the various developments which have been considered in the preceding pages may be added, each as the preceding element is completed, working continually toward the technical university and the highest ultimate divisions of the scheme, the department of experimental engineering and research.

"The method of organization would be that which best insures the management of the whole of the great scheme and of each of its subdivisions by men expert each in his own field, whether that of director of the technical university, principal of one of its schools, or professor or instructor, or workman in shop, drawing-room or laboratory. Such an organization of a staff of experts being provided, the administration will be certain to work smoothly and efficiently, without special attention to detail on the part of the trustees. Their largest problem will be the matter of securing the endowment and its income from deterioration in later years and consequent impediment or interruption of the enterprise.

"Every division of the institution, from lowest to highest and first to last, should be so planned as to work in concert with the public schools of similar grade as far as practicable. The technical high school might accept certificates from the academic high schools of the city and from other academies of similar rank; the pupils of the city schools might be given admission to the classes of the technical school in the shops and technical departments; a half-time school, as advocated by Professor Higgins, of Worcester, might possibly come of such mutual aid of city and technical schools. The technical school would be able, in some cases probably, to promote the initiation of special instruction in manual training and in the kindergarten forms of technical work in the public schools. Every possible means of allying the technical and the common school work should be availed of, and the cardinal principle should be constantly proclaimed and enforced: the purpose of the whole movement is to advance the best interests of the people of Pittsburg and its vicinity. It should be made distinctly understood that it is desired to make use of all possible ways to that end and to cooperate with every other educational movement."

In closing this far too lengthy paper I must acknowledge the great interest taken in the development of the scheme for the new technical school by the Engineers' Society of Western Pennsylvania, by the Women's Domestic Arts Association and by a number of eminent engineers, physicists and technologists at home and abroad; and the sole purpose of my paper is to ask the further cooperation and kindly advice of the members of this Association in formulating our plans, in steering clear of 'derelicts' and in making the Pittsburg Carnegie School of Technology what its generous patron wishes it to be and what the demands of this great industrial nation require it to be. Any communication sent Mr. Wm. McConway, chairman of our committee, Pittsburg, Pa., will be received and acknowledged with great pleasure.

J. A. BRASHEAR.

SECTION A (MATHEMATICS AND ASTRONOMY) OF THE AMERICAN ASSOCIATION.

THE officers of this section were: vice-president, James McMahon; secretary, G. A. Miller; councilor, G. B. Halsted; sectional committee, James McMahon, G. A. Miller, H. A. Howe, Florian Cajori, F. H. Loud; member of the general committee, C. A. Waldo. The meetings of the section were well attended and most of the papers aroused discussion. With the exception of the anniversary meeting at Boston, the program was the most extensive in the recent history of this section. It consisted of the following twenty-five papers. As the last six are of special interest to section B, they were presented at a joint session of sections A and B.

'Supplementary Report on Non-Euclidean Geometry': Professor G. B. HALSTED, University of Texas.

This is a supplement to the report read at the Columbus meeting. It will be published in SCIENCE.

'Kepler's Problem for High Planetary Eccentricities': Professor H. A. HOWE, University of Denver.

The solution of the equation $M = E - e \sin E$ is commonly called Kepler's problem. The known quantities e and M are respectively the eccentricity and the mean anomaly. E is to be found.

The purpose of this paper is to develop a direct method of solving Kepler's problem for planetary orbits of high eccentricity, which shall be more expeditious than any heretofore discovered, and shall be sufficiently accurate to meet the most exacting requirements of astronomers. This method is an outgrowth of one published by the author several years ago.

Let E' be an approximate value of E found by the well-known equation

$$\tan (E' - \tfrac{1}{2}M) = \frac{1+e}{1-e} \tan \tfrac{1}{2}M. \qquad (1)$$

Let $2\eta = E' - M - \sin (E' - M)$, and

$$2\varepsilon = \tfrac{1}{2}(E' - E) - \sin \tfrac{1}{2}(E' - E).$$

Then

$$E' - E = \frac{2\eta}{1 - e \cos \frac{1}{2}(E' + E)} - \frac{e \cos \frac{1}{2}(E' + E)}{1 - e \cos \frac{1}{2}(E' + E)} 4\varepsilon. \qquad (2)$$

But the unknowns, E and 4ε, are in equation (2), and must be made to disappear. In the most eccentric of the asteroid-orbits the value of the last term of equation (2) does not reach 0.″0006; this term is therefore rejected, and we write with sufficient accuracy

$$E' - E = \frac{2\eta}{1 - e \cos \left\{ E' - \frac{\eta}{1 - e \cos (E' - \eta)} \right\}}. \qquad (3)$$

E' may be found from (1), and $E' - E$ from (3); then $E' - (E' - E) = E$, the quantity desired. The paper was illustrated by large charts and will be published in the *Astronomical Journal.*

'The Great Fireball of December 7, 1900': Professor H. A. HOWE and Miss L. L. STINGLEY.

