ity and environment. At least we may expect a flood of new light on the subject from histometrical investigations, and if the conclusion is different from what the author of the method anticipated it will not at all detract from the credit due him for its development.

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### METALS ON METALS, WET

TO THE EDITOR OF SCIENCE: A year or two ago I repeated to a class in elementary physics the statement, familiar to generations of engineers on the authority of General Morin, supported by the approval of Rankine, that the coefficient of friction of *metals on metals, wet,* is considerably greater than that of *metals on metals, dry.*

Thereupon a thoughtful youth in the class asked me why, if this were the case, it was customary to put sand on wet car-rails to prevent the slipping of the driving-wheels. Taken aback by this unexpected scepticism, I begged for time to find the right answer to the disturbing question and set to work experimentally on the problem. The student reported after a time that trackmen had told him the water they had trouble with was usually slimy, which seemed to be a fairly satisfactory explanation of the puzzle; but meanwhile my experiments had shown some interesting facts, which I will here set forth.

Using a disk of brass, about 7.5 cm. in diameter and about 0.6 cm. thick, on a flat brass plate, I found:

1. That, when there was no load on the disk, a few small drops of water placed between it and the plate multiplied by a factor which might be as great as 3 the friction between the two.

2. That, when the disk was heavily loaded, the presence of the few small drops of water between it and the plate made little, if any, relative difference in the friction between the two.

3. That when plenty of water was used, so that it covered the whole space beneath the disk and extended somewhat beyond the edge, the disk without load was drawn along the plate quite as easily, apparently, as when both were dry.

From these facts I came to the conclusion that the increase of friction observed in case 1 was not due to an increase in the *coefficient* of friction caused by the water, but merely to the increase of pressure between the disk and the plate, caused by the suction of the capillary perimeters of the water-spots between them. When there is much water, its perimeter is outside the edge of the disk, is wide, or thick, and has little effect.

Some little search in books dealing with the subject of friction has failed to show there any recognition of this possible explanation, and refutation, of the Morin-Rankine statement of the large value of the coefficient for *metals on metals, wet;* but I should hardly have written you about the matter if I had not recently found this statement repeated in the "Smithsonian Physical Tables" published in 1903. I hope the new edition of these tables will not quote Rankine on this particular without further evidence.

EDWIN H. HALL

CAMBRIDGE, MASS.,
April 29, 1911

## SCIENTIFIC BOOKS

*The Stability of Truth.* By DAVID STARR JORDAN. New York, Henry Holt & Co. 1911. Pp. 180.

"This little book," says the author, "represents the substance of a course of lectures delivered on the John Calvin McNair foundation in the University of North Carolina, January, 1910."

The chapter headings are: Reality and Science, Reality and the Conduct of Life, Reality and Monoism, Reality and Illusion, Reality and Education, Reality and Tradition.

Evidently something has happened in philosophy, in science or in both when a scientist of the first class, not to say the author of this volume in particular, puts out a book with the good old philosophical term, "Reality" at the head of every chapter. Doubtless in the minds of most scientists there will be little question about where "something has happened."

They will say that philosophy has at last discovered that neither its problems nor its methods are so fundamentally different from those of science as was once supposed; that there is now a great philosophical movement, with an evolutionary logic—the conception of the working hypothesis—as its avowed method; and that it is therefore now possible for a scientist to stroll into the field of philosophy and set to work with his own tools. And indeed the spirit of this philosophical movement variously known as "pragmatism," "evolutionism" and "experimentalism," is certainly very different from the Hegelian idealism, which found the difference between philosophy and science to consist in the fact that the doctrines of the former are "necessary," while those of science are merely "hypothetical."

Still, in such a *rapprochement* as is taking place between philosophy and science it would be strange if all the change were on one side. For one thing, it seems obvious that the surrender of absolutistic methods by philosophy means added responsibilities for scientific method. Under the old régime science, even while renouncing and denouncing philosophy and all its works, found comfort in turning over to philosophy certain ethical and social questions which it found difficult to handle or which interfered with the pursuit of "purely scientific truth."

Much of the doctrine of this book (whose title, by the way, means that the only truth that is stable is that truth is not stable) is to the effect that if important human interests formerly turned over to transcendental methods are now thrown back upon scientific method, this method must be human enough to take care of them. And this means that scientific method and interest can not be purely intellectualistic. The author says:

> The purpose of this book is to set forth the doctrine that the final test of truth is found in trusting our lives to it. . . . The primal impulse, as well as the final purpose of science is the conduct of life. . . . Pure science can not be separated from applied science. . . . Knowledge is power; power is evidence that our belief is knowledge.

These and other similar statements on almost any page warrant the reader in saying that the book points at the hyper-intellectualism of science no less than at that of philosophy.

