

ABSTRACTS

OF PAPERS COMMUNICATED TO THE ROYAL SOCIETY OF LONDON

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10 OCTOBER 1938

Determination of lung volume: a simple constant volume modification of Christie's method. By F. J. C. HERRALD and J. McMICHAEL. (*Communicated by C. G. Douglas, F.R.S.—Received 11 August 1938.*)

It has been shown that the method of estimating lung volume by oxygen dilution from a spirometer as recommended by Christie is liable to a considerable error owing to the fact that the volume of the whole lung-spirometer system is undergoing a steady diminution and that even mixing of the gases is never achieved throughout the system. The error is most pronounced at functional residual air values over 3 l. The error may be eliminated by adding oxygen to the system at a uniform rate so as to keep the volume of the lung spirometer system approximately constant throughout the mixing period.

The standard error of single determinations is 0.186 l.

The lung volume and its subdivision in healthy males. By E. A. ASLETT, P. D'ARCY HART and J. McMICHAEL. (*Communicated by C. G. Douglas, F.R.S.—Received 11 August 1938.*)

The lung volume subdivisions of sixty-four normal male subjects has been determined in the sitting position. The results have been analysed statistically and correlated with various physical and radiological measurements. From the regression equations, formulae have been estimated for predicting the more important lung volume subdivisions. The best method of finding total lung volume is from a formula

using the product of radiological chest area and antero-posterior chest diameter; the vital capacity may be reasonably predicted from height or surface area.

It has also been observed that the changes in body build occurring in obesity are associated with deviations from the more common arrangement of the lung volume subdivisions when these are expressed as percentages of the total lung volume.

Quantitative methods in psychology. By LEWIS F. RICHARDSON, F.R.S.
(Received 20 August 1938.)

In his opening address to a discussion on this subject (*Proc. Roy. Soc. B*, **125**, 415, 1938) Dr C. S. Myers has asserted that "We can never say that one experienced sensation of sound has twice the intensity of another...."

A research on this question was made by L. F. Richardson and J. S. Ross (*J. Gen. Psychol.* **3**, 288-306, 1930). The experimenter passed different electric currents of the same frequency through a telephone; and the observer, who was kept in ignorance of the currents, was asked to assign numbers to the loudness in comparison with that of a standard current, which by convention was taken to produce unit loudness. Each of our eleven observers succeeded in making such numerical mental estimates. One of the observers was Dr C. S. Myers himself; and a summary of his results appears in the publication aforesaid. The original laboratory notes show that I acted as experimenter towards him on 17 August 1928. The record of the mental estimates is in Dr Myer's handwriting, and shows that to different telephone currents he assigned loudness ratios ranging from $\frac{1}{3}$ to 6. One of his estimates happened to be 2. I had previously explained to him that "Two would mean twice as loud".

Those who are in doubt about the possibility of quantitative estimates of mental events are requested to refer to the forthcoming interim report by a committee of the British Association (Sections A and J), where the question is argued from various, some of them contrary, points of view. I would particularly direct attention to Dr Semeonoff's summary of experimental work on intuitive estimates by independent investigators in England and America.

This paper, being identical with its abstract, will not be published in the *Proceedings*.

Micrurgical studies on virus infected plants. By F. M. L. SHEFFIELD.
(Communicated by R. N. Salaman, F.R.S.—Received 25 August 1938.)

Cells of virus-infected plants were examined by micromanipulative methods.

The pH of the cell contents was found to be the same in diseased and in healthy plants.

The non-crystalline intracellular inclusions of aucuba mosaic disease of tomato disintegrate immediately on slight mechanical pressure or on pricking. They are almost unaffected by acids from pH 7-2.2. They break down if the osmotic pressure is reduced below 0.07 M, but can be isolated into solutions of 0.1 M. These inclusions contain virus, but virus may also be dispersed through the cell.

The striate material of tobacco and enation mosaics cannot be isolated, for immediately it is touched with a micro-needle it breaks down into needle-like fibres.

The development of the spark discharge. II. By T. E. ALLIBONE and S. R. MEEK. (*Communicated by S. R. Milner, F.R.S.—Received 26 August 1938.*)

A further account is given of the development of the high-voltage electric spark in air at pressures ranging from 76 to 0.3 cm. Hg. The account is based on photographs taken with a rotating film camera. Many photographs were synchronized with voltage and current oscillograms of the spark.

The leader-stroke/main-stroke mechanism established for the lightning flash and the spark at atmospheric pressure is shown to persist at all pressures down to 1 cm. Hg. The velocities of the leader-strokes have been measured under a variety of circuit conditions. The peculiarities of the oscillograms of breakdown first noted by Rogowski and his school are explained in terms of single and multiple leader-stroke formation. As the pressure is reduced the positive leader-stroke develops at the expense of the negative leader-stroke, and the separate stages of the stepped-leader stroke development are more clearly enhanced.

