

once its purpose and test. In accordance with this view, it might prove simpler, as well as more honest and logical, to make any desired concessions to usage as exceptions rather than by introducing subsidiary rules of doubtful sanction, such as the fifty-year limit. We could then work with the ideal before us, and such differences as continued to exist would concern particulars merely.

Many of the points treated in the various codes are, relatively, matters of slight importance, and are doubtless capable of being settled for all except the most cantankerous by simple rules or by-laws which might accompany a general platform or code, since in many such matters usage furnishes the only criterion of judgment and no logical or moral principles are involved. Instead of being essentially complicated, however, nomenclature is in reality a very simple matter. Stability and uniformity are the prime requisites, and these can be attained under the binominal system by adhering to the use of the oldest specific name without regard to generic reference, and by confining the application of a generic name to the genus in which its assigned type or first binominal species is included. The complicated and debatable nature of the various codes arises from the neglect of these principles or from attempts at limiting their application, either for avoiding bibliographic labor or in the interests of usage.

O. F. COOK.

U. S. NATIONAL MUSEUM,
July 27, 1898.

SCIENTIFIC LITERATURE.

SOME RECENT WORKS ON MECHANICS.

- A Treatise on Analytical Statics.* By E. J. ROUTH. Cambridge, University Press. 8vo., Vol. I., pp. xii + 407, 1891; Vol. II., pp. xii + 224, 1892.
- Traité de mécanique rationnelle.* Par PAUL APPELL. Paris, Gauthier-Villars et Fils. 8vo., Vol. I., pp. vi + 549, 1893; Vol. II., pp. vi + 538, 1896.
- The Elementary Principles of Mechanics.* By A. JAY DU BOIS. New York, John Wiley & Sons. 8vo., Vol. I., pp. x + 231, 1894; Vol. II., pp. viii + 392, 1894; Vol. III., pp. x + 296, 1895.
- Dynamics.* By P. G. TAIT. London, Adam and Charles Black. 1895. 12mo. Pp. xii + 361.
- Elements of Mechanics.* By THOMAS WALLACE WRIGHT. New York, D. Van Nostrand & Co. 1896. 12mo. Pp. viii + 392.
- Applied Mechanics.* By JOHN PERRY. New York, D. Van Nostrand & Co. 1898. 12mo. Pp. viii + 678.
- Ueber die Theorie des Kreisels.* Heft I., Die Kinematischen und Kinetischen Grundlagen der Theorie. Von F. KLEIN und A. SOMMERFELD. Leipzig, B. G. Teubner. 8vo. Pp. iv + 196.

The didactic excellence of the numerous treatises on the principles of mechanics which have appeared in recent years demonstrates an increasing appreciation of the importance of those principles and a progressive effort towards brevity and lucidity in their exposition. The doctrine of energy, now about half a century old, has not only supplied new ways of visualising the familiar and of investigating the unfamiliar in mechanics, but it has also forced us to recognize the omnipresence of mechanical phenomena. The growth of this doctrine and the accompanying developments of the mathematico-physical sciences have furnished, during the past twenty years especially, extensive additions in subject-matter and in applications not hitherto available to writers of works on mechanics. Almost equally important with these additions in the way of material are the improvements in terminology which have been slowly but surely gaining general approval during the present half century. The new points of view afforded by the doctrine of energy, and the critical spirit which has given precision to the terminology, have led also to a revision of the foundations of mechanics. Recent writers devote much space to explanation, illustration and discussion of the so-called axioms of the science; and the trend of current thought is toward the conclusion that most of these axioms are not such at all in the Euclidean sense, but that they are facts of nature which have been discovered by observation. Less stress than formerly is now laid on alleged mathematical proofs of mechanical principles and more attention is given to the phenomena wherein

those principles apply. The old notion that mechanics is merely a branch of applied mathematics is giving way to the more philosophical view that the core of the science consists in its physical principles and that mathematical analysis plays the secondary though wonderfully important rôle of the most effective instrument for investigating mechanical phenomena.

Students who are acquainted with Routh's *Rigid Dynamics* will easily anticipate the character of his *Analytical Statics*; and students not familiar with either should hasten to pursue both works, for in many respects they are the best treatises extant. Their excellence consists in clear exposition of principles, in detailed application of those principles to typical examples, and in elaborate collections of instructive problems.

