alternately, occur in a fraction of a second, and at this inconceivable speed could not be detected by the human eye nor by an ordinary camera.

Farmers have observed that their crops grow better after an electrical storm and have attributed the fact to the rainfall which is apt to be heavy at such a time. Lightning is really the responsible factor. Scientists in the great fertilizer plants are lately uncovering one of Nature's age-long chemical secrets. Lightning produces one-hundred-million tons of nitrogen over the earth's surface every year, depositing it upon the soil to aid all growing things. A bolt of lightning coming down through the air which is composed of approximately four-fifths nitrogen and one-fifth oxygen, breaks down the chemical constituency of the air and bestows fixed nitrogen upon the land as a boon to the farmer, at no cost. Lightning thus serves a useful purpose and is a blessing in disguise, however terrifying its form.

For years the General Electric Company has experimented with artificial lightning and has produced ten million volts in the laboratory. Recently an outdoor lightning observatory believed to be the only one of its kind in the world, has been constructed 102 feet above ground, on the roof of the largest building of the Pittsfield, Massachusetts, General Electric plant.

The strange-looking structure is equipped with a periscope and a twelve-lens lightning recorder camera. Built largely of metal, it is grounded to the steel framework of the building on which it rests. It is coated with aluminum paint on the outside; with flat black on the inside. It is fourteen feet in diameter, topped by an eight-inch crystal sphere.

Lightning flashing in any direction within a radius of twenty miles is reflected on the silvery surface of the roof and thence in the crystal sphere and is made visible through the eyepiece of the periscope by a mirror set at an angle of 45 degrees, in its dark-walled tube.

The camera is directly beneath the periscope platform. It is exposed to the weather when in use but is protected with a curtain of compressed air. The compressed air is admitted into a perforated metal ring beneath which the camera is placed. The invisible curtain does not interfere with the taking of pictures and effectually keeps out all but the most severe downpour.

RESEARCH ITEMS.

Linear Diophantine Approximations.—Khintchine (*Math. Ann. B.*, **113,** 398–415) has contributed an interesting article about the solution of the non-homogeneous n-dimensional $[n > 1]$ diophantine approximation problem. The theorem of Kronecker, *viz.*, that given n irrational numbers $\theta_1, \theta_2, \ldots\ldots \theta_n$, then corresponding to every $t > 1$ we can find integers $x, y_1, \ldots\ldots y_n$ such that

$$(1) \quad x\theta_i - y_i \mid < \frac{1}{t}. \quad i = 1, 2, \cdots n$$

and $0 < \mid x \mid \leqslant t^n$. Khintchine considers the non-homogeneous case, *i.e.*, when (1) is replaced by (2) $\mid x\theta_i - a_i - y_i \mid < \frac{1}{t}$, where a_i's are given real numbers. It is well known even in case $n = 1$, this problem is not solvable if the restriction on x is the same as above (or even when t^n is replaced by Ct^n). It was recognised by the author long ago that the theorem would only be true with some restriction on the irrational number θ. Ten years ago he found out the condition in case $n = 1$. The condition expressed in terms of continued-fractions is that the quotients of the continued-fraction-development of θ were bounded. It should be observed that if the contrary is true then the homogeneous problem for θ is solvable with much less restriction on x. [*i.e.*, $x = o(t)$ instead of $x = O(t)$.] The theorem he proves is the generalisation of this to higher dimensions. It should also be noted that generalisations of diophantine approximations to higher dimensions is often impossible or extremely complicated. As the author observes that the inequalities $\mid x\theta - y - a \mid < \frac{1 + \epsilon}{\sqrt{5}\, x}$ is solvable for a sequence of values of x, and the analogue of this in the case of higher dimensions not being true. The extremely interesting result that he proves is the following :

Let $\theta_1, \theta_2, \ldots\ldots \theta_n$ be real numbers. The necessary and sufficient condition in order that a positive constant A exists satisfying the condition

$$o < x < At^n \mid x\theta_i - y_i - \alpha_i \mid < \frac{1}{t}. \quad i = 1, 2, \cdots n$$

for all $t \geqslant 1$, is that there should exist another constant a (both the constants depend on the θ's such that the inequalities

$o < x < At^n \quad \mid x\theta_i - y_i \mid < \frac{1}{t}$ *does not* possess a solution for any integral t.

The necessity of this follows easily by a method analogous to the one-dimensional case. The proof of sufficiency is extremely intricate.