On December 7, 1900, at about 3:20 p.m., mountain time, there passed over the northwestern quarter of Colorado a magnificent fireball, which exploded with startling detonations in the vicinity of the Bow Range near the north boundary-line of the state. The director of the Chamberlin Observatory prepared circulars of inquiry, containing a number of questions, which were lavishly distributed over the region from which the meteor was visible. The local press was also largely utilized for a dissemination of the queries. About 150 letters came in reply. Miss Stingley, of the class of 1903 in the College of Liberal Arts of the University of Denver, made a digest of these letters, and determined the meteor's path across the state. It passed nearly through the zenith of La Salle, and the main body came to earth in the vicinity of the town of Pearl. Its distance from the earth's surface, when near La Salle, was about 25 miles, and about 12 miles at the time of bursting. When the fireball was near Pearl an observation made by Mr. Thomas, of Manassa, a civil engineer, who was 250 miles away, gave it a height of 7 miles. Mr. Godshall, manager of a copper mining company, who was in Wyoming, about 40 miles beyond Pearl, saw the body come down in a curve somewhere in the general direction of Pearl.

Several observers thought that they saw fragments fall before the meteor reached Pearl, but on account of the wildness of the country none of the pieces have yet been found, though they have been searched for. The orbit has been computed on the usual hypothesis that the path is a parabola. The body was moving nearly in the plane of the ecliptic, and caught up with the earth, which was traveling less rapidly in the same general direction. The search for fragments will continue. The paper will be illustrated by a large map showing the meteor's path across the country, and by a drawing exhibiting the relation of its orbit to that of the earth. It will be published in *Popular Astronomy*.

'Divergent and Conditionally Convergent Series whose Product is Absolutely Convergent': Professor F. CAJORI, Colorado College.

In an article on 'Divergent and Conditionally Convergent Series whose Product is Absolutely Convergent,' in the *Trans. of the Am. Math. Soc.*, Vol. II., pp. 25–36, were given special cases in which an absolutely convergent series is obtained as a result of multiplying two conditionally convergent series together, or one conditionally convergent series by a divergent series. But the sum of one of the two factor-series of each pair given in that article is zero. In the present paper it is shown that this is not a necessary property of conditionally convergent series whose product is absolutely convergent, and that the nth sum of such series may be of the degree $-r$, with respect to n, where $\frac{1}{2} < r \gtreqless 1$.

'The Application of the Fundamental Laws of Algebra to the Multiplication of Infinite Series': F. CAJORI.

The behavior of infinite series with respect to the laws of algebra may be considered under two heads: An inquiry into the validity of the laws; (1) when applied to the *terms* of an infinite series; (2) when applied to the infinite series *themselves*.

The second inquiry, when made for the multiplication of series, leads to the conclusion that in this operation (assuming Cauchy's definition for the product of two infinite series), the associative, commutative, and distributive laws are obeyed.

The two series obtained by removing the parentheses from the series,

$$S_1 \equiv \sum_{p=0}^{p=\infty} \left(\frac{1}{4p^r+1} - \frac{1}{4p^r+4} + \frac{1}{4p^r+1} - \frac{1}{4p^r+4} \right),$$

$$S_2 \equiv \sum_{p=0}^{p=\infty} \left(\frac{1}{4p^r+4} + \frac{1}{4p^r+4} - \frac{1}{4p^r+1} - \frac{1}{4p^r+1} \right),$$

where $\frac{1}{2} < r \gtreqless 1$, are conditionally convergent, but their product is absolutely convergent.

