INDEX TO VOLUME 171 (A)

Adiabatic piezo-optic coefficient of liquids (Raman and Venkataraman), 137.
Appleton, E. V. and Weekes, K. On lunar tides in the upper atmosphere, 171.
Arnot, F. L. and M'Ewen, M. B. The formation of helium molecules, II, 106.

Braddock, H. J. J. Cosmic ray bursts at high altitude, 314.
Bruce, H. D. Optical thickness of the transition layer between transparent media, 411.
Brookman, E. F. See Norrish and Brookman.
Budden, K. G., Ratchiffe, J. A. and Wilkes, M. V. Further investigations of very long waves reflected from the ionosphere, 188.
Burgoyne, J. H. The combustion of aromatic and alicyclic hydrocarbons, II, 421.

Carmichael, H. and Dymond, E. G. High altitude cosmic radiation measurements near the north geomagnetic pole, 321.
—— Upper air investigations in North-West Greenland, 345.
Combustion of aromatic and alicyclic hydrocarbons (Burgoyne), 421.
Conn, G. K. T. and Twigg, G. H. Infra-red analysis applied to the exchange reaction between ethylene and deutoethylene, 70.

Copper-cuprous oxide photoelectrons (Mott), 281.
Coriolis perturbations in methane spectrum (Jahn), 450.
Cosmic radiation near the north pole (Carmichael and Dymond), 321.
Cosmic ray bursts at high altitude (Braddock), 314.
Coulomb law, deviation for the proton (Fröhlich, Heitler and Kahn), 269.
Crystal rectifiers, theory (Mott), 27.

Davoud, J. G. and Hinshelwood, C. N. The thermal decomposition of diethyl ether, 39.

Diamagnetic anisotropy of organic molecules (Lonsdale), 541.
Diethyl ether, thermal decomposition (Davoud and Hinshelwood), 39.
Diffusion in absorbing media (Henry), 215.
Dymond, E. G. See Carmichael and Dymond.

Effusion and thermal transpiration (Srivastava), 469.
Electron transfer in argon (Arnot and Hart), 383.
Electrons, path in polar crystals (Fröhlich and Mott), 496.
Evans, G. R. See Walke, Williams and Evans.
Exchange reaction between ethylene and deuterium (Twigg and Rideal), 55.
Exchange reaction between ethylene and deutoethylene (Conn and Twigg), 70.

Fatigue of metals (Orowan), 79.
Fröhlich, H., Heitler, W. and Kahn, B. Deviation from the Coulomb law for the proton, 269.
Fröhlich, H. and Mott, N. F. The mean free path of electrons in polar crystals, 496.
Index

Ganz, E.  See Allen and Ganz.

Hart, W. D.  See Arnott and Hart.
Heitler, W.  See Fröhlich, Heitler and Kahn.
Helium, liquid, thermal conductivity (Allen and Ganz), 242.
Helium, liquid, thermodynamics (London), 484.
Helium molecules (Arnott and M’Ewen), 106
Hinshelwood, C. N.  See Davoud and Hinshelwood.

Iron-nickel-aluminium system (Sucksmith), 525.

Jahn, H. A.  Coriolis perturbations in the methane spectrum, IV, 450.

Kahn, B.  See Fröhlich, Heitler and Kahn.
Kane, G. P.  The influence of nitrogen peroxide on the two-stage ignition of hydrocarbons, 251.

London, H.  Thermodynamics of the thermomechanical effect of liquid helium, 484.
Lonsdale, K.  Diamagnetic anisotropy of organic molecules, 541.
Lunar tides in the upper atmosphere (Appleton and Weekes), 171.
Lutkin, F. E.  The nature of atmospherics, VI, 285.

M’Ewen, M. B.  See Arnott and M’Ewen.
Merrington, A. C. and Oatley, C. W.  An investigation of the accuracy of König’s formula for the Rayleigh disk, 505.
Methane at λ point, X-ray investigation (Schallamach), 569.
Mott, N. F.  Note on copper-cuprous oxide photocells, 281.
——— The theory of crystal rectifiers, 27.
——— See also Fröhlich and Mott.

Nature of atmospherics (Lutkin), 285.
Nitrogen peroxide and hydrocarbon ignition (Kane), 251.
Norrish, R. G. W. and Brookman, E. F.  The mechanization of polymerization reactions, I, 147.

Oatley, C. W.  See Merrington and Oatley.
Optical thickness of transition layer (Bruce), 411.
Orowan, E.  Theory of the fatigue of metals, 79.

Pekeris, C. L.  The propagation of a pulse in the atmosphere, 434.
Polymerization reactions (Norrish and Brookman), 147.
Pulse propagation in atmosphere (Pekeris), 434.

Radiation, theory (Schott), 1.
Raman, Sir Venkata and Venkataraman, K. S.  Determination of the adiabatic piezo-optic coefficient of liquids, 137.
Ratcliffe, J. A.  See Budden, Ratcliffe and Wilkes.

Rayleigh disk, accuracy of König's formula (Merrington and Oatley), 505.

Rideal, E. K.  See Twigg and Rideal.

