

divided into any number of parts which order—or if we replace this by an equivalent definition in purely logical terms—would include itself at once in a number of different orders, and enables us to work with ease in applied geometry.

5. Professor Royce wants to know if I could, in a paper, exclude the direct attribution to Cantor the theory of plural infinity. In fact, my intention in that paper was simply to acknowledge myself, in a general way, to be no more than a follower of Cantor in regard to infinity, not to make him responsible for any particular opinion of my own. However, Cantor proposed, if I remember rightly, so far to modify the kinesthetic theory of numbers as to make the multitude of ordinary things equal to that of the integers, numbers, and that of the atoms of ether equal to the multitude of possible collections of such numbers. Now, since it is essential to that theory that one entity shall take place, and that process only, it would seem to follow that such an entity, be it the rational number, or the next infinitesimal, so that if there are an infinite multitude in a finite space, the infinitesimals must be not real distances, and not the mere mathematical conceptions, like $1/n$, which all that I intend for.

C. S. PATTON.

MILBURN, PA., Feb. 14, 1904.

CURRENT NOTES ON PHYSIOGRAPHY.

DEFLECTION OF RIVERS BY SAND-BARS.

AN article on "The effect of sand-bars upon ultimate drainage," by J. E. Newcomer, *Geol.*, VII, 415-441, describes several examples of rivers whose discharge is deflected to the right or left by the presence of an offshore sand-bar in front of their mouths, and suggests that such deflection may explain the course of rivers that now flow parallel to pre-existent coast lines; for example, the Delaware below Bordenville, N. J.

This suggestion is evidently valid as a possibility, but it is not accompanied by tests that sufficiently distinguish deflections thus caused from deflections that arise from the spontaneous adjustment of streams to the weak strata that underlie the cuestas and of coastal plains having longitudinal relief. The lower Dela-

ware cannot be taken as an example of the latter class, because in the matter of its deflection it is the very stream that should not be deflected by adjustment to the older land, it only truly falls under the former class, because its deflection is in the case of the deep-seated sand-bar along our Atlantic Coast. Examples of sand-bar deflection are to be found in the strike of strong or weak rocks, indifferently, in wide normal deflections by adjustment, even only the low belts of weak rocks.

DEFLECTION OF THE SEVERN.

THE systematic development of rivers of low fields better illustration than of the interaction of the two the Severn and the want of Thames, considering which a number of new details and suggestions are given by S. S. Baskin, *Nat. Science*, XL, 1904, 277-280. The capture of the Severn by headward erosion along the western strand that underlies the fine sandstone of the Cotswold hills is advocated as a fact, and a restoration of the original course of the headwaters that have now been diverted from the Thames system is attempted. The growth of obsequent branches of the obsequent Severn on the line of the headward erosion branches of the Thames is well presented as the reason for the peculiar unsymmetrical arrangement of the Severn tributaries in the neighborhood of Gloucester. The Frome, a branch of the Severn, is shown to have captured several of the westernmost headwaters of the Thames in the Cotswold hills between Chalford and Malmesbury. The progressive diminution of the Coln, a branch of the Thames by the successive diversion to the Severn of the two lower branches that once came from Wales offered in explanation of the very curious features of the present Coln valley in the upland east of Gloucestershire: a valley of large curve meanders, added as the work of the original river, a narrower valley of small meanders, left in the floor of the larger valley, is the work of the river after one of its upper branches was captured by the Severn; the wriggling course of the present stream on the floor of these smaller meanders is due to the further loss of volume after the second upper branch was captured.

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SCIENCE

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FRIDAY, APRIL 20, 1900.

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MS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ATOMIC THEORY FROM THE CHEMICAL STANDPOINT

THE Atomic Theory, is the most fundamental hypothesis of the chemistry of to-day and plays a greater part in this than in any other science, and to give an account of all the classes of chemical phenomena which it is sought to explain by its aid would require far more time than I have at my disposal. I shall limit myself to giving as briefly as possible the main facts which have led chemists to adopt it and to stating which of the various properties which have been ascribed to the atoms are, and which are not, essential to its use in chemistry, and what properties may be attributed to them solely on the basis of chemical experiments.

The question whether any given portion of matter is continuous, absolutely the same throughout, even if infinitely divided, or whether it consists of particles separated by comparatively empty space, is, of course, almost as old as philosophic thought. The beginnings of chemistry lie still further back; the first man who questioned why wood burns, or why grape juice turns to wine, was an incipient chemist.

About the middle of the seventeenth century, Robert Boyle, who originated our present conception of element and compound, applied the atomic theory to chemistry, in-

* Read before a joint meeting of the Chemical and Philosophical Societies of Washington, November 25, 1899.

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SCIENCE.

[N. S. VOL. XI. No. 277.]

Nos. (1), (2), (3) Precise Leveling, in Kansas and Colorado.

No. (4) The Peruvian Arc, its relative Value, etc.