Hence,

$$(S_1S_2)(S_1S_2)(S_1S_2) \text{ is abs. convergent.}$$

But

$$(S_1S_2)(S_1S_2)(S_1S_2) = S_1^3 \cdot S_2^3, \text{ and}$$

S_1^3 and S_2^3 are each divergent when $r < \frac{2}{3}$. Hence, when $\frac{1}{2} < r < \frac{2}{3}$, S_1^3 and S_2^3 are two divergent series whose product is absolutely convergent.

'On Systems of Isothermal Curves': Professor L. E. DICKSON, University of Chicago.

The object of this paper is to give an elementary geometrical definition of a system of isothermal curves in the plane. The definition is readily extended to families of curves on any algebraic surface. Two families of curves are discussed at length. From these the general definition is apparent.

'The Plane Geometry of the Point in Space of Four Dimensions': C. J. KEYSER, Columbia University.

The space under investigation is the *point* (in 4-space) regarded as the assemblage of all the lineoids (*i. e.*, ordinary 3-fold spaces), planes and lines containing it. This space is 3-dimensional in lineoids and in lines, the lineoid and the line being reciprocal elements; it is 4-dimensional in planes, the plane being *self-reciprocal*. The plane being taken as element, a theory results which is in its analytical aspect identical with the Plücker line theory of the lineoid, while the two theories are geometrically disparate. It is seen that, while neither of these geometries has a correlate in its own domain, each is in the domain of 4-space the perfect correlative of the other. Naturally, therefore, in the geometry of 4-space, whether it be the point-lineoid theory or the line-plane theory, the two doctrines in question play indispensable and precisely coordinate rôles. The subject is treated under the following six headings: Introductory considerations, concerning certain metric relationships, homogeneous coordinates of the plane, the linear complex plane, linear congruences of planes, projective transformations by means of complexes.

'The Next Opposition of Eros': Professor H. A. HOWE and Miss M. C. TRAYLOR.

The planet Eros, to which astronomers have recently given so much attention, is now too near the sun for observation. As it is evident that the observatories near the equator will have a better chance to rediscover the planet than those in the United States, computations have been made for Manila, where the Jesuit Fathers have a large telescope, and for Arequipa, Peru, where the Bruce 24-inch star camera is stationed. To represent the United States Denver has been chosen, its latitude being 39° 41′. For each of the three dates, May 1, June 1 and July 1 of 1902 have been computed the times of sunrise, of the beginning of the morning twilight, and of the rising of Eros. From these computations it appears that the conditions for early rediscovery are most favorable at Arequipa, excellent at Manila, and unpropitious at Denver. But before July 1 it should certainly have been observed in the United States.

In order to have a secure basis for a theory about the causes of the planet's variability, it is suggested that a table of standard magnitudes be computed for the entire period of visibility (May, 1902–October, 1903), on the assumption that the changes of brightness depend only on the relative positions of the sun, the earth and Eros. A comparison of the measured magnitudes with these will give data for theorizing.

A chart giving the path of Eros through the sky was exhibited, and also a pasteboard model of the orbits of the earth and the planet, showing their positions at favorable oppositions. This paper will appear in *Popular Astronomy*.

'On the Dimensions, Masses and Densities of the Satellites': Professor T. J. J. SEE, U. S. Naval Observatory.

The author points out the difficulty of measuring the angular diameters of very small bodies, on account of the tremors of the atmosphere, and then takes up the densities of the great planets as found in his recent investigations. He concludes that the average density of the four inner planets is 4.25, that of the outer planets 1.50. It is mentioned that the smaller inner planets have less density than the larger because the matter is less compressed by the action of gravity.

He then considers the diameters of the four large satellities of Jupiter; and, after analyzing the masses found by various investigators since the days of Laplace, adopts finally the masses used by Professor J. C. Adams. These masses, with the author's diameters, lead to the following densities for the several satellites:

Satellite I.	2.80	(Water = 1.)
Satellite II.	3.57	
Satellite III.	2.62	
Satellite IV.	0.76	

An investigation of Titan, the largest satellite of Saturn, shows its probable mass to be $\frac{1}{4700}$ that of Saturn, and the density 2.03. Thus Titan appears to be solid, and less dense than the planet Mercury (3.00), which is the rarest of the inner planets. Professor See concludes that on the average the satellites are of the density 2.36, about the same as the matter which compresses the crust of the earth (2.55) ; and that the small satellites which cannot be measured are of about the same density as those which can be investigated, such as the four satellites of Jupiter, and Titan, the largest satellite of Saturn.

