positive ions are in some way linked together, and transmit Thomson's corpuscles with immense velocity. There is a certain amount of shaking up involved in this transfer. It is the Joule effect. The positive ions remain at rest, and there are, therefore, no canal rays. When this wire is removed from the spark gap, the gas molecules receive the same compression and rarefaction waves, if the man who turns the crank of the machine continues his work. At the negative terminal the air molecules are loaded with the corpuscles, in the region of negative glow. They are then urged by convection as carriers, across the Faraday dark space. At the positive terminal the corpuscles pass from the gas into the metal conductor by a rarefaction or drainage process. Photographic plates reproduced in former papers[2] show that the drainage lines begin at the positive terminal. In this drainage column the carriers of the discharge move in a direction opposite to that in which the discharge is being urged. Cakes of ice floating on water would behave in a similar way, if a runner should jump from one to another, although the mechanism would be different. Nevertheless, such behavior of cakes of ice appears to be related to the athletics of the foot race, in somewhat the same way that positive ions in a gas are related to the flow of electricity in a power circuit.

FRANCIS E. NIPHER

JOINT MEETING OF MATHEMATICIANS AND ENGINEERS AT MINNEAPOLIS

THREE years ago in connection with the convocation of the American Association for the Advancement of Science in Chicago, a joint meeting of mathematicians and engineers was arranged through a committee of the Chicago Section of the American Mathematical Society. This meeting aroused much interest and resulted in the appointment of a committee of twenty, under the chairmanship of Professor E. V. Huntington, of Harvard University, to consider the whole question of the teaching of mathematics to students of engineering in this country, and to report its recommendations to the Society for the Promotion of Engineering Education at its summer meeting to be held at Madison, Wis., in June, 1910. This committee was constituted as follows: Philip R. Alger, professor of mathematics, U. S. Navy, Annapolis, Md.; Donald F. Campbell, professor of mathematics, Armour Institute of Technology, Chicago, Ill.; Edmund A. Engler, president of the Worcester Polytechnic Institute, Worcester, Mass.; Charles N. Haskins, assistant professor of mathematics, Dartmouth College, Hanover, N. H.; Charles S. Howe, president, Case School of Applied Science, Cleveland, Ohio; Emil Kuichling, consulting civil engineer, New York City; William T. Magruder, professor of mechanical engineering, Ohio State University, Columbus, Ohio; Ralph Modjeski, civil engineer, Chicago, Ill.; William F. Osgood, professor of mathematics, Harvard University, Cambridge, Mass.; Charles S. Slichter, consulting engineer of the U. S. Reclamation Service, professor of applied mathematics, University of Wisconsin, Madison, Wis.; Charles P. Steinmetz, consulting engineer of the General Electric Company, professor of electrical engineering, Union University, Schenectady, N. Y.; George F. Swain, consulting engineer, professor of civil engineering, Harvard University, Cambridge, Mass.; Edgar J. Townsend, dean of the College of Science and professor of mathematics, University of Illinois, Urbana, Ill.; Frederick E. Turneaure, dean of the College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.; Clarence A. Waldo, head professor of mathematics, Washington University, St. Louis, Mo.; Gardner S. Williams, consulting engineer, professor of civil, hydraulic and sanitary engineering, University of Michigan, Ann Arbor, Mich.; Calvin M. Woodward, dean of the School of Engineering and Architecture and professor of mathematics and applied mechanics, Washington University, St. Louis, Mo.; Robert S. Woodward, president of the Carnegie Institution of Washington, Washington, D. C.; Alexander Ziwet, professor of mathematics, University of Michigan, Ann Arbor, Mich.