K. V. I.

A Very Accurate Test of Coulomb's Law of Force between Charges.—Taking Coulomb's law of the force between two charges to be given by $F = \frac{\sigma\sigma'}{r^{2 \pm q}}$, Maxwell showed that $q < 1/21600$. This result quoted in all text-books gives the limit of accuracy of the inverse square law as determined by Maxwell and we have had to be satisfied with it till to-day. Now S. J. Plimpton and W. E. Lawton (*Phys. Rev.*, 1936, **50,** 1066) report experiments which prove that the exponent of r in the law of force differs from 2 by less than 1 part in 10^9. The electrostatic method of Maxwell and Cavendish was replaced by a quasi-static method in order to eliminate stray effects due to spontaneous ionization and contact potentials. The principle however is the same: A spherical air condenser consisting of two concentric insulated globes is employed. The upper globe has a small hole closed by a lid which has a projection making contact between the two globes. The outer globe is first charged to a high potential,

V, the lid is then removed by means of a silk thread and the outer shell being now earthed, the inner globe is tested for charge. If the inner shell has a potential less than v, $q < \frac{v}{V} F(a,b)$ where $F(a, b)$ is a quantity depending on the radii a, b of the spheres. In the present experiment the authors employed a galvanometer having a frequency of two cycles per second as the detector and placed it inside the inner globe so as to do away with contacts. The frequency was chosen low so as to eliminate induction effects. The outer sphere was charged to more than 3000 volts by means of a sinusoidal E.M.F. of 2 cycles per second produced by a "condenser generator". Since the galvanometer was thus used as a resonance instrument, the electromagnetic induction effects were not of any consequence and on account of the low frequency the fluctuations due to them were below the variations due to Brownian motion. The galvanometer was operated by a five stage resistance-capacity coupled amplifier designed for a frequency of about 2 c.p.s. and was observed through a conducting window in the outer sphere. In this way it was found that $v = 10^{-6}$ volt could be easily measured but there was no such potential shown by the galvanometer when the outer shell was charged. Hence the authors conclude that since $F(a, b)$ was 0·169 and $V > 3000$ volts and $v = 10^{-6}$ volt, $q < 2 \times 10^{-9}$.

A Mass-Spectrographic Study of the Isotopes of Argon, Potassium, Rubidium, Zinc, and Cadmium.—The isotopic analysis of K and Rb is important on account of its bearing on the problem of the radioactivity of these elements. Regarding A, Zn and Cd there is some discrepancy between different workers; particularly in Zn and Cd Stenvinkel and Svensson have reported the existence of some isotopes, *viz.*, Zn^{63} and Zn^{65} and Cd^{118} from a study of the band spectra of ZnH and CdH, while Aston does not obtain these isotopes. Now Alfred O. Nier has given the results of an investigation employing a mass-spectrograph of high resolving power (*Phys. Rev.*, 1936, **50**, 1041). His findings are:

A. A^{40}, A^{36} and A^{38} are present. $A^{40}/A^{36} = 325 \pm 4$ and $A^{36}/A^{38} = 5{\cdot}10 \pm 0{\cdot}07$.

K. K^{39}, K^{41} and K^{40} exist. $K^{39}/K^{41} = 13{\cdot}96 \pm 0{\cdot}1$ and $K^{40}/K^{39} = \frac{1}{8600} \pm 10\%$.

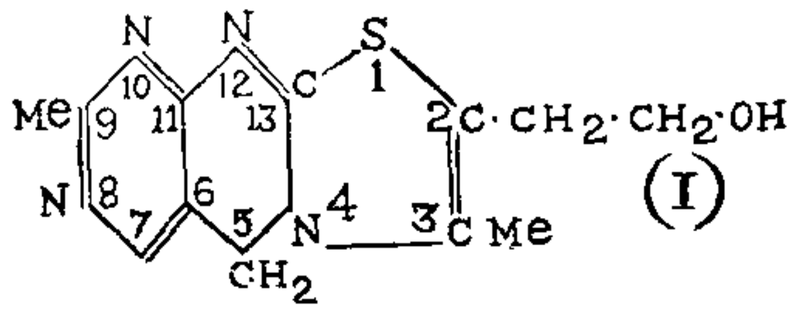
Rb. Rb^{85} and Rb^{87} were found. $Rb^{85}/Rb^{87} = 2{\cdot}68 \pm 0{\cdot}02$.

Zn. Mass Number: 64 66 67 68 70
Percentage: 50·9 27·3 3·9 17·4 0·5
Zn^{65} and Zn^{63} were not found.