Ionic recombination in air. By J. SAYERS. (*Communicated by E. V. Appleton, F.R.S.—Received 26 August 1938.*)

An experimental study has been made of the recombination of ions in air. It is found that, up to pressures of 1 atm., the recombination coefficient varies with pressure in a manner which is accurately predicted by the theory of J. J. Thomson; that is, the recombination coefficient varies proportionally with the pressure up to about 100 mm., thereafter varying less rapidly as the pressure is increased, until, at 1000 mm., the recombination coefficient becomes pressure-independent.

The apparent variation of the recombination coefficient with the ionization intensity, noted by other workers, has been confirmed and explained as being due to the formation, by the ionizing rays, of complex molecules such as ozone, new experimental evidence in favour of this explanation being adduced.

A number of subsidiary experiments have yielded detailed information concerning the nature of the recombination process, from which the inaccuracies in previous work on this subject may be appreciated.

Using the new values of the recombination coefficient for air, it has been possible to calculate the equilibrium ion density and the electrical conductivity at various levels in the lower atmosphere. For this purpose the rates of ion production measured by Regener by means of sounding balloons have been employed. The results so obtained are shown to agree very closely with the direct measurements of the atmospheric conductivity made in the stratosphere ascent of "Explorer II" at South Dakota by Stevens and Anderson.

Molecular interaction in monolayers. III. Complex formation in lipid monolayers. By J. H. SCHULMAN and E. STENHAGEN. (*Communicated by E. K. Rideal, F.R.S.—Received 29 August 1938.*)

Two new methods are described for investigating the process of penetration of monolayers by substances injected into the substrate. In one the monolayer is confined by a movable barrier and maintained at constant pressure by means of a non-reactive piston fluid, the area change on injection being noted. In the other an electrically operated Langmuir trough is employed, the slide retaining the monolayer travelling automatically so as to retain the monolayer at constant pressure during the process of penetration or ejection of one constituent.

It is found that molecules containing ring systems such as digitonin, on penetrating a ring structure monolayer such as cholesterol form only 1 : 1 complexes; a number of cases of specific penetration in these systems are examined. A saturated chain molecule such as sodium cetyl sulphate penetrating a ring structure monolayer such as cholesterol, forms a 1 : 1 complex. The collapse pressure of the complex is found to be dependent on the concentration of the reactant in the substrate and to be in equilibrium with it. The difference in surface-free energies of formation of the complex with different bulk concentrations of reactant can be evaluated both from the surface-pressure differences as well as from the variations in the bulk concentrations, thus showing an experimental justification of Gibb's Law and that the complexes behave as chemical compounds. Other examples of this type were found to form complexes of composition both of 1 : 2 and 1 : 1. Saturated chain reactants, e.g. sodium cetyl sulphate on penetrating saturated chain monolayers, e.g. cetyl alcohol, form stable complexes of composition 1 : 3 and 1 : 1, whilst an unstable 1 : 2 complex can be identified under certain conditions. The rate of decomposition of a complex monolayer at constant pressure follows the unimolecular law.

The presence of 1 : 3 and 1 : 1 complexes giving solid mixed monolayers with saturated chains and of 1 : 2 and 1 : 1 complexes with *trans*-unsaturated chains suggests that the monolayer lattices of these complexes correspond to different "crystal" symmetries or types, and if this proves to be the case on crystallographic examination, Patterson's classification appears to be applicable.

Marked differences, due to *cis* and *trans* isomerism, are obtained on penetration, supporting the concept of interlocking chains.

Haemocuprein and hepatocuprein, copper-protein compounds of blood and liver in mammals. By D. KELLIN, F.R.S., and T. MANN. (*Received 29 August 1938.*)

1. *Haemocuprein* is a blue copper-protein compound present in the red blood corpuscles and serum of mammals.
2. A method for isolation of this compound in a pure crystalline state from the red blood corpuscles of ox is described.
3. A highly purified and partly crystalline haemocuprein may also be obtained from the red blood corpuscles of sheep and horse and the blood serum of horse.
4. Pure haemocuprein contains 14.35% N, 1.12% S and 0.34% Cu.

5. An almost colourless copper-protein compound, *hepatocuprein*, containing 0.34% Cu, can be isolated from ox liver.

6. Haemo- and hepatocuprein have several properties in common. Both have the same copper content, can be extracted from the crude material with the same alcohol-chloroform mixture and purified by the same method. In both compounds the copper is only loosely combined with the protein and is easily liberated by dilute trichloroacetic acid.