No. (5) Physical observations made in connection with the Pribilof Islands Expedition of 1897; in which the magnetic irregularity on St. George Island, the sea water densities in the North Pacific and Bering Sea, and the determination of the force of gravity on St. Paul Island, are all treated.

No. (6) A report on the Proceedings of the International Geodetic Association, and on Geodetic Operations in the United States; comprising statements with reference to the international latitude service, gravity measures, the figure of the earth, the Peruvian arc, and the longitudes of Paris and Greenwich. Under Geodetic Operations in the United States are treated; base lines, triangulations and arcs, astronomical work, miscellaneous operations, past and future operations, and the work of the United States Engineers.

No. (7) The Determination of Time, Longitude, Latitude, and Azimuth; in which the method of making these observations and computations is treated fundamentally. This paper is the fourth edition of an appendix to previous Coast Survey reports. It is now brought up to date, and embodies the most recent knowledge on the subject. A description is given of the most approved practical methods developed from field experience during half a century.

No. (8) A Plane Table Manual, in which are given the field methods employed with this valuable and convenient instrument. The subject is treated under: I. A preliminary statement; II. The instruments and adjustments; and III. The field work. Under the latter head the three-point problem is treated at length, and numerous tables are given, among which may be noted one for computing differences of ele-

vation, one showing heights corresponding to angles of elevation, and one giving corrections for effect of curvature and refraction.

No. (9) Problems of Physiography concerning Salinity and Temperature of the Pacific Ocean—closes the report and is treated in three heads: Bering Sea, Okhotsk Sea, and the Central Pacific Ocean.

There are 25 cuts in the body of the work, besides 55 in the different appendices. Many of these are half-tone illustrations and add materially to the value and appearance of the Report.

E. D. P.

SCIENTIFIC BOOKS.

Clark University, 1889-1899. Decennial Celebration. Worcester, Mass., Published by the University. 1899. 4to. Pp. 566.

Of the three verbs to be, to do, and to know, the great majority of young men unhesitatingly regard the *esse* as expressing the ultimate purpose and end of life. This is, as a matter of course, the idea of the practical man, who knows what he wants, and does not desire to want anything else. The average trustee of an American college will think it a very commendable thing for a professor to employ all the time he can possibly save in making money; but if he devotes much energy to any purely theoretical research, the trustees will look upon him askance, as a barely respectable squanderer of his opportunities. In England, this notion takes a turn that really makes it a little less gross; yet being foreign, perhaps we can discern its error more easily than in its more familiar guise. Thus, Dr. Karl Pearson, in the introduction to his 'Grammar of Science,' deliberately lays down the principle that no end whatever is to be approved without a reason, except the end of the preservation of society; and applying this rule, declares that the only valid excuse for the encouragement of scientific activity lies in its tending to maintain 'the stability of society.' This is a truly British phrase, meaning the House of Lords and vested rights and all that. Only recently, we have seen an American man of science and of weight

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discuss the purpose of education, without once alluding to the only motive that animates the genuine scientific investigator. I am not guiltless in this matter, myself; for in my youth, I wrote some articles to uphold a doctrine I called Pragmatism, namely, that the meaning and essence of every conception lies in the application that is to be made of it. That is all very well, when properly understood. I do not intend to recant it. But the question arises, *what is the ultimate application*; at that time, I seem to have been inclined to subordinate the *conception* to the *act*, knowing to doing. Subsequent experience of life has taught me that the only thing that is really desirable without a reason for being so, is to render ideas and things reasonable. One cannot well demand a reason for reasonableness itself. Logical analysis shows that reasonableness consists in association, assimilation, generalization, the bringing of items together into an organic whole—which are so many ways of regarding what is essentially the same thing. In the emotional sphere, this tendency towards union appears as Love; so that the Law of Love and the Law of Reason are quite at one.

There was a simple fellow who, in a benighted age and land, wandered about uttering appreciations of the elements of human life which have made an extraordinary impression upon most of us. Of all his sayings, there is none whose truth has been brought home to me more strongly by what I have been able to detect in successful men and women than this: Whoever makes his own welfare his object will simply ruin it utterly: *ὁ εὐρῶν τὴν ψυχὴν αὐτοῦ ἀπολέσει αὐτήν*. American education, for the most part, is directed to no other object than the welfare of the individual scholars; and thereby incites *them* to pursue that object exclusively. A great university bears upon its seal the remark of its founder: "I wish to found an institution where any man can learn any thing." It was a noble idea; and it would be mean to pick flaws in it—especially as he did not say what ulterior purpose he might have in view. But the university which parades this casual remark as its motto, seems to proclaim to its students that their individual well-being is its only aim. Our scientific schools distribute circulars

which dwell chiefly upon the handsome incomes their alumni are making, thereby calling up such images as a handsomely laid table with a pair of Hâvre-de-grace ducks and a bottle of Château Margaux. What comes of such a conception of education and of life, for surely, the purpose of education is not different from the purpose of life? The result is that, notwithstanding all the devices and tricks of the American teachers' art, it may be doubted whether any teaching ever anywhere did less to make happy men and women. At any rate, the spiritual meagerness of the typical American school-book is extreme. The great medieval universities, the modern German universities, the new science colleges of England, which did, and do, great things for their students personally, were never in the least founded for their students' individual advantage, but, on the contrary, because of the expectation that the truths that would be brought to light in such institutions would benefit the State. This end was, and is, so constantly in view that the scholars are led to regard their own lives as having a purpose beyond themselves.

