THURSDAY, DECEMBER 15, 1870

PRACTICAL PHYSICS

THE Vicissitudes of Families of Words, and especially of scientific nomenclature, would require another Burke to write their changeful history. Take, for instance, the word *Philosophy*,—how odd its present distorted meaning as compared with its literal sense, and how curious its alliance with such terms as Natural, Experimental, Mechanical, Chemical, and the like. Then, again, take *Science*,—how strange its present opposition to *Learning*, and how remarkable the adoption of the word *History* in conjunction with *Natural!* Most surprising of all, however, is perhaps the opposition set up between the words *natural* and *physical*; which has gone to such length that Prof. Huxley, in his recent Address to the British Association, could properly and intelligibly employ such a phrase as "those phenomena of nature which we call physical."

In French, the equivalent term for Natural Philosophy, "philosophie naturelle," is still sometimes used, and in a sense, if not coincident with, yet kindred to, that of its English representative; in German, however, the similar term, "Natur-Philosophie," has assumed a totally different meaning, and the word "Philosophie" by itself is, if possible, still farther from the English *philosophy*. For the latter word, in its English meaning, there is no equivalent whatever in German; while the occurrence of such expressions in English as Philosophical Instruments, co-existent with Moral Philosophy, strikes the German ear and intellect as insular eccentricity. But the German terminology is also in this respect not free from oddities. Thus, while "Experimentalische Physik" and "Theoretische Physik" (or sometimes "Mathematische Physik") cover nearly, although not precisely, the ground occupied by Experimental Philosophy and Natural Philosophy (in the orthodox sense) respectively; the word "physikalisch" has assumed a meaning opposed not to Moral but to Chemical, and a distinction has grown up between "physisch" and "physikalisch," corresponding to that between the English terms Natural and Physical.

To the terms just mentioned, Prof. Kohlrausch has now added a new one, on the title-page of a recently published little work, entitled, "Praktische Physik."* He thereby designates a series of practical exercises designed originally for the students who frequent the so-called "Physikalische Prakticum" in the University of Göttingen, for the purpose of being initiated into the use of physical instruments and the execution of physical operations. A work of this nature has long been a desideratum; although it has had a kind of forerunner in Prof. Frick's well-known "Physikalische Technik," *i.e.* Technical (or Operative) Physics, and to be distinguished from "Technische Physik," which means Physical Technology, or the application of Physics to manufactures and arts. Prof. Frick's work, however, of which three editions have appeared, was intended rather as an instruction in the making of lecture experiments and in the handling of the required apparatus, replacing in so far the older works of Abbé Nollet* and Sigaud de la Fond;† while the present work of Prof. Kohlrausch is designed as an initiation into original experimental measurements and researches. It has long appeared to the present writer as a kind of double drawback, inherent to current lectures as well as text-books on philosophy, that while, in all instances, more time or space is devoted to the description of apparatus and practical processes than is necessary or useful for the common student, they are yet, in this very respect, insufficient for the intending physicist. Taking in hand the best kind of treatises on Physics, whether of an entirely elementary or a more ambitious character, it will be found that a preposterous amount of space is taken up by drawings of instruments which the general student will never have to handle in his life, and by explanations of the manner in which certain procedures, measurements, and so forth have been taken, which it is practically equally useless for him to know, and which as a means of educating the mind have no value, while they tend to make science repulsive. On the other hand, the most voluminous works cannot but be pronounced, in this very respect, as deficient, if the wants of the young physicist are taken into account. Special works, like those of Profs. Frick and Kohlrausch, go some way towards supplying this want; and it is to be hoped also that, by multiplying or extending their scope, they will prove not only of additional benefit to intending physicists, but also to ordinary students, by ridding the vulgar treatises, and eventually lecture courses, of much superfluous matter that acts as a serious incumbrance and impediment to the spread of *real* physical science.

Prof. Kohlrausch's little book, of scarcely more than one hundred pages, reproduces, or very nearly so, the practical *curriculum* familiar to those who, in former time, attended at Göttingen the exercises which Profs. Weber and Listing superintended there for many years. The subjects selected range over a considerable field, and include a variety of problems; but the work was not intended to be exhaustive. Common weighing, specific weights and densities, thermometry, magnetism and galvanism, and optical instruments, furnish the chief topics on which exercises are indicated. Of course, the work is not designed to be read by itself, but to serve as a manual of instruction in the practical execution of the several processes. Nor should it be thought that even practical work of the kind here indicated can serve as a training for future discoveries, any more than early verse exercises make any one a poet; it completes, and familiarises with, the knowledge of discovered truths, but does not teach the discovery of truth. Original research of high value can be made as little on the pattern or with shreds of old, as genuine poetry can be composed in imitation and with patches borrowed from the ancients. Scientific investigation is a work of inspiration, and if directed towards a new aim, requires also novel instruments and new procedures. Chemical operations proper possess, it is true, a considerable degree of uniformity, and are capable of methodical treatment and exposition; but physical processes and manipulations are multiform, numerous, and difficult to classify. This is the reason why physical laboratories are as yet few and far between, and none of them so systematically organised as the chemical laboratories; and that, while the workers in

* *Leitfaden der Praktischen Physik.* Von F. Kohlrausch. (Leipzig, 1870.)

* L'Art des Expériences. † Cabinet de Physique.

