of special notice: (1) A general tendency toward an increase in hardness with depth, or with age of the rocks from which the water is drawn. (2) A tendency for the hardness of the water to decrease, if drawn extensively and continuously from a certain sandstone for several years. (3) The clear evidence furnished by the chlorine determinations, of pollution of surface waters and shallow wells in the cities. In south Minneapolis—the older, more densely settled part of town—shallow well waters contain 44 parts per million of chlorine, while in other, less settled parts, 4 parts per million is the maximum. A few analyses follow:

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Total solids | 202.1 | 247 3 | 303 9 | 288.5 | 386.9 | 220.0 | 327.6 | 236.0 |
| Silica | 16.6 | 18 2 | 11.6 | 12.3 | 16.8 | 5.0 | 13.1 | 6.7 |
| Iron oxide, etc | .7 | 1.3 | 1.9 | 1.3 | 5 7 | .6 | 3.1 | 2.2 |
| Calcium | 40 3 | 52.2 | 60 1 | 63.1 | 95.1 | 57.5 | 75.3 | 51.5 |
| Magnesium | 12.7 | 16 8 | 25.1 | 26.1 | 24.6 | 22.0 | 29.1 | 20.1 |
| Sodium and potassium | 4.8 | 13.1 | 7.1 | 9 4 | 11.3 | 6.8 | 6.5 | 10.2 |
| Carbonate radicle | trace | 4.2 | .8 | 2.6 | | | | |
| Bicarbonate radicle | 201.3 | 207 8 | 293 2 | 288 6 | 414 5 | 278.0 | 377 5 | 252 0 |
| Sulphate radicle | 3 5 | 19 6 | 11 0 | 8 4 | 19 8 | 4 0 | 15.5 | 2 7 |
| Chlorine | 2.2 | 8 6 | 5 3 | 5.6 | 6.9 | 4.6 | 2 4 | 5.3 |

It is noteworthy that samples number 6 and 8 from St. Paul have lower mineral content than samples number 5 and 7 from Minneapolis, though from the same formations. The amount of water taken from these formations in St. Paul is much greater than in Minneapolis.

1. Lake and river waters.
2. Waters from wells in glacial drift.
3. Saint Peter sandstone waters.
4. New Richmond sandstone waters.
5. Jordan sandstone waters of Minneapolis.
6. Jordan sandstone waters of St. Paul.
7. Dresbach sandstone waters of Minneapolis.
8. Dresbach sandstone waters of St. Paul.

FRANK F. GROUT,
*Acting Secretary*

## SOCIETIES AND ACADEMIES

### THE AMERICAN MATHEMATICAL SOCIETY

THE one-hundred and fifty-second meeting of the society was held at Columbia University on Saturday, February 25. Thirty-eight members attended the two sessions. President Henry B. Fine occupied the chair. The council announced the election of the following persons to membership in the society: Dr. Elizabeth R. Bennett, University of Nebraska; Mr. Daniel Buchanan, University of Chicago; Dr. H. B. Curtis, Columbia University; Mr. L. L. Dines, University of Chicago; Professor C. R. MacInnes, Princeton University; Professor Eva S. Magiott, Ohio Northern University; Mr. R. E. Root, University of Chicago; Professor Sarah E. Smith, Mount Holyoke College. Six applications for membership were received.

The following papers were read at this meeting:

E. J. Miles: "Some properties of space curves minimizing a definite integral with discontinuous integrand."

N. J. Lennes: "A necessary and sufficient condition for the uniform convergence of a certain class of infinite series."

N. J. Lennes: "Duality in projective geometry."

G. A. Miller: "The number of the abelian subgroups in the possible groups of order $2^m$."

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

G. D. Birkhoff: "A direct method for the summation of developments in Lamé's functions and of allied developments."

Edward Kasner: "Equitangentials in space."

Edward Kasner: "Conformal and equilong invariants of horn angles."

J. A. Eiesland: "On a contact transformation in physics."

D. C. Gillespie: "Definite integrals containing a parameter."

Joseph Bowden: "The Russian peasant method of multiplication."

N. J. Lennes: "A direct proof of the theorem that the number of terms in the expansion of an infinite determinant is of the same potency as the continuum."

Harris Hancock: "On algebraic equations that are connected with the cyclotomic equations and the realms of rationality which they determine."