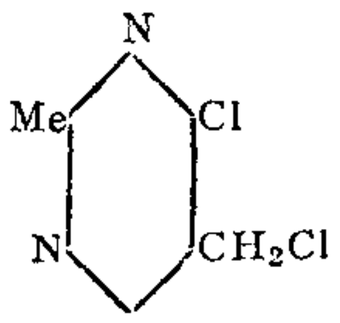
Cd. Mass Number:
116 115 114 113 112 111 110 108 106
Percentage:
7·3 0 28·0 12·3 24·2 13·0 12·8 1·0 1·4

Cd^{115} found by Aston is not confirmed and Cd^{118} was not observed. Making use of the isotopic constitution of K found by him the author concludes that K^{40} is the isotope responsible for the radioactivity of potassium, changing into Ca^{40}. In the case of Rubidium he considers that Rb^{87} is the active isotope changing into Sr^{87}, although the possibility of Rb^{85} being the active isotope is not entirely ruled out.

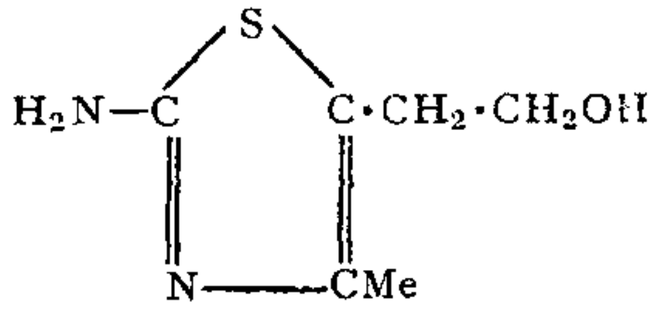
A Synthesis of Thiochrome.—Todd, Bergel, Frænkel-Conrat, and Jacob have recently described (*J. C. S.*, 1936, 1601) a synthesis of thiochrome (I), a yellow basic substance which is present in yeast, and which can be obtained from aneurin (Vitamin B_1) by oxidation with potassium ferricyanide in alkaline solution. (*Cf.* Peters, *Current Science*, 1936, **5**, 209.) Condensation of acetamidine with ethyl formylsuccinate gave *ethyl 4-hydroxy-2-methylpyrimidine-5-acetate*, from which by Curtius degradation 4-hydroxy-5-aminomethyl-2-methylpyrimidine was obtained; this yielded *4-hydroxy-5-hydroxymethyl-2-methylpyrimidine* with nitrous acid: the corresponding *chloro*-compound (II) was then obtained with phosphoryl chloride. 2-Amino-4-methyl-5-β-hydroxyethylthiazole (III*a* or III*b*) was synthesised from methyl α-chloro-γ-hydroxypropyl ketone and thiourea. Thiochrome was isolated from the resin obtained on heating a mixture of (II) and (III) at 110° for a short time.



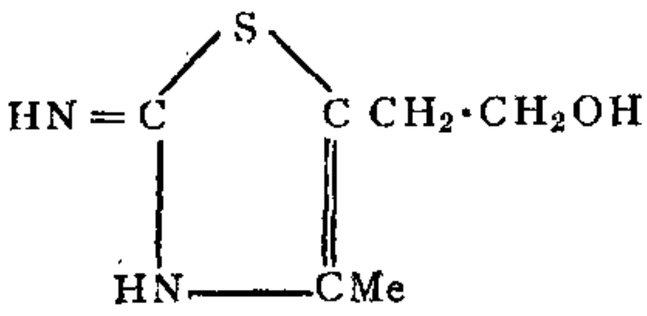
(I)



(II)



(III*a*)



(III*b*)

T. S. W.

Spermatogenesis of *Betta splendens*.—Fishes do not form such advantageous objects for germ-cell study as Amphibians do but *Betta splendens*, which has very few chromosomes for a Teleost and whose germ-cell elements are fairly large, offers good material. N. L. Bennington (*J. Morph.*, 1936, **60**, No. 1, December, p. 103) has studied the germ-cell origin and spermatogenesis in this animal. The following are his main observations: Residual spermatogonia larger than the normal spermatogonia persist along the walls of the lobules of the testis and give rise periodically to primary spermatogonia. The diploid chromosome number is 42, two of which are supposed to be sex chromosomes. During the division of the primary spermatocyte, the sex chromosome lags behind on the spindle. It is concluded that *Betta* is a form where the sex chromosomes are not very greatly differentiated from the autosomes. But no genetic evidence for the sex chromosomes is offered in the animal.

Growth and Division in Specialised Tissues.—Interesting data are afforded by A. Cohen and N. J. Berrill (*J. Morph.*, December 1936, **60**, No. 1, 243) on the methods of growth and division in specialised tissues in vertebrates. In the notochord for instance, it is only the non-vacuolated cells at the posterior tip and the periphery that divide. Vacuolated cells never divide. In the retina it is only the non-specialised cells occurring at the periphery that undergo division. The specialisation which progresses from the periphery to the centre marks the end of all cell division. The cells of the gut epithelium also divide by mitosis but during division a round shape is assumed by the cells and all functional activity stops. Fully formed cartilage cells divide both by mitosis as well as amitosis. It is concluded that the ability of functional cartilage cells and cells of the gut epithelium to divide is due to their comparatively simple structural differentiation as opposed to notochordal and retinal cells where specialisation has been carried so far that division is impossible.

