

applied to rigid bodies; the forms of the third order represent planes and the plane at infinity. Among the operations, the progressive and regressive products give the geometric operations of projecting and cutting; the inner product gives the orthogonal projections and the elements which we designate in mechanics by the terms moment, work, *et cetera*.

In ordinary differential geometry simple properties most frequently yield themselves only after very complicated calculations. This complication is due in general to the use of coördinates; with these coördinates algebraic transformations are made on numbers in order to obtain certain formulæ, namely, invariants, which are susceptible of geometric interpretations. On the other hand the geometrical calculus makes no use whatever of coördinates; it operates directly on the geometric elements; each formula which it produces is an invariant, capable of a simple geometric interpretation and leading directly to the graphic representation of the elements considered. Burali-Forti's work, though by no means a pioneer in the application of Grassmann's theories to differential geometry (note for example the memoirs of the younger Grassmann in the theory of curves and surfaces), shows the elegant power and simplicity of the geometrical calculus in elementary differential geometry and points the student to a vast field of transformations and researches in higher geometry.

The work is designed after the following plan which exhibits the skeleton of its contents:

I. The geometric forms.—1° Definitions and rules of calculus:—tetrahedron, geometric forms, equality of forms, points, segments, triangles, sum and product by a number, progressive product; 2° Vectors and their products:—vectors, bivectors, trivectors, rotation, operation index; 3° Reduction of forms:—forms of the first order, forms of the second order, forms of the third order, projective elements, identity between forms of the first order; 4° Regressive products:—forms of the second and third orders, forms of the third order, general properties of products, duality, regressive products in a projective plane; 5° Coördinates.

II. Variable forms.—1° Derivatives:—defi-

nitions, limit of a form, limit of a projective element, derivatives, mean forms, Taylor's formula, continuous forms; 2° Lines and envelopes:—lines and envelopes of straight lines on a projective plane, space curves and envelopes of planes; 3° Ruled surfaces:—ruled surfaces in general, skew ruled surfaces, developable surfaces; 4° Frenet's formulæ:—arcs, curvature and radius of curvature, torsion and radius of torsion, formulæ of Frenet, spherical indicatrix and angle of contingence.

III. Application.—1° Helix; 2° Surfaces ruled relative to a curve—polar surface, rectifying surface, surface of principal normals, surface of binormals, skew ruled surfaces whose line of striction is given, developable ruled surface described by a straight line whose position is fixed with regard to the tetrahedron PTNB; 3° Orthogonal trajectories:—orthogonal trajectories of the generatrices of a ruled surface, evolutes, involutes, orthogonal trajectories of planes of an envelope; 4° Curves of Bertrand.

NOTES.—1° Forms which are functions of two or more variables; 2° Tangent plane; 3° Differential parameter of first order; 4° Curvilinear coördinates.

E. O. LOVETT.

PRINCETON, NEW JERSEY.

Chemical Experiments. By JOHN F. WOODHULL, Professor of Physical Science, Teachers College, Columbia University, and M. B. VAN ARSDALE, Instructor in Physical Science in Horace Mann School and Assistant in Teachers College. New York, Henry Holt & Co. 1899. Pp. 136. Price, 50 cents.

This book gives a series of very elementary experiments dealing chiefly with the elements oxygen, hydrogen, chlorine, sulphur, nitrogen and carbon. The apparatus recommended for the experiments is simple, and in several cases, quite ingenious. For pupils of a certain grade the book will doubtless prove useful, but the introduction of a few more quantitative experiments designed to illustrate fundamental principles seems desirable.

A Laboratory Outline of General Chemistry. By ALEXANDER SMITH. Chicago, Kent Chemical Laboratory of the University of Chicago. 1899. Pp. xii+90.

The work before us represents a very dis-

tinct advance in the teaching of General Chemistry. Dr. Smith appears to recognize more clearly than most teachers have done that chemical experiments for beginners should not be selected merely or chiefly to give a knowledge of the striking superficial properties of a few substances, but that they should be so devised that the student may acquire a direct experimental knowledge of those facts on which the real science of chemistry rests. For this reason the book contains an unusual number of carefully selected quantitative experiments. The book is notable also because of its introduction of experiments to illustrate ionization and the phenomena on which the modern theory of solutions is based. The directions are of such a nature, too, as are suited to develop independent thought and self-reliance. The student who thoroughly masters the course laid down will have made a good beginning toward an understanding of chemistry and of how chemists work.

W. A. NOYES.

GENERAL.

La Théorie de Maxwell et les Oscillations Hertziennes, by H. Poincaré (Paris, George, Carré et C. Naud, 1899), is a popular exposition of the mathematical treatise on the subject by the same author, which was reviewed in SCIENCE for January, 1895. It is one of the series of popular treatises on scientific subjects published under the general name 'Scientia.' It is very attractive both in form and in substance and will furnish much interesting reading to those who have neither time nor inclination to study the mathematical treatise.

M. I. P.

THE excellent 'Manual of Bacteriology' of Muir and Ritchie (The Macmillan Company, 1899), already reviewed in these columns, has in the second edition been revised, brought up to date and somewhat enlarged. It is, as was the first edition, a bacteriology for medical folk. About one-quarter of its pages are concerned with general technique; the remainder with excellent, short and clear, but fairly comprehensive descriptions of pathogenic micro-organisms. The exposition of that difficult and dangerous theme, immunity, is admirable. The bibliographic suggestions are good, the historical glimpses illuminating. Altogether, the book is

of such evenly sustained excellence throughout, that among a small host of competitors of similar scope in various languages, it easily holds the leading place.

T. M. P.

THE authorities of the Royal College of Surgeons in England have made arrangements for the compilation of a descriptive catalogue of the vertebrate brains in the Museum. Dr. G. Elliott Smith, of St. John's College, Cambridge, will undertake the work.

BOOKS RECEIVED.

The Elements of Alternating Currents. W. S. FRANKLIN and R. B. WILLIAMSON. New York and London, The Macmillan Company. 1899. Pp. 212.

Pulmonary Tuberculosis ; Its Modern Prophylaxis and the Treatment in Special Institutions and at Home. S. A. KNOPF. Philadelphia, P. Blakiston's Son & Co. 1899. Pp. 343.

The Story of the Fishes. JAMES NEWTON BASKETT. New York, D. Appleton & Co. 1899. Pp. xxii + 297.

About the Weather. MARK W. HARRINGTON. New York, D. Appleton & Co. 1899. Pp. xx + 246.

Determination of Radicles in Carbon Compounds. H. MEYER. Authorized translation by J. BISHOP TINGLE. New York, John Wiley & Sons; London, Chapman and Hall, Ltd. 1899. Pp. iv + 133. \$1.00.

SCIENTIFIC JOURNALS AND ARTICLES.

IN *The American Naturalist* for October the leading article is an interesting paper of 'Notes on European Museums,' by O. C. Farrington, giving many interesting details of methods of installation. An important paper by O. P. Hay is 'On some Changes in the Names, Generic and Specific, of certain Fossil Fishes,' noting a number of names which must be considered as synonyms and replaced by others which are suggested. The 'Utility of Phosphorescence in Deep-Sea Animals' is discussed by C. C. Nutting, and C. P. Sigerfoos describes 'A New Hydroid from Long Island Sound' under the name of *Stylactis hooperi*. The habits of 'A Balloon-Making Fly,' an *Empis*, is described by J. M. Aldrich and L. A. Turley, while the question 'Have we more than One Species of *Blissus* in North America' is answered in the negative by F. M. Webster. The fourth part of 'Synopsis of North-American Invertebrates'