ment of the number of typewritten and printed pages handled during the past year. The manuscript pages, usually typewritten, amounted to 16,263, and proof sheets read and corrected during the year to 10,840; the latter, as a rule, were read twice. The editorial work increases with the growth and diversity of the Survey's work. Thus for five years, 1889 to 1894 inclusive, the number of manuscript pages edited was 46,891 and of proof pages read 22,795, whereas during the equal period from 1894 to 1899 inclusive, the corresponding numbers were 65,763 and 35,769.

The work of the Engraving Division also grows from year to year, as the output of original maps from the topographic and geologic branches is enlarged. The Chief Engraver has ingeniously simplified the technical processes, and he has organized his force on the best models of private business enterprise. The precise cost of each item of engraving, correcting, or printing is ascertainable, and the efficiency of each worker is demonstrated. To a certain extent this reacts upon the scientific branches of the Survey, since the character of original manuscripts may be such as to facilitate or to impede the work of reproduction. But in spite of efficient organization the division is not equal to the tasks imposed upon it. The publication of topographic maps (of which the number is being increased by cooperation) and the issues of geologic folios will be delayed if the appropriation for this work is not materially enlarged.

Following the precedents set under King and Powell, it has been the policy of the present Director of the Survey to secure the strongest men available for each branch of the work, and to encourage the development of individual members. Among the gratifying results of this policy was the cordial recognition of the service rendered by members of the Geological Survey, Messrs. Hayes and Davis, attached to the Nicaragua Canal Commission under Admiral Walker. In the last four years the geologic personnel has been increased by the addition of a number of strong men, recently graduated from the leading centers of geologic instruction. Several of them entered through Civil Service examination, and others, whose university work succeeded practical field experience on the Survey, came back to it after their years of study. It has been said in the course of discussions concerning a National University that the Geological Survey at present constitutes the geologic branch of such a university, since it receives post-graduate students from the highest universities in the country and gives them opportunity to pursue independent researches in geology.*

BAILEY WILLIS.

SCIENTIFIC BOOKS.

POINCARÉ'S COURS DE PHYSIQUE MATHÉMATIQUE.

Théorie du potentiel Newtonien. Par H. POINCARÉ. Rédigées par ÉDOUARD LEROY et GEORGES VINCENT. Paris, Georges Carré et C. Naud. 1899. 8vo. Pp. 366.

Cinématique et mécanismes, potentiel et mécanique des fluides. Par H. POINCARÉ. Rédigé par A. GUILLET. Paris, Georges Carré et C. Naud. 1898. 8vo. Pp. 385.

The fertility in mathematical resources of the eminent author of these volumes and the wide range of physical questions which he has illuminated by means of those resources excite at once our surprise and our admiration. He has proved, in fact, that it is still possible, as it was

* The preceding article is not intended to present a complete catalogue of the activities of the Geological Survey or of its publications. The administration, distribution of work and funds, and the assignment of the personnel, are given in detail in the Director's Annual Report, issued in December of each year, and may be had on application to the Director of the Geological Survey. Complete lists of the publications are kept as nearly up to date as possible and may be had on request.

in the days of Laplace and Gauss, for one mind to possess a working knowledge of the entire group of the mathematico-physical sciences.

An idea of the comprehensive scope of this *Cours* may be gained by the following list of titles to the preceding ten numbers of the series: 1°, Théorie mathématique de la lumière, I., 1 Vol.; 2°, Électricité et Optique, 2 Vol.; 3°, Thermodynamique, 1 Vol.; 4°, Leçons sur la Théorie de l'Élasticité, 1 Vol.; 5°, Théorie mathématique de la lumière, II., 1 Vol.; 6°. Théorie des Tourbillons, 1 Vol.; 7°, Les oscillations électriques, 1 Vol.; 8°, Capilarité, 1 Vol.; 9°, Théorie analytique de la propagation de la chaleur, 1 Vol.; 10°, Calcul des probabilités, 1 Vol. These, together with the two works announced above, which are Nos. 11° and 12° of the series, make a total of thirteen octavo volumes devoted to at least ten fairly distinct subjects of mathematical physics. All of these volumes have appeared within a period of about ten years, during which the indefatigable author has found time also for many researches in pure mathematics and for important contributions to dynamical astronomy.*

The reader who is not already acquainted with this important series of works will naturally enquire what are its characteristic features and what are the advantages to be gained by a study of this rather formidable aggregate of three to four thousand pages of intensely mathematical literature.