Robertson, J. M.  See de Lange, Robertson and Woodward.

Ruhemann, M.  Two-phase equilibrium in binary and ternary systems, 121.

Schallamach, A.  X-ray investigation of the structure transition of methane at the λ point, 569.

Schott, G. A.  A theory of radiation, 1.

Srivastava, B. N.  Effusion and thermal transpiration in quantum statistics, 469.

Sucksmith, W.  A magnetic study of the iron-nickel-aluminium system, 525.

Titanium and scandium, long-period activities (Walke, Williams and Evans), 360.

Trans-azobenzene, X-ray analysis (de Lange, Robertson and Woodward), 398.

Twigg, G. H. and Rideal, E. K.  The exchange reaction between ethylene and deuterium on a nickel catalyst, 55.

Twigg, G. H.  See also Conn and Twigg.

Two-phase equilibrium in binary and ternary systems (Ruhemann), 121.

Upper air investigations in Greenland (Carmichael and Dymond), 345.

Venkataraman, K. S.  See Raman and Venkataraman.

Walke, H., Williams, E. J. and Evans, G. R.  K-electron capture, nuclear isomerism and the long-period activities of titanium and scandium, 360.

Waves, very long, reflected from the ionosphere (Budden, Ratcliffe and Wilkes), 188.

Weekes, K.  See Appleton and Weekes.

Wilkes, M. V.  See Budden, Ratcliffe and Wilkes.

Williams, E. J.  See Walke, Williams and Evans.

Woodward, I.  See de Lange, Robertson and Woodward.

END OF THE ONE HUNDRED AND SEVENTY-FIRST VOLUME (SERIES A)
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## CONTENTS

**SERIES A VOL 171**

**No. A 944. 1 May 1939**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A theory of radiation. By the late G. A. Schott, F.R.S.</td>
<td>1</td>
</tr>
<tr>
<td>The theory of crystal rectifiers. By N. F. Mott, F.R.S.</td>
<td>27</td>
</tr>
<tr>
<td>The thermal decomposition of diethyl ether. By J. G. Davoud and C. N.</td>
<td></td>
</tr>
<tr>
<td>Hinshelwood, F.R.S.</td>
<td>39</td>
</tr>
<tr>
<td>The exchange reaction between ethylene and deuterium on a nickel</td>
<td></td>
</tr>
<tr>
<td>Infra-red analysis applied to the exchange reaction between ethylene</td>
<td></td>
</tr>
<tr>
<td>and deuterioethylene. By G. K. T. Conn and G. H. Twigg</td>
<td>70</td>
</tr>
<tr>
<td>Theory of the fatigue of metals. By E. Orowan</td>
<td>79</td>
</tr>
<tr>
<td>The formation of helium molecules. II. By F. L. Arnot and M. B.</td>
<td></td>
</tr>
<tr>
<td>M’Ewen</td>
<td>106</td>
</tr>
<tr>
<td>Two phase equilibrium in binary and ternary systems. I. The system</td>
<td></td>
</tr>
<tr>
<td>methane-ethane. By M. Ruhemann</td>
<td>121</td>
</tr>
</tbody>
</table>

**No. A 945. 19 May 1939**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determination of the adiabatic piezo-optic coefficient of liquids.</td>
<td>137</td>
</tr>
<tr>
<td>By Sir Venkata Raman, F.R.S., and K. S. Venkataraman</td>
<td></td>
</tr>
<tr>
<td>The mechanism of polymerization reactions. I. The polymerization of</td>
<td></td>
</tr>
<tr>
<td>styrene and methyl methacrylate. By R. G. W. Norrish, F.R.S., and</td>
<td>147</td>
</tr>
<tr>
<td>E. F. Brookman</td>
<td></td>
</tr>
<tr>
<td>On lunar tides in the upper atmosphere. By E. V. Appleton, F.R.S.,</td>
<td>171</td>
</tr>
<tr>
<td>and K. Weekes</td>
<td></td>
</tr>
<tr>
<td>Further investigations of very long waves reflected from the ionosphere. By K. G. Budden, J. A. Ratcliffe and M. V. Wilkes</td>
<td>188</td>
</tr>
<tr>
<td>Diffusion in absorbing media. By P. S. H. Henry</td>
<td>215</td>
</tr>
<tr>
<td>The influence of pressure on the thermal conductivity of liquid He ii. By J. F. Allen and E. Ganz</td>
<td>242</td>
</tr>
</tbody>
</table>
### Contents

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The influence of nitrogen peroxide on the two-stage ignition of hydrocarbons. By G. P. Kane</td>
<td>251</td>
</tr>
<tr>
<td>Deviation from the Coulomb law for the proton. By H. Fröhlich, W. Heitler and B. Kahn</td>
<td>269</td>
</tr>
</tbody>
</table>

