SCIENCE

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FRIDAY, MAY 1, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GENERAL MEETING OF THE AMERICAN PHILOSOPHICAL SOCIETY.

THE general meeting of the American Philosophical Society was held in Philadelphia on Thursday, Friday and Saturday, April 2, 3 and 4. A large number of members were in attendance, and the meeting was in every way a most successful and important one. Morning and afternoon sessions were held in the historic hall of the society on Independence Square, and luncheons were served here each day to members and invited guests. On Thursday evening a reception for members of the society and their friends was held at the hall of the Historical Society of Pennsylvania, on which occasion the president, Professor Edgar F. Smith, delivered an address on the origin and early history of the American Philosophical Society, which will be published in full elsewhere. On this occasion President Daniel C. Gilman of the Carnegie Institution also spoke on the work of that institution during the first year of its development. Professor Wm. H. Welch, who was to have spoken on the objects and aims of the Rockefeller Institute for Medical Research, was prevented by sickness from being present.

At the close of the morning session on Friday the annual election of members was held, and the following persons were chosen:

Residents of the United States.—Edward E. Barnard, Sc.D., Williams Bay, Wis.; Carl Hazard Barus, Ph.D., Providence, R. I.; Franz Boas, Ph.D., New York; William W. Campbell, Sc.D., Mt. Hamilton, Cal.; Eric Doolittle, Philadelphia; Basil Lanneau Gildersleeve, LL.D., Baltimore; Francis Barton Gummere, Ph.D., Haverford, Pa.; Arnold Hague, Washington, D. C.; George William Hill, LL.D., Nyack, N. Y.; William Henry Howell, Ph.D., Baltimore; Edward W. Morley, Ph.D., Cleveland; Harmon N. Morse, Ph.D., Baltimore; Edward Rhoads, Haverford, Pa.; Alfred Stengel, M.D., Philadelphia; William Trelease, Sc.D., St. Louis.

Foreign Residents.—Anton Dohrn, Naples; Edwin Ray Lankester, LL.D., F.R.S., London; Sir Henry E. Roscoe, F.R.S., D.C.L., London; Joseph John Thomson, D.Sc., F.R.S., Cambridge, Eng.; Hugo de Vries, Amsterdam.

Action was also taken at this session looking to the adequate celebration of the two hundredth anniversary of the birth of Franklin, the founder of the organization. This was expressed in the following preamble and resolution which were unanimously adopted:

Inasmuch as the two hundredth anniversary of the birth of Benjamin Franklin occurs in January, 1906, it is proper that the American Philosophical Society, which owes its existence to his initiative and to which he gave many long years of faithful service, should take steps to commemorate the occasion in a manner befitting his eminent services to this society, to science and to the nation. Therefore be it

Resolved, That the president is authorized and directed to appoint a committee of such number as he shall deem proper to prepare a plan for the appropriate celebration of the bi-centennial of the birth of Franklin, and to report the same to this society.

The president appointed the following members to constitute the committee: Hon. George F. Edmunds, *Chairman;* Professor Alexander Agassiz, Boston; President James B. Angell, Ann Arbor; Professor George F. Barker, Philadelphia; Professor A. Graham Bell, Washington; Mr. Andrew Carnegie, New York; Professor C. F. Chandler, New York; Hon. Grover Cleveland, Princeton; President Charles W. Eliot, Cambridge; President Daniel C. Gilman, Baltimore; President Arthur T. Hadley, New Haven; Provost C. C. Harrison, Philadelphia; Hon. John Hay, Washington; Dr. I. Minis Hays, Philadelphia; Professor Samuel P. Langley, Washington; Capt. Alfred T. Mahan, U. S. N.; Dr. S. Weir Mitchell, Philadelphia; Professor Simon Newcomb, Washington; Governor S. W. Pennypacker, Harrisburg; Professor E. C. Pickering, Cambridge; Professor Michael I. Pupin, New York; President Ira Remsen, Baltimore; Professor John Trowbridge, Cambridge; Dr. Charles D. Walcott, Washington; Hon. Andrew D. White, Ithaca; President Woodrow Wilson, Princeton.

On Friday evening the annual dinner of the society was held at the Hotel Bellevue, at which about eighty members were present, the occasion being a most enjoyable one and a fitting climax to the social side of the meeting. Professor W. B. Scott acted as toastmaster and the following toasts were responded to:

'The Memory of Franklin,' Professor Albert H. Smyth, of Philadelphia.

'Our Sister Societies,' Rear Admiral Melville, of Washington, and Professor Henry F. Osborn, of New York.

'Institutions for the Promotion of Knowledge,' Dr. Cyrus Adler, of Washington.

'The American Philosophical Society,' Mr. J. G. Rosengarten, of Philadelphia.

The opinion was freely expressed, by many members who had come from a distance, that the entire meeting was one of the most enjoyable and profitable which they had ever attended. All were hearty and unanimous in the desire that the general meetings of the society should be continued and made an annual event. No further justification of these meetings is needed than that they have been successful, that they have attracted many members from a distance and that their continuance is desired by those who are acquainted with them; furthermore, it should not be necessary to defend our oldest scientific society for carrying out in practical form the broad policy which it has upheld for more than a century and a half.

