diets complete in every respect with the exception of the vitamin to be investigated. The lactating mother must first be entirely depleted of all storage from the previous dietary régime before any vitamin-containing material may be subjected to biological assay. Unless depletion is first secured, all such transfer experiments yield nothing but irregular and in many instances absolutely erroneous results.

My results on the great requirements of vitamin B for lactation have been substantiated by the work of Macy and coworkers[5] and by Evans and Burr.[6] Daniels, Jordan and Hutton[7] have, however, recently introduced confusion in the literature and it is the purpose of this communication to point out to the latter investigators the reasons for their conflicting evidence. In the first place, Daniels and coworkers after making their transfer experiments from stock diets have failed to deplete the lactating mothers from vitamin reserves. The second point of weakness lies in their dietary management. Instead of proceeding with a diet complete in every respect with the exception of the vitamin B factor, they attempt to feed liquid or dry milk as the sole source of a maternal ration for lactation. In this connection it may be pointed out that Daniels and coworkers[8] have recently made definite conclusions, employing the lactation method of biological assay, on the destruction of vitamin B in evaporated milk, in which study they used a ration consisting of casein, bread, cod-liver oil, ferric citrate and potassium iodide —another diet deficient in more than one factor, *i.e.*, minerals. Such technique could not possibly lead to results worthy of conclusions of any consequence. The third error these investigators have made is the departure from the standard technique of using four instead of six young in the litter. Since seven to eight young is the average size of a litter of the albino rat, six young would certainly be a more accurate and severer test than four young. The conclusion of Daniels *et al.* that "it would seem that any food which can furnish enough of the antineuritic vitamin for the development of four suckling rats must contain enough for the normal human infant" has no basis for consideration. Although the young rat grows about twenty-five times as fast as the baby, the baby weighs about 650 times as much as the rat at birth, and approximately 300 times as much as the rat at weaning. Besides, final deductions with regard to the rôle of vitamin B in infant nutrition, especially dosage, must come from the clinicians.[9]

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THE NATIONAL ACADEMY OF SCIENCES. II

The preparation of an active extract of the suprarenal cortex: W. W. SWINGLE and J. J. PFIFFNER (introduced by E. G. Conklin).

Studies on an active extract of the corpus luteum: J. J. PFIFFNER (introduced by E. G. Conklin).

On the use of oblate ellipsoids for the measurement of magnetic susceptibility in anisotropic substances: DONALD FOSTER (introduced by C. J. Davisson). If the results of magnetic measurements are to be independent of the exterior form of the specimen, it is necessary to produce uniform magnetization and to determine the intensity of the effective magnetic field inside the material. These two requirements introduce fundamental and persistent difficulties in all magnetic measurements. Uniformity of magnetization of a body placed in a uniform field requires that the surface of the body be of the second degree. The field intensity is then calculable for certain directions of magnetization. On this account, the ellipsoidal form of specimen is unique; and it has been commonly used, especially for measurements on single crystals. When oblate ellipsoids are used the susceptibility may be measured in various directions while employing only one specimen. It is shown in this paper that the results of such measurements are ambiguous because they depend on the orientation of the minor axis of the ellipsoid with respect to the crystallographic axes. As an example, it is shown from published data on iron crystals that the I, H curves for a given crystallographic direction in different ellipsoids may differ as much as do the curves for different directions. The difficulty may be avoided by using crystals in the form of straight wires.

On the polarization of X-radiation: WILLIAM DUANE. Previous papers have described experiments with X-rays produced when electrons impinge against free atoms in a gas. This paper describes experiments on the polarization of the X-rays. The details of the researches may be found in the November, 1929, number of the *Proceedings* of the National Academy. The results indicate that, even when all the electrons have practically the same speed