**No. A 946. 6 June 1939**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note on copper-cuprous oxide photocells. By N. F. Mott, F.R.S.</td>
<td>281</td>
</tr>
<tr>
<td>The nature of atmospherics. VI. By F. E. Lutkin. (Plates 1-6)</td>
<td>285</td>
</tr>
<tr>
<td>Cosmic-ray bursts at high altitude. By H. J. J. Braddock</td>
<td>314</td>
</tr>
<tr>
<td>High altitude cosmic radiation measurements near the north geomagnetic pole. By H. Carmichael and E. G. Dymond. (Plate 7)</td>
<td>321</td>
</tr>
<tr>
<td>Upper air investigations in North-West Greenland. By H. Carmichael and E. G. Dymond</td>
<td>345</td>
</tr>
<tr>
<td>K-electron capture, nuclear isomerism and the long-period activities of titanium and scandium. By H. Walke, E. J. Williams and G. R. Evans. (Plates, 8, 9)</td>
<td>360</td>
</tr>
<tr>
<td>Electron transfer in argon. By F. L. Arnot and W. D. Hart</td>
<td>383</td>
</tr>
<tr>
<td>X-ray crystal analysis of trans-azobenzene. By J. J. de Lange, J. Monteath Robertson and I. Woodward</td>
<td>398</td>
</tr>
<tr>
<td>Optical thickness of the transition layer between transparent media. By H. D. Bruce</td>
<td>411</td>
</tr>
<tr>
<td>The combustion of aromatic and alicyclic hydrocarbons. II. The ignition of aromatic hydrocarbons at high temperatures. By J. H. Burgoyne</td>
<td>421</td>
</tr>
</tbody>
</table>

**No. A 947. 7 July 1939**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The propagation of a pulse in the atmosphere. By C. L. Pekeris</td>
<td>434</td>
</tr>
<tr>
<td>Coriolis perturbations in the methane spectrum. IV. Four general types of Coriolis perturbation. By H. A. Jahn</td>
<td>450</td>
</tr>
<tr>
<td>Effusion and thermal transpiration in quantum statistics. By B. N. Srivastava</td>
<td>469</td>
</tr>
<tr>
<td>Thermodynamics of the thermomechanical effect of liquid He II. By H. London</td>
<td>484</td>
</tr>
</tbody>
</table>
Contents

The mean free path of electrons in polar crystals. By H. Fröhlich and N. F. Mott, F.R.S. ........................................... 496

An investigation of the accuracy of König's formula for the Rayleigh disk.
By A. C. Merrington and C. W. Oatley. (Plate 10) ........................................... 505

A magnetic study of the iron-nickel-aluminium system. By W. Suksmith ........................................... 525

Diamagnetic anisotropy of organic molecules. By K. Lonsdale ........................................... 541

X-ray investigation of the structure transition of methane at the λ point.
By A. Schallamach. (Plates 11, 12) ........................................... 569

Index ........................................... 579
ABSTRACTS

OF PAPERS COMMUNICATED TO
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In accordance with a resolution of Council, summaries or abstracts of papers are to be published as soon as practicable. The publication of such abstracts in no way indicates that the papers have been accepted for publication in any fuller form. These abstracts are issued for convenience with the “Proceedings of the Royal Society of London” but do not form a part of the “Proceedings”. 4 JULY 1939

Calculated wave functions and energy values for X-ray terms of potassium.

By W. A. Thatcher. (Communicated by D. R. Hartree, F.R.S.—Received 28 April 1939.)

Self-consistent field calculations, without exchange, have been made for two states of the potassium atom ionized in an inner group, namely, for the configurations

$$K^+[(1s)^1 (2s)^2 (2p)^6 (3s)^2 (3p)^6]$$

and

$$K^+[(1s)^2 (2s)^2 (2p)^5 (3s)^3 (3p)^4].$$

The results are given in this paper. The perturbation of the wave functions of the outer electron groups on removal of an electron from an inner grant is found to be considerable, so that, for example, the (3s) and (3p) wave functions of a K atom ionized in the (1s) group are more like those of a normal Ca atom than like those of a normal K atom. The results may be applied to take this perturbation into account in the theory of the Auger effect or of X-ray dispersion.

The application made in the present paper is to the calculation of X-ray ionization energies. The total energies of these configurations and of the normal state of K⁺ have been calculated by Slater’s method, and the calculated values of $\nu/R$ for the $K$, $L_{\text{II}}$ and $L_{\text{III}}$ edges and $K\nu$ doublet obtained and compared with the observed values. The agreement is very good for the $K$ edge and good for the $K$ lines but less so for the $L$ edges.

A new method of evaluating one of the quantities, $\gamma_k(nl, n'l'/r)$, required into the evaluation of the energy integrals is given.
The friction of clean metals and the influence of adsorbed gases. The temperature coefficient of friction. By F. P. Bowden and T. P. Hughes. (Communicated by C. H. Desch, F.R.S.—Received 2 May 1939.)

A method is described for measuring the kinetic friction between metal surfaces which have been freed from the oxide and surface films that are normally present. The removal of the films has a profound effect, and the kinetic friction between the outgassed metals may be twenty times greater than that observed for the same metals cleaned in air.

The addition of a trace of oxygen to the clean metal causes an immediate reduction in the friction. Adsorbed hydrogen and nitrogen have little or no effect. Although the friction is reduced by a single film, it is clear that polymolecular layers are necessary before a substance can act as an effective boundary lubricant for moving surfaces.

