OBITUARY NOTICES.

JOHN KENNETH HAROLD INGLIS.

1877—1935.

By the death in 1935 of John Kenneth Harold Inglis the University of New Zealand lost a gifted and inspiring teacher of chemistry and an able administrator. He was born in Christchurch, New Zealand, in 1877, and was educated in that city, receiving most of his school training at Christ's College and his University training at Canterbury College, which is part of the University of New Zealand. He was granted the B.Sc. degree with honours in chemistry in 1898 and the M.A. degree in 1899. The ensuing two years he devoted to post-graduate and research work in the University of Edinburgh, and was subsequently granted the D.Sc. degree by that University. His research work in Edinburgh was done in collaboration with the late Professor Hugh Marshall, and is described in a joint paper in the *Proceedings of the Royal Society of Edinburgh* for 1902 on " The Action of Silver Salts on Solutions of Ammonium Persulphate." In this, the first published paper with which Inglis was connected, the authors show that through catalytic action by the silver ion the persulphate ion oxidises part of the ammonium ion present to nitrate ion, and that, if the concentration of the silver ion is relatively small, the reduction of the persulphate ion follows the unimolecular law. Inglis then went to the Physikalisch-chemisches Institut of the University of Leipzig, and worked for some time there, chiefly in collaboration with Professor Robert Luther. In 1903, however, he enrolled as a research student in the Chemical Laboratory of University College, London; and in 1904 he was appointed Assistant in Chemistry there under Sir William Ramsay, to fill a vacancy resulting from the appointment of Dr. M. W. Travers to the Chair of Chemistry in the University of Bristol. In 1906 Inglis was appointed Professor of Chemistry in University College, Reading (now the University of Reading); he resigned that position at the end of 1911 on his appointment to the Chair of Chemistry in the University of Otago in Dunedin, one of the constituent colleges of the University of New Zealand. In 1911 he was also admitted by examination to the Fellowship of the Institute of Chemistry of Great Britain and Ireland. He held the Chair of Chemistry at Otago for nearly twenty-four years, until his sudden death by heart failure at the end of 1935 in his fifty-eighth year. In 1915 he married Ethel Joanna, daughter of William Barron of Dunedin; she pre-deceased him in 1929, leaving one daughter, who survives him. Two other children of the marriage died in infancy.

At Leipzig Inglis' work was chiefly on the oxidation potential of ozone and on the electrochemistry of permanganic acid. In the course of this he confirmed the importance of the catalytic action of manganous ion in permanganate reactions. At University College, London, he carried out further work on ozone, including its estimation, apparent solubility in water, and interaction with aqueous hydrogen peroxide. In 1903 he published jointly with W. W. Taylor a paper on the aluminium electrode, in which evidence was adduced that the peculiar anodic behaviour of aluminium is probably due to the impermeability to aluminium ion and sulphate ion of a film of aluminium hydroxide, whereas halogen and several other ions readily pass through such a film.

Inglis' chief work at University College, London, however was on the fractional distillation at low temperatures of liquefied gases and on the application of this method, previously used by Ramsay and Travers in their classical work on the inert gases, to the analysis of complex gaseous mixtures. The most important outcome of this work was its application by Inglis to a detailed study of the sources of loss of combined nitrogen in the chamber process for making sulphuric acid, with the assistance of Messrs. Spencer, Chapman and Messel, Ltd. By careful analyses of the chimney gases from the chamber plant he showed that the loss is due chiefly to incomplete absorption of nitrogen peroxide and nitric oxide in the Gay Lussac tower, and that reduction to nitrous oxide causes less than one-tenth of the total loss. The analytical difficulties arose from the fact that the chimney gases contained besides nitrogen and oxygen small and variable amounts of carbon dioxide, nitrous and nitric oxides, nitrogen trioxide, nitrogen peroxide, sulphur di- and tri-oxides, and the vapour of sulphuric acid. During the same period Inglis, jointly with J. E. Coates, made careful measurements of the density of liquid nitrogen and liquid oxygen and of mixtures of these, from which it appeared that, whereas liquid nitrogen was normal, liquid oxygen was about one-tenth polymerised.

At Reading Inglis and his pupils carried out work on the conductivities of α-oximino-fatty acids, the electrolytic chlorination of aromatic organic acids, and the optical properties of compounds containing asymmetric carbon atoms with all four valencies directly attached to carbon. In the last compounds it was expected that racemisation of optically active members would be less pronounced than in compounds in which one valency of the asymmetric carbon atom is attached to hydrogen; but owing to difficulties in the way of purification only preliminary work was done before Inglis left for New Zealand.

In the University of Otago Inglis was faced with the disability which is unfortunately common in the smaller universities of the Dominions, namely, that the head of a scientific department has to deal with a large and varied amount of teaching and administrative work with such inadequate assistance and facilities that the conditions for research work are most discouraging. Consequently Inglis' activities there were mainly in teaching and administration. He was Chairman of the Professorial Board from 1916—1919; and he took an active share in building up the Faculty of Home Science, which was founded in 1911, the year in which he was appointed to the Chair of Chemistry. His outstanding characteristic was sterling honesty and integrity, and, although at times his directness and singleness of purpose prevented him from quite appreciating the other man's point of view, no one ever failed to respect him. It is safe to say that without exception his former students will mourn his loss.