[5] I. C. Macy, J. Outhouse, A. Graham and M. L. Long, *J. Biol. Chem.*, 1927, 73: 189–201.
[6] H. M. Evans and G. O. Burr, *ibid.*, 1928, 76: 263–273.
[7] A. L. Daniels, D. Jordan and M. K. Hutton, *J. Nutr.*, 1929, 2: 19–29.
[8] A. L. Daniels, M. L. Giddings and D. Jordan, *J. Nutr.*, 1928, 1: 455–466.
[9] R. J. Hoobler, *J. Am. Med. Ass'n.*, 1928, 91: 307–310; R. H. Dennett, *ibid.*, 1929, 92: 769–772; J. I. Waring, *Am. J. Dis. Child.*, 1929, 38: 52–57; A. P. Bloxsom, *Am. J. Dis. Child.*, 1929, 37: 1161–1169; S. V. Haas, *Arch. Ped.*, 1929, 46: 467–479; G. W. Bray, Roy. Soc. Trop. Med., *Hyg. Trans.*, 1928, 22: No. 1, 9–42.

and direction of motion, the X-rays are not completely polarized. The degree of polarization amounts to about 0.50. Other details of the results will be discussed as thoroughly as time permits.

The distribution of light intensity in a Fresnel diffraction pattern: THEODORE LYMAN. Fresnel in his celebrated memoir calculated the distribution of the intensity of the light in the diffraction pattern from a straight edge for the case where source and screen are separated by a finite distance. He then verified the results of his calculation by experiment with such a satisfactory degree of accuracy that no one since his time has been tempted to repeat his work. His quantitative results, however, were concerned only with the positions of the maxima and minima in the pattern; he did not possess the means of measuring the relative intensity of the light. As far as I am aware, all those who have studied diffraction patterns since the time of Fresnel have also confined their experimental investigations to determinations of the positions of maxima and minima (see for example, Hufford and Davis, *Phys. Rev.*, 33: 589, 1929). In view of the interest that is taken nowadays in the theory of diffraction phenomena of this type is seemed worth while to make an attempt to measure the relative intensity of the light in various parts of the pattern from a straight edge. In this attempt I have employed photographic photometry. The results agree with the predictions of Fresnel's theory to a degree of accuracy limited by the experimental error. The paper gives some details of the procedure.

On mosaic crystals: F. ZWICKY (introduced by R. A. Millikan). Properties of solids may be roughly divided into two groups. Properties of the first group are "structure insensitive." They can be accounted for by the theory of ideal crystal lattices. This theory, however, is utterly helpless in regard to properties of the second type, which are "structure sensitive." The conception of a mosaic structure of the crystals provides a solution of the difficulties involved. It can be shown by a very general consideration that an ideal crystal, though dynamically stable, is thermodynamically unstable. A really stable atomic lattice is characterized by the fact that on top of the primary structure as deduced from the X-ray structure analysis there is superposed a secondary structure, which shows perfect regularity also. In general, it has to be interpreted as a slight periodic change in density. The elementary spacing of the secondary structure (mosaic) is usually to be found in the region from 100 Å to 10000 Å. Structure insensitive properties depend mainly on the primary lattice, whereas structure sensitive properties are essentially related to the secondary lattice. A great number of phenomena can immediately be accounted for quantitatively. Several very interesting predictions of optical, mechanical and chemical effects, which so far were unknown, could already be verified in the laboratories of the institute.

The experimental evidence of the mosaic structure of Bi single-crystals: ALEXANDER GOETZ (introduced by R. A. Millikan). The presented subject concerns observations obtained in two different ways on single-crystals of Bi, the interpretation of which leads to the assumption that these crystals consist of small blocks of a definite size, which size is independent of the perfection of the crystal or the method of its production. (a) The microscopic investigations of fresh cleavage planes (111), using the largest resolving powers, show the presence of a triangular pattern of lines (in undistorted regions), the distances involved being always a small whole-number-multiple of $1.4 \pm 0.2\,\mu$. The etching process applied to these planes shows that these lines [indicating the penetration of the $(11\bar{1})$ planes through the (111) plane] possess a larger chemical passivity than the region surrounded by them. Hence they predetermine the size and position of a smallest etching figure identical with the size of an element of the mosaic structure. The calculated size for Bi is ca. $1.8\,\mu^3$. The element contains ca. 5×10^{10} atoms. (b) Investigating the conditions under which it is possible to predetermine the orientation of a crystal by inoculation with a seed-crystal, indications were found of the existence of a "block-state" over a small range of temperature (1°–2°) near the melting-point. The orientation of the final crystal as well as its perfection depends on the influences applied to this state.