The temperature coefficient of friction between clean metals was determined over a wide temperature range. Most of the metals investigated show a small but regular decrease in the kinetic friction as the temperature rises. If the temperature causes excessive softening of the metal the friction may rise to a high value.

The mechanism of sliding on ice and snow. By F. P. Bowden and T. P. Hughes. (Communicated by C. H. Desch, F.R.S.—Received 2 May 1939.)

Experimental studies of the friction on ice surfaces have shown that the low frictions observed at temperatures near the melting point were due to lubrication by a thin water film at the points of contact between the sliding surfaces. The coefficient of kinetic friction was found to be independent of the load, apparent area of contact, and speed of sliding over a certain range. When the temperature of the ice was decreased, the friction rose markedly as the water film became more difficult to form. Using ski of various materials, it was observed that the friction depended very largely on the thermal conductivity of the ski. This result suggested that frictional heating played a large part in melting a water film during sliding; it had been previously considered that pressure melting was alone responsible for the formation of this water film.

Experiments with miniature and real ski on snow surfaces showed that the same general laws were obeyed as on ice surfaces. The higher frictions obtained on snow were attributed to the extra work done in displacing and compressing the snow crystals.

Spontaneous rhythmic impedance changes in the trout's egg. By M. J. Hubbard and Lord Rothschild. (Communicated by J. Gray, F.R.S.—Received 12 May 1939.)

Unfertilized and fertilized eggs of the rainbow trout show spontaneous periodic changes of impedance. Measurements were made with an a.c. bridge and electron oscillograph as detector.
At an input frequency of 3000 cycles the maximum change in impedance per egg cycle corresponds to an approx. 0.4% impedance change in the equivalent parallel resistance and capacitance network in the standard arm of the bridge. The maximum capacitance and resistance changes in the latter are approx. 4.0 and 0.4% respectively. The effect occurs only after about 7 hr. immersion in water. The frequency is about 1.5 min. Killing the egg abolishes the effect. An increase in temperature increases the frequency and vice versa.

It is suggested that the impedance cycle consists of two components: (1) the main periodic change whose frequency is about 1.5 min., and (2) an in-phase periodic change of much smaller amplitude with a frequency of one-quarter that of the former.

The cause of multiple discharges in a Geiger-Muller counter. By C. H. Collie and F. Morgan. (Communicated by F. A. Lindemann, F.R.S.—Received 12 May 1939.)

The formation of double kicks in a Geiger-Muller counter has been investigated experimentally. It is shown that they can be produced by the presence of small amounts of xylene vapour in the counter, and that the double kick is due to the release of an electron from the cathode when the xylene ions are discharged 10^{-3} sec. after the first discharge.

Investigations of the mechanism of the transmission of plant viruses by insect vectors. By H. H. Storey. (Communicated by F. T. Brooks, F.R.S.—Received 16 May 1939.)

When puncturing through a membrane into a fluid, Cicadulina mbila ejects saliva only when it stylets are in motion, and not when they are at rest and fluid is being drawn into them. This saliva sets to a gel and is moulded internally by the stylets to form a sheath. No other material of insect origin has been observed to flow from the stylets.

The salivary glands of infective insects, when inoculated into the abdomens of non-infective ones, caused a few of these to become infective. Comparative experiments with other organs from the insect support the interpretation that the salivary glands may contain virus, either in small quantities or occasionally.

Attempts to demonstrate virus in a fluid upon which many infective insects had fed were almost always negative. Only when infective and non-infective insects fed simultaneously on a film of fluid held between two membranes did a few of the non-infective insects become infective, and these never caused infection more than once in a series of tests.

Results were similar with a maize leaf on which infective insects had fed. Simultaneous feeding on a small area of leaf alone caused a few non-infective insects to become infective, and these again were of low infective ability.

It is suggested that an infective C. mbila ejects virus in very small quantities, so that only rarely can another individual take up enough ejected virus to make it
infective and then only weakly so. The manner in which the virus is carried into the plant is still obscure; it is difficult to reconcile the view that the gelling saliva is the vehicle with the evidence of an earlier paper.

The crystal structure of di-n-propylmonocyanogold. By R. F. Phillips and H. M. Powell. (Communicated by C. S. Gibson, F.R.S.—Received 19 May 1939.)

Di-n-propylmonocyanogold crystallizes in the orthorhombic system, \(a_0 = 17.06\), \(b_0 = 22.36\), \(c_0 = 10.0\) A, space group Pca. There are 16 molecules of the formula \(\text{AuPr}_2\text{CN}\) per cell. A Patterson analysis and Fourier syntheses on (001), (100) and (010), two of these non-centrosymmetric, have been made and show that the true molecule consists of four of these units. The molecule is based on a square with gold atoms at the corners, linked by CN groups along each side, and two propyl groups are attached to each gold atom. The length of the side is found to be 5.18 A in accordance with the structure

\[
\text{Au—C≡N → Au—}
\]

The four covalencies of the auric gold atom are at right angles to each other and coplanar, and the bond length is close to 1.3 A. Although the syntheses are based on eye estimated intensities and the structure contains heavy atoms, the general positions of the largely overlapping propyl and cyano groups are clearly shown, especially in the centrosymmetric projection on (001). Spacial considerations are used to assign more definite sites to the lighter atoms in accordance with the projections, and the 144 atoms of the unit cell have been located. The bonds from the gold atoms to propyl groups all lie in the plane of the square, but the rest of the propyl groups are arranged out of this plane in a complicated way. Intermolecular distances are not less than 3.5 A. The low symmetry of the structure is attributed to the difficulty of packing an awkward shaped molecule without leaving gaps.