Nevertheless, since there has been some misunderstanding as to the purpose of these general meetings, it may not be amiss to point out the fact that in no sense are they intended to antagonize or to supplant the meetings of other societies. On the contrary, they occur at a time when few other societies are meeting and they attract papers of a general rather than of a specialized character. The broad and comprehensive scope of the society, which includes the whole range of useful knowledge, so far from being a hindrance to the success of the meetings, has been a particular attraction and source of strength. The opportunity of hearing and becoming acquainted with men eminent in the most diverse fields of thought is likely to promote catholicity of spirit even if it does not greatly advance individual specialties, and, after all, the present world stands quite as much in need of the former as it does of the latter. Amidst all the special societies which exist in this country there is surely room for one which shall welcome learned men from all fields whatsoever, and it is fitting that this common meeting ground should be the oldest learned society in America, founded by the many-sided Franklin, and devoted to the promotion of useful knowledge, 'nullo discrimine.'

The program of the meeting with abstracts of some of the papers presented follows; most of these papers will be printed in full in publications of the society:

THURSDAY, APRIL 2.

Morning Session, 10 o'clock.

President Smith in the chair.

President's Address of Welcome: Professor EDGAR F. SMITH.

The Structure of the Corn Grain and Its Relation to Popping: Professor HENRY KRAEMER, of Philadelphia.

There is a marked difference in the structure of the several parts of corn grains, and according to the character of the endosperm three distinct kinds of grains may be distinguished as follows: (1) One variety, representing the sweet corns, contains comparatively few nearly spherical starch grains from 4 to 10 microns in diameter, besides considerable dextrin becoming red with iodine, and a small amount of a reducing sugar. (2) The second class includes the dents and possibly also the soft corns, and in these the greater portion of the endosperm is whitish and more or less mealy; the starch grains in this mealy area are rounded or slightly polygonal, vary from 5 to 25 microns in diameter, and have a central rarefied area or point of origin of growth, which may be either wanting or usually not more than 2 microns in diameter. (3) The third class includes the pop-corns, in which the endosperm is more or less translucent and horny, and the cells of which contain closely arranged polygonal starch grains from 7 to 18 microns in diameter, and having a central rarefied area from 2 to 7 microns in diameter. Some of the flint corns closely resemble the pop-corns and form a group intermediate between the latter and the dent corns.

If the entire grains of these several groups are heated in a popper or in a hot-air oven at a temperature between 145°C.

and 160°C. for from four to ten minutes, there will be a splitting or popping open of the grain from the apex and a modification of the contents varying according to the kind of corn. In the sweet corn the grain swells very perceptibly, becoming hollow in the center, the endosperm becoming more or less friable and containing an increased amount of reducing sugars. In the dent corns there is a splitting of the hulls and the endosperm, and this may take place on the flat surface or along the edge, or the upper portion may separate like a lid. There is not much alteration in the endosperm cells of this class, only a small amount of soluble starch being formed. In the pop-corns there is a splitting of the grain along the two radii, the endosperm swelling very considerably, the peripheral portions cohering with the hull and thus leaving a central more or less rounded mass; where the popping is perfect the quarters turn back and meet below the embryo. On examining the endosperm of the popped grain it is observed that there has been considerable alteration in the starch grains and cell walls, and that the starch has been changed into a soluble form, the amount of which depends upon the degree of alteration in the endosperm cells and their contents.

The structural characteristics of the starch grains in the altered areas of the different pop-corns would seem to indicate that the popping of the grain of corn results from the expansion of the individual starch grains, the degree of expansion depending upon the relative amount of water and air in the grains. As an illustration of this it may be stated that perfectly fresh pop-corn or pop-corn that has been soaked in water for twenty-four hours will pop but little in the true sense of the word. On the other hand, a pop-corn which was seven years old, but had not lost its germinating power, would not pop unless first soaked in water and then allowed to dry for from four to twelve hours. That this property probably resides in the starch grain is further shown by the fact that pieces of the pop-corn grain will pop.

Beaver County (Pa.) Orchids: Mr. IRA FRANKLIN MANSFIELD, of Beaver, Pa.

A brief account of twenty-eight species of orchids which the writer has found in Beaver County, Pa.

The Forward Movement in Plant Breeding: Professor L. H. BAILEY, of Ithaca, N. Y.

The current idea in plant breeding is to breed 'varieties,' to produce something 'new' that can be named and described. However, a variety is not a thing or an entity, but only an aggregation of forms that agree rather more than they differ. Any one of these minor forms might be separated as another variety. The ultimate form or unit is the individual plant, and from this individual, irrespective of the variety it represents, the plant-breeding of the future must proceed.

The new idea is to breed for definite characters that make for efficiency. We must 'scale' our plants according to what they perform or what they contain. Thus, the new corn breeding does not attempt to produce new 'varieties' of corn, but to increase the efficiency of any variety by increasing its yield, protein or starch content, its drought-resisting or disease-resisting qualities. The new work with corn in Illinois, with wheat in Minnesota, with cotton and other crops by the United States Department of Agriculture, was described and illustrated.