'Photometric Observations of Eros': HENRY M. PARKHURST, New York City.

These observations, extending from September 13 to March 22, comprised 382 double extinctions, in comparison with a large number of standard stars, including four other asteroids. From these observations the constant of brightness, reducing the distances to unity, was ascertained to be 9.78 mag., and the constant factor for phase angle .037. The phase correction, additional to the correction for defect of illuminated surface, was found to be uniform through the whole variation up to 58°. The observations confirm the discovery of the rapid change of brightness, undoubtedly due to rotation. The author's conclusion is that this change is probably due to the spheroidal form of Eros, the amount of the change depending upon the direction of the axis of rotation with regard to the earth.

'On the History of Several Fundamental Theorems in the Theory of Groups of Finite Order': Dr. G. A. MILLER, Cornell University.

This paper will appear in a future number of SCIENCE.

'On Certain Methods in the Geometry of Position': Professor ARNOLD EMCH, University of Colorado.

In this paper the author attempts to outline those methods which seem to be best adapted for an introductory study of projective geometry. Particular stress is laid upon the study of homology in advanced plane geometry and descriptive geometry. It is shown that the principles of homology result naturally from the orthographic and also central projection, and that their application is conversely the best means for the construction of projective figures.

'The Parallaxes of 54 Piscium and Weisse 17^h, 322': Professor F. L. CHASE, Yale Observatory.

This paper was supplementary to a paper read by the same author before this section a year ago under the title, 'The Series of Parallaxes of Large Proper Motion Stars made with the Yale Heliometer,' a research begun in 1892, the observational part of which was finished the present year. In that paper the author had stated that the results of a preliminary solution indicated two of the 97 stars under investigation to possess a parallax of nearly 0''.25, which values, if confirmed by further observation, would place them among the first ten or twelve nearest stars so far as at present known. These two stars have been further investigated, two additional pairs of comparison stars being selected for each of them, and the observations with the original pairs repeated at the same time.

Altogether there were 56 observations on 54 Piscium and 54 on Weisse 17^h, 322, distributed as follows:

54 Piscium, Mag. 6.2.

Series I.	12 obs. with a & b	Mags. 7.5 & 7.3	(orig.)
Series II.	12 obs. with a & b		(rep.)
Series III.	16 obs. with c & d	Mags. 8.7 & 8.7	
Series IV.	16 obs. with e & f	Mags. 7.5 & 5.5	

Weisse 17, 322 Mag. 8.0.

Series I.	10 obs. with a & b	Mags. 7.0 & 8.0	(orig.)
Series II.	12 obs. with a & b		(rep.)
Series III.	16 obs. with c & d	Mags. 7.2 & 5.5	
Series IV.	16 obs. with e & f	Mags. 8.6 & 7.2	

The observations treated in the customary way and the equations derived therefrom being solved, the following results were obtained:

for 54 Piscium from

Series I.	$\pi = +0''.241$	$\pm 0''.026$	Wt. 36.10
Series II.	$\pi = +0.081$	± 0.017	Wt. 42.26
Series III.	$\pi = +0.183$	± 0.035	Wt. 59.53
Series IV.	$\pi = +0.055$	± 0.023	Wt. 51.40

for Weisse 17, 322,

Series I.	$\pi = +0''.218$	$0''.030$	Wt. 33.60
Series II.	$\pi = +0.189$	0.034	Wt. 35.08
Series III.	$\pi = +0.198$	0.022	Wt. 45.87
Series IV.	$\pi = -0.047$	0.031	Wt. 38.92

The author then goes on to discuss the disparity between some of the results, which are rather amazing in view of the size of the probable errors found. He investigates the question of a possible large systematic error and concludes that any such error, if it exists, must arise from the employment of different comparison stars, and is not due to changes dependent on the time. He finds only one of the comparison stars to possess any appreciable proper motion, viz., star *c* in the first table, which amounts to $-0^s.01$ in R.A. and $0''.3$ in Decl. the proper motion of 54 Piscium, according to Porter, being $-0^s.034$ in R.A. and $-0''.38$ in Decl., and of Weisse 17^h, 322, $-0^s.040$ in R.A. and $-1''.22$ in Decl.