W. B. Fite: "Irreducible homogeneous linear groups of order $p^m$ and of degree $p$ or $p^2$."

The next meeting of the society will be held at the University of Chicago on Friday and Saturday, April 28–29. On this occasion Professor Maxime Bôcher will deliver his presidential address, the subject of which will be "Charles Sturm's Published and Unpublished Work on Differential and Algebraic Equations." Except for the summer meetings, this will be the first convention of the whole society since 1896. A large attendance is expected from both east and west.

The San Francisco Section of the society will meet at Stanford University on Saturday, April 8.

F. N. COLE,
*Secretary*

## THE AMERICAN PHILOSOPHICAL SOCIETY

*The Investigation of Explosives at the Pittsburgh Testing Station:* Professor CHARLES E. MUNROE, Washington, D. C.

The many and increasing number of accidents giving rise to serious casualties that have attended the mining of coal has in recent years led thoughtful men to inquire into the causes of such accidents with a view to their prevention. Among other causes, it was found that the improper use of explosives, or the use of improper explosives had often operated to produce these accidents, and it appeared evident that here was a cause that ought, by study of materials and methods, to be remedied. This study was begun some years ago, but it was much advanced when, following a series of disasters in the fall of 1907, by which 623 men were killed, Congress appropriated money for the investigation. A testing station was opened at Pittsburgh in the following year, where the explosives could be exploded, under known conditions, in the presence of sensitive fire-damp and of coal-dust laden air. A standard was fixed upon which the explosive must satisfy. An explosive which passes the test is styled a "permissible" explosive and its name is published. The list about to be published by the Bureau of Mines will contain the names of 69 permissible explosives made by sixteen different American manufacturers. These explosives are sometimes styled "short flame" or "safety" explosives, but the term "safety" is improper. According to a canvass by the Bureau of Mines, 8,942,857 pounds of short-flame explosives were made in 1909. Professor Munroe, with the aid of lantern slides, described the apparatus employed and its method of use.

## THE BOTANICAL SOCIETY OF WASHINGTON

THE 70th regular meeting of the society was held at the Cosmos Club, Tuesday, February 7, 1911, at 8 o'clock P.M. In the absence of both president and vice-president Dr. W. H. Evans was chosen chairman pro tem. Thirty-one members were present. Dr. C. O. Appleman, E. G. Boerner, G. N. Lamb, W. J. Morse, C. A. Reed, Wm. Shear, C. B. Smith, A. V. Steubenrauch and Dr. W. Van Fleet were admitted to membership.

The following papers were read:

*The Effect of Temperature on the Respiration of Fruits:* H. C. GORE.

The rates of respiration were given of many fruits at different temperatures. It was found that the forty different fruits studied obeyed approximately the same law in regard to the effect of temperature. The rate of respiration increased two to three times for each 10° C. rise, following van't Hoff's rule for increase in rate of chemical reactions with temperature. The respiratory activity of the different fruits varied greatly and no correlation appeared between it and composition or size. In general, fruits which grow and mature rapidly and soon become overripe, respired rapidly; while fruits having a long growing season and maturing slowly were much less active.

*Collecting Grasses in Mexico:* A. S. HITCHCOCK.

Mr. Hitchcock described his recent trip to Mexico for the purpose of collecting and studying the grasses of that region. He gave considerable attention in his paper, to the physiographic and climatic conditions and the relation of these conditions to the flora. Tables and maps were submitted showing the topography of the country, and the monthly rainfall and temperature of several representative stations. The speaker described the floral regions, the distribution of the grasses as affected by rainfall and altitude, and reviewed briefly the agricultural and range conditions, including the forage crops. The paper was illustrated with about fifty lantern slides from photographs taken by himself and his son, Frank H. Hitchcock, who accompanied him as assistant.

The forty localities visited by Mr. Hitchcock included many type localities, which led to the rediscovery of certain little-known or doubtful species of grasses described by earlier writers, among which species may be mentioned *Bouteloua repens* HBK., *Panicum decolorans* HBK., *P. buchingeri* Fourn., *P. cordovense* Fourn. and *P. ichnanthoides* Fourn. It is highly probable that Mr. Hitchcock collected specimens from the same group of plants from which the types of the last two species were obtained. On the other hand, species previously supposed to be restricted in range were found to be widely distributed. *Panicum arizonicum* Scribn. & Merr., known in Mexico only from the northwestern states, was collected as far south as the state of Oaxaca. These facts emphasize the point that, when possible, the specialist should make his own collections.