The first thing that strikes one in all this work is its contrast with the old ideals. The 'points' of the plants are those of 'performance' and 'efficiency.' It brings into sharp relief the accustomed ideas as to what are the good 'points' in any plant, illustrating the fact that these points are for the most part only fanciful, are founded on *a priori* judgments, and are oftener correlated with mere 'looks' than with efficiency. An excellent example may be taken from corn. In 'scaling' any variety of corn, it is customary to assume that the perfect ear is one nearly or quite uniformly cylindrical throughout its length, and having the tip and butt well covered with kernels. In fact, the old idea of a good variety of corn is one that bears such ears. Now, this ideal is clearly one of perfection and completeness of mere form. We have no knowledge that such form has any correlation with productiveness, hardiness, drought-resisting qualities, protein or starch content, and yet these attributes are the ones that make corn worth growing at all. An illustration also may be taken from string beans. The ideal pod is considered to be one of which the tip-projection is very short and only slightly curved. This, apparently, is a question of comeliness, although a short tip may be associated in the popular mind with the absence of 'string' in the pod; but we do not know that this character has any relation to the efficiency of the bean pod. We are now undergoing much the same challenging of ideas respecting the points of animals. These 'points,' by means of which the animals are 'scored,' are in large part merely arbitrary. Now, animals and plants are bred to the ideals expressed in these arbitrary points, by choosing for parents the individuals that 'score' the highest. When it becomes necessary to recast our 'scales of points,' the whole course of evolution of domestic plants and animals is likely to be changed.

We are to breed not so much for merely new and striking characters that will enable us to name, describe and sell a 'novelty,' as to improve the performance along accustomed lines. We are not to start with a variety, but with a plant. It is possible to secure a five per cent. increase in the efficiency of our field crops. This would mean the annual addition of hundreds of millions of dollars to the national gain.

The purpose, then, of our new plant-breeding is to produce plants that are more efficient for specific uses and specific regions. They are to be specially adapted. These efficiency ideals are of six general categories:

1. Yield ideals.
2. Quality ideals.
3. Seasonal ideals.
4. Physical conformation ideals.
5. Regional adaptation ideals as to climate, altitude, soil, etc.
6. Resistant ideals as to diseases and insects.

The main improvement and evolution of agriculture are going to come as the result of greater and better crop yield and greater and better animal production. It is not to come primarily from invention, good roads, rural telephones, legislation, discussion of economics. All these are merely aids. Increased crop and animal production are to come from two agencies—improvement in the care that they receive and improvement in the plants and animals themselves. In other words, the new agriculture is to be built upon the combined results of better cultivation and better breeding. So far as the new breeding is concerned, it is characterized by perfect definiteness of purpose and effort, the stripping away of all arbitrary and factitious standards, the absence of speculative theory and the insistence on the great fact that every plant and animal has individuality.

Development of the English Alphabet: Professor FRANCIS A. MARCH, of Lafayette College, Easton, Pa.

Language is growth. We will to utter sounds, and the muscles move by their own laws. The sounds weaken by the law of least effort, strengthen under the accent, are assimilated by neighboring sounds while the writing of a word remains unchanged, so that any letter may come to stand for any sound and any sound be found represented by many different letters. This is the condition of a language as it grows. Such a language needs to be shaped by reason to the use of man.

An alphabet addressed to the eye is machinery to suggest the elementary significant sounds, and is open to improvement like all labor-saving machinery.

The Roman alphabet was a simple set of largely straight-line forms suited for cutting in stone from right to left like our capitals. It has been improved into cursive forms easily connecting from left to right. This change was established in the fifteenth century.

It brought two forms of *I* into use, *i* and *j*. The penmen often swept the *i* below the line with a flourish, and the types *i* and *j* were used indifferently for either the vowel or consonant force of the Roman *I*. In the beginning of the seventeenth century they were differentiated and *j* used only as a consonant.

The Roman *V* also had two cursive forms, *v* and *u*, used indifferently for vowels and consonants, differentiated at the same time, all under the lead, as our Dr. C. P. G. Scott has lately shown us, of the great scholar Philemon Holland and his printers.

The philologists have also developed six continuant lingual consonant diagraphs with a diacritic *h*, viz., *dh, th, sh, zh, dzh* = *j*, *tsh* = *ch*, to which the attention of workers in alphabetics is invited. There are also a new type *z* for sonant *s* and a nasal *ng*.

But the vowels are the most tangled field. Between *A* and *E* has been established the sound in 'at,' 'fare'; between *A* and *O* that in 'not,' 'nor'; between *A* and *U* that in 'fun,' 'burn.' Three new types are wanted. It is proposed to obtain them as Holland did. There are two forms (*a* and *ă*) used for both the sounds in 'father' and făt'; *a* is to be used always for the first, *ă* for the last. "I can't tell a lie, papa; you know I can't. I did it with my little hătchet." The words are not obscured, the spelling is perfected.

There are two graphic forms (*o* and *ŏ*) used for the sounds of 'no' and 'not'; *o* must be used only for the first, *ŏ* only for the second sound.

So let the lower case *u* be used only for the vowel in 'full,' 'rule' and the small capital *U* only in 'but,' 'burn,' etc. It will be seen in accompanying diagrams how easily the use of these types may be introduced, and how far the general use of them will go in reducing our chaos to cosmos.

The society is urged to use types in her documents as plainly within her general sphere, 'philosophy for fruit,' as a special field in which her members have always been leaders from Franklin to Haldeman, and the authors of the last state paper on spelling. This is a time of crisis. The language of the Pacific and the coming world ought not to be left to pidgin English.

Archeology and Mineralogy: Professor Paul Haupt, LL.D., Johns Hopkins University, Baltimore, Md.