Yet even this is a low view of learning and of science. No reader of this JOURNAL is likely to be content with the statement that the searching out of the ideas that govern the universe has no other value than that it helps human animals to swarm and feed. He will rather insist that the only thing that makes the human race worth perpetuation is that thereby rational ideas may be developed, and the rationalization of things furthered.

No other occupation of man is so purely and immediately directed to the one end that is alone intrinsically rational, as scientific investigation. It so strongly influences those who pursue it to subordinate all motives of ambition, fame, greed, self-seeking of every description, that other people, even those who have relatively elevated aspirations, such as theologians and teachers, altogether fail, in many cases, to divine the scientific man's simple motives. The Clark University, in recognizing the pursuit of science as its first object, with teaching,—of course, an indispensable means of securing continuity of work,—as only a subordinate, or at most a secondary object, has perhaps

the most elevated ideal of any university in the world; and I believe it to be so much the better for the individual students. At any rate, I can only record my personal observation in two visits, after having endeavored at many universities to learn to appreciate the atmospheres of such places, that there is a sweetness and a strength there quite exceptional. I am far from regretting that the institution has been through tribulations, and has purged itself of every element alien to its idea. To-day the good seed has germinated, so that it can no longer be choked by lower motives if it now only receives what is necessary to its continuance. It is earnestly to be hoped that it may speedily find its Constantine or its Helena. If not, one can but pity the family of its founder, which will have missed so narrowly a crown of high distinction. In that case, one must believe that among the American people, so appreciative of broad ideas, there may be found some thousands of persons, who whether they are quite sure of the immeasurable superiority of the aims of Clark or not, will at any rate feel that one institution of this peculiar kind ought to exist in the land, and will come forward with annual subscriptions to enable it to tide over a prolongation of its period of trial, and to wait for the rescue that sooner or later, from some quarter or another, is sure to come. The volume before us affords indisputable proof of the extraordinary interest and respect which this small institution commands from every genuine man of science the whole world over. Mr. Clark has, at any rate, drawn the eyes of all Europe with expectation upon the city of Worcester. To allow the university, after this, to sink into nothingness would be to make a nasty smirch upon the scutcheon of America, that would long remain an offence to all our eyes.

C. S. PEIRCE.

Analysis of White Paints. A Collection of Notes on the Chemical Analysis of White and Tinted Paints. By GEORGE H. ELLIS, B.Sc., Analytical Chemist and Assayer. Late Chemist Chicago, Burlington and Quincy Railway Company. The Technical Press, Evanston, Ill. Pp. 61 + vi.

This little book is a reprint of a series of

papers originally published in the *Paint, Oil and Drug Review*, and their aim is to give a detailed description of the best methods of analysis of white and tinted paints. The book is intended not only as a reference book for experienced chemists, but also as a complete manual for the use of those who have little knowledge of chemistry. Thus a full description is given of the analysis of clay. It is a lamentable fact that so many manufacturers who are just coming to feel the need of a chemist in their works, do not recognize the desirability of having as chemist one who has at least a moderately thorough knowledge of chemistry. A book like the one before us will be of great value to the inexperienced paint-chemist, and will not come amiss to others. It will be of most value, however, to those chemists into whose hands there comes only occasionally a sample of paint for analysis. Chapter 1 is on preparing samples for analysis. Chapter 2 describes the different white pigments, and their qualitative and quantitative analysis, with specimen analyses by the author. The pigments considered are calcium carbonate, gypsum, china clay, silica, barium sulfate, magnesium carbonate, magnesium silicate, zinc oxid, and white lead. Chapter 3 presents schemes for the analysis of mixed paints, a problem often difficult owing to the presence of several different pigments as well as perhaps adulterants. The methods given are excellent and are described with clearness. The use of barium carbonate as a white pigment is referred to only in a brief note, where it is stated to be little used in American paints. I do not recall having seen any mention elsewhere of its use, but a highly praised paint came into my hands lately, which consisted of nearly equal parts barium carbonate and zinc oxid.

An appendix gives a brief scheme for the estimation of turpentine, benzin and water, a list of the principal pigments with their trade names, atomic weight table, and metric conversion table. The book has a full index. It is to be hoped that the author will supplement this book by a similar one on colored pigments and tints and their analysis.

JAS. LEWIS HOWE.

The Refraction of the Eye, Including a Complete Treatise on Ophthalmometry. A Clinical Text-