Note on the constitution of cyano derivatives of gold. By C. S. Gibson, F.R.S. (Received 19 May 1939.)

The results of the investigation described in the previous paper make it possible to suggest structural formulae for the decomposition products of di-n-propylmonocyanogold which are more satisfactory than those originally put forward by the author.

It seems probable that the insoluble di-n-propyldicyanodigold produced by loss of half the n-propyl radicals from di-n-propylmonocyanogold has a chain structure represented thus:

\[
\text{Pr}^\alpha
\]

\[
\ldots \text{Au—C≡N → Au—C≡N → Au—C≡N → Au—C≡N...}
\]

\[
\text{Pr}^\alpha
\]

\[
\text{Pr}^\alpha
\]
By complete loss of the n-propyl radicals aurous cyanide is produced which in all probability has also a chain structure represented thus:

\[
\ldots \text{Au} = \text{C} = \text{N} \rightarrow \text{Au} = \text{C} = \text{N} \rightarrow \text{Au} = \text{C} = \text{N} \ldots
\]

analogous to that of silver cyanide:

The action of ultra-violet radiation on barium and strontium azides. By W. E. Garner, F.R.S. and J. Maggs. (Received 22 May 1939.)

Crystals of the alkaline earth azides are decomposed by ultra-violet light at room temperature. The threshold wave-length for this reaction is \( \sim 3000 \) A in agreement with the threshold for the absorption by the \( \text{N}_3 \) ion in the solid state. There is an induction period before the evolution of nitrogen becomes measurable, after which the pressure increases at a linear rate.

Pretreatment of the crystals with ultra-violet produces changes in the length of the induction period and slopes of the log \( p \)-log \( t \) time curves for the thermal reaction. For short times of illumination of the crystals, \( p = k_t \tau^3 \) and \( \tau = k_0/\tau^3 \), where \( \tau \) is the time of illumination and \( t \) the length of the induction period. This is interpreted as indicating that ultra-violet light produces centres from which nuclei grow, these centres requiring 3–4 barium atoms before a nucleus is formed. The centres are possibly \( F' \) centres produced by the decomposition of \( \text{N}_3 \) ions by the light. On prolonged illumination, nuclei are formed at room temperatures. Evidence of a solarization effect was obtained for high intensities of light.

The number of nuclei formed in the thermal treatment is enormously increased by previous exposure to ultra-violet light, and it is shown that ultra-violet light produces two types of centres from which the nuclei grow, one being confined to the action of wave-lengths less than 2360 A.

The thermal decomposition of \( \text{BaN}_3 \) is unaffected by fields of 1250 V/cm.

The thermal decomposition of crystals of barium azide. By A. Wischin. (Communicated by W. E. Garner, F.R.S.—Received 22 May 1939.)

Measurements have been made of the rate of nuclear growth in the decomposition of crystals of barium azide and it has been found that the nuclei increase in radius at a linear rate. The activation energy for nuclear growth is \( 23.5 \) kcal., and the frequency of activation \( \sim 10^{14} \) molecular layers per second.

The numbers of nuclei increase as the third power of the time, which indicates that nuclei formation is a bimolecular process. The activation energy associated with this process is 74 kcal.

The pressure of the nitrogen evolved increases as the \( 10^8 \)-\( 10^6 \) power of the time, which is in good agreement with that calculated from the rate of nuclear growth and the rate of increase in the numbers of the nuclei.
On the decomposition of metallic azides. By N. F. Mott, F.R.S. (Received 22 May 1939.)

A theoretical discussion of the decomposition of metallic azides, based on the Wagner-Schottky theory of ionic conductivity and the electron theory of solids. The main points discussed are: the formation of metallic nuclei and the nature of the induction period; the way in which the presence of nuclei catalyses the reaction; the action of ultra-violet light. The similarity between the decomposition of azides and the photochemical reduction of silver halides is pointed out.

The mechanical efficiency of frog's muscle. By A. V. Hill, Sec.R.S. (Received 24 May 1939.)

A theoretical discussion is given of the mechanical efficiency (work/total energy) of frog's muscle. This is based on the heat of shortening, the heat of maintaining a contraction, and the constant defining the effect of tension on the rate of energy liberation. Equations are given relating the efficiency to the speed of shortening, in a contraction at constant speed. The constants are known for frog's muscle at 0° C and absolute values of the efficiency are calculated.

Experiments are described using a "protected" thermopile and a constant-speed ergometer, from which it appears that the relation between efficiency and speed is of the predicted form, and that the maximum efficiency and the optimum speed are very close to the predicted values.