In seven passages of the Old Testament we find references to a precious stone of Tarshish, *i. e.*, southern Spain (Exod. xxviii. 20, xxxix. 13; Ezek. i. 16, x. 9, xxviii. 13; Song of Solomon, v. 14; Dan. x. 6). As a rule, it is stated that the Greek Bible translates 'chrysolite,' and that the chrysolite of the ancients was our topaz; but the passage of Pliny quoted in support of this view clearly points, not to topaz, but to crystals of cinnabar. Anthrax also, which the Greek Bible has for *tarshish* in Ezek. x. 9, means cinnabar. Pliny calls cinnabar *minium,* while we apply this term to the yellowish-red oxide of lead which is called by Pliny *usta cerussa.* Pliny says the best chrysolites are those which, when brought in contact with gold, make the gold look like silver; this is, of course, due to the 86 per cent. of mercury in the crystals of cinnabar (Pliny, xxxvii. 126: *optimæ sunt quæ in conlatione aurum albicare quadam argenti facie cogunt*). Pliny states that the Romans received cinnabar almost exclusively from Spain, and the best cinnabar came from *Sisapo,* the present quicksilver mines of Almaden, north of Cordova in southern Spain.

Just as Pliny applies the name *minium* to cinnabar, so the ancients used the name 'sapphire' for lapis lazuli. The ancients received lapis lazuli almost exclusively from the famous mines in Badakhshan, the mountainous region in northeastern Afghanistan, on the northeastern flank of the Hindukush, the Paropannisus of the ancients. The Assyrian king Esarhaddon (680–668 B. C.) calls this lapis lazuli mountain *Bikn,* adding that it was situated in the remotest part of Media. Esarhaddon must have advanced to the Paropannisus, as far east as did, three hundred years later, Alexander the Great, and the Macedonian conqueror would probably not have extended his victorious march so far east if he had not obtained in Babylonia some information regarding those eastern regions.

After we have established the fact that the sapphire of the ancients denotes lapis lazuli, while the stones of Tarshish represent crystals of cinnabar, we can explain the stanza in the Biblical love-ditties (Song of Solomon, v. 14) where the maiden describing the beauty of her lover says:

> His arms are poles that are golden,
> bedecked with rubies of Tarshish;
> His body is one piece of ivory
> adorned with azure blue sapphires.

That is, his bronzed arms are covered with ornamental designs tattooed in vermilion (the brilliant red pigment formerly made by grinding select pieces of cinnabar), while his white body is tattooed in ultramarine (the beautiful blue pigment formerly obtained from lapis lazuli). Tattooing has been common among the Semites from the earliest times. The mark which the Lord appointed to Cain was a tattooed tribal mark.

I maintain, therefore: the stones of Tarshish are ruby-like crystals of cinnabar from the quicksilver mines of Almaden, and Tarshish is a Phœnician word meaning 'dressing of ores,' especially 'spalling.' King Solomon's mines were located in southern Spain and in southeastern Africa; the silver came from Spain and the Ophir gold from the Eldorado north of the former South African Republic, opposite Madagascar.

The Activity of Mont Pelée: Professor ANGELO HEILPRIN, of Philadelphia. Illustrated with lantern slides.

Reaction as an Agent in Securing Navigable Depths in River and Harbor Improvements: Professor LEWIS M. HAUPT, of Philadelphia.

This paper dealt with the necessity which exists for deeper channels to meet the requirements of modern vessels; the inability of contending with the ceaseless activities of nature by mechanical means; the enormous tonnage which requires ample facilities for its rapid and economical distribution by the cheapest medium; the existing resources of the engineer as at present applied and the results secured therefrom; the rapid increase in the annual appropriation for the construction and maintenance of this class of works, and the latest developments which have proved the practicability of a new form of tool for securing results by the utilization of the principle of reaction, instead of velocity and concentration by means of two jetties. It also emphasized the inability of currents of fresh water to scour to sufficient depths when buoyed up by the heavier salt water which obstructs and raises them on their path over a bar and the greater specific gravity of the wave-driven sand, or littoral drift, of which the bars of tidal inlets are composed. The location and cause of the abnormal depths found in gorges or under the lee of obstacles, and the resultant counter-scarps, illustrated by numerous slides showing the proper position and form to secure a continuous channel across an obstructing bar at half the cost of the usual devices, and by natural forces which will maintain the channels which they carve.

The above general claims and principles were illustrated and confirmed as to their value by a practical demonstration on a large scale of incompleted work on the coast of the Gulf of Mexico, which has proved to be remarkably permanent and effective.

Afternoon Session, 2 o'clock.

Vice-President Barker in the chair.

The Curtis Steam Turbine: Mr. W. L. R. EMMET, of Schenectady, N. Y.

The Principle of Least Work in Mechanics, and its Possible Use in Investigations Regarding the Ether of Space: Professor MANSFIELD MERRIMAN, of Bethlehem, Pa.

The use of this principle in engineering computations was briefly explained. It was pointed out that its application is only valid in the case of bodies that are perfectly elastic and that its successful use in the determination of stresses in indeterminate structures depends upon this assumption. If the ether of space be perfectly elastic it is probable that the principle of least work can be applied to determine the stresses which accompany the action of gravitation, and an effort is being made in this direction, the results of which appear to indicate that the ether has properties in some respects unlike those of elastic bodies.