N. T. M. WILSMORE.

THOMAS MARTIN LOWRY.

1874—1936.

THOMAS MARTIN LOWRY, who died at Cambridge on November 2nd, 1936, came of an old Cornish family which had been long connected with the Methodist Church; he was born at Low Moor, Bradford, Yorks, on October 26th, 1874, the second son of the Rev. E. P. Lowry, senior Wesleyan Chaplain and staff officer at Aldershot. He was educated at Kingswood School, Bath, and thence passed to the Central Technical College, South Kensington, with a Clothworkers' scholarship in 1893; he was awarded the Fellowship of the City and Guilds of London Institute in 1920. From 1896 to 1913 he was assistant to Prof. H. E. Armstrong and, from 1904 to 1913, Lecturer in Chemistry at the Westminster Training College; he became head of the chemical department in Guy's Hospital Medical School in 1913 and was the first teacher of chemistry in a Medical School to be made a Professor of the University of London. In 1920 he was appointed to the Chair of Physical Chemistry which had just been created in Cambridge with the aid of a benefaction from the Oil Companies, and held this position at his death. He married a daughter of the Rev. C. Wood in 1904 and is survived by his widow, two sons and a daughter.

During his long service with Prof. Armstrong, Lowry gained recognition for his delicate work in organic chemistry. The proficiency which he then acquired as a crystallographer expressed itself later in the aptitude which he displayed in applying exact physical methods of measurement to the solution of chemical problems; he developed a rare instinct for grasping the essentials of any subject which he attacked and for ensuring that the quantitative methods used were devoted to the measurement of something which was clearly defined. The vast mass of quantitative physical data collected by Lowry is thus not of merely ephemeral interest but will provide useful working material for future generations of physical chemists.

Lowry laid the foundations of his lifelong study of optical rotatory power quite early in his career as an investigator by discovering the mutarotation—a term which he introduced—of nitro-*d*-camphor and the stereoisomerism of a number of halogen derivatives of camphor. He isolated two isomeric π-bromonitro-*d*-camphors which change one into the other in solution until equilibrium is reached, thus furnishing a case of what he termed dynamic isomerism; the interconversion was followed by measurements of the rotatory power. The new technique thus initiated was applied to many cases of dynamic isomerism and the conditions determining the isomeric change were worked out. It was found that under favourable external conditions the mutarotation of nitro-*d*-camphor in chloroform solution can be arrested for some days and that the isomeric change of nitro-*d*-camphor is greatly accelerated in benzene solution by the addition of one part in a million of piperidine. The arrest of the change in chloroform solution is due to oxidation of the solvent and to the formation of products which neutralise the basic catalysts present in minute proportion. It may be noted that nitro-*d*-camphor provided one of the first examples of the catalytic action of bases which cannot be ascribed to the presence of hydroxylic ions and is therefore not covered by the conventional theory developed by Ostwald. The further study of this question led Lowry and Faulkner in 1925 to the discovery that the mutarotation of tetramethylglucose could be arrested in both cresol and pyridine solutions but proceeded almost too rapidly for measurement in a mixture of these two solvents. It was thus shown that the isomeric change is conditioned by the presence of an amphoteric solvent which alone is capable of acting as a complete catalyst of the process.

The migration of a hydrogen ion in such compounds as nitro-*d*-camphor and sugar derivatives depends on the addition and removal of a proton at two opposite poles of the molecule. The type of isomeric change involved in this process was termed *prototropy* by Lowry in 1923, although he regarded it as a special case of *ionotropy*, in which a whole radical migrates from one to another part of a molecule as an anion or a cation. This led him to an extended definition of acids and bases, also advanced independently by Brönsted, in which acid and base are defined respectively as the *proton-donor* and *proton-acceptor*. Lowry also saw that similar conditions prevail in conjugated systems in which opposite charges at the two ends may be neutralised by a migration of an electron throughout the system. The earlier portions of the work on this subject were summarised in a report to the British Association in 1904 and subsequent reports of a Committee of Section B on Dynamic Isomerism from 1905 to 1916; the details are given in a series of some thirty papers published mostly in the *Journal* of the Chemical Society. The results of this work were applied later by Lowry in a number of investigations, as, for instance, in a very complete study of the rotatory powers, densities, electrical conductivities, etc., of nicotine and its derivatives in the pure state and in aqueous solutions.

At the time when the earlier work on mutarotation was in progress little was known about the variation of optical rotatory power with wave-length—in fact hardly anything had been learnt since the death of Biot in 1862. It is perhaps Lowry's greatest contribution to chemical and physical science that he realised that little progress in this field could be made until values of rotatory power were determined over the widest possible range of wave-lengths, instead of for a single arbitrarily-selected point on a dispersion curve. So much had this subject been neglected, that when Drude wished to test his mathematical theory of rotatory power in 1907, the only data available were those for quartz. In 1913, Lowry and Dickson were able to show that the optical rotations of ten simple alcohols could be expressed by *one term* of Drude's equation, namely, $\alpha = k/(\lambda^2 - \lambda_0^2)$. A year later, Lowry showed that *two terms of opposite sign* completely represent the anomalous rotatory dispersion of ethyl *d*-tartrate, thus confirming the conclusion which had been reached many years before by Biot and by Arndtsen that anomalous rotatory dispersion originates in the superposition of two partial rotations of opposite sign and of unequal dispersions. These partial rotations may be due to diverse causes, so that some controversy has resulted as to their origin, but the essential validity of the conception, as represented by Drude's equation, was established beyond doubt. The anomalous rotatory dispersion of tartaric acid and the tartrates formed the subject of the Bakerian Lecture delivered by Lowry and Austin in 1921.

