelago. It comprises nineteen photographic plates in folio, four of which are exquisitely coloured, with explanatory text and a map devoted almost exclusively to this important subject. Thus we have here embodied at once a descriptive and illustrated record of the archaeological treasures in the Dresden Collection, which serve to mark the progress of the arts in the Eastern Archipelago and neighbouring regions from the earliest historic period, that is, from the first contact of those lands with the Indian religious and artistic world.

The arrangement is thoroughly systematic and most convenient for purposes of reference and comparative study, objects in stone, metal, wood, porcelain, and allied materials being grouped separately, and dealt with in the order indicated. The four stone figures from Java, reproduced on the first two plates, show at once the advantage of this arrangement. Here we have on Plate I. a genuine Brahmanical Trimurti placed side by side with a full-breasted female figure of undoubted Buddhist type; on Plate II. an unmistakable Brahmanical Siva, again contrasted with the representation in high relief of two men, who, from their devout attitude and other indications, are evidently of Buddhist origin. Taken collectively these two groups thus present a striking illustration of both streams of Hindu culture, by which the island of Java was successively flooded. On this point the Curator's remarks in the accompanying text are highly instructive:—

"The Hindu antiquities found in Java are either Brahmanistic, Buddhist, or mixed. Brahmanism repeatedly occurs in its Sivaistic phase. Buddhism, pure only in Borobudur and Tyandi Mendut ('Veth,' Java, ii. 172), is found mixed with Sivaism, Sivaistic divinities sometimes surrounding images of Buddha (Leemans, 'Borobudur,' 444), Buddhist figures at others encircling Sivaistic idols ('Veth,' ii. 103, 173), or else assuming monstrous forms, such as often characterise Brahmanical deities ('Veth,' ii. 96, and Max Uhle, 'Descriptive Catalogue in MS. of the Royal Ethnological Museum,' No. 1464)."

The greatest monuments of Buddhism appear to be concentrated mainly in the central parts of Java, while those of the Brahmanical cult are scattered round them in all directions. Extensive Brahmanical settlements had

already been formed in the island long before the first arrival of the Buddhist missionaries, who, according to Dr. Meyer, made their appearance probably about the fifth century of the new era. The stupendous Buddhist temple of Borobudur, rivalling that of Angkor-Vaht in Camboja, is assigned to the eighth or ninth century. But no attempt has been made to determine the date of the earliest Brahmanical remains in Java or the other islands of the Archipelago. They cannot, however, be much more recent than the first century of the Christian era, and may possibly be some two or three centuries earlier. It is to be regretted that this point cannot be determined with some approach to accuracy, for it has obviously a most important bearing on the question of the migrations of the Indonesian races, and especially on the diffusion of the Malayo-Polynesian languages throughout the Indian and Pacific Oceans. Those writers, who are disposed to regard these as comparatively recent events, should at least bear in mind that there are practically no traces of Sanskrit or Prakrit elements either in Malagasy, or in any of the Eastern Polynesian dialects. Hence, if Malaysia be taken as the point of dispersion west to Madagascar, east to the South Sea Islands, the migrations must necessarily have taken place at some time before the spread of Hindu influences throughout the Eastern Archipelago.

However, the collection is not confined to Hindu subjects, and on Plate VII. are figured a large number of iron spear-heads, some of which are undoubtedly subsequent to the introduction of Islām in the thirteenth century. Many of these objects, which were found in Jokjokarta (Java), are of simple type, much corroded by rust, and no doubt of considerable antiquity. But others show distinct traces of damaskeening, an art unknown before the arrival of the Arabs, although now universally diffused throughout the Archipelago. The process, locally known by the name of *pamor*, consists in manipulating steel and iron by means of acids, the designs being inlaid by the priests (Pfyffer, "Sketches from Java," p. 32).

Conspicuous among the bronze objects is a magnificent lion's head of absolutely unique type and great size (compass round neck 34 cm., diameter 30 cm., weight 100 kilograms), apparently from Camboja, although first discovered in Java. This superb bronze, whose analysis yielded copper 92.49, tin 5.53, lead 1.40, cobalt and nickel 0.07, iron 0.12, total 99.61, is referred by Dr. Meyer to the flourishing period of Cambojan art as embodied in the monuments of Angkor Vaht, and would accordingly be some 600 or 800 years old. Front and side views are here given in half the natural size on two separate plates. From these it is evident that the lion is playing the part of a rakshasa or guardian to some Buddhist shrine, such as are found sculptured at Borobudur. Another rakshasa of a very different character is a wooden figure of Garudha from the island of Bali, reproduced by the new phototype process, which has already rendered such valuable services to the arts, and especially to archaeology in Germany. Here Garudha is represented as a winged human figure bearing on his shoulders probably a Vishnu, of whom the legs alone, suspended in front, have been preserved. It is described as perhaps a Sivaitic representation from some Brahmanical temple in Bali, where Vishnuism and Sivaism are said to be intimately associated. The introduction of the Hindu cult into Bali, where it still holds its