*The Rediscovery of the Xochinacaztli of the Aztecs, with Notes on Mexican Anonaceæ:* W. E. SAFFORD.

Before the conquest of Mexico the Aztecs used certain spices and aromatic plants in confectioning their celebrated chocolate. The mostly highly prized by the ancient Mexicans was the flower called *teonacaztli*, or *xochinacaztli* ("sacred-ear" or "ear-flower"). Up to the present day the identity of this plant has remained a mystery. The writer has finally succeeded in tracing it to *Cymbopetalum penduliflorum*, belonging to the Anonaceæ.

*Cymbopetalum penduliflorum* (Dunal) Baillon was called *xochinacaztli* (ear-flower) on account of the resemblance of its three inner petals to the human ear. It occurs in the mountains of Guatemala and southern Mexico.

*Sapranthus fœtidus* (Rose) Safford the fœtid carrion-flower, is very closely allied to the palanco (*Sapranthus nicaraguensis*) of Central America. Another species, with flowers having an equally disgusting odor, but with broader petals and an orbicular bract on the peduncle, proves to be identical with the plant described by Dunal as *Unona violaceus*, and must therefore take the name *Sapranthus violaceus* (Dunal) Safford. Specimens of it were collected by Dr. J. N. Rose at Rosario, Sinaloa, in 1897 (No. 1842).

Among the well-known anonas are the sugar-apple, *Anona squamosa*, usually called anona blanca in Mexico; *A. reticulata*, the bullock's-heart, or anona colorado; *A. cherimolia*, the Peruvian chirimoya, introduced at a very early date into Mexico; and the pleasantly acidulous-fruited sour-sop, *A. muricata*, usually known as Guanábana in tropical America.

*Anona purpurea* DC., called soncollo, or sincuya, is a species often confused with *A. muricata*, which it resembles in having large flowers with leathery petals and fruit covered with projecting points; but its flowers are sessile and its fruit is not edible, while its leaves differ from those of *A. muricata* in being much broader and larger.

*Anona longiflora*, usually called chirimoya, is very closely allied to *A. cherimolia*. Its flowers, however, are much larger and its leaves, covered with velvety pubescence beneath, are broader and more obtuse. It was first described by Sereno Watson from specimens collected by Dr. Edward Palmer near Guadalajara in 1886.

*Anona diversifolia* n. sp. called izlama, or illamatzapotl, has flowers and fruit resembling those of *A. squamosa*, with the carpels not so closely united as in *A. cherimolia*, and *A. reticulata*. It is distinguished from all other Mexican anonas by a large persistent orbicular, clasping bract at the base of the peduncle. The type was collected by Dr. Edward Palmer at Colima, Mexico, in 1897 (No. 60).

W. W. STOCKBERGER,
*Corresponding Secretary*

## THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 689th meeting was held on February 11, 1911, President Day in the chair. Two papers were read:

*Thermodynamics of Concentration Cells:* Dr. HENRY S. CARHART, of the University of Michigan.

The paper was in illustration of the general equation expressing the laws of thermodynamics, of which the Helmholtz equation for the E.M.F. of a voltaic cell is an example, viz:

$$A = H + T(dA/dT),$$

in which $H$ is the change in the internal energy of the system and $A$ the maximum work or free energy for a reversible process conducted isothermally.

A number of possible cases were outlined and two of them were emphasized for illustration and experimental verification.

1. When $H$ is constant. Then $A = H + aT$. The relation is then linear and $dA/dT$ is constant.

2. If with Nernst ("Thermodynamics and Chemistry," *Sitzungsberichte der Kön. Preuss. Akad. der Wiss.*, 1909, 1, 247) it is assumed that $H$ may be expressed in terms of the integral powers of $T$, then

$$H = H_0 + aT + bT^2 + cT^3 +$$

By integrating the general equation and substituting this value of $H$, it is proved that the constant $a$ is zero and the two equations for $A$ and $H$ are

$$A = A_0 + a'T - bT^2 - \tfrac{1}{2}cT^3 -$$

$$H = H_0 + bT^2 + cT^3 +$$

Nernst assumes that $dA/dT = dH/dT = 0$ in the limit when $T = 0$. This condition would exclude the term $a'T$ and would exclude therefore the case where $H$ is either zero or constant.