SCIENCE NOTES.

Royal Asiatic Society of Bengal.—At the ordinary monthly meeting, held on the 4th January, an important contribution on *the Alimentary Canal of* Epilachna Indica (*Coccinellidæ : Coleoptera*), *with a discussion on the Activities of the Mid-gut Epithelium*, was read by S. Pradhan.—'On a comparative study of the alimentary canals of carnivorous and herbivorous beetles of the family Coccinellidæ (Coleoptera), it was seen that there were a large number of both structural and physiological peculiarities in the case of *Epilachna Indica* which are important from the view-point of digestion among insects in general. The alimentary canal of another species of *Epilachna*, *i.e.*, *E. Corrupta*, has already been described by two American workers, Potts (1927) and Burgess (1932), but their accounts have differed from each other. In this paper the author has presented the results of his investigations on *E. Indica*."

At the same meeting Messrs. Narendra Chandra Vedantatirtha (*Calcutta*) and Maulvi Shamsuddin Ahmad (*Calcutta*), were balloted for as ordinary members.

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The Second Annual Meeting of the Indian Academy of Sciences, was held on the 11th, 12th and 13th January 1937, Rajasabhabhushana Sir C. V. Raman, Kt., F.R.S., N.L., presiding. The Inaugural ceremony was held at Sir Puttannachetty Town Hall on the 11th, when Mr. S. G. Forbes delivered an address. Two public lectures were arranged during the session one on the 11th by Sir C. V. Raman on 'Recent Advances in Astronomy and Astrophysics' (illustrated by lantern slides) and the other on the 12th by Prof. K. S. Krishnan on 'The Approach to the Absolute Zero of Temperature'.

Thirty papers under Section A and seven under Section B, were communicated for the Scientific meeting.

A visit was arranged on the 13th instant to the Tobacco Factory, Cleveland Town. The visitors were shown round by the management, and the several processes from the tobacco to the finished product ready for the market, were explained.

The following scientists have been elected Honorary Fellows of the Academy.

(1) Prof. Max Born; (2) Sir Henry Dale; (3) Dr. Irving Langmuir; (4) Prof. P. Niggli; (5) Prof. R. W. Wood.

British Association.—The Annual Meeting of the British Association will be held next year in Nottingham on September 1–8 under the presidency of Sir Edward Poulton. The following sectional presidents have been appointed.—Section A (Mathematical and Physical Sciences), Dr. G. W. C. Kaye; B (Chemistry), Dr. F. L. Pyman; C (Geology), Prof. L. J. Wills; D (Zoology), Prof. F. A. E. Crew; E (Geography), Prof. C. B. Fawcett; F (Economics), Prof. P. Sargant Florence; G (Engineering), Sir Alexander Gibb; H (Anthropology), Dr. J. H. Hutton; I (Physiology), Dr. E. P. Poulton; J (Psychology), Dr. Mary Collins; K (Botany), Prof. E. J. Salisbury; L (Education), Mr. H. G. Wells; M (Agriculture), Mr. J. M. Caie.—*Nature*, **138**, No. 3502, 1004.

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The Effect of Annealing Procedure on the Tensile Properties of Arsenical Copper Bar. By E. F. G. Gilmore.—(*Bulletins of Indian Industrial Research*, 1936, No. 3).—This paper gives the results obtained in a series of tests carried out with a view to ascertain the effects of (*a*) annealing temperature and conditions, (*b*) period of annealing under constant conditions, (*c*) size of test pieces, upon the tensile properties.

A short description is given of the construction of the annealing furnace through which either steam or nitrogen could be passed continuously. The preparation of the test pieces and their characteristics are also described.

It was found that constant conditions of annealing were obtained by heating for not less than 60 minutes at 750° and for 120 minutes at 650°. Longer periods of annealing had no effect on the process. Further, the properties of the specimens annealed at the lower temperature were more satisfactory. No differences in the tenslie stress were observed in the experiments employing steam or nitrogen, but the specimens heated in steam remained comparatively bright while those heated in nitrogen were tarnished a dull brown. The steam method is therefore recommended for general practice. K. R. K.

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Report of the Forest Products Research Board for the year 1935. (His Majesty's Stationery Office. Price 2*s*.)—The work described includes investigations on the physical, seasoning and fire-resistant properties and the working qualities of timbers, both home-grown and