The observed maximum efficiency (40%) of the initial process corresponds to an efficiency of 20% for the whole muscular cycle including recovery. This is not much less than the maximum efficiency in man. The efficiency of human muscular movements is considered.

A curious equality (or approximate equality) is discussed; the rate of heat production in maintaining a contraction at constant length is about equal to the extra heat of shortening at velocity b. This may have some significance not yet apparent.

The electrical conductivity of thin films of mercury. By E. T. S. Appleyard and J. R. Bristow. (Communicated by A. M. Tyndall, F.R.S.—Received 25 May 1939.)

The electrical resistance of mercury films deposited in very high vacua on surfaces cooled to various temperatures between 20-4 and 90° K has been investigated. The thickness of the films has been estimated by direct weighing to 3%. The results indicate that the delayed appearance of conductivity as deposition proceeds is due to agglomeration of the mercury into solid droplets, and that the cause of the sudden onset of conductivity is the touching of these droplets. The temperature coefficients of resistance of these films are all positive and reversible after annealing at the highest point in the temperature range. From a study of these coefficients it
is concluded that films above 500 A in thickness deposited at 64° K or lower can be regarded as coherent slices of metal, differing only from the bulk metal in being strained and in possessing a high residual resistance which can be modified by annealing treatment.


Mercury films prepared in high vacua have been examined in the superconducting state. The transition temperature from the normal to the superconducting state in films previously annealed at 90° K or more is very close to that of the bulk metal. On the other hand, films deposited at 4-2° K and not afterwards annealed show a displacement of the transition temperature downwards by about 0-2° K. In neither case is there evidence of any variation of transition temperature with the thickness of the films.

The critical longitudinal magnetic fields required to restore normal conductivity in the films at various temperatures have been determined.

If \( H_f \) is the critical magnetic field for a film at a definite temperature and \( H_M \) that for the bulk metal at the same temperature, it is found that at all temperatures \( H_f/H_M \) is larger than unity, and increases rapidly as the film diminishes in thickness. For a film of a definite thickness \( H_f/H_M \) increases steeply as the transition temperature is approached. It is inferred from this result that the depth of field penetration likewise increases steeply as the transition temperature is approached.

The spectrum of rubidium hydride, RbH. I. Analysis. By A. G. Gaydon and R. W. B. Pearse. (Communicated by A. Fowler, F.R.S.—Received 26 May 1939.)

A band spectrum attributed to rubidium hydride, RbH, has been observed in a discharge tube source containing metallic rubidium and hydrogen. The spectrum has been photographed on a 20 ft. concave grating spectrograph, and a rotational and vibrational analysis has been made.

The spectrum is of the "many-line" type characteristic of the alkali-metal hydrides, and is produced by a \( ^1Σ \rightarrow ^1Σ \) electronic transition.

The band system is strongly degraded to longer wave-lengths, corresponding to a large change of vibrational frequency; \( \nu_e \) is 936-77 cm.\(^{-1}\) for the ground electronic state and 244-6 cm.\(^{-1}\) for the excited state.

The constants associated with the vibration and rotation of the molecule have been calculated for the ground and excited electronic states. The excited state shows anomalies similar to those observed for the other alkali-metal hydrides.
The spectrum of rubidium hydride, RhH. II. Potential curves, wave functions and intensity distribution. By A. G. Gaydon and R. W. B. Pearse. (Communicated by A. Fowler, F.R.S.—Received 26 May 1939.)

The intensity distribution among the various vibrational transitions of the electronic emission spectrum of rubidium hydride is described; in addition to the normal Franck-Condon parabola, which in this case is very open, there are very well-marked secondary and tertiary parabolae.

To account for these subsidiary parabolae it is necessary to apply the methods of wave mechanics. As rubidium hydride is a particularly favourable example, an attempt has been made to compare the observed intensity distribution with that expected theoretically.

The potential functions have been calculated from the molecular constants derived from the analysis of the spectrum, and the potential curves are drawn and discussed briefly.

The wave functions for the various vibrational levels of a harmonic oscillator have been calculated for the two electronic states, and these have been distorted, by a simple method, to correspond approximately to the potential curves.

Using these wave functions, the intensity distribution has been calculated. It is in good general agreement with the observations, but shows some discrepancies in detail. The various assumptions and approximations made in making the calculations are examined. It is concluded that such discrepancies as exist are probably to be attributed to the approximate method of distorting the wave functions of the harmonic oscillator to correspond to the potential curves.

Morphogenesis and metabolism: studies with the cartesian diver ultramicro-manometer. V. Aerobic glycolysis measurements on the regions of the amphibian gastrula. By J. Needham, V. Rogers and S. C. Shen. (Communicated by Sir Frederick Hopkins, F.R.S.—Received 30 May 1939.)