7. They do not combine with molecular oxygen and do not exhibit any of the catalytic properties of enzymes such as peroxidase, catalase, polyphenol and cytochrome oxidase or carbonic anhydrase.

8. The possible biological significance of haemo- and hepatocuprein is discussed in relation to the known effects of copper on blood formation, growth and metabolism of organisms.

Critical and co-operative phenomena. III. A Theory of melting. By J. E. LENNARD-JONES, F.R.S., and A. F. DEVONSHIRE. (*Received 29 August 1938.*)

A mathematical theory of the change of phase from solid to liquid is given in terms of interatomic forces. It is based on two former papers of this series (I and II), in which a statistical theory of a dense assembly, whether solid, liquid or gas, was worked out. Each atom was regarded as moving in a cell determined by its neighbours, and the potential energy within this cell, calculated as a function of the volume of the assembly.

To this theory we have now added the concept of order and disorder and have discussed the relation between solid and liquid in terms of the amount of disorder present. This has been achieved by regarding a solid as similar to an alloy in that it consists of a lattice of atoms and a lattice of "holes", the latter interpenetrating the first. The energy necessary to interchange an atom and a hole is taken to be a function of volume. This leads to a new contribution to the free energy and also to the pressure of the assembly due to disorder. When this is added to the pressure calculated in former papers, the isotherms have a shape similar to those associated with a liquid-vapour change of phase. The theory gives the melting temperature as a function of pressure and shows that the change of phase is accompanied by an increase of volume and latent heat of fusion. Calculations of these changes are made for argon and nitrogen and found to be in good agreement with experiment.

The metabolism of the eggs of *Psammochinus miliaris* during the fertilization reaction. By H. LASER and LORD ROTHSCHILD. (*Communicated by J. Gray, F.R.S.—Received 31 August 1938.*)

1. The metabolism of *Psammochinus miliaris* eggs was examined before, during and after fertilization.

2. Immediately after activation, i.e. during the first 5 min., there occur:

- (a) a sudden increase in O_2 consumption;
- (b) a sudden increase in acid production.

3. Neither of these effects persists, the O_2 consumption falling to a low value, sometimes below the pre-fertilization rate. This decrease in O_2 consumption is not maintained, the rate increasing about 10 min. after activation to its normal value.

4. There are indications that the R.Q. falls to an unusually low value immediately after activation.

5. The comparative absence of HCO_3^- ions associated with manometric methods involving the use of KOH for the absorption of CO_2 in media containing HCO_3^- ions causes a large decrease in respiration rate.

6. The relationship of these metabolic changes to physico-chemical changes observed in the eggs at the same time is discussed.

On the Hamilton-Jacobi theory and quantization of a dynamical continuum. By P. WEISS. (*Communicated by R. H. Fowler, F.R.S.—Received 1 September 1938.*)

The Hamilton-Jacobi theory of point mechanics is extended to the mechanics of continuous media, following on the lines first proposed by Prange. The method is based on the equivalence between the Euler equations and the "boundary formula" (*formule aux limites*) in the calculus of variations. It is shown that the notions of Lagrange brackets and Poisson brackets can be extended, but only if the Euler equations of the continuum are of hyperbolic type. Consequently, these notions only apply to a dynamical continuum and not to equilibrium problems. Except for this restriction, the method is applicable quite generally, for linear as well as for non-linear theories. Once the dynamical laws are expressed in terms of Poisson brackets, the transition to the quantum theory can be effected by a brief, formal argument in the same way as in point mechanics.

On the Hamilton-Jacobi theory and quantization of generalized electrodynamics. By P. WEISS. (*Communicated by R. H. Fowler, F.R.S.—Received 1 September 1938.*)

A procedure of quantizing a dynamical continuum, developed in a previous paper, is applied to the electromagnetic field in generalized form as given by Mie and by Born. Important special cases are the Proca field of the heavy electron, whose structure is similar to the linear case of Mie's theory, and the Maxwell field which is the linear case of Born's theory. In the theory of Mie, which is not gauge-invariant, the stress-energy-momentum tensor suggested by the mathematical procedure differs from the one defined in physics, but it is shown that both tensors lead to the same physical results. In the theory of Born, which is gauge-invariant, the "potential"

of the field is described by a line-function $\oint \phi_i dx^i$ which has an absolute physical significance while the world vector (ϕ_i) has not. In this way the ambiguity concerning the stress-energy-momentum tensor is avoided. The well-known peculiar difficulties due to the "antisymmetry" of electrodynamics can be overcome by a clear formulation of the correct initial data in the classical theory. The present method is relativistically invariant throughout, so that an explicit proof of the invariance of the quantum conditions becomes unnecessary.