He finally concludes by combining the various solutions, first, by their weights, and second, by the magnitude of the probable errors, and finds the following values:

for 54 Piscium,

I. $\pi = +0''.137 \pm 0''.014$ Prob. error 1 Ob. $= \pm 0''.193$
II. $\pi = +0.117 \pm 0.011$

for Weisse 17, 322,

I. $\pi = +0''.132 \pm 0''.013$ Prob. error 1 Ob. $= \pm 0''.166$
II. $\pi = +0.140 \pm 0.014$

But the author remarks that it has been considered worth while to make still another series on Weisse 17^h, 322, with the third set of comparison stars e. f. where there is a great difference in brightness, using screens in various ways to see if difference of brightness could account for the anomalous results obtained. Meanwhile the results above given must be considered as only provisional.

'The Distance of the New Star in Perseus': Professor F. L. CHASE.

When the new star in Perseus first appeared last February it at once became the great desire of the author to determine, if possible, the parallax of this most remarkable object. So far as is known to the author, no one has as yet succeeded in determining the distance of one of these new stars. In 1892 he began a series of observations on Nova Aurigæ for the same purpose, but it will be remembered this star rapidly diminished in brilliancy, though with several fluctuations, and was not observable with the Yale heliometer for more than two or three months, which would not give a very sensible parallax factor. With Nova Persei conditions have been much more favorable, and even now the star is conspicuously brighter than the brightest comparison star employed, which was, according to Argelander, of the 7.4 magnitude.

There was but a single pair of comparison stars suitable for the purpose, viz., B.D. + 43°, 720 Mag. 7.4 and B.D. + 43°, 766 Mag. 8.0. Calling the first *a* and the second *b*, the position angles were respectively about 252° and 94°, and the distances, 2900″ and 2700″ from the Nova.

The plan was to make the observations in the usual symmetrical order *Na*, *Nb*, *Nb*, *Na*, so as to eliminate, as far as possible, the effect of refraction and other effects which may vary with the time. Since the distance, *ab*, was not beyond the range of the heliometer it was thought expedient to measure this distance also each night, and thus have besides the sums of the distances, an independent basis for correcting the changes in the scale value from night to night. Each night's work, then, consists of six observations of distance each of four pointings in reversed positions of the instrument, as follows: *Na*, *Nb*, *ab*, *ab*, *Nb*, *Na*. Such observations were secured on five nights from February 26 to March 18, and seven from July 19 to August 4. These treated in the usual manner by the differences $Na - Nb$, corrected for scale value furnish seven equations of condition of the form:

$$+1.0x - 1.88y + 0.15z = \overset{(O-C)_R}{-0.003} \text{ or } \overset{(O-C)_R}{-0.004},$$

the equation derived from the observations of February 26, where $x =$ the correction to the scale value, $y =$ the parallax, and $z =$ the proper motion.

A solution of the normals derived from these equations gives:

$$y = \overset{R}{-0.0003} \pm \overset{R}{0.0013} = -0''.003 \pm 0''.017 \text{ Wt. } 38.85$$

or,

$$-0.0002 \pm 0.0013 \quad -0.003 \quad 0.017 \text{ `` ``}$$

But since the distance *ab* furnishes an independent scale value, it was thought in the beginning that with this independent value we might solve the parallax from each comparison star separately, and thus see if there is any marked difference in the parallaxes of the comparison stars themselves. A closer investigation later, however, showed that this method would involve the parallaxes of the comparison stars in precisely the same manner as before, and hence would furnish nothing further than another value of the parallax relative to that of the mean parallax of the two comparison stars, differing from that already found simply by the difference in the scale value used.

The value found by this method was:

$$\pi = -0''.006 \pm 0''.022$$

as compared with

$$\pi = -0''.003 \pm 0''.017$$

given above; which agrees with the uncertainty of the computations.

The author was able to find only one of the comparison stars in any other catalogues than the A. G. Zone Catalogue for 1875, and this one shows no appreciable proper motion.

Of course the result here given must be considered as only provisional, inasmuch as nothing is known as to the proper motion of the Nova and it is barely possible that this may be such as to have just neutralized the effect of parallax. Should the star remain sufficiently bright for another six months, however, it will then be possible to determine the effect of proper motion and hence give a definitive result.

'Hyperbolic Curves of the *n*th Order': Mr. A. C. SMITH, University of Colorado.