The Nernst Lamp (with experimental demonstration): Mr. ALEXANDER JAY WURTS, of Pittsburg.

The Problem of the 'Trusts': Mr. C. STUART PATTERSON, of Philadelphia.

An Inquiry into the Relation between the Objective Operations and Events Revealed to Us by the Scientific Study of Nature, and the Corresponding Actual Operations and Events Which are What Have Taken Place in the Universe of Real Existences: Professor G. JOHNSTONE STONEY, F.R.S., of London.

Hitherto every attempt to ascertain the events that are actually happening in the universe of real existences—in other words, the study of ontology—has been pursued almost exclusively from the human standpoint of the metaphysician. This limited mode of treatment has led to a few negative results, which are chiefly of value by helping to dispel popular errors; but it has established little that is positive, or that can be of service to the scientific student of nature. And yet the scientific investigation of nature has led us in more than one direction into contact with problems of ontology—as when physiology brings us face to face with such a fact as that there is some interpendence between the thoughts that are our mind, and objective events going on in our brain. What help has ontology rendered in a case of this kind, or throughout our studies in physics, when we make any attempt to penetrate to the causes of the events that occur? In fact, the inquiries hitherto made into ontology have been pursued on a wholly different plane, and do not seem to have solved any of the real enigmas which the study of nature presents. It appears, therefore, in an eminent degree desirable that an attempt shall be made to bring ontological studies into line with physical by ascertaining in what way the scientific study of nature (with which experience shows that the human mind is fitted to cope) stands related to the real events and real existences of which the universe actually consists (but which our human minds find it more difficult to probe).

The aim of the present paper is, therefore, to bring ontological and physical investigations into accord by substituting a Copernican for the Ptolemaic point of view of the metaphysician, and by throughout following up the ontological investigation from the standpoint of the student of nature.

FRIDAY, APRIL 3.

Morning Session, 10 o'clock.

Vice-President Langley in the chair.

The Double Star System Σ 518: Mr. ERIC DOOLITTLE, of Philadelphia. (Introduced by Professor M. B. Snyder.)

The Constant of Aberration: Professor CHARLES L. DOOLITTLE, of Philadelphia.

The Degree of Accuracy of the Newtonian Law of Gravitation: Professor ERNEST W. BROWN, F.R.S., of Haverford, Pa.

Two bodies attract one another inversely as the square of the distance, that is, if the distance be halved the force is increased four times; if the distance is divided by ten the force is increased one hundred times. This is the Newtonian law of gravitation. The moon, earth, sun and planets all should obey this law, which was discovered by Isaac Newton in the seventeenth century.

How far do the bodies obey it? The most sensitive is the moon. We are able to observe its motions so accurately and predict its places with such unfailing certainty by means of this law that we can scarcely have much doubt that it is correct. But, nevertheless, there are some small deviations, and the question is whether these deviations are due to errors in the calculations of astronomers or to something wrong in the law itself.

Hansen's theory of the moon's motion has been accepted up to the present, but there are still some small differences between his theory and observation. Two at least of these have been unexplained in the periods of revolution of the perigee and node. My calculations have shown that the differences are due to errors in Hansen's theory and that on a correct theory they do not exist. Thus it appears that Newton's law is accurate to one millionth per cent.! It is by far the most accurate physical law known and perhaps the most striking evidence of the fact that our existence and surroundings are not the result of chance.

New Applications of Maclaurin's Series in the Solution of Equations and in the Expansion of Functions: Professor P. A. LAMBERT, of Bethlehem. (Introduced by Professor C. L. Doolittle.)

In an equation of any degree, numerical or literal, $f(y)=0$, introduce a factor x into several terms. There results an equation $f(x, y)=0$ which defines y as an implicit function of x. The successive derivatives of y with respect to x are now formed, and the values of y and the derivatives found when $x=0$. An application of Maclaurin's series gives the value of y in a series in powers of x multiplied by factors which depend on the coefficients of $f(x, y)=0$. By properly selecting the terms of $f(y)=0$ into which the factor x is introduced and placing $x=1$ in the series values of y, all the roots of the equation $f(y)=0$, real and imaginary, are found in convergent series involving only the coefficients of $f(y)=0$.

The same device of introducing a factor x which is eventually made unity makes it possible to obtain by a direct application of Maclaurin's series all the expansions which hitherto have been obtained by Lagrange's series and Laplace's series.

The Mechanical Construction and Use of Logarithms: Mr. CHARLES E. BROOKS, of Baltimore. (Introduced by Professor GEORGE F. BARKER.)

In this paper is described a simple instrument for constructing the logarithmic spiral with great accuracy. The device will be useful for drawing the curve in the class room; it may be used also for the preparation of tables of logarithms of all the possible systems, or for the mechanical solution of arithmetical problems.

The machine consists of a screw pivoted so that it may be rotated, but will remain parallel to the paper. A wheel is threaded to the screw and rests with its circumference on the paper. As the screw is rotated, the wheel rolls on the paper, but this rolling makes it travel along the screw. The track of the rolling wheel is, therefore, a spiral.

To show that this spiral is the logarithmic curve, consider the equation of motion of the center of the wheel, which has the same motion as the point which draws the curve. Let OA (see figure) be the screw, pivoted at O; let B be the wheel; C its center. Call C the point $\rho\theta$ measuring with O as origin and any line OP as axis. Let the pitch of the screw be p, and the radius of the wheel be r.