Drude's equation is only applicable to transparent media, for which the limits of its validity coincide with the conditions under which maximum experimental accuracy can be obtained. Lowry reached these limits in the case of quartz, where his measurements with a column nearly half a metre in length, giving a rotation of nearly 13,000° for the Hg 5461 line, extended down to 2263 A., where the rotation is over 100,000° in one direction, and to 32,000 A. in the other, the latter wave-length lying beyond the first infra-red absorption band. Over this entire range, the rotation of quartz, for about 1,000 wave-lengths, could be expressed with the greatest precision by a Drude equation with two terms of opposite signs together with a small constant. The characteristic frequencies of these two terms lie far in the Schumann region at 1130 and 310 A. respectively, and only a few months before his death Lowry was still exploring the possibility of showing their real existence by direct physical methods.

The validity of Drude's equation having been established, Lowry could proceed to rigid definitions so far as the region of transparency is concerned for normal and anomalous rotatory dispersions, namely where the rotation α, and $d\alpha/d\lambda$ and $d^2\alpha/d\lambda^2$ are of constant sign throughout or where α, $d\alpha/d\lambda$ and $d^2\alpha/d\lambda^2$ all pass respectively through zero values. An alternative classification is to describe as *simple* those dispersions which can be represented by one term, and as *complex* those requiring more than one. In general, however, simple dispersions are usually observed only when the characteristic frequencies of all the partial rotations lie close together in the Schumann region, as, for instance, in the sugar series, where the different asymmetric carbon atoms sometimes, but not always, produce a simple rotation. The effect of additional partial rotations of lower frequency, if present, will then always predominate, and between 1933 and 1935 Lowry found that for the two aldehydic sugars, tetra-acetyl μ-arabinose and penta-acetyl μ-fructose, prepared by Wolfrom, the rotations associated with the carbon atoms completely cancel one another, leaving only the pure simple rotation due to the aldehydic groups.

Another subject which interested Lowry was the conception of induced dissymmetry which he and Walker introduced in 1924. They observed with camphor and other substances, that one of the frequencies appearing in the Drude equation corresponds to the characteristic ultra-violet absorption of the carbonyl group, and hence concluded that the electronic structure of the carbonyl group also becomes dissymmetric under the influence of the asymmetric carbon atom. This introduction of a second (induced) centre of dissymmetry Lowry considered to give rise to anomalous rotatory dispersion in some cases.

In recent years, Lowry extended his work on rotatory dispersion from transparent to absorbing media, *i.e.*, to a study of the Cotton effect, with considerable success. In collaboration with H. Hudson he was able to develop equations which adequately express the course of the dispersion curve throughout the wave-length range covered by an absorption band. These equations were derived from results obtained by W. Kuhn in 1930.

During the War Lowry was largely concerned with the production and use of amatol mixtures and the difficulties which arose in shell-filling owing to the polymorphism of ammonium nitrate. He determined the four transition temperatures between the five solid forms of this salt and ascertained the form of the velocity curve for change of state; he also plotted the equilibrium diagram between ammonium nitrate and water. Another outcome of war-time activities is found in Lowry's studies of the chlorides of sulphur, a subject which had been investigated in Cambridge before his arrival. By a series of freezing-point determinations he was able to prove the existence of the red sulphur dichloride, SCl_2, in solution and to obtain it as a crystalline solid at low temperatures; he found that the proportion of sulphur dichloride present in a sulphur–chlorine system can be measured by its absorption of light of wave-lengths 5200 and 5400 A., to which sulphur monochloride and chlorine are transparent. He also obtained trisulphur tetrachloride, S_3Cl_4, and sulphur tetrachloride, SCl_4, the latter being an almost colourless crystalline solid which dissociates so rapidly that no evidence could be obtained of its existence in the liquid phase. Lowry found that sulphur tetrachloride is anomalous in having a higher dielectric constant in the solid state than when fused, behaviour which points to a change of molecular structure on fusion; this is in harmony with the observation that sulphur tetrachloride cannot be detected in the liquid phase and was interpreted by the equation

$$\underset{\text{Solid}}{[\mathrm{S\overset{+}{C}l_3}]\ \mathrm{\overset{-}{Cl}}} \rightleftharpoons \underset{\text{Liquid}}{\mathrm{SCl_2} + \mathrm{Cl_2}}$$

Lowry noted that phosphorus pentachloride similarly has a higher dielectric constant in the solid than in the liquid state; this he also attributed to a difference in molecular structure, which cannot, however, be analogous to the case of sulphur tetrachloride because vapour density determinations show phosphorus pentachloride to exist as such in the gaseous phase. The investigation of the sulphur–chlorine system is complicated by the occurrence of a number of dissociation reactions which proceed at different velocities and are influenced by the presence of catalysts, but Lowry was able to confirm his conclusions by measurements of the dielectric constants, densities, surface tensions and parachors in the system. It was found that sulphur dichloride is dissociated to the extent of about 16% into the monochloride and chlorine at the ordinary temperature.