In a plane are given n straight lines with Cartesian equations. Any point in the plane is taken as origin and through this a line is drawn intersecting the n lines in n points. In this manner n segments, measured from the origin, are obtained on the line through the origin. The algebraic sum of these segments taken on this same line will determine a point, P, which will describe a curve of the nth order as the ray through the origin rotates through 360°. It was shown how the general equation of the locus could be obtained and some linear transformations were considered.

'A Uniform Method of determining the Elements of Orbits of all Eccentricities from three Observations of Apparent Position': Dr. F. R. MOULTON, University of Chicago.

The methods of determining orbits which are in most general use were devised by Gauss one hundred years ago. They are different for orbits in which the eccentricities are less than, equal to, and greater than, unity, although there is no singularity, which is essential to the problem, for the eccentricity equal to one. The method of this paper is uniform for all orbits, it is considerably more convenient than that of Gauss, and the radius of convergence of the series employed is examined in each case.

The longitude of the node and the inclination are computed by the usual methods, which are satisfactory, and the heliocentric distances and the arguments of the latitude at the epochs of the three observations are computed as in the method of Gauss.

Let $u_1, u_2, u_3, r_1, r_2, r_3$ represent the arguments of the latitude and the heliocentric distances at the epochs of the three observations. Then the parameter, p, is defined by the equation

$$k\sqrt{p}(t_3-t_1)=\int_{u_1}^{u_3} r^2 du,$$

where r^2 is expressed as a series in u whose radius of convergence is determined as a function of u_2 and e. It is shown how the coefficients are to be found. The eccentricity, e, and the longitude of the perihelion from the node, ω, are given by

$$\left\{\begin{aligned} e\sin(u_1-\omega) &= \left\{\frac{p-r_1}{r_1}\cos(u_3-u_1)\right. \\ &\qquad \left.-\frac{p-r_3}{r_3}\right\}\operatorname{cosec}(u_3-u_1), \\ e\cos(u_1-\omega) &= \frac{p-r_1}{r_1}. \end{aligned}\right.$$

The time of perihelion passage is determined from the law of areas.

'On the Modular Functions associated with the Riemann Surface

$$s^3 = z(z-1)(z-x)(z-y)\text{'}:$$

Dr. J. I. HUTCHINSON, Cornell University.

The object of the present paper is to extend the results obtained by Picard in his memoir 'Sur des fonctions de deux variables independantes analogues aux fonctions modulaires' (Acta Math., II., p. 114). Picard considers in the first place the integrals of the first kind, and in particular the moduli of periodicity of the normal integrals. By changing the values of x, y in a continuous manner so as to return finally to their initial values, the moduli undergo a linear transformation, which can be represented by a linear transformation on two parameters, u, v, in terms of which all the moduli are rationally expressible.

These transformations forming an infinite group G can be generated by five special ones $S_1\ S_2 \ldots S_5$, the explicit equations for which were given by Picard in a subsequent paper (Acta Math., V.).

The two variables x, y are then automorphic functions of u, v, and all functions belonging to the group can be rationally expressed in terms of these.

According to theorems previously obtained by Picard, there exist functions possessing a pseudo-automorphic character, exactly analogous to the fuchsian theta functions which Poincaré uses in connection with the automorphic functions of a single variable.

These functions can be constructed out of the theta constants. In order to do this it is necessary to determine the effect of the transformations of the group G on the latter, which is accomplished by means of the transformation theory of the theta functions. A table is constructed by means of which pseudo-automorphic functions can readily be constructed.

'Some Future Solar Eclipses, in particular that of June 8, 1918, total at Denver': Professor F. H. LOUD and Mr. L. R. INGERSOLL, Colorado College.

The tables used in computing the circumstances of the eclipses herein discussed are those 'On the Recurrence of Solar Eclipses' published by Professor Simon Newcomb in 1879. After some remarks upon the limits within which the errors of such a computation may be expected to fall, the results of what seems the preferable combination of Professor Newcomb's tabulated data are stated as follows:

On June 8,1918, the moon's shadow passes across the United States from northwest to southeast, covering Denver from $4^h\ 22^m\ 59^s$ P.M. to $4^h\ 24^m\ 23^s$—a period of $1^m\ 24^s$; while on the central line the duration is $1^m\ 33^s$.

The width of the shadow-path is about 59.3^m and the velocity of the shadow 2900^m an hour. The eclipse will be visible from Chamberlin Observatory, Denver, and Mt. Arapahoe, Grand Co.