An investigation of the concentration cell *Zn amal. dilute/$ZnSO_4$ solution/Zn amal. concen.* gave the following data, which are best represented by the linear equation

$$E = -0.001455 + 0.00003084\ T:$$

| Temp. | Obs'd E.M.F. | Comp'd E.M.F. | Per cent. difference |
|---|---|---|---|
| 11.1 | 0.007300 | 0.007307 | + 0.10 |
| 15.4 | 7444 | 7439 | — 0.07 |
| 19.8 | 7574 | 7575 | + 0.01 |
| 24.6 | 7720 | 7723 | + 0.04 |
| 29.4 | 7870 | 7871 | + 0.01 |
| 32.8 | 7983 | 7976 | — 0.09 |
| 36.6 | 8086 | 8094 | + 0.10 |
| 42.0 | 8262 | 8259 | — 0.04 |
| 47.0 | 8417 | 8414 | — 0.04 |

The greatest difference between the observed values and those computed by the above equation is 0.008 millivolt.

The $ZnSO_4$ solution was then replaced by $ZnCl_2$ solution and the measurements were repeated. The results are best represented by the same equation within the limits of temperature 10°.1 and 49°.3 within which the observations were made. Moreover, there is no break at the transition point of $ZnSO_4$ at 39°.0.

This relation is strictly linear and is directly and conclusively opposed to Nernst's assumption that the constant $a$ and $a'$ are both necessarily zero.

*Upon the Construction of the Wheatstone Bridge for Resistance Thermometers:* Professor C. F. MARVIN, of the U. S. Weather Bureau.

The speaker mentioned the well-known fact that the resistance of metals such as platinum, nickel, etc., commonly employed in the construction of resistance thermometers, does not change with temperature according to a strictly linear law of relation, therefore, the scales of temperature obtained directly from resistance thermometers are not the same as the standard scale of temperature by the gas thermometer. The object of the paper was to call attention to certain interesting mathematical relations between the bridge equations and those for platinum and nickel resistances, which, if availed of, enable the manufacturer to give the arms of the bridge such resistances that the indicated temperatures on the bridge scale correspond to the true temperature of the thermometer on the gas scale within a few hundredths of a degree over ordinary meteorological ranges of temperature, say from — 40° to + 60° Centigrade. This result is obtained, moreover, when the subdivisions of the bridge scale are exactly equal throughout, and when the intervals of resistance on the bridge wire, or equivalent device, are made as exactly equal to each other as possible. Numerical data shown for nickel indicated that the logarithmic equation: $R = a + bt$ fitted the temperature resistance changes of some samples of nickel. Other samples, however, require an equation of three terms, viz:

$$\text{Log. } R = a + bt - ct^2.$$

Diagrams and equations of bridges with the resistance placed in series with either the thermometer in the one case, or the balancing coil in the other, were explained.

In all cases the bridge equations reduce to the general form: $R = (A + Mt/N \pm t)$; in which $A$, $M$ and $N$ are constants fixing the numerical value of the resistances in the arms of the bridge. The plus (+) sign applies when the shunted rheostat is in series with the balancing coil, and the equation then represents a curve, mathematically similar to a parabola, or a curve convex upward. The equation with the minus (—) sign is required for the ordinary slide-wire connections, and with the shunted rheostat in series with the thermometer. In these cases the curve conforms very closely to the logarithmic or other curve *concave* upward.

By computing the constants of the bridge equation from three points taken from the corresponding temperature resistance curve for the platinum or other thermometer that may be used, and then adjusting the resistances in the bridge accordingly, the indicated temperatures on the bridge are either identical with the gas-scale temperatures, or differ therefrom by only a few hundredths of a degree at the extremities of the range of eighty to one hundred degrees.

Numerical examples were worked out and the resistances computed for the arms of the bridge to fit a platinum and a nickel thermometer. It was mentioned in the discussion that all of the equations apply equally to the case in which the differential galvanometer is employed instead of the bridge to determine the resistance of the thermometer.

It is expected that this paper in full will be published in the *Journal of the Franklin Institute.*

(The abstracts of the two foregoing papers are by their authors.)

Professor Cleveland Abbe, of the U. S. Weather Bureau, spoke informally concerning the altitude of the aurora, describing briefly Professor Stoermer's recent successful method of measuring the altitude of an aurora, which consists essentially in simultaneously photographing the aurora from two points of known distance apart, some known star being also simultaneously photographed on the plates from which measurements can be made.

R. L. FARIS,
*Secretary*