The electronic structure of some polyenes and aromatic substances. VII. Bonds of fractional order by the molecular orbital method. By C. A. COULSON. (*Communicated by J. E. Lennard-Jones, F.R.S.—Received 3 September 1938.*)

A new definition of the order of a bond in an aromatic compound is proposed, depending upon the energy change in the molecule when a slight variation is supposed to be made in the length of this bond. This order is shown to be dependent upon the coefficients in the occupied molecular orbitals. A curve is drawn relating the order and the length of a link, and the method is applied to a discussion of the lengths and orders in the conjugated chain molecules $C_{2n}H_{2n+2}$.

The emission band spectrum of chlorine. III (continua). By W. H. B. CAMERON and E. ELLIOTT. (*Communicated by S. R. Milner, F.R.S.—Received 5 September 1938.*)

The spectrum of chlorine excited by active nitrogen has been photographed and measured. The continua previously known were recorded, together with a number of diffuse bands, hitherto unknown, associated with the continuum whose maximum of intensity is at a wave-length of 2580 Å.

An interpretation of these bands and associated continuum is given, based on the assumption of transitions from a stable upper electronic state, probably analogous to the "D" state of $I_2(^1\Sigma_u^+)$ to a lower electronic state which has only a shallow minimum in its potential energy-internuclear distance curve.

A comparison is made between the chlorine spectrum excited by active nitrogen and by a high frequency electrical discharge.

The Australian aboriginal skull: its non-metrical morphological characters. By FRANK J. FENNER. (*Communicated by F. Wood-Jones, F.R.S.—Received 6 September 1938.*)

This paper consists of the records of 1182 adult Australian aboriginal skulls examined for their non-metrical morphological characters, following the plan developed by F. Wood-Jones.

It was possible to distinguish three regional types of Australian skull: the southern type, from South Australia, Victoria, New South Wales and probably southern Western Australia; the coastal Northern Territory type; and the Queensland type.

The latter two varieties are thought to be differentiations from the original southern type by later extra-continental racial admixture, with Melanesians in Queensland and possibly with Malays in Northern Territory. Some support is lent to this suggestion by the published results of blood-grouping of the Australian aborigines.

The main bulk of the paper consists of detailed observations and cannot easily be summarized. It is a contribution to the study of the racial differences of the human skull.

Investigations on magne-crystallic action. VI. Further studies on paramagnetic crystals. By K. S. KRISHNAN, A. MOOKHERJI and A. BOSE. (*Communicated by C. V. Raman, F.R.S.—Received 5 September 1938.*)

The magnetic anisotropies of some typical salts of the rare earth and the iron groups have been measured at low temperatures down to about 90° K. A simple cryostat, with automatic temperature control, suitable for measurements on the magnetic anisotropies of crystals at low temperatures, is described. The results are discussed on the basis of the theory of paramagnetism in crystals developed by Van Vleck, Penney and Schlapp.

1. In those crystals in which the paramagnetic ions are all in the S-state, e.g. $Gd_2(SO_4)_3 \cdot 8H_2O$, $Mn(NH_4)_2(SO_4)_2 \cdot 6H_2O$, the anisotropy $\Delta\chi$ is found to vary inversely as the square of the absolute temperature.

2. In $Gd_2(SO_4)_3 \cdot 8H_2O$ the maximum anisotropy, though only 1.4% of the mean susceptibility at room temperature, is still much larger than should be expected from the Stark separation of the S-levels of Gd^{+++} under the crystalline electric fields. The bulk of the observed anisotropy appears to arise from the magnetic interaction between the neighbouring Gd^{+++} ions.

3. Chromic salts have a very feeble anisotropy, almost as feeble as if the Cr^{+++} ion were in the S-state. The criterion for judging the suitability of a paramagnetic salt as working material in the production of low temperatures by the Debye-Giauque method is discussed.

4. From measurements on the magnetic anisotropy of nickel salts at different temperatures, the strength of the coupling between the orbital and the spin angular momenta of Ni^{++} is calculated, and is found to agree with the spectroscopic value.

5. Praseodymium and samarium ethylsulphates are of special interest. As we go down to low temperatures their anisotropies increase at first, reach a maximum, and then diminish rapidly.

6. The crystal fields in the rare earth chlorides, which are hexahydrated, are as strongly asymmetric as in the sulphates, which are octahydrated.

7. Magnetic measurements on the cupric alkali chlorides enable us to decide between the alternative structures proposed for these crystals from X-ray studies.