Sept. 10, 1923. An eclipse of duration 3^m 24^s is total from San Diego, Cal., eastward along a line near the United States and Mexican boundary. Width of shadow-path 102 miles.

Jan. 24, 1925. An eclipse visible (as total) from northern Michigan to New Haven, Ct., reaching the latter point at 9^h 5^m A.M., and lasting 2^m 8^s.

Two maps of the Denver eclipse were shown.

'Bibliography of Quaternions and Allied Systems of Mathematics': Professor ALEXANDER MACFARLANE, Lehigh University.

The association for the promotion of quaternions and allied mathematics has in preparation a bibliography of all the literature of the subject. The field embraces all that has been written on what is called geometric algebra, or space analysis, and its three main subdivisions are quaternions, Ausdehnungslehre, and geometric algebra previous to Hamilton and Grassmann. The extent of this literature is not so small as is commonly supposed. As regards the first branch, the papers of Hamilton himself are numerous, and he has been followed by about one hundred writers. The writings of Grassmann are also numerous, and he has been followed by about the same number of writers.

It is desired to make the bibliography as complete as possible, and the writer desires mathematicians to cooperate by sending to him the necessary data about their own writings, or any rare writings in their possession.

'The Bruce Micrometer': Professor C. J. LING, Denver Manual Training High School.

The filar micrometer attached to the telescope at the Chamberlin Observatory at University Park, Colorado, is the gift of the late Miss Caroline W. Bruce. It is especially adapted to rapid work and work on faint objects. Instead of being screwed to the tail piece of the telescope, it is so attached that it slides off, thus leaving the zero of the position circle unchanged. The position circle is furnished with a system of solid stops which enable it to be turned exactly 90° when micrometric measures of both $\Delta\alpha$ and $\Delta\delta$ are being made. These stops can be rapidly thrown back, enabling the circle to be turned any desired angle, and so rapidly thrown exactly to their former position. The circle can also be clamped at any position and adjusted by the use of a tangent screw.

The eye piece can be moved rapidly in both R. A. and Decl., admitting of the use of exceptionally long and a large number of spider webs. It is possible to observe objects differing in declination by more than 30′, and this with a comparatively small motion of the micrometer. A micrometer screw of 20 threads to the inch makes rapid work possible. This is provided with three heads which are graduated so as to be read rapidly, two of which may be clamped in position.

The field is illuminated by two pairs of two candle power electric lamps whose intensities are regulated by a rheostat and mechanical shades, making it possible to rapidly adjust the illumination or to throw it off entirely. The observer can also illuminate at will either or both of the verniers of the position circle.

The results obtained from many hundreds of observations demonstrate that the micrometer is admirably adapted to combine rapidity and accuracy, making it an extremely efficient instrument, and this is all the more worthy of mention since it is accomplished without undue haste on part of the observer.

'The Metric System in the United States': Mr. JESSE PAWLING, Jr., Central High School, Philadelphia.

A brief history of the action of Congress in the subject of weights and measures is given. This includes the passage by the House and failure to pass by the Senate of the bill of 1796; the petitions urging legislation in uniformity of weights and measures from various states; the bills of 1866 to legalize the metric system and to allow it for the use of the post-offices; the failure to consider the bills of 1892 for the adoption of the metric system for the exclusive use in the customs service, though urged by 150 petitions; the passage of the bill of 1896 and its reconsideration, which referred it back to the committee from which it was not reported, and the bills following this for the same purpose, the adoption of the metric system for the use of the Departments of the Government, none of which were considered.

The work of the English Decimal Association has advanced the interests of the metric system. The association has among its members, members of Parliament and business people of England. It has secured the pledges of members of Parliament to vote for the metric system. It has secured the teaching of the metric system in the schools. It circulates literature and has a lecturer who addresses audiences wherever a meeting can be secured in England. It circulates reports of consuls on the metric system in other countries. It has secured the cooperation of the labor organizations, Chamber of Commerce, and National Union of Teachers. It has no dues and any one can become a member.

A similar organization may do good work in this country for the interests of the metric system. It could secure the cooperation of Congressmen. It might aim at having the metric system taught in the schools. It could educate the people by literature and lectures like the English Decimal Association. It might secure advertisements of foreign goods in the metric system and in many other ways popularize the metric system with nominal or no dues.