The possible influence of the Mosaic structure on the determination of Avogadro's number: F. ZWICKY (introduced by R. A. Millikan). The direct determination of X-ray wave-lengths, making use of ruled gratings (Bearden), gives values which are ca. 0.2 per cent. higher than those obtained by reflection from crystals (Siegbahn). The theory of the mosaic structure of crystals, recently proposed by the author, suggests a possibility of accounting for this discrepancy. The mosaic pattern of rocksalt, for instance, is represented by a cubic frame work of planes whose density is about 5 per cent. larger than the density of the perfect blocks in between them. As the latter ones cause the interference of the X-rays, their characteristic lattice constant d must be introduced in Bragg's formula. d is obviously larger than the d_o which is usually obtained by assuming that the crystal is of perfectly uniform density throughout. For rocksalt, the theoretical estimate is $3 \times 10^{-4} < \frac{d-d_o}{d} < 3 \times 10^{-3}$. Experiments are being carried out at this institute to test whether the above considerations can be substantiated.

The Boltzmann distribution law in quantum theory: EDWIN H. HALL. At the Solvay Conference of 1924, which dealt with the subject of electric conduction in metals, the question arose as to whether the Boltzmann distribution law in its simplest form holds between n, the number of "free" electrons, and n_o, the number of unionized atoms, per cu cm of the metal. Q being the amount of energy required to ionize an atom within the metal, the law in question can be stated, tentatively, thus: $n = n_o \varepsilon^{-(Q \div kT)}$, (A). It was in fact so stated by O. W. Richardson in the following inquiry (p. 128 of the Conference Report): "Does the formula [given above] hold in the theory of quanta?" A number of the confrères present confidently expressed the opinion

that it did hold. Others, including Lorentz and Bridgman, expressed a doubt. A reader of the whole report would be likely to get the impression that the conference approved the use of the equation, in the form given above, as governing the amount of ionization within a metal. One member said, "The Boltzmann equation applies even in cases where one can apply the rules of quanta. It is thus that Einstein made use of it in 1917 in his derivation of the law of Planck." The paper of Einstein here referred to is printed in the *Physikalische Zeitschrift*, 18: 121–128. The following passage occurs on p. 122: "According to the quantum theory a molecule of a given kind can, apart from its orientation and motion of translation, take only a discrete series of conditions $Z_1, Z_2 \ldots Z_n \ldots$, the internal energy of which shall be $E_1, E_2 \ldots E_n \ldots$. If molecules of this sort belong to a gas of temperature T, the relative frequency W_n of the condition Z_n is given by the formula $W_n = p_n \varepsilon^{-(E_n \div kT)}$, (5), corresponding to the canonical distribution of states in statistical mechanics. In this formula k $(= R \div N)$ is the familiar Boltzmann constant, p_n a number, independent of T, characteristic of the molecule and of its n^{th} quantum condition, which can be defined as the 'statistical weight' of this condition. The formula (5) can be derived from the Boltzmann principle or by a purely thermodynamic method. Equation (5) is the expression for the widest generalization of the Maxwellian distribution law of velocities." It is to be observed, however, that Einstein's equation (5), when applied to the two quantum conditions m and n, gives $W_m = \frac{p_m}{p_n}$. $W_n \varepsilon^{-(E_m - E_n) \div kT}$, (B). There is nothing in Einstein's paper to show that $(p_m \div p_n)$ must be 1. If this factor must be used in applying the Boltzmann formula between two different quantized states, it must be necessary to use some corresponding factor in applying this formula between quantized and unquantized states. Accordingly, it would seem that Richardson's question should be answered in the negative, unless the formula which he gave is to be amended so as to read $n = \frac{p_n}{p_{no}}, n_o \cdot \varepsilon^{-(Q \div kT)}$, (C), where $(p_n \div p_{no})$ is a factor to be determined.