Volume I. of the work on statics consists of eleven chapters having the following titles: The Parallelogram of Forces; Forces Acting at a Point; Parallel Forces; Forces in Two Dimensions; On Friction; The Principle of Work; Forces in Three Dimensions; Graphical Statics; Centre of Gravity; On Strings; and The Machines. Amongst these the chapter on the principle of work is of most practical importance. That on strings, subject to any forces and including the elastic catenary, is also replete with useful as well as instructive information.

Volume II. consists of three parts, devoted to attractions, including the theory of the potential function; to the bending of rods; and to *astatics*, respectively. While each of these is a capital contribution, the first is by far the most interesting and important. Though not exhaustive, it is probably the most readable and instructive exposition of the theory of attractions and potential function in the English language. The part devoted to the conditions of equilibrium of bent rods is somewhat novel in a treatise on statics. It would seem rather to belong in a work on the theory of elasticity. Without going into the complex details of the latter, however, the author has considered many of the most important properties of bent and twisted rods, including the case presented by helical springs. The last part presents, in about forty pages, an excellent summary of the

principal theorems which have been discovered in the interesting though not specially useful subject of *astatics* since its foundation by Moebius in his *Lehrbuch der Statik* in 1837.

For more than one hundred and fifty years the French have held first rank in the production of treatises on mechanics, and their reputation is well sustained in the admirable work of Appell. In his two rather bulky octavo volumes he has given a very comprehensive view of the whole science of rational mechanics. The mode of treatment is distinctly French. One is continually reminded of the clearness and elegance of the great masters, Lagrange, Laplace, Poisson and Poincot. The salient feature of the work is perfection of mathematical method, the point of view of the author being apparently that of the mathematician rather than that of the mechanician.

Volume I. consists of three parts. The first of these is devoted to the theory of vectors, kinematics and the elementary theory of kinetics. The second is devoted to statics and gives a very complete treatment of the subject in all its essential aspects, much space being allotted to the method of virtual displacements. The third part treats of the dynamics of a point and includes a luminous exposition of the principles of d'Alembert, Lagrange and Hamilton.

Volume II. consists of two parts. The first of these treats of the higher methods of Hamilton and Jacobi in application to the dynamics of a point, and the second is devoted to the dynamics of systems in general. The author's exposition of the principles of d'Alembert; of the energy method of Lagrange; of the principle of least action; and of all the elaborate mathematical machinery of Poisson, Hamilton and Jacobi, seems to be more complete and satisfactory than that afforded by any other single work. Every important principle or process is illustrated by application to one or more typical examples, and many unsolved problems are appended to the main chapters of the work. The text bears evidence of careful proof reading, since the number of misprints is very small for a work of so many pages.

The defects of this treatise, though unimportant to all but the novice, are characteristic of

Continental writers on mechanics. They consist in the use of antiquated 'if not ambiguous terminology, like 'vitesse virtuelle,' 'quantité de mouvement,' 'force vive,' etc.; and in the treatment of mass as a mere mathematical inconvenience to be got out of sight, if not out of mind, as soon as possible.

As may be inferred from the three volumes aggregating upwards of 900 pages, there is room in the work of Professor Du Bois for pretty thorough treatment of the elements of mechanics. A detailed examination of the work will convince one that this room has been well filled. Many parts of the work might have been much condensed and some parts might have been omitted entirely without detriment to an elementary book, but it was the purpose of the author to prepare a text-book which would be of use to students during the whole of their college course and afterwards as a work of reference. This purpose, it must be said, has been very well executed, and the work will prove exceedingly useful to teachers and professional readers as well as to students.

The plan of the work is in accordance with the divisions of the science adopted by Thomson and Tait in the *Natural Philosophy*; the first part being devoted to kinematics, and the last two to dynamics, that is, to statics and kinetics respectively. The development of the fundamental principles is systematic and logical, and an invaluable feature of the volumes is found in the large number of numerical examples fully worked out. By means of typographical devices the author appeals to all classes of readers, the paragraphs in large type forming an abridged course, the articles in small type being for advanced students, and articles involving the use of the calculus being set off by brackets. Italics and full-face type are also used with a freedom which seems Teutonic rather than English in its tendencies, and many readers will wonder how statements which are already admirably clear and intelligible are rendered more so by those pictorial devices.