Chemistry surpass in numbers, they also outdo in individual productiveness, the workers in Physics. But since the institution of physical laboratories is nevertheless spreading, the very novelty of their existence makes the publication of books like that of Prof. Kohlrausch, proceeding from older establishments, a real boon to those called upon to superintend or take a share in the direction of the practical work of new ones; and it is only to be hoped that from other places of renown also, both in England and abroad, similar publications may also soon proceed. C. K. AKIN

GALLOWAY'S QUALITATIVE ANALYSIS

Manual of Qualitative Analysis. By Robert Galloway, F.C.S. Fifth edition, xxi. and 415 pp. (London: John Churchill and Sons.)

OF the various manuals of Qualitative Analysis now in use, none is more deservedly popular than the work of Professor Galloway. Much of this success is doubtless due to the painstaking care with which the author has sought in successive editions to reduce the operations of Qualitative Analysis to a more methodical and systematic process. The present edition is in great part rewritten, and much new and original matter has been incorporated. More systematic methods for separating the alkaloids are given, together with many additional reactions for their individual discrimination. The processes for detecting the poisonous metals in presence of organic matters are also much improved. A description of Bunsen's neat and expeditious flame reactions is likewise a new feature in the book. The delicacy and certainty of these reactions ought undoubtedly to lead to their more general adoption in our laboratories; even if their application is found to be limited, the lesson in neatness and dexterity in working to be acquired in their performance would prove invaluable to the student.

One of the characteristics of this book is its thoroughness, and the very example of this quality will not be lost upon the beginner. As an illustration of what we mean, we give the following extract from the introductory remarks on the province and scope of qualitative analysis:

> The analyst, by means of re-agents, interrogates the substance to be analysed as to what are its component parts; the reactions are the language in which the answer is returned. The student has therefore to learn the mode of questioning the substance, and the language in which the answer will be conveyed; in other words, he has to learn, not only what general and special re-agents are to be employed, but the order in which they are to be applied, and also the reactions they produce with the bases and acid-radicals, before he can attempt to search for these bodies in substances. No amount of *reading or lecture-hearing* will furnish the student with this knowledge; he can only obtain it by making the experiments himself of the different bases and acid-radicals with the re-agents, and "*he must always reflect, before the addition of the re-agent, for what purpose he applies it, and what are the phenomena he intends to produce.*" And the conditions indispensable for the production of correct and decisive reactions must be carefully observed, for a half-knowledge in all departments of science is of little worth, but in chemical analysis it is worse than useless.

There must always be diversity of opinion respecting the best method of teaching Qualitative Analysis, or indeed of teaching any branch of practical science; since so much depends upon the qualifications and conscientiousness of the teacher. In the Preface to the present edition of his book, Professor Galloway makes some very pertinent observations respecting the advantages which the method he adopts possesses over that employed by Fresenius and in the Giessen Outlines. It is quite possible that by faithfully following the plan laid down by the German professor, the student may succeed in correctly determining a larger proportion of the mixtures given to him for analysis, and yet the amount of actual benefit which may accrue to him may be far less than if he were more frequently unsuccessful by working under a system which left more to his individual judgment and intelligence. We believe that the method of Fresenius, as an educational agent, is radically bad; its tendency is to make the learner degenerate into a mere analytical machine. Such a system (to employ the phraseology of Mr. Galloway), of simply *telling* this and *showing* that, may be most pernicious in its consequences. The chief object in teaching chemistry is thus too frequently missed; science so studied renders the student utterly incapable of correctly reasoning upon the knowledge he acquires, for merely to create a number of proficient analysts is not the primary end of the introduction of qualitative analysis into the *curriculum* of our schools and colleges. A perfect system, then, is that which, whilst employing the most satisfactory and expeditious analytical methods, yet allows sufficient latitude for the student to exercise and strengthen the powers of his originality, reason, and intelligence. Such a system Professor Galloway has attempted to frame, and we have no hesitation in asserting that in the hands of a conscientious student his book will lead to the result which he desires to obtain. T. E. THORPE

WORKS IN NATURAL HISTORY

Works in Natural History, &c. By the Rev. F. O. Morris, B.A.

THIS is, in several respects, a very remarkable pamphlet. It shows us, to our great gratification, that the study of Natural History is, thanks to the labours of Mr. Morris, gradually finding its way into Royal Palaces and Baronial Halls, for we learn that Her Most Gracious Majesty the Queen has accepted the dedication of his "History of British Birds;" that his Excellency the Right Honourable the Earl of Carlisle, K.G, &c. &c., influenced probably by Her Majesty's example, has extended his patronage in a similar manner to the "Natural History of the Nests and Eggs of British Birds;" that his "British Butterflies" and "British Moths" are under the genial and aristocratic guardianship of the Honourable Mrs. Musgrave and the Right Hon. Lady Muncaster; that his "Anecdotes in Natural History," and "Records of Animal Sagacity and Character," are dedicated by permission to the Most Hon. the Marquis of Westminster, K.G. and the Hon. Anne Emma Caven dish; while His Grace the Archbishop of York stands sponsor to "The Difficulties of Darwinism." Surely even in the so-called Golden Age of English literature, no author could have had the good fortune to secure so many noble patrons.

Appended to the title of each of Mr. Morris's works are "Notices of the Press," and in this department the compiler of the pamphlet would, we think, have acted more wisely and more in accordance with the dignity of