From the specific doctrines of the book the following points have been specially noted: (1) The recognition, rather unusual in a natural scientist, of the social character of consciousness and the self. "I think, therefore I am, gives place to we think, therefore we are." (2) Mr. Balfour's philosophic doubt is well hit off as "a process by which men question the only things they know to be true in order to prove the reality of things they know not to be true." This applies to all "transcendental doubt." (3) The "recrudescence of superstition," which accompanies an age of science, "is made possible by the fact that the traditions of science are so diffused in the community at large that fools find it safe to defy them." (4) Superstition and dogmatism are shown to be identical in so far as both ignore the process of experimentation. (5) The chapter on Reality and Monism, which is one of the best, puts two questions to Haeckel's monism: Is it a genuine scientific hypothesis, that is, one capable of verification? Is it of any ethical significance in the conduct of life? The author finds for the negative in both cases. (6) In the last chapter on Reality and Tradition, the "warfare between science and theology" is found to be quite as much a warfare between old and new science and to exist in the individual mind of the scientist and theologian alike.

In view of the general insistence upon the organic connection between science and the conduct of life, some readers may find difficulty with certain passages on "Belief," in which belief is justified as a "philosophical" category by "its effect on the conduct of life," even though it "is not reducible to terms of human experience" (pp. 42, 44). But "as men of science," we can not accept any hypothetic "articles of faith" not resting on "scientific induction." "I ought not to say I believe when I can not say I know" (p.

88). Some may take this to mean that "the conduct of life" may still be considered (*e. g.*, ethically or "philosophically") apart from science, and, conversely, that science may still have an aspect (*e. g.*, the pursuit of truth) that is independent of the conduct of life.

The author's captivating style is too well known to call for comment. The publishers have given the book a very attractive form.

A. W. MOORE

*Allen's Commercial Organic Analysis.* Volume IV., Resins, India-rubber, Gutta-percha and Essential Oils. Philadelphia, P. Blakiston's Son and Co. Pp. viii + 466. $5.00 net.

The subjects covered in this volume are: Resins, by M. Bennett Blackler; India-rubber, Rubber Substitutes and Gutta-Percha, by E. W. Lewis; Hydrocarbons of Essential Oils, by T. Martin Lowry; Ketones of Essential Oils, by T. Martin Lowry; Volatile or Essential Oils, by Ernest C. Parry; Special Characters of Essential Oils, by Henry Leffmann and Charles H. LaWall.

As with the previous volumes of the series, the book contains a very large amount of detailed information which is very valuable for any one who has occasion to work with the great number of organic compounds which are used in industry. The preparation of the successive chapters by chemists who have expert knowledge of the subjects of which they write insures accuracy and a wealth of information which it would be impossible to secure in any other way.

W. A. NOYES

## SCIENTIFIC JOURNALS AND ARTICLES

THE April number (volume 12, number 2) of the *Transactions of the American Mathematical Society* contains the following papers:

Anna J. Pell: "Biorthogonal systems of functions."

Anna J. Pell: "Applications of biorthogonal systems of functions to the theory of integral equations."

C. N. Moore: "On the uniform convergence of the developments in Bessel functions."

H. H. Mitchell: "Determination of the ordinary and modular ternary linear groups."

G. D. Birkhoff: "General theory of linear difference equations."

THE April number (volume 17, number 7) of the *Bulletin of the American Mathematical Society* contains: "Groups generated by two operators satisfying two conditions," by G. A. Miller; "Fundamental regions for cyclical groups of linear fractional transformations on two complex variables," by J. W. Young; "On the relative discriminant of a certain Kummer field," by Jacob Westlund; "Note on reciprocal figures in space," by Peter Field; "Mathematical physics for engineers," review of Gans' Einführung in die Theorie des Magnetismus, Schaefer's Einführung in die Maxwellsche Theorie, and Jahnke and Emde's Funktionentafeln und Curven, by E. B. Wilson; "Shorter Notices": Huntington's Fundamental Laws of Addition and Multiplication in Elementary Algebra, by N. J. Lennes; Borel's Théorie de la Croissance, by R. D. Carmichael; Tannery's Elemente der Mathematik, by J. B. Shaw; Weitzenböck's Komplex-Symbolik, by C. L. E. Moore; Staude's Analytische Geometrie des Punktepaares, des Kegelschnittes und der Fläche zweiter Ordnung, by D. D. Leib; Festschrift zur Feier des 100 Geburtstages Edouard Kummers, by L. E. Dickson; Thiele's Interpolationsrechnung, by H. L. Rietz; Slaught and Lennes's Plane Geometry, by F. W. Owens; Breckenridge, Mersereau and Moore's Shop Problems in Mathematics and Lester's Integrals of Mechanics, by C. F. Craig; Annuaire du Bureau des Longitudes, by E. W. Brown; De Montessus' Leçons élémentaires sur le Calcul des Probabilités, by E. B. Wilson; "Notes"; "New Publications."

The May number of the *Bulletin* contains: Report of the February meeting of the society, by F. N. Cole; "On the classification of crystals," by Paul Saurel; "Horner's method of approximation anticipated by Ruffini," by Florian Cajori; Review of the New Haven Colloquium Lectures, by G. D. Birkhoff; "Shorter Notices": Bauer's Vorlesungen