The volumes devoted to kinematics and statics are very full of well arranged and digested matter for an elementary work, the volume on statics containing also four chapters

(158 pp.) on retaining walls, elasticity of materials, theory of flexure and the continuous girder, respectively. The volume on kinetics is likewise quite complete, all but one short chapter on the gravitational potential being occupied with what may be called pure theory.

Amongst many commendable features of the work of Professor Du Bois special mention should be made of the clearness of definition and the precision of terminology which prevail throughout the volumes. In these respects the work is on the whole especially satisfactory. The only exceptions we have noted are in Chapter VIII. of Vol. III., wherein the potential as defined by equation (1) does not appear to have the dimensions assigned to it in problem (11). In the same chapter also, p. 113, a well known theorem of Gauss is attributed to Laplace; while on pp. 114 and 115 Poisson's extension of Laplace's theorem is referred to without explanation of Laplace's theorem itself.

Professional and unprofessional students who have read Professor Tait's profound article on mechanics in the last edition of the *Encyclopædia Britannica* welcome the reprint of that article with additions in the handy text-book form presented by the Messrs. Black. Some modifications of the original article have been made in this reprint, and the subjects of attractions, hydrostatics, hydrokinetics and waves have been incorporated as additions. The result is a treatise on dynamics which for thought-promoting information per unit area is equalled only by the *Natural Philosophy* of Thomson and Tait. Every student will feel a regret that the author did not enlarge the work much beyond its present limits. This regret is especially keen with respect to Chapter V., wherein the methods of Lagrange and Hamilton are all too briefly developed. But the author anticipated and answered this criticism. In his preface he says: "One obvious objection may be made to many parts of this book—undue brevity. It was inevitable, when much had to be compressed into moderate space; yet, at the worst, is not brevity, if it but convey its message, transcendently preferable to prolixity?"

The work of Professor Wright is a completely rewritten edition of his book on mechanics published a few years ago. A larger page and

larger type have been used, and the work is in every respect an improvement over the earlier edition. The scope of the book is limited to coplanar kinematics and dynamics, and it seems remarkable that so much of the groundwork of the science is covered in spite of that restriction. The author has also limited himself in the use of the calculus, the book being so arranged as to form a consecutive elementary course without resort to that branch of mathematics which is still a mystery to many well developed minds. On the other hand, by such limited use of the calculus he seeks to prevent the student 'from thinking, as is often the case, that there is a kind of mechanics called elementary, another analytical, a third theoretical, and so on.' For the average student, it must be admitted, this type of book is more readable than any other, and we can heartily recommend Professor Wright's book as one of the freshest, most interesting and most instructive of the type. In the old days, when all students of some colleges were compelled to pursue mechanics, it was commonly considered a 'dis-mal science.' Saxe, in his *Reflective Retrospect*, says:

"I recollect those harsh affairs,
The morning bells that gave us panics.
I recollect the formal prayers
That seemed like lessons in mechanics."

But no one can read Professor Wright's book without being interested at least in the historical references and apt quotations he has worked in along with the formal parts of the science. Even the ponderous gravity of John Milton has to submit to a sly dig from the wily mechanician. Witness this conclusion from Milton's data:

"Men called him Mulciber: and how he fell
From heaven they fabled, thrown by angry Jove
Sheer o'er the crystal battlement: from morn
To noon he fell, from noon to dewy eve,
A summer's day: and with the setting sun
Dropt from the zenith like a falling star,
On Lemnos th' Ægean isle."

"Taking the summer's day fifteen hours, show that the distance of Lemnos isle from heaven is about one-fourth of the distance to the moon."