'The New National Bureau of Standards': Mr. JESSE PAWLING, Jr.

The new Bureau is to be located in the suburbs of Washington, where it is free from disturbance. It has an appropriation of $300,000 and a laboratory costing about $200,000 is to be erected. Great care is to be exercised in selecting the personnel, and none but those trained for the work will be employed, as it is under civil service laws. Members of the Bureau are traveling to inspect laboratories of Europe. When established the Bureau will employ a number of young men just graduated from universities, giving them opportunities to develop along the lines which they wish to follow. It will invite specialists to do work in their line.

The Bureau standardizes three grades of weights and measures:

1. Those for commercial use.

2. Those for manufacturing and technical processes and professions; and

3. Those for extreme accuracy for scientific purposes.

'A Summary of the Salient Effects due to Secular Cooling of the Earth': Professor R. S. WOODWARD, Columbia University.

The effects summarized in this paper are:

(*a*) The slow process of heat conduction in the earth's crust, leading to the conclusion that nothing less than a million years is a suitable time unit for recording the historical succession of events.

(*b*) The insignificant modification of the process of conduction arising from the hydrosphere, leading to the conclusion that secular cooling goes on substantially as if the earth had neither atmosphere nor ocean.

(*c*) The resultant effect on the lithosphere of secular contraction and the process of isostacy.

(d) The effects of secular contraction on the length of the sidereal day.

'The Energy of Condensation of Stellar Bodies': Professor R. S. WOODWARD.

The problem considered in this paper is that of the energy due to the gravitational condensation of gaseous matter from a state of infinite diffusion to a finite spherical mass in which Laplace's law of density holds. The problem is worked out in its generality, formulas specifying the distribution of density, pressure, and potential in the mass being given. Special attention is given to the probable case of the fixed stars of a vanishing surface density.

'The Physical Basis of Long Range Weather Forecasts': Professor CLEVELAND ABBE, U. S. Weather Bureau.

In the absence of the author and of the member who was to present it this paper was read by title. The papers by Professor See and Dr. Moulton were presented by Professor Howe. Those by Professor Dickson, Mr. Keyser, Mr. Parkhurst, Dr. Hutchinson and Professor Macfarlane were read by the secretary. All the other papers were presented by their authors. Several other papers were read before the joint session of Sections A and B. These will be included in the report of Section B.

G. A. MILLER,
Secretary of Section A.

ON THE STABILITY OF VIBRATIONS.

Observations.—The following experiment seems to me to be an interesting illustration of the equation of the damped harmonic oscillation. It also presents a striking illustration of the stability of a given type of vibration.

The necessary apparatus is very simple, consisting of an ordinary open organ pipe (say c'' of the one foot octave) and a cylindrical tin box, 4–5 cms. in diameter and 5–6 cms. long, with a central hole at one end about 1 cm. in diameter. This is adjusted so as to be of the same period as the organ pipe. A König's resonator will do equally well, but if the box has a slightly loose lid, it brings out other phenomena also deserving notice.

The experiment is as follows: Using a resonator giving b' to e'', depending on the intensity of the blast and with a loose (not sealed) lid, let it be placed symmetrically to the slit of the pipe at a distance, x, from it, as shown in the figure. Then as x decreases from a large distance, to say 3 cms., the resonator trembles violently (felt with the finger), but neither raises nor depresses the note. As x decreases further to 1.7 cms., no marked effect occurs, but pressure in the influx of the organ pipe will force out the octave, which it did not do before. Between $x = 1.7$ and $= 1.5$ there is destructive interference; a mere whiffing is heard from the combined instrument, but an impure octave may be forced out by pressure. Finally, when x decreases further to say 1.1 cms., a clear d'' suddenly breaks forth and is the chief feature of the experiment. For smaller distances (1.1 to .7 cms.) the d'' flattens again to c''.

The same sharpening is produced when the resonator is placed on top of the open organ pipe, mouth inward. If two resonators are used, one as in figure, the other on top, the sharpened note of the one is further sharpened by the other.

When the so-called destructive interference occurs there is no vibration in the resonator; but on pressing the finger against its bottom, the c'' may again be heard.

If the lid of the resonator be cemented on with wax, or if a round König resonator be used, there is no whiffing. The interval, x, of instability is then very small (about .2 cm.) so that the note passes very suddenly from c'' to d''. Too loose a lid merely depresses the tone at short distances.