As θ increases an amount $\Delta\theta$, c moves through an arc cc' equal $\rho\Delta\theta$. At the same time the wheel turns through an arc $\rho\Delta\theta$, so the angular motion around OA is

$$\frac{\rho\Delta\theta}{r}.$$

Under the influence of the thread on OA it is moved along OA a distance

$$p\cdot\frac{\rho\Delta\theta}{r}.$$

But this distance is $\Delta\rho$, so we have

$$\Delta\rho=\frac{p\rho\Delta\theta}{r},$$

or

$$\frac{\Delta\rho}{\Delta\theta}=\frac{p}{r}\rho,$$

and in the limit,

$$\frac{d\rho}{d\theta}=\frac{p}{r}\cdot\rho.$$

Integrating,

$$\rho=ce^{\frac{p}{r}\theta}$$

That is, θ is the logarithm of ρ.

The Theory of Assemblages and the Integration of Discontinuous Functions: PROFESSOR I. J. SCHWATT, of Philadelphia. (Introduced by Professor C. L. Doolittle.)

An historic review of the state of the theory of continuous and discontinuous functions prior to the creation of the theory of assemblages by Bolzano and Cantor is first given. It is then shown how the theory of assemblages has served to make this part of the theory of functions more clear and definite. The question of the content of a mass of points, distributed along a line, is discussed; the more important principles of the theory of assemblages are given, and applications of these principles to the integration of discontinuous functions are made.

The Franklin Papers in the Library of the American Philosophical Society: Mr. J. G. ROSENGARTEN, of Philadelphia.

In the collection of this society there are some seventy large folio volumes of 'Franklin Papers.' Franklin left all his papers to his grandson, William Temple Franklin, who, after a long interval, published in London and in Philadelphia six volumes of Franklin's works. Of course, this represented but a small part of his papers. Those used in the preparation of Temple Franklin's edition are now the property of the United States, which has never yet printed a calendar of them. Temple Franklin selected from his grandfather's papers those that he thought suitable for publication, and left the rest of them in charge of his friend, Charles Fox, to whom he bequeathed them, and Charles Fox, in turn, after a long lapse of years, presented them to the American Philosophical Society, in whose custody they have remained ever since.

They have been roughly classified, and are bound in a rude and careless way. Under the present efficient librarian, Dr. Hays, a calendar is being made as fast as the limited means at his disposal will permit, and, when that is completed, it is hoped that it will be printed as a useful guide to the miscellaneous matter collected here. Sparks, Hale, Ford, Parton, Fisher and others who have written about Franklin have used them, but even the most industrious student may well be appalled at the labor required to master all the contents of these bulky volumes, representing Franklin's long and many-sided activity.

He kept copies of most of his own letters and the originals addressed to him, often indorsing on them the heads of his replies. These volumes contain papers from 1735 to 1790—the first forty-four volumes, letters to him; the forty-fifth, copies of his own letters; the forty-sixth, his correspondence with his wife; the forty-seventh and forty-eighth, his own letters from 1720 to 1791; the forty-ninth, his scientific and political papers; the fiftieth, his other writings—notably his Bagatelles, those short essays which had such a vogue, and are still read; the fifty-first, poetry and verse, his own and that of others, no doubt selected by him for use in his publications; the fifty-second, the Georgia papers—he was agent for that colony; and the remaining twenty volumes all the multifarious correspondence, other than official, mostly during his long stay in France, his various public offices at home and abroad, his enormous correspondence about appointments from men of all nationalities, who wanted to come to America, under his patronage, to fight, to settle, to teach, to introduce their inventions, for every imaginable and unimaginable purpose.

Both in England and France he kept all notices of meetings, such as those of the Royal Society, and other scientific bodies of which he was a member, invitations, visiting cards, notes, business cards, etc., and at home he kept copies of wills, deeds, powers of attorney, bonds, agreements, bills and drafts, checks, bills of lading, public accounts and even certified copies of acts of Congress and account books, and, in addition, Temple Franklin left eight volumes of letters to him from 1775 to 1790.

In this mass of material his biographers have found much that was of value, but there remains almost untouched the interesting correspondence of his friends in England during the years before and those of the War of Independence. There are examples of his own clever *jeux d'esprit* in the 'Intended Speech for the Opening of the Parliament in 1774,' in which the King himself is made to foretell the 'seven or ten years' job' that his 'ministers have put upon him to undertake the reduction of the whole continent of North America to unconditional submission.' His friend Hartley sent it to him in 1786, when the prophecy had been fully realized. Again in 1778 he received a full report of the famous dying speech of Chatham and of that of Lord Shelbourne in his defense of the

American cause, speeches which have hardly been reported in full.

During these eventful years his correspondents in England and in the Colonies kept him well informed both of the actions and plans of the government and of the opposition. Some of these may be of interest as showing how earnestly both sides were presented to him, that he might use his influence to maintain peace. Priestley, who was then the secretary of Lord Shelbourne, writes from London in February, 1776, with a due report of political and scientific information, and Lee and Wayne write to him during the campaign which was to end in Burgoyne's surrender, and thus contribute largely to the alliance with France, which owed so much to Franklin's influence not only with the French court and French statesmen, but with the philosophers and the people.