Geometrical optics in an absorbing medium: P. S. EPSTEIN (introduced by R. A. Millikan).

Ozone in luminescence: E. L. NICHOLS and FRANCES G. WICK. Various substances previously rendered thermoluminescent by the action of X-rays were exposed for several minutes at room temperature to a current of air a portion of the oxygen content of which had been converted into ozone. The following results were obtained. (1) The intensity of the luminescence subsequently developed by heating was in all cases markedly reduced. (2) During the exposure to ozone the oft-times very feeble glow exhibited by substances after being subjected to X-rays which occurs even at ordinary temperatures was enhanced. We conclude that excitation is a dual process consisting: (a) of reduction in which the oxygen set free is in an active state; (b) in the reoxidation of the reduced product. Also that reduction in which active oxygen is not formed may result in luminescence by subsequent exposure to ozone or presumably to other active forms of oxygen.

A theory of the increase in thermionic and photoelectric emission due to adsorbed electropositive atoms: J. A. BECKER (introduced by C. J. Davisson).

Foundations of relativistic cosmology: H. P. ROBERTSON (introduced by Oswald Veblen).

Secondary electron emission from a cathode in ionized neon: W. UYTERHOEVEN and M. C. HARRINGTON (introduced by K. T. Compton). An attempt is made to measure the secondary emission under positive ion bombardment of metal collectors in the positive column under conditions as near as possible to those in the cathode fall. A combination of a fixed collector and a movable one opposite the first was used. The movable one was given a negative potential and the ion current to it compensated; then the potential of the fixed electrode was varied and the corresponding change in current to each measured. The results obtained so far show that for an accelerating potential of about -150v, the secondary emission can reach 50 p.c. of the total current collected on a negatively charged electrode. (*Proc. Nat. Ac. Sc.*, 15: 32, 1929.) The electron mean free path seems to depend markedly on the degree of ionization of the gas, the measured values being less than the gas kinetic values (*e.g.*, 50 p.c.). A large fraction of the electron emission from the metal is apparently due to the impact of metastable atoms on the collector (Oliphant, *Proc. Roy. Soc.*, A124: 228, 1929), but for higher accelerating potentials of the positive ions their effect becomes more and more important (Penning, *Physica*, 8: 13, 1928).

The solution of problems in the designs of statically indeterminate structures through study by elastic models: GEORGE E. BEGGS (introduced by L. B. Stillwell). A structure is statically indeterminate when the forces reacting against or within the structure can not be determined by the three equations of equilibrium. Some of the important types of indeterminate structures are continuous girders and trusses, arches and arch dams, tunnel sections, continuous frames and suspension bridges. For the design of such structures, elaborate mathematical methods have been developed, but these methods are often inadequate and impractical for the solution of many problems. With a view to eliminating the tedious and disheartening calculations which have limited the freedom of engineers in creating economical and beautiful forms of construction of the indeterminate type, the writer has developed methods for design through experiment with elastic models. By proper procedure it is possible by such methods to predict not only the nature of structural action, but also to evaluate the stresses and strains in the full-sized construction represented by the model and to estimate the safety of the construction.

Meusnier families of curves: E. KASNER.

Tertiary and Quarternary history of Yellowstone Park: R. M. FIELD (introduced by W. B. Scott).

Maps of the Pleistocene glaciation: C. A. REEDS and E. ANTEVS (introduced by J. C. Merriam).

Suggested correlation of solar radiation weather and varved clay: CHESTER A. REEDS.—The varved glacial clays which record the annual retreat of the last Continental ice sheet from North America, Sweden, Finland, Argentina, and elsewhere, exhibit three noticeable variations in sedimentation. First, a seasonal variation which postulates a strict periodicity not only in the melting of the ice, but in the deposition of the summer and winter layers; second, an annual variation in which regular changes in thickness occur from year to year, and third, in groups of years. The varves vary in thickness for different deposition basins, but as the relative differences remain constant over wide regions it is possible to identify and correlate the varves in separate sections. It has been shown that weather and solar radiation changes occur in groups of years simulating those of the varved clays.