In the early part of its investigation the committee collected a large amount of information in regard to the present status of mathematical instruction for engineering students. Since that time, however, a much more inclusive inquiry has been undertaken by the International Commission on the Teaching of Mathematics, of which the American Commissioners are Professors D. E. Smith, J. W. A. Young and W. F. Osgood. In

[2] *Trans. Acad. of Sc. of St. Louis*, XIX., Nos. 1 and 4, Plates X., B, XX., A, B and C, and XXI., A.

order to avoid unnecessary duplication, this committee voted to turn over all the results of its own inquiry in this field to the larger commission, to be worked up in accordance with the general scheme adopted by that commission, and to be incorporated in their report. This material is therefore not included in the present report.

Aside from the collection of data, Professor Huntington's committee decided that the most important need at the present time is a series of synoptical text-books, which shall present: (1) the fundamental principles of the science, in compact form, and (2) a classified and graded collection of problems (which would naturally be subject to continual change and expansion). It is their hope that the Minneapolis report, which is confined to the first part of the desired text-book, will stimulate throughout the country practical contributions toward the second.

Copies of these syllabi were distributed among the hundred or more engineers, physicists and mathematicians who joined in a good fellowship dinner on the evening preceding the presentation of the report. Additional copies may be had upon request from the chairman. The following quotations from the preface will indicate its scope and purpose:

"The object of this report is to present a synopsis of those fundamental principles and methods of mathematics which, in the opinion of the committee, should constitute the minimum mathematical equipment of the student of engineering.

"It is hoped that this report may be serviceable in two ways: first, to the teacher, as an indication of where the emphasis should be laid; and secondly, to the student, as a syllabus of facts and methods which are to be his working tools. It does not include data for which the student would properly refer to an engineer's hand-book; it includes rather just those things for which he ought never to be obliged to refer to any book—the things which he should have constantly at his fingers' ends.

"The teacher of mathematics should see to it that at least these facts are perfectly familiar to all his students, so that the professor of engineering may presuppose, with confidence, at least this much mathematical knowledge on the part of his students. On the other hand, if the professor of engineering needs to use, at any point, more advanced mathematical methods than those here mentioned, he should be careful to explain them to his class.

"The defects in the mathematical training of the student of engineering appear to be largely in knowledge and grasp of fundamental principles, and the constant effort of the teacher should be to ground the student thoroughly in these fundamentals, which are too often lost sight of in a mass of details.

"The committee has not found it possible to propose a detailed course of study. The order in which these topics should be taken up must be left largely to the discretion of the individual teacher. The committee is firmly of the opinion, however, that whatever order is adopted, the principal part of the course should be problems worked by the students, and that all these problems should be solved on the basis of a small number of fundamental principles and methods, such as are here suggested."

The report was freely discussed and frankly criticized by a large number of speakers, including the following: Professors E. J. Wilczynski, University of Chicago; A. G. Hall, University of Michigan; E. H. Comstock, School of Mines of the University of Minnesota; G. A. Miller, University of Illinois; A. E. Haynes, College of Engineering of the University of Minnesota; E. F. Nichols, president of Dartmouth College; T. F. Holgate, dean of Northwestern University; Alexander Ziwet, University of Michigan; E. R. Maurer, College of Engineering of the University of Wisconsin; Henry Crew, department of physics of Northwestern University; H. E. Slaught, University of Chicago; B. L. Newkirk, University of Minnesota; E. F. Chandler, University of North Dakota; J. J. Flather, head of mechanical engineering, University of Minnesota, and L. E. Dickson, University of Chicago, chairman of the meeting. Also numerous discussions in writing were received by the chairman or through the secretary, including one from President R. S. Woodward, of the Carnegie Institution of Washington, one from Professor A. E. Haynes, of the University of Minnesota, and one from William Kent, president of the Technical Literature Company of New York.