Of a radically different type from any other work noticed in our list is the text-book on

applied mechanics of Professor Perry. It is also quite different from the standard works on the subject by Rankine, Weisbach and others. In fact, it is a unique work, full of information as an egg is full of meat, and written in a style which is very lively in comparison with the sedate models set by previous writers. As stated on the title-page, the book is intended to be 'A treatise for the use of students who have time to work experimental, numerical and graphical exercises illustrating the subject.' As to the qualifications of a reader taking up the work the author says in his preface: "I should like to think that, before a student begins the part in small type, he has worked through Thomson and Tait's small book on *Natural Philosophy*, and that he has read the early part of my book on 'The Calculus for Engineers.' " The vigorous way in which the views of the author are set forth may be inferred from the following quotations from the introductory chapter:

"When we think of what goes on under the name of teaching we can almost forgive a man who uses a method of his own, however unscientific it may seem to be. Nevertheless, it is not easy to forgive men who, because they have found a study interesting themselves, make their students waste a term upon it, when only a few exercises are wanted—on what is sometimes called the scientific study of arithmetic, for example, or of mensuration."

"In our own subject of Applied Mechanics there are teachers who spend most of the time on graphical statics, or the graphing of functions on squared paper, or the cursory examination of thousands of models of mechanical contrivances. One teacher seems to think that applied mechanics is simply the study of kinematics and mechanisms; another, that it is the simple exercise work on pure mechanics; another, that it is the breaking of specimens on a large testing machine; another, that it is trying to do in a school or college what can only be done in real engineering works; another, that it is mere graphics; another, that it is all calculus and no graphics; another, that it is all shading and coloring and the production of pretty pictures without center lines or dimensions. Probably the greatest mistake is that of

wasting time in a school in giving information that one cannot help picking up in one's ordinary practical work after leaving school."

"In teaching beginners it is well to start on the assumption that students already possess the notions of the differential and integral calculus, and it is the teacher's duty to put before them the symbols used in the calculus at once. It is surely much better to do this than to evade the calculus in the fifty usual methods which we sometimes see adopted."

The book contains thirty chapters, followed by an appendix of useful tables, including 4-place logarithms and anti-logarithms, and a full index. Every chapter is replete with useful information, and most topics are treated in ways that are refreshing by reason of the novelty of method and the incisive language of the author. We may not in all cases accept his views or approve his style, but there is not a dull page in the text, and his views and style are everywhere entertaining and instructive. There is much new matter in the book, and the numerous illustrations (371 of them) are in general excellent, many of them exhibiting apparatus designed by the author and now published apparently for the first time. To teachers, to engineers and to readers of mechanics, as well as to students, this book cannot be too highly commended.

During the hundred years ending with the first half of the present century the most important contributions to mechanical science were made by writers who were alike eminent as mathematicians and as mechanicians. Such were the great masters Lagrange, Laplace, Poisson, Cauchy, Gauss, Dirichlet, Lamé, etc. Since that time, however, the mathematicians and mechanicians have parted company to a great extent and their diverging paths have presented little in common. Whether this fact is to be regretted or not must be left for the historians of our times to decide. In the meantime each according to his bias will rejoice that pure mathematics is not, or that pure mechanics is, deeply concerned with things material. Those subject to the latter bias will rejoice that the prestige of the Göttingen school of mathematicians is maintained by the presence of Professor Klein in the field of mechanics.

The volume before us is an elaboration, through the aid of Dr. Sommerfeld, of Professor Klein's lectures at the University of Göttingen. It does not pretend to be a systematic treatise, but, very appropriately, assuming a general knowledge of mechanics on the part of the reader, proceeds to discuss, in considerable detail, the typical problem of the top in its kinematical, kinetic and mathematical aspects.

The book is divided into three chapters. The first of these is occupied with the kinematical principles of the problem, and the systems of coordinates required to specify the motion of a top are elaborately considered. The most important novelty of the work in this part consists in the very natural introduction of complex numbers and quaternions, about one-fifth of the chapter being devoted to the latter.

The second chapter considers the principles of kinetics and develops the formulas applicable to the notion of a free mass and to the rotation of a rigid body, special emphasis being given to the theory of impulses. The last chapter is devoted to Euler's equations of rotation and to their integration; and a promise is indicated that the following volumes may treat, among other applications, the important problem of variations of terrestrial latitudes. Both of these chapters present much that is novel with respect to matter and mode of presentation, leading us to await with interest the appearance of subsequent volumes.