The cartesian diver manometer has been applied to the measurement of aerobic glycolysis, following the two-cup method of Warburg. After a description of the calibration and testing of the method, which is applicable to total gas changes of the order of one-tenth of one cubic millimetre, it is shown that the aerobic glycolytic rate of all the regions of the amphibian gastrula is extremely low, approaching zero, and hence that the Pasteur reaction is equally efficient in the organisation centre and the ventral ectoderm. The absence of any difference in respiratory rate between these two regions, previously observed in gastrulae of toad and axolotl, is here confirmed by a different method for the frog. Similarly, the difference in respiratory quotient between the two regions previously observed in axolotl gastrulae, is here confirmed by a different method for the frog. It seems legitimate, therefore, to regard the general picture of metabolic changes in gastrulae found in the present series of papers as probably valid for most Amphibia.
On relativistic wave equations for particles of arbitrary spin in an electromagnetic field. By M. Fierz and W. Pauli. (Communicated by P. A. M. Dirac, F.R.S.—Received 31 May 1939.)

The force-free theory of particles with arbitrary spin values already published by one of the authors is generalized to the relativistic wave equations of such particles in an electromagnetic field, with a preliminary restriction to the c-number theory. The spin values 3/2 and 2 are treated in detail, and for the general case it is merely proved that consistent wave equations exist. The consistency of the system of field equations is attained by deriving them from a Lagrange function containing suitable additional terms which depend on new auxiliary quantities. All the differential equations of the field are derived by variation of the action integral, and the vanishing of the auxiliary quantities in the absence of an external field is made to follow as a consequence of them.

In the special case of zero rest-mass there exist identities between the equations, which are now invariant under a group of transformations which is the generalization of the group of gauge transformations in Maxwell's theory. In the particular case of spin 2, rest-mass zero, the equations agree in the force-free case with Einstein's equations for gravitational waves in general relativity in first approximation; the corresponding group of transformations arises from the infinitesimal co-ordinate transformations.

The reflexion of very long wireless waves from the ionosphere. By M. V. Wilkes. (Communicated by E. V. Appleton, F.R.S.—Received 1 June 1939.)

This paper is concerned with the theoretical interpretation of the experimental data already published by Best, Ratcliffe and Wilkes and by Budden, Ratcliffe and Wilkes on the reflected wave received via the ionosphere at short distances (about 90 km.) from the British Post Office transmitter at Rugby (wave-length 18,800 m.; 16 kcyc./sec.). It is shown that the diurnal changes in reflexion height are in agreement with what would be expected if reflexion took place from the bottom of a region of the type described by Chapman, in which the ionization is in quasi-equilibrium with the changes in zenith angle of the sun. The polarization and amplitude of the wave reflected from a layer of ionized gas in a magnetic field when a plane polarized wave of wave-length comparable with the dimensions of the layer is incident on it are discussed, and in particular the type of wave reflected from a Chapman region is deduced. It is shown that the observed constancy of the amplitude of the downcoming wave until near the end of the sunset period leads to the conclusion that in the reflecting region the frequency of electronic collisions is not greater than about $2 \times 10^6$ per sec., and the possibility of collisional absorption taking place below the reflecting level is discussed. The question of whether or not the "Lorentz term" is to be included in the magneto-ionic equations is considered, and it is shown that the long-wave evidence, though not conclusive, appears to be against including it.
Studies on the insect virus relationships of Hy. 3 virus, potato virus Y and cucumber virus 1 when transmitted by *Myzus persicae* (Sulz.), *Myzus circumflexus* (Buckt.) and *Macrosiphum gei* (Koch). By F. M. Roberts and M. A. Watson. (Communicated by Sir John Russell, F.R.S.—Received 1 June 1939.)

Three strains of *Hyoscyamus* virus 3, two of cucumber virus 1, and potato virus Y, were tested for their transmissibility by the aphides, *Myzus persicae*, *M. circumflexus* and *Macrosiphum gei*. The efficiency of the vectors in transmitting all the viruses increased with increasing time of fasting before feeding on the infected plants. Their efficiency decreased as the time of feeding on the infected plants increased. The most probable explanation of these effects is that the viruses are inactivated by some substance produced by the aphides when feeding.

The most successful vector on the whole was *Myzus persicae*, and the least successful was *Macrosiphum gei*, but the relative efficiency of the vectors varied with the different viruses, indicating that their degree of success depended upon several interacting factors. The most important of these factors appeared to be:

(a) The concentration of virus in the host plant.

(b) The localization of virus in the host plant.

(c) The capacity of the vector for inactivating the virus.

The viruses which have thus been shown to be similar in their insect-virus relationships are also similar in their physical properties, and there are many other aphid-transmitted viruses which resemble them in this respect. It is suggested that such viruses may form a natural group, with the same type of vector-virus relationship. This relationship appears to be a complex one, and it is unlikely that the viruses are mechanically transmitted.

The number of configurations of an assembly with long-distance order. By T. S. Chang. (Communicated by R. H. Fowler, F.R.S.—Received 1 June 1939.)

Starting from the equilibrium properties of an ideal alloy with a superlattice of the type *AB* and with arbitrary compositions which are obtained by application of Bethe’s method, we have found the partition function of the alloy by a process which is simply the reverse of deducing the equilibrium properties from the partition function. It is shown that if this partition function is expanded in powers of \((kT)^{-1}\), it agrees with the corresponding rigorous expression up to the power \((kT)^{-1}\).