Lowry was in the habit of publishing his papers in series with a common general heading and a more distinctive sub-title; in the series headed "Studies of Valency" the general title was indicative of his constant endeavour to apply modern physical conceptions quantitatively to chemical problems rather than to any continuity of subject. Thus, in one of these papers he concluded that hydrogen is capable of co-ordination like most other elements, basing his decision on such considerations as the crystal structure of ice, the existence of the dissociation $KHF_2 \rightleftharpoons \overset{+}{K} + \overset{-}{H}F_2$, in which the complex anion should have the constitution $\overset{-}{F}\overset{+}{H}\overset{-}{F}$, and the phenomena of tautomerism. In other papers of the same series he dealt with the constitutions of thallium and tellurium compounds; he resolved phenyl-*p*-tolylmethyltelluronium iodide into its optically active components by means of the camphorsulphonic acids and showed that the dextro- and the lævo-rotatory iodide undergo very rapid racemisation in acetone and ethyl acetate solutions.

During the last few years Lowry was engaged on the experimental study of the binary systems, N_2O_3–H_2O and N_2O_4–H_2O, with a view to completing the triangular phase diagram for the ternary system, H_2O–N_2O_3–N_2O_5. In the course of this difficult piece of work it was observed that on passing nitrogen peroxide into ozonised oxygen a blue gas, probaby NO_3, is produced; the gaseous mixture ignites below 100°, showing a deep blue wave-front. This curious example of combustion is probably represented by the equation $NO_3 + O_3 = NO_2 + 2O_2$.

Lowry found ample opportunity for the exercise of his gift of attracting collaborators in his work when appointed in 1920 to organise the new laboratory of physical chemistry in Cambridge. Here his ability as an organiser and his faculty for arousing enthusiasm were given full scope; the result is seen in the large number of important experimental papers published by Lowry and his co-workers during his sixteen years as Professor of Physical Chemistry. Few science laboratories in the country have risen to such high rank as creative institutions in so brief a period.

As a master of organic technique and theory Lowry possessed an advantage denied to many physical chemists; he had a vast detailed knowledge of those branches of science which he had made his own, and this information was freely at the service of others. He was an indefatigable worker and his pertinacity was shown in the way in which he returned over and over again to some earlier subject of investigation as new modes of elucidating a problem occurred to him. Whilst he discussed freely any subject which he understood, he was too honest to advance opinions on matters of which he was ignorant and did not always realise that others might not be so reticent. A bright idea, such as a qualitative application to chemistry of a quantitative physical conception, could always capture his attention, but his instinct for exact measurement quickly brought him back to earth. To Lowry scientific theory existed as a means of correlating the facts and though tenacious of his views he would replace them readily by others which fitted better.

Lowry had been an active member of the Faraday Society since its foundation in 1903 and played a leading part in its discussions, acting as its President in 1928—1930. As a firm believer in the stimulating effect of exchange of ideas between men of similar general interests but of different modes of approach he was often instrumental in attracting foreign specialists to this country, going to great pains to arrange meetings for them and extending to them an ample hospitality.

Lowry acted as Director of Shell-filling from 1917 to 1919; he did valuable service on the Trench Warfare Committee and the Chemical Warfare Committee and was an associate member of the Ordnance Committee at the time of his death. His war services gained him the C.B.E. and the Italian Order of St. Maurice and St. Lazarus. He took the D.Sc. (London) in 1899 and held the honorary degree of M.A. (Cambridge) and doctorates of science of Dublin and Brussels; he became a Fellow of the Royal Society in 1914.

In addition to some hundreds of important papers published with numerous collaborators, Lowry wrote several useful books; the last of these, on "Optical Rotatory Power," was issued in 1935 and will long remain a standard work on the subject. The immense amount of accurate experimental work which Lowry has left on record secures him a permanent place in the history of the science to which he was devoted. His old colleagues and students in the laboratory of physical chemistry which he built up at Cambridge will remember him as a staunch friend, an inspiring teacher and an indefatigable worker who has passed too soon from their ranks. W. J. POPE.

CAMILLE MATIGNON.

1867—1934.

ARTHÈME CAMILLE MATIGNON was born on January 3rd, 1867, at Saint Maurice-aux-Riches-Hommes, a little village in the Department of the Yonne in Burgundy; he died suddenly in Paris on March 18th, 1934. He was educated first at the school of St. François de Salles at Troyes and at the Lycée Condorcet at Paris, whence he passed to the Ecole Normale in 1886; after a brilliant career as a student he took his licentiate in mathematics and the physical sciences in 1888 and his final examinations in the physical sciences in 1889. Berthelot then appointed him an assistant at the Collège de France, and in this capacity Matignon carried out a number of pieces of work, chiefly of a thermochemical nature, which gained for him his doctorate. In 1893 Matignon was appointed a lecturer in the University of Lille and in 1894 became also Director of bleaching, dyeing and finishing at the Institut industriel du Nord; in 1898 he was appointed a lecturer at the Sorbonne and an Assistant Professor at the Collège de France, becoming an auxiliary Professor in 1903. When Le Chatelier succeeded Moissan at the Sorbonne in 1908 Matignon was elected to the Chair of Inorganic Chemistry at the Collège de France and held this position until his death. He was decorated as a Chevalier of the Légion d'Honneur in 1908 and was elected a member of the Académie des Sciences in succession to Haller in 1926; he was President of the French Chemical Society in 1932 and had acted as chief editor of *Chimie et Industrie* since the establishment of this journal in June, 1918, under the auspices of the French Society of Chemical Industry. He was elected an honorary Fellow of the Chemical Society on November 2nd, 1933.