In the first place, it should be said that the works are in no sense treatises. They assume, in general, a considerable knowledge of the subject on the part of the student, and do not attempt, as a rule, to give that degree of detail which is essential in an elementary presentation. Secondly, it must be said that these works are much more mathematical than physical. Indeed, it will doubtless appear to some that the title of the series ought to be Cours de mathématique physique; for the ease with which the author substitutes mathematical abstractions for physical realities is often painful to one who is at all conscious of the obstinate properties of matter. In many cases, also, the formulas dealt with are entirely divested of the factors which are indispensable to their use by the physicist; so that while the mathematical argument may proceed unimpeachably the results attained are often quite unsuited for the physical laboratory or the computer's mill. But let no mathematician who has the slightest liking for physical applications and no physicist who has a fondness for mathematical methods of research be deterred by such trifling matters of detail from an attentive study of these volumes. For the mathematician will find in them a wealth of beautiful analysis satisfying all the canons of modern precision and at the same time not obtrusively technical and practical; while the physicist, on the other hand, will be delighted and instructed by the luminous expositions of obscure questions, by the fresh and rigorous proofs of old theorems, by the more refined processes of modern analytical procedure, and by the sharper limitations of the fields explored. In short, it is one of the prime merits of these works that they afford a common ground on which the pure and applied mathematicians may meet to their mutual advantage. Of course, there must be some concessions. The pure mathematician must admit, while reading the *Cours*, at any rate, that the phenomena of nature present intricate though special and perhaps grossly utilitarian illustrations of his general theorems; and the physicist must own, with due contrition, that it is not uninteresting and profitless, occasionally, to free one's self from the restrictions of matter, or even to investigate the imaginary properties of hypothetical mediums.

The volume devoted to the Thèorie du potentiel Newtonien is chiefly concerned with the properties and application of the function dependent on the law of the inverse square of the distance, but considerable attention is given also to the logarithmic potential, which has come to play an important rôle in some physical problems. The book is divided into nine chapters. The first deals with the potential at a point external to the attracting mass, with the equation of Laplace and with the harmonic developments of the potential function. The second is concerned with the potential at a point internal to the attracting mass, and with the equation of Poisson. The third is devoted to the potential

* Especially his 'Nouvelles théories de mécanique céleste.'

due to surface and line distributions of mass. The fourth and fifth are occupied with the function of Green and the problem of Dirichlet. The sixth gives an exposition of the potential theory as applied to double strata (double couches); that is, two infinitely near surface or stratum distributions of equal but opposite densities. The seventh and eighth continue the consideration of the problem of Dirichlet, the former by means of the process of Green's equivalent stratum (here called La methode du balayage), and the latter by the method of Neumann. The ninth chapter is devoted to an extension of the method of Neumann to the case of simply connected regions, and to certain functions (called Fonctions fondamentales) which conform to the conditions of the potential function due to a simple surface distribution of mass.

The treatment of the subject, except for the few final pages in which the 'fonctions fondamentales' are discussed, is very precise from the purely mathematical point of view. "J'ai cherché," the author says, p. 348, "à donner partout à mes raisonnements un charactère de parfait rigueur." For this reason the work will doubtless prove most interesting to the mathematician and most instructive to the physicist. But the latter can hardly conceal the regret that his demands for precision are not equally met. Thus, to cite some illustrations, the Newtonian potential is defined by the equation

$$V = \Sigma \frac{m}{n},$$

where m is any element mass and r its distance from the attracted mass; and we are told that the components of attraction in the coordinate directions are

$$X = \frac{\partial V}{\partial x}, \quad Y = \frac{\partial V}{\partial y}, \quad Z = \frac{\partial V}{\partial z};$$

but not a word is said about the gravitation constant nor of the difficulties a reader who may know the dimensions of force may have in interpreting $\partial V/\partial x$, etc. Again, how do 'potentiel newtonien d'une surface sphérique homogène' and 'potentiel logarithmique d'une circonférence' sound to one whose imagination is always shocked by the suggestion of surface and line distributions of real matter? Again, on p. 215, ξ, η, ζ figure as components of a velocity, but on p. 217 the author says: "Supposons maintenant que le vecteur ξ, η, ζ soit, en chaque point, normal à la surface, c'est-a-dire que l'on ait:

$$\xi = a, \ \eta = \beta, \ \zeta = \gamma,$$

a, β, γ désignant les cosinus directeurs de la normale au point x, y, z." The reader will find out, of course, sooner or later, how to remove these inconsistencies, but it would have been very easy to avoid them entirely and to have thus fulfilled the requirements of the physicist as well as those of the mathematician.