From this partition function, we find an approximate expression for the number of ways of arranging \(\frac{1}{2}N(θ + θ')\) particles upon a lattice of the type *AB* consisting of \(N\) sites in total, with \(\frac{1}{2}Nθ\) particles on one sublattice and \(\frac{1}{2}Nθ'\) particles on the other, producing \(X\) pairs of nearest neighbours formed by the particles. This is given by an expression involving \(d = 1 - θ - θ'\) and \(q = 4X/2N\), \(z\) being the number of nearest neighbours of a site. The exact value of this number is evaluated for the special case in which the \(N\) sites are on a straight line, and is found to agree with the approximate formula exactly.
The scattering of alpha particles in helium. By S. Devons. (Communicated by W. L. Bragg, F.R.S.—Received 1 June 1939.)

The scattering of alpha particles in helium has been investigated for scattering angles of 27° and 38.5°, and for energies up to 8.5 MeV. It is found that the results are consistent with the existence of a broad level of Be8 with spin two quantum units, and with an energy of about 3.3 MeV in excess of the ground state, which is assumed to possess a mass equal to that of two alpha particles. The results for alpha particle energies greater than 7.0 MeV are not very accurate owing to the low intensity of the sources of thorium active deposit available.

A contribution to the theory of diffusion in non-ideal liquids and membranes. By J. F. Danielli. (Communicated by Sir Frederick Hopkins, F.R.S.—Received 5 June 1939.)

This paper has been written to cope with certain physical problems encountered in the study of the permeability of living cell membranes to penetrating molecules.

No theory of diffusion through liquids and solids has previously been presented which takes account of the structure of the diffusion medium. In this paper the point of view is adopted that all such media can be represented to a first approximation by an appropriate system of potential energy barriers, to cross any one of which a molecule must have more than a minimum kinetic energy—the activation energy of diffusion.

In § 1 certain cases are discussed where, within limits, the activation energy of diffusion may be ignored (actually, assumed identical for all molecules).

In § 2 it is assumed that the rate of diffusion over a single potential energy barrier is determined by a simple exponential equation of the form

\[ \text{rate} = r \phi (kT/2nm)^{1/2} \exp \left( -mv^2/2kT \right) C, \]

where \( r \) is a constant, \( \phi \) is the probability that a molecule having at least the kinetic energy \( \frac{1}{2}mv^2 \) will actually diffuse, \( \frac{1}{2}mv^2 \) is the activation energy of diffusion over the potential energy barrier, \( m \) is the mass of the diffusing molecule, \( k \) is the gas constant per molecule, \( T \) is the absolute temperature, \( C \) is the concentration of the diffusing molecules. Various interfaces are taken as representing single potential energy barriers, and it is shown that to a first approximation this exponential law accounts for the temperature variation of the rate of diffusion across such interfaces, provided no changes of structure, such as solidification, are involved.

In § 3 the same equation is applied to the diffusion of ions and molecules in water. It is shown that, to a first approximation, the equation accounts for the variations in rate of diffusion found with different ions and molecules.

In § 4 this approximate equation is applied to the problem of diffusion through a thin fatty membrane, 10^-4 cm. thick (the cell membrane). An expression is obtained for the permeability of this membrane, and it is shown that for a molecule such as glycerol the main resistance to diffusion lies at the oil-water interface, and that the resistance in the interior of the fatty layer may, by comparison, be neglected.

In § 5 is discussed some of the assumptions made in the previous sections.
Wave form, energy and reflexion by the ionospheres of atmospherics. By T. H. Laby, F.R.S., J. J. McNeill, F. G. Nicholls and A. F. B. Nickson. (Received 6 June 1939.)

The wave form of the electromagnetic pulse radiated from a lightning flash, known as an atmospheric, has been studied.

The atmospherics are received on a vertical aerial which is connected through an aperiodic amplifier to a cathode ray tube. The spot on the screen of the tube is photographed on a film fixed to the external surface of a cylindrical drum which rotates at a uniform peripheral speed.

Many hundreds of wave forms have been recorded from atmospheric sources 70 to 1500 km. distant, and incidental to the observations we have made, evidence has been obtained of the reflexion of atmospherics at an ionized layer. Such records show the intervals of time elapsing between the arrival of the first pulse along the ground, and the various reflected pulses.

From the simple theory and methods of reduction given in the paper, it is possible to determine the height of the reflecting ionized layer, and the distance of the flash. When this is done, the height of the layer is found to be between 53 and 82 km., values in reasonable agreement with the lower limits of the $E$ layer.

The observations are consistent with the sky wave and the ground wave, having the same velocity to 0.7%.

Oscillograms of typical atmospheric wave forms are shown, together with a possible interpretation of many of them. The assumption is made that the electrical discharge which radiates an atmospheric is a damped oscillation with a period determined by the instantaneous resistance, inductance and capacity.

The relation between the distance of an atmospheric source and its field strength is found to be linear and figures are given for the peak power and the total energy radiated as found from representative examples.

On fluctuations in electromagnetic radiation. By M. Born, F.R.S. and K. Fuchs. (Received 6 June 1939.)

A mistake (pointed out by Dr Fierz) in the former paper, Proceedings A, 170, 252, is corrected.