In his early work with Berthelot, Matignon made an extensive study of the heats of combustion of the more important gaseous hydrocarbons and followed this by determinations of the heats of formation of ethyl alcohol, formic and acetic acids, and of a large number of sugars and related compounds. These investigations, carried out with the aid of Berthelot's calorimetric bomb, entailed much careful work in the preparation of highly purified materials and in the analysis of the products of combustion. Matignon then conceived the ambitious project of working out the energy relations subsisting between the closely related members of some one large group of organic compounds; he chose for this purpose a set of about seventy derivatives of urea, many of which were new, and studied their heats of formation, hydrolysis and interconversion. The results of this extensive piece of experimental work led him to confirm Murdoch and Doebner's view that hydurilic acid is the diureide of ethanetetracarboxylic acid; he also concluded that allantoin is the corresponding derivative of dihydroxyethanetetracarboxylic acid, a view now abandoned in favour of the half-acetal constitution advanced later by Piloty and others. In the course of this work Matignon drew attention to a number of thermochemical regularities, such, for instance, as that the replacement of hydrogen attached to nitrogen by an alkyl radical leads to a greater increase of the heat of combustion than when the replaced atom is directly joined to a carbon atom; the application of this rule led him to confirm Grimaux's conclusion that his " pyvuril " is 5-methylallantoin. The rule was extended later to embrace the fact that nitric esters are more powerful explosives than nitro-derivatives. Matignon's thermal studies of urea derivatives were in part prompted by the desire to elucidate the important part played in the living organism by the changes which these substances undergo; he was the first to apply thermochemical data to the interpretation of reactions in which the formation and hydrolysis of such compounds are involved. He was thus able to foresee that formic acid and urea should react at the ordinary temperature to yield formylurea and to show experimentally that the condensation proceeds as a reversible reaction; a study of the hydrolysis of parabanic, oxaluric and dimethylparabanic acids by water and by alkalis showed these also to proceed as balanced reactions and indicated the probability that equilibria of the type established are operative in vital processes. Incidentally to this work a number of salts of urea with weak acids, such as acetic and glycollic, were prepared and shown to be completely hydrolysed by water in the cold; the several types of acidic function exhibited by such compounds as hydurilic and oxaluric acids were also elucidated.

After his return to the Collège de France in 1898 Matignon addressed himself to more fundamental thermochemical questions and more particularly to the thermodynamics of chemical systems. His examination of the part played by heat in chemical reactions led him to the statement of an empirical law of thermodynamics which Nernst termed the " Le Chatelier–Matignon rule." This states that for gaseous equilibria in which one gaseous and one or more solid phases are concerned, such as the sublimation of solids, the dissociation of calcium carbonate, and the like, the relation $Q/T = 32$ holds approximately in all cases, Q being the heat evolved at constant pressure and T the absolute temperature at which the gaseous pressure attains one atmosphere. This empirical law is an extension to chemical dissociation and reaction of Trouton's law concerning heats of vaporisation. The Le Chatelier–Matignon rule can be stated in several ways and may be used to foretell whether certain hypothetical reactions can take place and, if so, whether they are reversible or not; a few of the many previously unknown reactions which were thus predicted and afterwards experimentally verified may be here stated :

(1) The following reactions are reversible: $2KCl + Pt + 2Cl_2 = K_2PtCl_6$ and $2K_4Fe(CN)_6 + Cl_2 = K_3Fe(CN)_6 + 2KCl$. (2) Calcium carbide can absorb nitrogen; this was afterwards verified by Erlvein, who thus obtained calcium cyanamide. (3) Gaseous hydrogen sulphide acts upon potassium carbonate but not on the sodium salt. (4) Sodium chloride reacts with sodium hydrogen sulphate because the normal dissociation pressure accords with the relation $Q/T = 32$. (5) In the reaction $BaO + \frac{1}{2}O_2 = BaO_2 + K$, K should have a value of about 18 instead of 12 as previously recorded; the value was found later to be 19. (6) Oxalic acid acts on sodium chloride, liberating hydrogen chloride. (7) Potassium iodide should absorb oxygen; Basset and Dodé showed in 1934 that this reaction occurs at high temperatures and pressures, yielding potassium iodate. (8) Arsenious anhydride and sodium nitrite should absorb oxygen in accordance with the equations

$$As_2O_3 + O_2 = As_2O_5 + 62{\cdot}6\ K \text{ and } 2NaNO_2 + O_2 = 2NaNO_3 + 45\ K;$$

Matignon and his co-workers showed that these reactions proceed at high temperatures and pressures.