English students of the theory of the potential will be glad to find good French authority for the term Laplacian as applied to the sum of the three second derivatives of the potential with respect to the coordinate directions. Thus, for example, the author writes, p. 118, "Le laplacien ΔV, more commonly written $\Delta^2 V$ or $\nabla^2 V$ by English writers, 'fait un saut brusque. . ."

The most important technical features of the book are to be found in the investigations of the potential of single and double surface distributions, in the considerable space devoted to the logarithmic potential, and in the thorough though tedious treatment of the problems of Green and Dirichlet.

The volume on kinematics, potential and hydromechanics presents an unusual though not incongruous combination of subjects. A good knowledge of kinematics and a considerable acquaintance with the potential theory are, in fact, necessary preliminaries to the study of the mechanics of fluids.

Over half of the book, 200 pp., is devoted to kinematics and mechanism. Beginning with the elements of the subject, Chapter I treats of the rectilinear and curvilinear motions of a point, Chapter II of the coplanar motion of an invariable figure, Chapter III of the motions of a rigid body, Chapter IV of helicoidal motions (theory of screws), Chapter V of the relative motion of a point, and Chapter VI of the motions of various forms of mechanisms, including belts, gearing, links, etc. In the development of the purely kinematical principles the author supplies both geometrical and analytical proofs. Many of the former and some of the latter appear to follow new lines in this

well gleaned field. This work does not seem to be, as a whole, very satisfactory, however, in view of the heavy drafts which kinetics and some branches of applied mechanics now make on kinematics. A more condensed and a more analytical treatment would have been clearer, we think, and would have left room for some important generalities omitted, especially such as are essential in hydrokinetics, in elasticity, and in the kinetics of non-rigid bodies. There is in this part also an occasional departure from the modern demands for mechanical precision, as on pp. 10, 11, where, by the unnecessary suppression of a length symbol, the ancient fallacies of the equality of linear and angular velocities and of linear and angular accelerations are revived. Again, to cite another illustration of a lack of clearness, in Chapter V, which is entitled 'Mouvement relatif d'un point,' and which considers the motion of a point referred to two sets of rectangular axes, one of which moves in any manner with respect to the other, the author says, p. 121: "On peut avoir à considérer trois mouvements: 1° le mouvement du point M par rapport aux axes fixes ou mouvement absolu; 2° le mouvement des axes mobiles ou mouvement d'entraînement; 3° le mouvement de M tel qu'il apparaîtrait à un observateur invariablement lié aux axes mobiles ou mouvement relatif." This shows also, among other things, that it is still easy to speak of the absolute even in mechanics.

The second part of the book presents, in the first two chapters, a rather elementary introduction to the theory of the force function, potential function and the flux of force, and to Green's theorem and Dirichlet's problem. There is added, also, in the third chapter, an elementary investigation of the attraction of ellipsoidal shells and of a homogeneous ellipsoid.

The most interesting and important chapters of the book are the last two, which are devoted to hydromechanics. The treatment is confined to the ideal case of perfect fluids and is, on the whole, elementary. About 60 pages are given to the theory and applications of the principles of hydrostatics. Most prominent and important among the applications is the somewhat extended discussion of the conditions of equilibrium of floating bodies. Among many instructive results it is shown that a right homogeneous cylinder may float in stable equilibrium in four different positions, in one of which its axis is vertical, in one horizontal, while in the other two the axis is oblique to the vertical.

The final chapter, of 61 pages, is devoted entirely to hydrokinetics. Proceeding from the Lagrangian to the Eulerian equations of motion, the author develops the elements of the subject with unusual clearness and mathematical elegance. After the introduction and definition of the velocity potential the theorem of Lagrange —once a potential always one—is demonstrated by an apparently new proof, which seems peculiarly well adapted to show the meaning and limitations of the theorem. The beautiful and very important theorem of Bernoulli is also demonstrated in a new and rigorous fashion. The part of the chapter dealing with irrotational motion closes with an exposition of the motion of liquids under gravity in the case wherein the products of the component velocities and their space derivatives can be neglected.