In order to investigate the possible relation between varved clays, weather and solar radiation, the varved clays at Haverstraw, New York, and New Haven, Connecticut, have been measured, correlated and diagramed. The Haverstraw clays have been measured by Chester A. Reeds and Ernst Antevs working independently. Antevs has sectioned the New Haven clays and correlated them with the Haverstraw deposits. The clays at Haverstraw reveal a record of 736 consecutive years in their deposition, while those at New Haven cover a period of 343 years. Where the graphs of the separate deposits overlap they show close agreement. In addition to the annual variation these graphs indicate a thickness of sediments in groups of three, four and five years with occasionally larger and smaller groups. The means of each four consecutive varves suggest the correlation with the weather and solar radiation changes, as noted by Mr. H. H. Clayton (1923). Mr. Clayton has observed that the solar radiation measurements of the Astrophysical Observatory of the Smithsonian Institution clearly indicate the existence of a three to four year change in solar radiation, which is reflected in a three to four year change in pressure, rainfall, etc. These changes he attributes to a variability in the intensity and amount of faculae on the surface of the sun. It has been shown by Dr. C. G. Abbot that there is a real relation, though not a very close one, between sun-spots and solar radiation. Investigators agree that weather conditions are far more variable than sun-spot numbers. The means of four, eight and eleven varves show that the short fluctuations of four years were more prominent than the longer ones. Since the curves from the different areas simulate one another, it may be assumed that the yearly variation in thickness and in groups of years was not due to local conditions, but to primary factors embracing a variable fluctuation in the melting of the ice from year to year and in periods of years. These in turn were governed by fluctuations in the weather and solar radiation extending over seven and one third centuries.

The hoofed animals of the Patagonian Miocene: W. B. SCOTT. The Tertiary formations of Patagonia contain a series of ungulate groups which more or less parallel those of the northern hemisphere but are very distinct from them. Most of these groups are known with a fair degree of completeness, so far as their osteology is concerned; but two groups, the Astrapotheria and the Entelonychia, have been almost unknown save for the skull. The material collected by Mr. E. S. Riggs, of the Field Museum in Chicago, contains skeletons of both of these groups, and it is now possible to assign them to definite systematic positions. Thanks to the kindness of Mr. Riggs, who collected these specimens, I have been able to study them. The Entelonychia were a branch of the dominant South American group of the Toxodontia, in which the hoofs had been converted into blunt claws and the forefeet modified for digging. The whole extraordinary anatomy shows, as Lydekker was the first to suggest many years ago, that these were fossorial in habit. They were far too large to be burrowers, but no doubt sought food, such as roots and tubers, by digging it up. The Astrapotheria had a certain superficial resemblance to elephants. The skull indicated decidedly the presence of a long proboscis; the limbs are remarkably elongate and slender in proportion; the foot is five-toed and very elephantine in appearance, but not in detail. The practice oft followed of putting the Entelonychia and the Astrapotheria into the same order rests entirely upon insufficient information. The new material shows that it is quite untenable.

Two isomeric lactones of rhamnonic acid: C. S. HUDSON and E. L. JACKSON.

The quantum efficiency of ozone formation in the fluorite region: W. ALBERT NOYES, JR., and WILLIAM E. VAUGHAN (introduced by W. A. Noyes). The quantum efficiency of ozone formation in the fluorite region has been determined by two different methods. In the first of these the intensity of the incident radiation was measured and the amount of absorption by the oxygen in the discharge tube determined in a separate experiment. The oxygen was at atmospheric pressure and the ozone was determined by a colorimetric method using the starch iodide reaction. The rate of flow of the oxygen was varied over wide limits to test the validity of the assumption of negligible photo or thermal decomposition. In the second series of experiments the intensity of the radiation was measured back of the reaction vessel and the amount of absorption determined directly. The same method of analysis, using both acid and basic solutions of potassium iodide to absorb the ozone, was employed. The average of the first series of measurements gave 2.2 molecules of ozone per quantum absorbed by the oxygen, and the second series 1.9. The relationship of these values to the band spectrum of oxygen is discussed and they are found to agree with the most probable prediction of theory. A slightly higher value might not be impossible if the interpretation of the band spectrum is slightly modified.