The fact that non-volatile acids, bases and salts will react completely with non-volatile salts if one of the possible products is volatile under the prevailing conditions, was established by Berthollet about 1800; Matignon showed this to be a special case of what he termed the " law of volatility in chemical reactions," which is of general application. The law may be stated as follows : A temperature exists at which reaction will occur in any system of non-volatile liquid or solid substances if that reaction can yield volatile products. This law was verified in a number of cases, notably in those represented by the equations

$$3MgO + 2Al = Al_2O_3 + 3Mg(\text{vap.}) - 172{\cdot}3\ K \text{ and } 3BaO + Si = BaSiO_3 + 2Ba - 37\ K.$$

Both reactions proceed to completion and the second, in which ferrosilicon is heated with baryta in a steel tube at 1200°, might be used economically for the manufacture of barium.

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The law of volatility explains why, although carbon monoxide has a low heat of formation, carbon finds such wide applications as a reducing agent.

Whilst at the Sorbonne, Matignon carried out a great deal of work on the metals of the rare earths. By heating a mixture of the oxide of the metal with magnesium so as to liberate the rare-earth metal in nitrogen and in hydrogen, he showed that nitrogen combines rapidly with thorium, cerium, lanthanum, praseodymium, neodymium, samarium, gadolinium, ytterbium and yttrium and that hydrogen is rapidly absorbed by the last six of these metals. In collaboration with Delépine he prepared anhydrous thorium chloride by heating thoria in carbon tetrachloride vapour, reduced it to the metal by sodium, and prepared the hydride, ThH_4, and nitride, Th_3N_4. With Burion he worked out a general method for the preparation of such anhydrous chlorides as those of thorium, silicon, aluminium, vanadium, praseodymium, neodymium, samarium, vanadium, chromium, etc., based on the action of sulphur chloride and chlorine simultaneously on the corresponding oxides. This method of preparation proved very convenient and facilitated the production of large quantities of the rarer anhydrous chlorides. These were used for the determination of the physical and more particularly of the thermal constants of the salts and for the preparation of compounds which served to illustrate and extend Matignon's work on energetics. Thus he showed that seven compounds of neodymium chloride, $NdCl_2$, and eight of samarium chloride, $SmCl_3$, with ammonia exist, each stable within certain temperature limits at atmospheric pressure; a compound in which samarium acts as a bivalent element, namely, the chloride, $SmCl_2$, was obtained by the action of hydrogen or ammonia on the perchloride, $SmCl_3$. The fact that samarium can act as a bivalent element was confirmed by the preparation of the iodide, SmI_2; later Urbain and Burion obtained the compound $EuCl_2$, and Klemm and Shuth, $YbCl_2$, and it now appears that samarium, europium and ytterbium alone among the metals of the rare earths can exhibit bivalency. A large proportion of the available physical and thermal data concerning the elements of the rare earths were provided by this chapter of Matignon's activities.

Matignon showed that all technical samples of zinc dust contain nitrogen, in general, 0·2—0·4%, but that nitrogen is not absorbed by zinc between its melting and boiling points; commercial aluminium and ferromanganese also contain nitrogen. In general the metallic nitrides are more stable than the oxides towards heat; the consequence was drawn that nitrides which are unattacked by oxygen at high temperatures, such as those of silicon and aluminium, were formed during the cooling of the earth and later yielded ammonia, assimilable by plant life, by the action of water. In collaboration with Lassieur, Matignon showed that zinc begins to combine with oxygen at 600° and with nitrogen at 670°; they prepared the pure crystalline nitride, Mg_3N_4, and showed it to have a higher heat of formation than lead oxide.

During the War the shortage of sulphuric acid led Matignon and Meyer to study the ternary system, water–sodium sulphate–ammonium sulphate, with a view to utilising sodium bisulphate for the large-scale manufacture of ammonium sulphate. The need for nitrogenous manures also led to the study of the equilibrium between ammonium carbonate and urea; during this work, carried out with Fréjacques, it was found that urea, which begins to decompose at its melting point, 132°, is stable at temperatures above 150° in the presence of ammonia. Amongst war activities it may be noted that Matignon discovered an iron–alumina catalyst to be the most efficient in the ammonia synthesis, that he devised a scheme for utilising the oxidation reaction, nitric acid–nitrous acid, for carrying out oxidation reactions on a technical scale and applied it to converting a cargo of sugar, spoilt by sea-water, into oxalic acid, the nitric acid being regenerated by air oxidation from the nitrous fumes.

Matignon was fertile in expedient and his papers reveal many ingenious laboratory devices. He prepared monosodioacetylene, NaC_2H, which is formed below 190°, and the disodio-derivative, produced above 210°, in a pure state by the action of the gas on sodium under conditions which prevented local superheating and showed that the monosodio-derivative decomposes quantitatively into disodioacetylene and acetylene at 210°. For the desiccation of gases he introduced the use of fused common salt ground up with metallic sodium, and he obtained hydrogen phosphide, containing a little hydrogen as the only impurity, by utilising the mixture of calcium and aluminium phosphides produced by the interaction of calcium phosphate and aluminium powder. During the War he studied many waste products, such as the marc or grape refuse and the vinasse from brandy distillation residues, with a view to their economic utilisation; in this connexion his association with the late Paul Kestner was a very happy one. He was an ardent apostle of intensive agriculture and applied much of his scientific and literary talent to supporting the thesis that the prime need of agricultural France was more artificial manure provided by more intense scientific effort and made available by more efficient industrial organisation. His campaign in this field had much success, though naturally less immediately than he would have wished; it is too soon to appraise at its true value the service which Matignon rendered to his country by laboratory work, writings, and the spoken word on the subject of scientific agriculture.