The discussion finally led to the following resolution, which was unanimously adopted:

Resolved, that this body tenders hearty thanks to Professor Huntington for the great interest which he has shown in this work and the untiring service which he has given to it; that we commend the work of the entire committee for the preparation of a report which it is believed must operate for betterment along the lines of its

recommendations; and while not prepared to approve in all respects the details, especially in the syllabus on dynamics, as shown by the full and free discussion at this meeting, yet we heartily endorse the spirit of the report and thank the officers of the Society for the Promotion of Engineering Education, who have shown their friendly cooperation in offering to publish these syllabi in their official *Bulletin*, for the purpose of drawing out further criticisms and suggestions either in printed papers or in written communications to the chairman of the committee.

The further report of this committee is to be presented at the next meeting of the Society for the Promotion of Engineering Education in June, 1911. The present meeting was organized, as was the original meeting in Chicago in 1907, by the Chicago Section of the American Mathematical Society.

Other papers read before the Chicago Section at the Minneapolis meetings, aside from those in astronomy for which joint sessions were held with Section A, were as follows:

"On the Use of the Co-sets of a Group," Professor G. A. Miller, University of Illinois.

"Congruencial Theory of Functions of Several Variables," Professor L. E. Dickson, University of Chicago.

"Generalizations of Theorems on Linear Algebras," Professor L. E. Dickson.

"On Primitive Roots of Ideals," Professor Jacob Westlund, Purdue University.

"The Problem of Defining the Set of Real Numbers," Dr. A. B. Frizell, University of Kansas.

"A Historical Note on the Newton-Raphson Method of Approximations," Professor Florian Cajori, Colorado College.

"One Parameter Families and Nets of Plane Curves," Professor E. J. Wilczynski, University of Chicago.

"Circular Numbers for a Plane Curve," Dr. Horace T. Burgess, University of Wisconsin.

"Rational Anharmonic Curves upon a Quadric," Dr. Horace T. Burgess.

"The Applications of Matrices to Cubic Forms," Dr. Horace T. Burgess.

"Envelopes of One Parameter Families of Plane Curves," Professor Walter J. Risley, James Millikin University, and Professor W. E. MacDonald, Canton College, China.

"A Reduction of Two Power Series in Many Variables to Two Equivalent Polynomials," Dr. W. D. MacMillan, University of Chicago.

"The Path of Light in a Medium Homogeneous in Concentric Spherical Layers," Dr. Harris F. MacNeish, Yale University.

"The Curves of Equal Action for Elliptical Coordinates," Professor Kurt Laves, University of Chicago.

"Robert of Chester's Translation of the Algebra of Al-Khowarazmi," Professor L. C. Karpinski, University of Michigan.

"Hindu Numerals in the Kitab al Fihrist," Professor L. C. Karpinski.

"Ruled Surfaces and Planed Hypersurfaces in Four-Dimensional Space," Dr. Arthur Ranum, Cornell University.

"Transformation Groups and Substitutions of an Infinite Degree," Dr. L. I. Neikirk, University of Illinois.

"Use of Quaternions in Differential Geometry," Professor J. B. Shaw, University of Illinois.

"On Plane Quintic Curves," Dr. H. L. Slobin, University of Minnesota.

"On the Construction of a Certain Class of Periodic Solutions of the Problem of Three Bodies," Professor F. R. Moulton, University of Chicago.

"Curves on Quintic Scrolls," Professor Frank B. Williams, Clark College.

The next meeting of the Chicago Section will be in Chicago on Friday and Saturday, April 28 and 29, 1911.

H. E. SLAUGHT,
Secretary of the Section

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE second annual meeting of the American Phytopathological Society was held in affiliation with the American Association for the Advancement of Science at Minneapolis, Minn., December 28–30, 1910. The attendance was not as large as at the Boston meeting, but an excellent program of twenty-eight papers was presented. A joint session with Section G of the American Association and the Botanical Society of America was held at the Minnesota Agricultural College on Thursday, December 29, and other sessions at the University.

The society wishes to express its appreciation and gratitude to the local committee and especially to Dr. F. E. Clements for the excellent rooms and facilities provided.

The constitution of the society, drafted and approved by the council, was adopted. The following officers were elected: