

Research Notes.

Variation of the Mass of an Electron with its Velocity.

As is well known there are two theories of the electron leading to different expressions for the dependence of the mass on the velocity, namely the theories of Abraham and of Lorentz, the result of the latter agreeing with that of the Relativity Theory. Bucherer's experiments are taken to provide evidence for the correctness of the theory of Lorentz as against that of Abraham, but the accuracy of the experiments is not sufficient to accept them as conclusive. Sommerfeld's theory of the fine structure of hydrogen lines provides an indirect proof of the correctness of the Lorentz formula. However, a direct experimental proof was a desideratum and one is now provided by the experiments of M. Nacken described in *Annalen der Physik*, 1935, 23, 313. Nacken has used cathode ray electrons accelerated through 200 kilovolts and 7 kilovolts respectively so that there was an advantage over using the β -rays from various sources in that the intensity of the beam could be increased and sharper lines could be obtained with shorter exposures. The cathode rays are deflected by electric and magnetic fields: there is however an improvement in that the electrons of 7 kv. and 200 kv. are made to trace the same path by adjusting the strengths of the electric and magnetic fields so that errors due to the geometry of the apparatus do not appear in the calculations. If J and J' are the currents in the magnetic field-coils and V and V' the potentials between the condenser plates required to produce the same deflection in the 200 kv. and 7 kv.

electrons respectively and $\beta = 0.161 \frac{V/V'}{J/J'}$

then if μ and μ_0 are the masses of the two

groups of electrons, $\frac{\mu}{\mu_0} \frac{\beta}{J/J'} = \text{a constant} =$

0.166 according to Lorentz's theory but slightly variable and equal to 0.154, 0.153, 0.153, 0.152 and 0.150 under the experimental conditions used by Nacken. The actual values obtained for this quantity were 0.166, 0.165, 0.164, and 0.162 with a mean of 0.164 while the error in determining J/J' might be 0.7% and that in V/V' could be 0.6%. Since the results to be expected according to Abraham's theory differ from the experimental values by 6.1%, 7% and 8.5% while the deviation of

the mean result from Lorentz's theory is only 1.2%, Nacken concludes that his results decide definitely in favour of the theory of Lorentz.

T. S. S.

The Velocity of Light in a Partial Vacuum.

THE late A. A. Michelson had made arrangements to determine the velocity of light in vacuum but his death prevented his concluding the work. F. G. Pease and F. Pearson who were associated with him in this work have carried it on to a successful conclusion and an account of the results so far obtained is given in *Astrophysical Journal*, 1935, 82, 26. The method used was that of the rotating mirror having 8 and 16 faces and the light travelled to and fro inside a steel pipe line, one mile long and evacuated to a pressure varying from 0.5 mm. to 5.5 mm. of mercury. The details of this stupendous undertaking are illustrated by beautiful photographs. The light-path used varied from 8 to 10 miles. The distance was accurately measured by comparison with a carefully measured base-line set up near the pipe line. The number of revolutions per second made by the mirror was correctly determined by stroboscopic observation of a tuning fork synchronised with the rotating mirror, the tuning fork being compared with a freely swinging pendulum which was compared with a chronometer which in its turn was rated by means of time signals from Arlington. "2885.5" determinations of the velocity were made during a number of years and the mean value obtained for the velocity of light was 299774 km. per sec., the average deviation from the mean being 11 km./sec. As Birge has pointed out (*Nature*, 1934, 134, 771), this result agrees with the values obtained by Mittelstædt (1928), Mercier (1923) and Rosa and Dorsey (1906) using other methods, and so the variation of the velocity of light postulated by Gheury de Bray and Edmondson may be only apparently confirmed by the measurements employing long base-lines.

T. S. S.

Photo-Oxidation in Near Infra-Red.

IN the photo-oxidation of organic substances in presence of chlorophyll, under favourable conditions one molecule of oxygen is absorbed per quantum of absorbed light, irrespective of the wavelength. If the

wavelength of the incident light is continuously increased, for any given substance, there will be a limit beyond which the absorbed quantum will be insufficient for the activation energy required for oxidation. This, in principle, simple method for determining the activation energy for autoxidation of organic substances, however, requires a dyestuff which absorbs in the red and infra-red, and also a filter that transmits in these regions. Chlorophyll is not suited for this purpose as it does not absorb even in the visible red region. H. Gaffron (*Berichte*, 1935, **68**, 1409) has discovered in Bakterio-chlorophyll (extracted from *thiocystis*) a suitable dyestuff for this purpose. A solution of this in acetone, containing thiosinamine as acceptor absorbs oxygen when irradiated with light even beyond $760 \mu\mu$. This observation settles that it is not the oxygen that is activated by the sensitised dyestuff—as has been postulated by some,—since the energy required for the activation of oxygen to $^1\Sigma$ state is 37000 cal. corresponding to $762 \mu\mu$, and thus light of longer wavelength would be ineffective.

M. A. G.

Inter-Molecular Forces in the Liquid State.

P. GIRARD AND P. ARADIE (*J. de Physique*, 1935, **7**, 295) have reported an interesting observation that the time of relaxation of a polar molecule in the liquid state, is extremely sensitive to the inter-molecular forces. Although Debye's theory of dispersion of dielectric constants is not strictly applicable to the pure liquid state, from the observed dispersion data, the characteristic period of relaxation τ can be evaluated by choosing a proper value for α in $\tau = \frac{4\pi\eta\alpha^3}{T}$, where η is the viscosity of the liquid, T the absolute temperature and α is a constant having the dimension of molecular radius. This value of α gives a direct measure of τ after allowing for the influence of η and T. A comparison of the values of α shows, contrary to expectation, that the time of relaxation for different polar molecules in the liquid state varies *inversely* as the polarity of the molecule. By a process of elimination, it has been deduced that this remarkable relation must be attributed to the inter-dipolar forces prevailing in the liquid state. This is confirmed by the observation that when the polar liquids are diluted by non-polar solvents, the relaxation

time increases to a maximum value of 3 to 7 times the original value, and then decreases. The nature of this curve would seem to indicate that the inter-molecular forces can have both effects, *vis.*, to increase or to decrease the time of relaxation according to conditions. It is briefly indicated that such effects can be attributed to the structure of the liquid state resembling more closely the crystalline state than the gaseous one.

M. A. G.

The Range of Action of Surface Forces.

BASTOW AND BOWDEN (*Proc. Roy. Soc. (A)*, 1935, **151**, 220) have made viscosity measurements of thin liquid films, which throw light on the state of the liquid molecules in the neighbourhood of a solid surface. The results show that the solution of a liquid crystal has pronounced rigidity; but no such effect is observed with normal liquids such as water, alcohol, acetic acid, etc., even in the neighbourhood of the freezing point. Furthermore, acetic acid shows a normal behaviour while it is in the supercooled state—a state in which there is comparatively high probability for the formation of the multimolecular layers. The results negate the conclusion of certain workers that there could be induced rigid structures of molecules extending from a surface to a distance of 1500 \AA to 50000 \AA . The length of such oriented structures, if they exist, is certainly less than 1000 \AA and probably very much less.

K. S. G. D.

The Influence of the Electrode Surface on Anodic Reactions.

THE mechanism of the anodic oxidation of compounds at different electrode surfaces is of considerable practical and theoretical significance. Glasstone and Hickling (*J.C.S.*, 1934, 1878) have recently advanced the view that hydrogen peroxide is formed as a primary reaction product on the surface of the anode. This has been seriously questioned by Walker and Weiss in a recent paper (*Trans. Far. Soc.*, 1935, **31**, 1011). They have adduced definite evidence to the non-formation of hydrogen peroxide. The formation of oxide films which change the nature of the anode surface has however been detected. From the standpoint of quantum mechanics, there is a potential barrier between the electrode and the reacting

ions round it, which are in an adsorbed condition. It has been shown that for the discharge of an anion at the anode, the following relation should be satisfied.

$$\phi + V_a > E_{\text{ion}} + H_{\text{ion}} - \Delta A$$

where ϕ is the work function of the metal electrode, V_a the applied anode potential, E_{ion} the electron affinity of the adsorbed anion, H_{ion} the hydration energy of the anion and ΔA the adsorption energy of the process. In the above relation, both ϕ and ΔA depend upon the properties of the surface. Anodes with high Oxygen over-voltage (e.g., Smooth platinum) favour the primary deposition of the anion, since the electron affinity of other anions is lower than OH^- . In the case of electrodes with low over-voltage (platinised platinum, metallic oxides), the primary discharge of the hydroxyl radicle may take part in the chemical oxidations on the anode.

M. P. V.

Study of Evaporation of Water from a Soil Surface.

THE dependence of fluctuations of water table on the surface evaporation and atmospheric pressure was investigated by Vaidhianathan and Luthra (*Research Publication*, November 1934, 5, No. 3, Punjab Irrigation Res. Inst.) at Lahore during June, the hottest part of the year. Surface evaporation was studied for 11 days by exposing P_2O_5 in shallow bottles kept under a bell jar, while the fluctuation of water-table was studied by means of observation pipes fitted with strainers. It was found that while pressure has an effect on the fluctuation of the level of the water table, when the surface evaporation is high, however, the fluctuations of water table and pressure became out of phase and evaporation became the most predominating factor. The conclusions of the previous workers made in Australia and elsewhere that pressure is the main factor effecting the water table do not apply to the conditions existing in Lahore. It was found that there is continuity in the moisture content of the soil between the water table and the surface even though the water table is at a depth of 22 feet below the surface indicating that the water lost by evaporation is being continually replenished from the ground water level. This is in contradiction to Keen's observations made at Rothamsted that water which receded 6 ft. is not drawn

up by surface evaporation. The amount of water evaporating from the surface was found to be 2.7×10^{-7} grs. per sq. cm. per sec. on the average for June, when the maximum temperature was 66°C .

A Statistical Examination of the Uplift Pressure Data obtained from Model Experiments.

A NUMERICAL estimate has been made of the "Experimental Error" involved in the data obtained from model experiments to determine uplift pressures by Malhotra and Uppal (*Research Publication*, Jan. 1935, 1, No. 5, Punjab Irrigation Res. Inst.). Attention was confined to the variations of "percentage drop of pressure" at individual pipes, the observations being taken from the same model though the head was varied. 97 individual pipes were used for each set of observations and they have been classified into 6 groups depending upon the experimental conditions. Eliminations due to choking and other causes have been made of some individual pipes. The analysis of variance due to Fisher was applied to the figures for "percentage drop of pressure". It was found (i) "that the upper limit of the 'Experimental Error' for any group of observations is less than 0.50" and (ii) that "all but about 1 per cent. of the observations would fit into a range of 3E on either side of the mean value for the pipe"; (iii) "In only one case 3E was as high as 1.5 and in all other cases it is less than 1.0"; and (iv) "An increase in the dimensions of the model did not affect the magnitude of the error."

Oil Formation in the Groundnut.

THE preference accorded to Indian groundnuts in the British market under the Ottawa Agreement is considerably neutralised by the poor quality of the Indian nuts as evidenced by the high free fatty acid content of the consignments from this country, the nuts from the Coromandel Coast ports being particularly bad in contrast with those from the West Coast ports, Mormugao and Bombay. An investigation into the causes affecting the quality of the groundnut has been undertaken by J. J. Patel and C. R. Sheshadri and the results of a study of the rate of oil formation and the effect of early harvest on the oil content are published (*Indian J. of Agr. Sci.*, 1935, 5, Part II). There is, throughout the period of development of the seed, a gradual and uniform

gain in the oil content and reduction in the free fatty acid content. The harvest of groundnut even one week before the kernels are fully ripe increases the free fatty acid content and reduces the oil content by about five per cent. Premature harvest is thus suggested as one of the causes of low quality. The other effects of such early harvesting such as the high moisture content and the need for prolonged drying and deterioration by fermentation are being studied.

A. K. Y.

Factors affecting the Absorption of Selenium from Soils by Plants.

ANNIE M. HURD-KARRER records the results of further studies on the toxicity of selenium to plants, now that the subject of this toxicity has assumed importance, owing to the fact recently established that this toxicity is communicated to animals growing on such vegetation (*J. Agri. Res.*, 1930, 50, No. 5). The work relates to pot culture studies conducted with two different kinds of soils "the Keyport clay loam" and "Pierre clay". Of the 17 different kinds of plants grown, the cruciferæ mustard and Broccoli absorbed the largest quantities, 1240 and 1180 parts per million respectively, while at the other extreme come the grain crops, and about midway the other crops, *viz.*, sunflower, flax, sweet-clover, alfalfa pea and spinach. The cruciferæ showed no outward signs of suffering or abnormality though they absorbed the largest quantities, while the gramineæ generally suffered most, the intermediate class remaining normal with the exception of the sunflower. The factors affecting the absorption by wheat of selenium added as sodium selenate to the soil and the resulting toxicity to this crop are summarised as available sulphur, soil type, percentage of sand, method of adding selenium, the form of selenium added and the growth of previous crops. It is suggested that the tendency of a crop to absorb selenium depends on its tendency to absorb sulphur, as in the case of the cruciferæ. Sodium selenate is absorbed by wheat more in the Pierre clay than in the Keyport clay loam. Applications of free sulphur reduce the absorption by wheat of the naturally occurring selenium in soils as well as that added as sodium selenate. Gypsum is similarly effective. The addition of quartz sand to Keyport clay loam increases the toxicity of the selenate in proportion to the percentage of sand.

Sodium selenate is not easily leached and is partially retained in the upper layers. Elemental selenium is apparently unavailable and non-toxic to wheat at least in quantities up to 200 parts per million in Keyport clay loams. The selenium was more toxic in the form of sodium selenate than in the form of selenite. Sodium selenate was either changed to a less toxic form or reduced to a sub-toxic concentration by the growth of successive crops of wheat.

A. K. Y.

The Duration of Life in an Albino Rat Population.

B. P. WILSON AND N. M. SHEARD (*Proc. Roy. Soc. Edin.*, 55, Pt. 1) have, for the purpose of presenting the data on the life span of the albino rat, divided its life into two phases. The first phase comprises the span of life spent by the rat in greater or less dependence on its mother; this phase ends during the fourth week post partum. The second phase comprises life after weaning. During the period following weaning very few animals died under the conditions in which they were maintained.

Data relating to 250 litters chosen at random are presented where the total number of young in these litters was 1,607. Of these a total of 492 animals died, or were killed by their mothers before the age of 30 days; while 1,115 survived upto or beyond this age. This would correspond to a death rate during this first phase of about 30 per cent. It was found difficult to establish in any given case whether death of either a litter or a single young was due to low vitality or to accidents such as cannibalism or squashing of young by the mother because the latter fails to assume the appropriate "nursing posture". These factors were eliminated when once the young was separated from their parents. It has been shown that not only is the mean duration of life shorter in males but the terminal age reached by females exceeds the terminal age of males. The force of mortality rises after the ninth month of life in geometrical progression.

Foetal Respiration.

J. BARCROFT'S Croonian Address on Foetal Respiration (*Proc. Roy. Soc. Lond.*, 1935, 118 (B), No. 808), attempts to state the principal facts known about the subject in the Mammalia. Needless to say that the

respiratory system goes hand in hand with that of the circulatory system. The umbilical arteries convey blood deficient in oxygen to the placenta, while the richer blood returns to the inferior vena cava by means of the umbilical veins. It is pointed out that the volume of blood passing through the foetal heart and the oxygen consumption of the foetus bear a relation to the weight of the foetus itself, though in the case of the rabbit, the placenta reaches its maximum size before the culmination of the progressive growth of the foetus. And on account of the rise in arterial pressure, more blood passes through the fully grown vascular bed in the placenta. Moreover the oxygen utilised by the foetus bears a constant relation to the weight of the foetus over last half of foetal life. Towards the end of pregnancy the relationship stands thus: On the foetal side a rapidly growing foetus with a foetal irrigation of the placenta and the consumption of oxygen with reference to the weight of the foetus is present while on the maternal side neither the blood flow nor the size of the placenta increases. Therefore the "Oxygen difference" between the blood in the umbilical artery and vein should be the same whilst the maternal blood leaves the uterus increasingly reduced as pregnancy advances. That this is so is clearly shown by the dark blood emerging from the pregnant side of the uterus of the rabbit, and as regards the oxygen difference, the factors involved in this are that "the oxygen breaks away from the haemoglobin of the mother, becomes dissolved in the plasma of the maternal blood and attains a certain partial pressure in that plasma. It then diffuses to the plasma of the foetal blood in which it necessarily exists at a lower pressure than that which it set up in the plasma of the mother. The oxygen then passes to the haemoglobin which it saturates up to whatever point may be possible at the partial pressure in question." Further it has also been noted that "the placental membrane is incapable of maintaining any considerable difference of pH between the maternal and foetal plasma and that the haemoglobin of the foetus is different from that of the mother. Regarding the passage of blood in foetus it has been long known that most of the arterial blood arriving by the inferior vena cava enters the left ventricle after passing through the foramen ovale into the left auricle; from the ventricle a large part enters the carotids and proceeds

to the head region. The blood from superior vena cava enters the right ventricle through the right auricle; from the ventricle the blood is projected through the ductus arteriosus into the aorta and the mixed blood passes to the body. Of the 300 c.c. of blood which traverses the foetal heart, about 150 c.c. goes to the head and other 150 c.c. to the abdominal aorta; of the latter 150 c.c. perhaps 100 c.c. goes to the placenta for aeration and 50 c.c. to the body of the foetus for the nourishment of the same." Thus a great volume of blood finds its way through the ductus arteriosus but how this flow is stopped at the time of birth is left unanswered since it is purely a post-natal problem.

The Charnockite Series of Uganda, British East Africa.

EVER since Sir Thomas Holland recognised the Charnockite series in India as intrusive plutonic rocks, similar members have been studied in other areas, but still the origin of such rocks has not been finally determined. Some petrologists believe that charnockites are the result of assimilation of argillaceous sediments, while others like Vredengurg hold that metamorphism alone is responsible for the formation of such a group of rocks ranging from acid to ultra-basic with a uniformity of character. Adams who studied the charnockite rocks of Ceylon could not come to any definite conclusions. A comprehensive study of the charnockites from Uganda, British East Africa, has been made recently by A. W. Groves (*Q.J.G.S.*, 91, No. 362). His study includes many chemical analyses, comparison with similar rocks in other areas, especially in India, and a detailed study of the development of Hypersthene. At the end of his paper he has tabulated a series of arguments to show that the charnockites do not result from the assimilation of sediments by magmas. The marked presence of "dry minerals," universality of secondary characters, linear arrangement of minerals and "the appearance of successive ferromagnesian minerals in the reverse of the accepted order for plutonic rocks of the calc-alkali series" have led him to conclude that the charnockites of the Uganda series of rocks are the result of plutonic metamorphism of normal igneous rocks. In view of such a conclusion by Groves, it is desirable to review the study of Indian charnockites to aid their correlation with similar rocks occurring in distant parts of the globe.

The Correlation of the Pre-Cambrian Granites by means of Heavy Mineral Analyses.

IN many localities correlation of isolated outcrops of igneous rocks by thin sections and field studies are beset with numerous difficulties. In recent times such obstacles have been overcome to a certain extent by the study of the heavy mineral analyses, and in most cases successful correlations have been established. J. T. Stark and F. F. Barnes (*Geological Mag.*, 1935, No. 854) during the course of their study of the closely related Pikes Peak and Silver Plume Granites of the Pre-Cambrian Age in the

Sawatch Range of Central Colorado have shown by means of the heavy mineral analyses that outcrops belonging to the two series of granites differ fundamentally, in their heavy mineral constituents. In the Silver Plume granite there is a large percentage of Zircon, while the Pikes Peak granite is characterised by a large percentage of Titanite. By a series of curves they have shown that though there are a large number of minerals common to both the series of granites yet the relative proportions of certain of the important minerals like Zircon and Titanite are sufficiently marked for being made use of in correlation.

Sugar Industry of India, 1933—34.*

THE year 1933-34 was one of general depression in the sugar industry of the world. The total production of sugar during that year exceeded the consumption by about 740,000 tons. But mainly as a result of protective tariffs, the Indian sugar market did not suffer any dislocation and on the other hand accommodated the produce of 112 factories which operated during that year. There was a marked decline in the total sugar imports into India. On the cultivation side, though the acreage under cane was less than in 1932, the cane grown exceeded the figure for that year in consequence of the increasing adoption of improved varieties of cane. The severe earthquake in Bihar on 15th January 1934 was responsible for a large damage to the cane crop. The factories designed to work were 123 during 1933-34 but only 112 were in operation. The total produce was 453,965 tons which was 163,788 tons more than the produce of 1932-33. In spite of a large number of new factories working and the loss in Bihar due to earthquake, the average recovery for the whole of India showed a slight increase over the previous year's figure.

Advancement in technical and scientific work was not lacking. The research stations in Coimbatore and Pusa and those in other provinces demonstrated the increasing usefulness of many Coimbatore varieties of cane which are rapidly ousting the local varieties out of cultivation. Financed by the Imperial Council of Agricultural Research the work on the design of a small power-driven mill started in 1931 resulted in success and the mill was standardised for cane conditions in Bihar and Orissa.

Of great importance to Indian Sugar Industry are the Government of India Acts Nos. XIV and XV of 1934 which provide for the levy of an excise duty of factory sugar and empower local governments to restrict sugarcane dealings

and fix cane prices in such a manner as to secure to the growers a fair price for their produce.

The total value of sugar machinery imported into India during 1933-34 was Rs. 3.36 crores of which nearly Rs. 2 crores were spent on British machinery alone. The import of machinery in 1932 was only half of this value.

Besides the 453,965 tons of sugar made in factories direct from cane, 225,000 tons were produced by indigenous process and 60,000 tons by refineries making a total production of 738,965 tons. Consequent to this large production there was also a sharp fall in the quantity of imported sugar. Gur production in 1933-34 was 10.8 per cent. higher than in the previous year with a corresponding fall in molasses imports.

The position of sugar trade of Java and Cuba is of interest. Java suffered enormous fall in her sugar exports owing to severe competition from other countries and the large increase in the production of British India. Under the management of sales by the 'NIVAS', quantities of sugar in excess of the production of 1933-34 were disposed of. During the year under review only 99 factories operated in Java as against 166 in the preceding year. The acreage under cane was only 208,947 in 1933-34 as against 423,924 in 1932. The Cuban sugar trade of 1933 was influenced considerably by the inflationary policy of the U.S. Government, the attempt at the formation of a sugar crop restriction and marketing agreement, the possibility of reduction in Cuban duty and finally the overthrow of Machado Government in Cuba.

Though the world sugar industry of 1933-34 shows a large excess of production over consumption figures in contrast to the previous year, the outlook of Indian sugar industry is definitely better to-day, inasmuch as fear of over-production is lessening. The excise duty has put a wholesome check on excessive expansion of factories and, at the same time, the country has shown signs of increasing sugar consumption.

G. GUNDU RAO.

* Review by R. C. Srivastava, Supplement to the *Indian Trade Journal*, Aug. 15, 1935.