Those of his English colleagues who had the honour of attending the bicentenary of the birth of Priestley celebrated by the French Chemical Society in 1933 and heard the address which Matignon delivered on the life and work of the discoverer of oxygen recognised that they were listening not only to an orator but also to one who took a real delight in historical studies; the discourse was not of mere ephemeral interest but will remain as a substantial contribution to the history of early chemical research. The scientific knowledge of the ancients, as, for example, the agricultural wisdom displayed by Virgil in the " Georgics," roused Matignon to enthusiasm; his interest in the past and in the history of his own country of Burgundy led to his election as President of the Société Archéologique de Sens in 1932 and of the Congress called at Avallon in 1933 to celebrate the tercentenary of Vauban.

Matignon was an eloquent speaker and wrote in a lucid, convincing style. The editorials which he contributed monthly to *Chimie et Industrie* from 1918 to the end of his life were read with interest by the whole chemical world; the last of these—on the fiftieth anniversary of the death of Dumas—was published a few days after his own death. Matignon's striking personality and his gay, vivacious enthusiasm made him a notable figure. He did much to promote the re-establishment of those normal relations between scientific men which had been so rudely shattered by the Great War; he had many friends far outside his own country who will remember him with affection and respect. W. J. POPE.

JULIUS ARTHUR NIEUWLAND.

1878—1936.

THE sudden death of the Rev. Julius Arthur Nieuwland, C.S.C., Professor of Organic Chemistry at Notre Dame University, which occurred on June 11th, 1936, ended a life full of interest in science and rich in accomplishments.

Born at Hansbeke, near Ghent, Belgium, on February 14th, 1878, and taken to South Bend, Indiana, when he was about three years of age, Nieuwland grew up in this American Middle Western city, where his parents had settled. There he attended a parochial school, was graduated from the University of Notre Dame in 1899, and ordained priest in the Congregation of the Holy Cross in 1903. The sciences that interested him most were botany and chemistry. In 1904 he obtained the Ph.D. degree from Catholic University, Washington, D.C., the subject of his thesis being " Some Reactions of Acetylene."

Thereafter he taught botany at the University of Notre Dame for fourteen years and organic chemistry from 1918 until his death. His interest in botany was lifelong. Much of his time was devoted to field excursions and the classification of higher plants. He founded and edited the *American Midland Naturalist*, a journal devoted primarily to the natural history of the prairie states, and prepared an " Outline of Plant Organography and Terminology."

His chemical researches continued along the lines begun by his thesis. He was the first to use copper as a catalyst for acetylene reactions and prepared divinylacetylene, a compound formed by the chemical union of three molecules of acetylene. Later, the possibilities of monovinylacetylene, which he also obtained, without isolating or identifying it, were recognised and formed the basis of further work leading to chloroprene and finally to its product of polymerisation, the artificial rubber " DuPrene." These investigations, an outgrowth of a purely theoretical study of acetylene reactions, were carried out in the laboratories of the DuPont Company, with whom Father Nieuwland collaborated.

His acetylene researches also formed the basis for the development of lewisite under the direction of Professor G. N. Lewis of the University of California.

Father Nieuwland, or Dr. Nieuwland as he preferred to be called, was a member of the American Chemical Society, the Chemical Society, London, the German Chemical Society, the American Association for the Advancement of Science, the Biological Society of Washington, the Washington Academy of Science, and the Indiana Academy of Science, of which he was president in 1934. He was honoured for his work in chemistry by awards of several medals, such as the Gold Medal of the American Institute and the Nichols Medal, presented by the New York Section of the A.C.S. in 1935.

Nieuwland was a very modest man, respected and loved by all who knew him. Through his death science has lost a capable investigator and his students and fellow workers a valued adviser.

W. S. CALCOTT.

P. A. ELLIS RICHARDS.

1868—1936.

BY the passing on the 22nd of December last of Percy Andrew Ellis Richards, at the age of 68, chemistry lost one of its most devoted servants and this Society one who throughout a long period as a Fellow held it in high regard.

Born in 1868 and educated at St. Paul's School and King's College, London, he studied analytical chemistry under the late Professor C. W. Heaton, whom he succeeded in the post of lecturer in chemistry and physics at Charing Cross Hospital. On the death of his chief he set up in practice as consulting and analytical chemist. Soon afterwards he was appointed public analyst for the parish of St. Martin-in-the-Fields, and, when his parish and others were united to form the City of Westminster, continued as one of the three public analysts for the City. He was appointed to a similar post at Hammersmith in 1904 and for many years acted as honorary analyst to Charing Cross Hospital. His experience and ability in medical chemistry and toxicology were drawn upon in his work in connexion with some famous cases.

Richards was a loyal and active Fellow of the Institute of Chemistry, serving on the Council for two periods of four years, as auditor for four years, and as examiner in Branch E for a further four-year period. He served the Society of Public Analysts for seventeen years as honorary secretary and was then elected to the presidential chair, an honour which he carried with distinction.

During the many years he was in practice he carried out work for the Local Government Board—now the Ministry of Health—upon the " facing " of rice, upon preservatives in imported meat, and upon vinegar, the results of which are embodied in official communications. He also served on two Departmental Committees appointed by the Minister of Health; the first of these was on preservatives and colouring matters in food and the second on " improvers " in flour. In 1906 he was a member of the Joint Advisory Committee of the Society of Public Analysts and the Pharmaceutical Society which had the subject of drugs under consideration and to this Committee he acted as honorary secretary.

A public analyst of distinction, Richards was no less successful as a teacher. In addition to the post at Charing Cross Hospital, he held that of professor of chemistry at Queen's College, London, and was also lecturer in chemistry and metallurgy at the Royal Dental Hospital. His very many students at these institutions will remember with affection the kindly and gracious teacher who spared no pains in explaining so lucidly all their difficult problems. He wrote for his students at Charing Cross Hospital a small text-book on practical chemistry which he later enlarged to cover a wider syllabus; this became probably the best-known work on the subject among medical students. He had many private pupils in analytical chemistry who have since successfully established themselves in posts under various Governments, Local Authorities, and in commercial chemical posts. All these, the writer among them, will note his passing with especial regret, for we owe much to the careful and conscientious training he gave us. We were privileged to gain an insight into the working of his mind and into those painstaking methods wherein results were checked and again checked before final acceptance.

His contributions to chemical and medical literature were many and embraced subjects far removed from his own particular sphere of food and drug analysis. Many Fellows of this Society will be conversant with those published in *The Analyst* and there is consequently little need to recount them all here. He was the first to notice the action of weak acids on soluble fluorides and successfully demonstrated that citric and tartaric acids, and even carbon dioxide, caused the liberation of hydrofluoric acid from them and that therefore their use as food preservatives was attended by some danger of injury to health. Up to that time fluorides and fluosilicates were so used, but nowadays are very infrequently encountered. He contributed papers to *The Lancet* and other medical journals upon the saline waters of Salsomaggiore and Boston Spa, upon the determination of platinum in dental alloys, and upon the determination of iron in animal organs. In the last he was associated with Dr. William Hunter in researches on pernicious anæmia, in which disease there is an accumulation of iron in the liver, kidneys and spleen; as his contribution to this work he carried out determinations of iron content in a very large number of cases.

Throughout a busy life Richards found time to serve on various councils and committees at the institutions wherein he taught. He had, too, a marked ability in the field of finance and served very successfully Queen's College as bursar and the Royal Dental Hospital as honorary treasurer. All these additional duties he performed very faithfully and with distinction; there were no adverse balances in Richards' day which wise investment and careful husbanding of resources could counter.

The life now ended began in days when modern chemistry was hardly out of its infancy, when most of the processes which are now commonplace with us were unknown, and when many of the refined instruments we now use were not invented. One may instance the Kjeldahl process for the determination of nitrogen in organic compounds; one of the stories Richards told was of the use of the combustion method for the determination of proteins in milk! Another story had reference to the comparatively massive quantities of material worked upon; for the determination of fat, quantities of the order of 50 grams were taken and the method usually consisted in grinding the dried material with sand and ether in a mortar, the fat being finally recovered. These and other methods equally crude were current in Richards' early days. He witnessed the introduction of all the refinements we now use; his life may be said to span the period between macroscopic and microscopic analysis, for microanalysis has now been brought to a perfection at once ingenious and beautiful. One might elaborate this theme and quote many examples of almost unbelievable progress. But most of us know the history of our own science and among ourselves there is no necessity to dwell upon it. Richards learnt his organic chemistry at a time when constitutional formulæ were unknown and he never forgot to remind his pupils of the many advantages these and other things brought. For them no lists of compounds of empirical formula CH_2O and so on; for them a nearly completed Periodic Table—no having to memorise precisely where many lacunæ fell. One wonders how he would view the possibility, lately revealed, of our having to extend the table to include elements of our own manufacture, wherein the works of Nature have been excelled by her creature Man; or whether he would feel quite happy in the contemplation of constitutional formulæ for some vitamins.

Richards lived to witness the transition of analytical chemistry from a position almost of contempt to its rightful place of equality with synthetic chemistry, a fact which afforded him keen pleasure, though for the last few years this was tinged with regret that his failing health prevented him taking an active part in this progress. It seemed that fate had laid him by just when, being at the height of his powers, he could have contributed not a little to the progress of our science. During his life he gave much to chemistry; some of us who knew him well think he might have spared himself a little and thus have escaped that breakdown in health that robbed us of his co-operation. Very few can hope to excel his record, not many even to equal it, but all will honour him for what he gave so freely and ungrudgingly to us and our cause. F. W. EDWARDS.

PERCY RICHARD SANDERS.

1875—1937.

PERCY R. SANDERS was born on March 19th, 1875, and entered the Inland Revenue Service in 1895. He studied at the Royal College of Science, London, from 1896 to 1898 and worked in the Government laboratories before being appointed to take charge of the Customs Chemical Station at the port of Newhaven. He was an enthusiastic Territorial Officer; during the early part of the Great War he was placed in charge of the construction of an extensive scheme for the defence of the Newhaven Port, and was awarded the Military Cross. After the war, he returned to the Customs and Excise Department, in which he served until his death on January 18th last. He maintained his interest in chemistry throughout the whole of his career and earned the esteem of all with whom he came into contact, officially and socially. A. MORE.