The rest of the chapter is concerned chiefly with vortex motion (vortices, tourbillons). Here also there is much fine mathematical work, though the notation is in some respects repulsive and though the printer would appear in some places to have sown his d's and ∂'s broadcast. On pp. 348–353 there is some especially interesting work preliminary to the proof of Helmholtz's theorem that the molecules once observed to be on a vortex line remain on it. This work consists in the proof of three special theorems drawn from the general equations of rotational motion for the particular case of steady motion. Let at any point x, y, z of the fluid

$$E = -T - V - \int \frac{dp}{\rho}$$

where T and V are the kinetic and potential energies respectively per unit mass, p is the pressure, and ρ is the density assumed to be dependent on p only. Then: 1st, for steady irrotational motion, for which the component spins and accelerations of the molecules vanish, it appears at once that E is constant throughout the mass, which is Bernoulli's theorem generalized; 2d, when the motion is steady but ro-

tational, E is constant along the same stream line (filet) defined by the equations

$$\frac{dx}{u} = \frac{dy}{v} = \frac{dz}{w},$$

where u, v, w, are the component velocities of the particle; 3d, when the motion is steady but rotational, E is also constant along the same vortex line, defined by the equations

$$\frac{dx}{p} = \frac{dy}{q} = \frac{dz}{r},$$

where p, q, r are the component spins.

Then follow a proof of the theorem of Helmholtz, above cited, and of the theorem that in the case of a liquid filling a recipient the velocity components u, v, w are determinate if the spins p, q, r are known at any instant. Several very instructive special cases of vortex motion are also considered; and the chapter closes with an exposition of the problem of the motion of a solid in a liquid, application being made especially to the case of pulsating spheres studied by Bjerknes. R. S. W.

The Elements of Vital Statistics. By ARTHUR NEWSHOLME, M. D. Third Edition. London, T. Swan Sonnenschein & Co., and New York, The Macmillan Company. 1899. Pp. xii + 353.

That a third edition of this book has been demanded within ten years of its first appearance is gratifying evidence of a growing public interest in Vital Statistics and an appreciation of sound and careful work. Vital Statistics, interpreting that phrase in a somewhat larger sense than is done by this writer, is probably the best avenue along which to approach the general field of statistics. It is the oldest, most developed and most systematized branch of the subject, and, if properly handled, can be made of great interest even to beginners. For these reasons I have long felt that the book of Dr. Newsholme was, perhaps, as good an introduction to statistics as anything in the English language. There is no American book to be compared with it, for the articles by Dr. J. S. Billings and Dr. Roger S. Tracy are buried in pages of other matter, one in a medical journal and the other in an encyclopædia, and neither vies in simplicity or fullness of treatment with the present work. This third edition is almost a new book, embracing fewer tables, more graphic illustrations, more references to results obtained in foreign countries and many new subjects. From the American standpoint it may be criticised as confined somewhat too closely to topics which especially interest English sanitary and medical statisticians. But as England is *facile princeps* in this field and the United States as a whole is inferior, not merely to those countries of Europe with which we naturally compare ourselves, but even to Russia, Greece, Spain and the colonies of Australia, the objection is not a serious one. During years of critical use of Dr. Newsholme's book I have never found in it a serious error of statement and the argumentative parts are sound, temperate and convincing. It is a typically English book, caring little for theory or refinements of analysis unless they have a clear bearing on the results, but strong in all such practical discussions as statistical evidence for the utility of vaccination, causes of infant mortality, or the fallacies to which statistical arguments are exposed. WALTER F. WILLCOX.

CENSUS OFFICE.

BOOKS RECEIVED.

Anatomie des Frosches. A. ECKERT and R. WIEDERSHEIM. Revision by DR. ERNEST GAUPP. 2d Edition. Braunschweig, Friedrich Vieweg und Sohn. 1899. 2d Part. Pp. 237–548 + xii.

Praxis und Theorie der Zellen-und Befruchtungslehre. VALENTIN HÄCKER. Jena, Gustav Fischer. 1899. Pp. viii + 260. Mark 7.

Fixirung, Färbung und Bau des Protoplasmas. ALFRED FISCHER. Jena, Gustav Fischer. 1899. Pp. x + 362. Mark 11.

Folk-lore in Borneo. WILLIAM HENRY FURNESS. Wallingford, Pa., Privately Printed. 1899. Pp. 30.

Sewage Analysis. J. ALFRED WANKLYN and WILLIAM JOHN COOPER. London, Kegan, Paul, Trench, Treübner & Co., Ltd.; Philadelphia, J. B. Lippincott Company. 1899. Pp. xvi + 220. $2.00.

New Plane and Solid Geometry. WOOSTER WOODRUFF BEMAN and DAVID EUGENE SMITH. Boston, Ginn & Company. 1899. Pp. ix + 382.

SOCIETIES AND ACADEMIES.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—PRELIMINARY PROGRAMS.

SECTION A, MATHEMATICS AND ASTRONOMY.

'REPORT on Progress in Non-Eulidean Geometry,' George Bruce Halsted, University of Texas, Austin, Texas.