In one respect the authors are, we think, open to a criticism which will apply also to many other Continental writers on mechanics. Since the appearance of Thomson and Tait's *Natural Philosophy* and Maxwell's *Matter and Motion*, progress in the ideas as distinguished from the methods of mechanics is attributable largely, if not chiefly, to the decapitation of the numerous 'forces' of the science other than the one which is the product of mass and acceleration. It seems like a step backwards, therefore, to encounter in this capital work some new species of force in addition to many of the species which have long been fossil in the best English terminology. Clearness of physical principles would seem to exclude all such terms as *Drehkraft*, *Schiebekraft*, *Stofskraft*, etc., along with *lebendige Kraft*. We shall hope

that future volumes of the authors will follow English terminology more closely, since, without regard to race prejudice, it appears vastly superior to that of other languages. The lack of a generally accepted precise terminology in French and German appears to have led the authors to attribute a similar indefiniteness to English terms wherein such defect does not exist. Thus, on page 81, they say: "Gewöhnlich wird in den englischen Büchern statt Impuls das etwas farblos wort momentum benutzt; die Komponenten des Impulses heissen dan 'the moments of momentum.' (!)"

R. S. W.

An Illustrated Flora of the Northern United States, Canada and the British Possessions, from Newfoundland to the parallel of the southern boundary of Virginia, and from the Atlantic ocean westward to the 102d meridian. By NATHANIEL LORD BRITTON, PH.D., and HON. ADDISON BROWN. Vol. III., Apocynaceae to Compositae; Dogbane to Thistle. New York, Charles Scribner's Sons. 1898. Large 8vo. Pp. xiv + 588.

A little less than two years ago (August 22, 1896) the first copies of Volume I. of this important work were distributed; less than a year later (June 15, 1897) a copy of Volume II. reached the writer; now (July 5) the third and last volume is at hand. When we bear in mind that these three volumes include descriptions of 4,162 species, and that every one of these is illustrated by outline drawings, one-half to three-fourths natural size, with many additional figures somewhat enlarged, we are able to realize the great amount of labor involved in their preparation and publication. The authors and publishers are to be congratulated upon such prompt completion of this work, whose value is greatly increased by the fact that so short a time has elapsed between the appearance of its volumes.

It is not necessary here to speak of the peculiarities of these volumes, since every working botanist in this country is familiar with them. The modern nomenclature, following the famous 'Rochester Rules,' and the modern sequence of families, following the system of Engler and Prantl, distinguish this from every other syste-

matic work on the plants of North America. It follows that those who do not like the Rochester Rules will not like this book, nor will those who persistently adhere to the Candollean sequence of families. However, it is inevitable that one result of its publication will be that the number of those actively opposing these modern features will rapidly grow less. It will soon be much easier to follow the modern innovations along the plain highway here made than to continue in the less and less frequented paths of the conservatives.

The General Key to the Orders and Families will be helpful, not only as a key, but also as affording a synoptical view of the system adopted. While necessarily keys are all much alike, this one shows in many ways the influence of the modern ideas in regard to plants. Here and there a slip occurs, and now and then there is a patch of old cloth used in the new garment. But these are to be expected, and they are not serious blemishes. In a second edition, for example, we may have a correction on page viii of the statement which makes embryo-sac synonymous with macrospore, and of the description of the leaves of Isoetaceae as 'tubular.'

Having accomplished so good a work the authors now owe it to the botanical public to bring out a small, thin-paper edition, without illustrations, so that all the descriptions may be brought within the limits of a small book. If the publishers will then give it a flexible binding, with narrow page margins, they will make a most useful book, which will be a fine adjunct to the fine large three-volume edition now before us.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC JOURNALS.

THE contents of the *American Journal of Science* for August are as follows: 'Jurassic Formation on the Atlantic Coast—Supplement:' By O. C. MARSH. 'Mineralogical Notes:' By C. H. WARREN. 'Origin and Significance of Spines—A Study in Evolution:' By C. E. BEECHER. 'Prehistoric Fauna of Block Island, as indicated by its Ancient Shell-Heaps:' By G. F. EATON.