His correspondence in Paris is a perfect picture of the time. One day he gets an invitation to attend experiments in electricity from a correspondent, Brogniart, who reports the successful treatment of sick people by electric fluid in 1778, and soon after the Curé of Damvillers asks him for a cure for dropsy for one of his parishioners.

His correspondence came from England and from all parts of the continent and from the West Indies in an unending stream.

A very curious letter is one from Richard Penn, dated London, October 20, 1778, which I think has never been printed, in which he says:

"I should think myself infinitely obliged to you if you could point out to me in what manner I could procure, either from America or in any other way, a temporary subsistence. I have not a doubt but that in time matters will turn out much to the advantage of everybody concerned and connected with that country."

When it is remembered that the hostility of the Penns to Franklin was so strong that Governor John Penn declined to be patron of the American Philosophical Society because it had chosen Franklin for its president, and that Richard Penn had been Lieutenant-Governor (as deputy for that uncle and his brother) from 1771 to 1773, it must have been difficult for Franklin not to feel that such a letter from such a man at such a time was indeed a tribute to his position, achieved solely by his own efforts.

It is well that this venerable society, so largely the result of his labors, should be made the custodian of the papers that follow almost his daily thoughts, and it is to be hoped that the preparation and publication of a calendar showing their contents may be completed at no distant day, certainly by the two hundredth anniversary of the birth of our founder, and thus perpetuate his memory.

Afternoon Session, 2 o'clock.

Vice-President Scott in the chair.

Further Notes on the Santa Cruz Edentates: Professor WILLIAM B. SCOTT, of Princeton.

The fossil edentates of the Santa Cruz beds in Patagonia differ very notably from the forms now living in South America. Of the three edentate orders represented in the Santa Cruz, only one, the armadillos, has persisted to the present day, while no trace of the true sloths or of the anteaters has yet been found. The ground-sloths are very numerous and form very interesting evolutionary series leading to the giant species of the Pampean, while the armadillos and glyptodonts are, for the most part, away from the main line of descent.

An Attempt to Correlate the Marine with the Non-marine Jurassic and Cretaceous Formations of the Middle West: Professor JOHN B. HATCHER, of Pittsburgh, *The Evolution and Distribution of the Proboscidea:* Professor HENRY F. OSBORN, of New York.

A New Fresh-Water Molluscan Faunule from the Cretaceous of Montana: Mr. T. W. STANTON, of Washington. (Introduced by Professor W. B. Scott.)

This paper describes and discusses a collection of invertebrate fossils from near Harlowton on the Musselshell River, Montana, collected in 1902 by Dr. Farr and Mr. Silberling, of the Princeton University expedition.

The species are only six in number, but with one exception each is represented by abundant and well-preserved examples. Of these two are referred to *Unio,* two to *Goniobasis,* one to *Campeloma* and one to *Viviparus.* The study of these fossils, in connection with their reported stratigraphic position and a general discussion of the early Cretaceous and late Jurassic non-marine formations of the region, leads to the conclusion that they are probably from a horizon near the base of the Upper Cretaceous, or possibly as low as the Lower Cretaceous.

Hints on the Classification of the Arthropoda, the Group a Polyphyletic One: Professor ALPHEUS S. PACKARD, of Providence.

Anatomy of the Flosculariidæ: Professor THOMAS H. MONTGOMERY, JR., of Philadelphia.

The Earliest Differentiations of the Egg: Professor EDWIN G. CONKLIN, of Philadelphia.

In the living eggs of fresh-water snails important differentiations are recognizable before the eggs begin to divide. Soon after the formation of the polar bodies clear non-granular protoplasm accumulates at the animal pole and spreads down over the surface of the egg towards the opposite pole. About three fourths of the surface of the entire egg is covered by this clear protoplasm, which gives this portion of the egg a milky appearance, while about one fourth of the egg surface at the vegetative pole is not covered by this protoplasmic layer and is bright yellow in color. These two portions remain distinct throughout the subsequent development of the egg, the protoplasmic area giving rise to the ectoderm, the yellow one to the endoderm and mesoderm. The germ layers are, therefore visibly outlined in the unsegmented egg. In these eggs the type of asymmetry of the adult snail (whether dextral or simitral) is also predetermined, probably while the egg is still in the ovary. The chief axis of the future animal is also marked out in the egg, and is probably to be traced directly back to the egg of the previous generation. In this case, therefore, these axial relations are probably continuous from generation to generation.

Some Properties of Nickel: Mr. JOSEPH WHARTON, of Philadelphia.

A Résumé of the Composition of Petroleum from Different Fields: Professor CHARLES F. MABERY, of Cleveland.

This paper explained the composition of petroleum from different sources, and described the series of hydrocarbons that make up the great body of petroleum. In Pennsylvania oil the series C_nH_{2n+n} predominates in the lower distillates and continues to include solid paraffine hydrocarbons. Pennsylvania oil also contains the series C_nH_{2n} and the series C_nH_{2n-2}, and probably also series still poorer in hydrogen in the less volatile portions.

Ohio oil has much the same composition, with the addition of the series C_nH_{2n-4}, and probably other series still poorer in hydrogen.

California oil does not contain the series C_nH_{2n+2} so far as known, but contains the other series mentioned.

Canadian oil contains all the series mentioned, with larger proportions of the series poor in hydrogen.