The study of chain reactions: H. S. TAYLOR (introduced by G. A. Hulett).

Morbidity and the association of morbid conditions: E. B. WILSON.

Bird-life of Mt. Duida, Venezula: F. M. CHAPMAN.

On new measurements on the intensity of cosmic rays as a function of depth beneath the surface of the atmosphere: R. A. MILLIKAN and G. H. CAMERON. New measurements on cosmic rays made by the most sensitive electroscope which the authors have thus far used bring to light three results of significance. First, the existence of very considerable homogeneity in the penetrating power of the rays responsible for the bulk of the ionization in the upper atmosphere. Second, the existence of an exceedingly hard component in the cosmic rays in excellent agreement with the recent findings of Regener. Third, the fact, heretofore ignored in all theories, that the nucleus plays an important rôle in the absorption of cosmic rays.

High frequency electric discharges in "non-conducting" vacua: R. W. WOOD. Discharges in vacua, usually regarded as non-conducting, were excited by a "continuous wave" tube oscillator having a frequency corresponding to a wave-length of $1\frac{1}{4}$ meters, with a potential of only a few hundred volts. Very remarkable changes in the gas content of the sealed tube under excitation were observed, the same tube showing a spectrum of pure atomic hydrogen, or pure oxygen, at the will of the operator. Luminous masses of singly ionized molecules of very definite shape (spheres, pointed spindles and pear-shaped bodies) appear in the tube, and their movements under magnetic and electric forces have been studied. These bodies may distribute themselves periodically along the tube, giving an appearance which reminds one strongly of stationary waves.

Capture of electrons by alpha particles: A. H. BARNES and BERGEN DAVIS. Swiftly moving alpha particles are passed through a highly evacuated vessel. They are deflected by a magnetic field and fall on a zinc sulphide screen, where they produce scintillations. There were about 60 alpha particles per minute, each having a velocity of 1.45×10^9 cm/sec. It was so arranged that electrons emitted by a hot filament were made to follow after the alpha particles by a suitable electric field. The alpha particle thus moves in a small part of its path surrounded by a cloud of electrons. These electrons can be made to move with a less velocity than the alpha particle, an equal velocity and a greater velocity as desired. It was found that the electron was captured only when it possessed definite energy. This energy which was obtained from applied field was closely equal to the value of the energy level in which the electron was captured. A second experimental tube was constructed in which the alpha particles could be in contact with electrons for only 3×10^{-10} sec. The electron density was less than 10^7 per cc. The average distance from electron to alpha particle was many times too great for it to fall to nucleus in 3×10^{-10} sec. under action of central forces. It is concluded that the electron or the alpha particle or both may possibly occupy a large region of space at certain energy relations but are exceedingly small at all other energies. The per cent. of captures increased rapidly with electron density up to 90 per cent. The second experimental tube permitted investigation as to whether one electron or two electrons are captured. It was found that at $V_0 = 590$ volts when the electrons and alpha particles are moving with equal velocity two electrons were captured. Also a whole series of voltages V_n was found at which double capture occurs. The condition is that two electrons together shall have an energy equal to that of removing two electrons from the helium atom. As an illustration, the work required to remove both electrons from helium atoms is $54.16 + 24.5 = 78.6$ electron volts. If the electric field V_n applied is such that the relative energy with respect to alpha particle of two electrons is 78.6 volts then double capture occurs, that is, $\frac{1}{2}(78) = 39 = (V_0^{\frac{1}{2}} - V_n^{\frac{1}{2}})^2$.

(To be continued)

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