or

$$p' < 0, \quad c > 0, \qquad 0° < \psi < 54° \; 44',$$

and if

$$\left(\frac{p}{3}\right)^3 + \left(\frac{q}{2}\right)^2 < 0,$$

where

$$\frac{p}{3} = \frac{1}{81}\left[9(2s^2 + q'^2) - 7c'^2\right]; \quad \frac{q}{2} = \frac{5c'}{9}\left[\frac{p}{3} + \frac{1}{9}\left(m^2 - \frac{11}{10}q'^2\right)\right]$$

and

$$m^2 = c'^2 + s^2.$$

For solution the equation in z is written in the form

$$y' = (\zeta + c')^2 - (\eta - q'^2) = f(\vartheta) = 0,$$

where

$$\zeta = s \tan \vartheta; \quad \eta = \frac{n}{s}\cos \vartheta.$$

A convenient graphical solution is proposed for the solution of $f(\vartheta) = 0$. Then

$$\rho/R = z = s \tan \vartheta + c.$$

Geocentric distances correct to four or five decimals result from the graphical solution. Further decimals may be obtained by a simple differential correction.

In practice no case with three solutions has been encountered.

C. A. NOBLE,
Secretary of the Section.

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION.

THE seventy-ninth annual meeting of the British Association for the advancement of science was held in Winnipeg August 25 to September 1. Fourteen hundred members and associates were in attendance. The opening event was the address of the President of the Association, Sir J. J. Thomson, on Wednesday evening, August 25, in which he gave an account of some of the more recent developments in physics and in his opening remarks took occasion to urge a closer union between mathematics and physics and to emphasize the advantages of

research in developing the qualities of a student. The following morning the sectional meetings opened with the addresses of the presidents of the various sections. In Section A President Rutherford took as his subject the present position of the atomic theory in physical science. The sectional addresses, as also a more general account of the meeting of the Association, will be found in *Nature* and in *Science;* for abstracts of the various papers presented the reader is referred to the annual Report of the proceedings of the Association. Section A covers the mathematical and physical sciences and the Winnipeg meeting of the section was a particularly successful one, in which however the subject of physics was dominant. There were six sessions in physics with crowded programmes and a large number in attendance. Cosmical physics, included in the Section for convenience, occupied several separate sessions. One session sufficed for the presentation of the papers in pure mathematics, which were the following:

(1) E. H. MOORE: "Theorems in general analysis."

(2) E. W. HOBSON: "On the present position of the theory of aggregates."

(3) G. A. MILLER: "Generalizations of the icosahedral group."

(4) G. A. BLISS: "A new proof of Weierstrass's factor theorem."

(5) J. H. GRACE: "On ideal numbers."

(6) P. A. MACMAHON: "On a correspondence in the theory of the partition of numbers."

(7) W. H. METZLER: "On a continuant expressed as the product of linear factors."

(8) E. W. DAVIS: "Imaginary geometry of the conic."

(9) F. CAJORI: "On the invention of the slide rule."

(10) J. W. NICHOLSON: "The asymptotic expansion of Legendre functions."

(11) Report on the calculation of Bessel functions.

1. Professor Moore started out from the statement of the fundamental principle: "The existence of analogies between central features of various theories implies the existence of a general theory which underlies the particular theories and unifies them with respect to those central features." The speaker emphasized the importance of such a general theory for the subject of integral equations. He also considered a number of impor-

tant analytic systems included under a certain general type, with reference to the properties which they had in common.

2. Professor Hobson recalled various points which have been raised in recent controversies relative to the theory of aggregates, and advocated the adoption of a definition of an aggregate of more restricted character than that of G. Cantor.

3. The general groups treated in Professor Miller's paper are those in which the two generating operators t_1, t_2 satisfy one of the three sets of conditions

$$t_1^2 = t_2^5, \quad (t_1t_2)^3 = (t_2t_1)^3; \quad t_1^2 = t_2^3, \quad (t_1t_2)^5 = (t_2t_1)^5;$$
$$t_1^3 = t_2^5, \quad (t_1t_2)^2 = (t_2t_1)^2.$$

Among others Professor Miller established the following important theorems: There are an infinite number of groups each of which may be generated by two operators satisfying one of these pairs of conditions. Each of the possible groups generated by t_1, t_2 contains either the icosahedral group or the group of order 120 which is unsolvable and does not contain a subgroup of order 60, and it must have one of these groups for its commutator subgroup.

4. The theorem of Weierstrass for which Professor Bliss has found a simplified proof is the following: Any convergent series in $p + 1$ variables $F(x_1, x_2, \cdots, x_p, y)$ in which the lowest term of y alone is of degree n, can be expressed as a product

$$(y^n + a_1y^{n-1} + \cdots + a_{n-1}y + a_n)\phi(x_1, \cdots, x_p, y),$$

where $a_1, \cdots, a_n$ are convergent series in $x_1, \cdots, x_p$ which vanish with these arguments, while ϕ is a convergent series with a constant term different from zero, in all $p + 1$ variables.

5. Dr. Grace's paper treated of the ideals in a field defined by the root of a quadratic equation.

7. Professor Metzler's theorem includes as special cases theorems due to Painvin, Sylvester, and Cayley, and may be stated thus:

$$|x_{i,k}| = \{r + na(\alpha - \beta)\}\{r + na(\alpha - \beta) - 2a\alpha + a\beta\}$$
$$\{r + na(\alpha - \beta) - 4a\alpha + 2a\beta\} \cdots \{r - na\alpha\},$$

where the determinant is of order $n + 1$ and a continuant in which the laws of the elements in the three diagonals are the following:

$$x_{i,i-1} = (n - i + 2)\alpha(\alpha - \beta), \quad x_{i,i} = r - (i - 1)\alpha\beta, \quad x_{i,i+1} = i\alpha\alpha.$$

8. Professor Davis gave a complete representation of the elements of the central conic whose axes are non-similar complex quantities.

9. The object of Professor Cajori's paper was to collect all available data bearing on the invention of the slide rule and to decide between the rival claims of Gunter, Wingate, and Oughtred. He concluded from the evidence that the slide rule was invented by William Oughtred, agreeing in this with Augustus DeMorgan although most writers of the present time attribute the invention to Edmund Wingate. Much of the literature bearing on the subject and consulted by Professor Cajori was not accessible to DeMorgan. The rest of the papers were read by title.

A very pleasant feature in connection with Section A was a smoker held on Tuesday evening, which brought the members of the section into closer personal contact with one another. In a general account of a meeting of the British Association the social and semi-popular scientific functions must not be forgotten, for these have their distinct values in the purposes of the organization. There were several well attended semi-popular scientific lectures in the evenings and quite a number of garden parties and receptions, both private and official, were given in honor of the members of the Association.

At the conclusion of the meeting the officials of the Association together with a number of invited guests, in all a party of nearly two hundred, made an excursion to the Pacific coast over the main line of the Canadian Pacific Railway. Short stops were made at the principal towns en route and at a number of the mountain resorts, and Victoria was reached by boat from Vancouver. The return trip was made by way of Edmonton, from which city the special train was run over the Canadian Northern Railway back to Winnipeg.

The meeting of the British Association next year will be held in Sheffield, England.

J. C. FIELDS.