All petroleums contain compounds of oxygen, nitrogen and sulphur, but in variable amounts, very small in Pennsylvania oil, large in California, Ohio and Canadian crude oils.

A summary of what is known concerning the origin of petroleum was given, with some suggestions based on recent knowledge of its general composition.

SATURDAY, APRIL 4.

Morning Session, 10 o'clock.

President Smith in the chair.

A Further Classification of Economies: Professor LINDLEY MILLER KEASBEY, of Bryn Mawr, Pa.

An economy is a system of activity whereby the utilities inherent in environment are, through utilization, converted into actual utilities.

These economies can be distinguished from one another in two ways: First, according to the motive making for utilization, and, second, in accordance to the means employed in the process. They may be classified as the automatic, characteristic of plants; the instinctive, characteristic of animals; the rational, characteristic of human life.

The rational economy may be subdivided into the natural, characteristic of savages; the proprietary, characteristic of barbarians; and the commercial, characteristic of western civilization.

Some Features of the Supernatural as Represented in Elizabethan and Jacobean Plays: Professor FELIX E. SCHELLING, of Philadelphia.

The Hamites and Semites in the Tenth Chapter of Genesis: Professor MORRIS JASTROW, JR., of Philadelphia.

The Most Insidious Cause of Error in Quantitative Chemical Research: Professor THEODORE W. RICHARDS, of Cambridge, Mass.

Experiments are recorded and quoted showing that most if not all crystals deposited from solutions contain included mother liquor. The experiments show also that before this mother liquor can be eliminated by pulverization, the absorption of water from a moist atmosphere begins to augment appreciably the weight of the substance. It is pointed out that this absorption can not be overcome in the case of hydrated salts without a loss of water of crystallization also. Hence hydrated salts can not be accurately weighed according to any usual procedure. In the case of anhydrous salts the elimination of absorption is easy, but in order to remove included water the cell walls enclosing it must be disintegrated. Mechanical, thermal and chemical methods of such disintegration are classified and applied to the preparation of pure materials. It is pointed out that other impurities are usually included with the solvent in the invisible cells, and that these other impurities must never be forgotten in the course of the further purification. Finally, it is suggested that these almost infinitesimal enclosed impurities might be used as a clue to the manner of growth of natural minerals, and hence to the mechanism of geophysical processes.

The Warfare against Tuberculosis: DR. MAZŸCK P. RAVENEL, of Philadelphia.

All efforts at the eradication of tuberculosis to be successful must be based on the fundamental fact of its communicability, and in the main it is to be treated as the other contagious diseases, though the restrictions need not be so severe.

Two parties are to be considered, the tuberculous persons and the community, and while the former are entitled to every consideration and attention, the good of society in general must be the principal consideration which guides our action. Fortunately, the interests of the two parties are not irreconcilable and much can be done by education to smooth the difficulties which lie in our path.

There should be in every state and in every large city societies whose objects are the study of methods of prevention and the dissemination of such knowledge in short, plainly written tracts among the people.

In addition to this, boards of health should issue circulars constantly giving such information and advice. At present only twenty-two states and seven cities issue such circulars and recommendations, while five states have societies and five cities have local societies for the prevention of tuberculosis.

These societies can do much good also in shaping legislation. States and cities should have uniform laws regarding expectoration in public conveyances, buildings and on sidewalks; overcrowding of factories and tenement houses, the construction of such buildings as regards light and ventilation, and the employment of children under age.

Health officers should have the power to force ignorant and vicious tubercular persons who persist in reckless expectoration into hospitals provided for them by the public. There should be compulsory notification and registration of persons suffering with phthisis, and apartments occupied by such persons should be thoroughly disinfected periodically, and always after death or vacation of the premises before new tenants are allowed to enter them.

The urgent need is for institutions in which the sick can be cared for and instructed. These should be of two types—sanatoria, built in open country districts in regions known to be specially adapted to the treatment of tuberculosis, and, second, hospitals for the hopelessly ill and destitute, where the maximum of comfort can be given to them and where they will cease to be sources of infection to their families and the public in general.

In spite of the enormous expenditure which would be involved in providing hospital accommodations for the indigent tuberculous, it would cost less than the present money loss to the country from deaths alone, and in a few years we could confidently expect a marked decrease in the disease.

SCIENTIFIC BOOKS.

The Diamond Mines of South Africa. Some Account of their Rise, and Development. By GARDNER F. WILLIAMS. New York and London, The Macmillan Co. 1902. Pp. 681. With 491 illustrations, 29 photogravures and 11 maps.

The most important volume that has ever appeared upon the diamond fields of South Africa, or in fact upon diamond mining in general, is that from the pen of Mr. Gardner F. Williams, General Manager of the De Beers Consolidated Mines. There is no doubt that the late Hon. Cecil J. Rhodes, who died during the early part of 1902, would have been deeply interested in this volume, and it was the desire of the author that he should see it —little realizing that this great organizer would so soon have passed away. But it must also be recognized that it was through the directing capacities and experienced mining knowledge of Mr. Williams himself that the De Beers Mines were managed in such a way that the cost of production was gradually brought down to the lowest possible limit; that theft was almost entirely done away with; and that each year had shown a decrease in the cost of production, and a greater security of these mines as an investment. To the union of these two men—one as the organizer, Mr.