SIR WILLIAM RAMSAY, K.C.B., F.R.S.

THE first scientific words, probably, ever printed from the pen of Sir William Ramsay read curiously now that the full chapter of his writings is closed. They served to introduce his career, and may, with an unexpected aptness, be recalled at its close. Though he left early, he left behind much that has already become a permanent part of the common heritage of science, well known to all. On this, once again for a moment, those now mourning his sad and untimely death may linger, loth to say farewell.

The words introduce his thesis for the doctorate at Tübingen under Fittig in 1872: "To determine the constitution of chemical compounds has been the endeavour of chemists ever since the mere discovery of new bodies has ceased to engross their chief attention." Little could the youth of nineteen then have tasted of the joys of discovery that he could so talk of "mere" discovery. Before him the unknown future held a career of discovery which was to raise him to an unchallenged pinnacle among his colleagues, not of new compounds, but of a whole family of new elements, unsuspected even though the Periodic Law had long since called their roll, and utterly different, in the entire negation of their chemical properties, from any kind of matter previously known. Yet fundamentally true the random words have proved themselves, even in connection with so great advances, in that crescendo of scientific accomplishment which heralded the coming of another century. It is no longer these discoveries that engross, but the problems of constitution to which they led up and contributed—no longer, however, the problem of the constitution of chemical compounds, but the key problem of all physical science and of materialistic philosophy, the problem of the constitution of the elements and the structure of the atom.

Ramsay, whatever had been his youth, training, or after circumstances, would never have been content to think the thoughts of others, nor to confine himself to the paths that they had roughhewn. His earlier work in physical chemistry—the determination of the molecular weight of liquids from their surface-tension with Shields, his work on accurate vapour density measurements, and his studies of vapour pressure with Young—already showed his disposition to stray from the well-beaten track. But the clue to the existence of a new gas in the atmosphere, found by Lord Rayleigh in the discrepancy between the density of atmospheric nitrogen and that prepared from compounds, started him off definitely into the trackless wild and gave his exceptional gifts full and free scope. Every faculty is now at its best, and in the field of chemistry so opened up little help is forthcoming from the current methods of experiment and deduction. In such an apparently trivial experimental detail, for example, as the choice of a suitable lubricant for taps and ground joints might lie the difference between mastery and total failure. Pertinacity, too, is called for to pursue a uniform series of negative results in the search for positive chemical properties of the new gases until the sum of the apparent failures should unite in a single satisfying positive conclusion, that the gases were non-valent, not merely exceptionally difficult to bring into combination. Lastly, new methods of reasoning from the physical qualities, in the absence of chemical, must be brought to bear before the atomic weight of these elements can be assigned and they can take their proper place in the scheme of elements.

Novel as it all appeared, fitting place was found for Ramsay's love of the early history of his subject and the delight he took in the work of the early pioneers. After a century's oblivion, the remarkable experiment of Cavendish on the sparking of air over alkalis was re-discovered, and another, and by no means the least, tribute so paid to the foresight of this remarkable man. Since then this same experiment has had on the industrial and practical side, in the fixation of atmospheric nitrogen, as remarkable a sequel as it received at the hands of Lord Rayleigh and Sir William Ramsay in the discovery of argon.

It is customary to regard the next step, which was essentially Ramsay's alone, the discovery of helium, as a very natural and direct development of his earlier work with Lord Rayleigh on argon. This is only partially true. In one sense the discovery of helium was entirely distinct; for, though, like the other inert gases, it exists in the atmosphere, unlike all the others it was not discovered there. The name, of course, recalls the long arm of scientific method and the discovery of the chief of its spectrum lines in the spectrum of the sun's chromosphere by Lockyer and Frankland in 1868. By the way, would it not be a graceful tribute to Ramsay, and also a step in the right direction of a consistent nomenclature, to rechristen this gas "helion," so making it correspond with the other members of the family, argon, neon, krypton, xenon, and, by chance, the three isotopic radioactive emanations?

When Ramsay came upon this gas for the first time, as it were, face to face in the gases from the uranium minerals which Hillebrand had thought to be nitrogen, recognised its signature in the λ of its D_3 line, and found that it was only present in minerals containing uranium and thorium, he broke, unawares, new ground in a field totally unconnected with that hitherto cultivated for argon. His proof that it possessed the same absolute lack of chemical combining power, his immediate recognition of the fact that he had found a second member of what was a new family of elements of which probably more existed, and the successful separation of these, and also helium itself, from the atmosphere in collaboration with Travers, brought back the research into its former course. The significance of the remarkable fact that helium alone of the inert gases existed otherwise than in a free state in the atmosphere, and that, in spite of its total lack of combining power, it was found pent up somehow in uranium and thorium minerals, was grasped only later by others. But it was essentially the starting point of a new departure which

in the fullness of time was again to link itself with its source.

It has been well remarked of Ramsay that he stood to the outside world for an essentially British school of chemistry. To describe him as original would be like saying water is wet. He was of the essence of originality, and, during the time the writer knew him, entirely without any apparent sheet-anchor of fixed conviction or established belief in scientific doctrine, which at all times, in a science somewhat prone to let go sheet-anchors, made him a unique and almost incomprehensible personality. It is true that in his later years he suffered from the defects of these qualities, and he failed to criticise sufficiently his own ideas and experimental results before making them public. He seemed to lose something of that sense of the great and terrible responsibility which must at all times rest heavily on the scientific leader, and never more than in the case of the pioneer. All through his work, probably, his collaborators had perforce to assume to an undue extent the *rôle* of "devil's advocate," and much of his best work was done in partnership with those who recognised this. But in the zenith of his powers at University College and in the full swing of his elucidation of the family of inert gases, he trod fearlessly and without an error the difficult path of the pioneer and won a permanent right to something far greater than the title of a successful discoverer. Argon, helium, neon, krypton, and xenon were capital discoveries, but the bringing of this group into harmony with the rest of the elements might have appeared a task almost insuperable in the face of their total lack of chemical properties. The recognition that they were monatomic and non-valent gases occupying a "zero" family of the Periodic Table, preceding that of the monovalent alkali-metal family, from which hitherto the table had seemed to start, was made in spite of the fact that argon itself is an "exception," in the orderly sequence of elements, of the same type as tellurium, which was then a very hotly debated and puzzling question.

This was physical chemistry in a sense as original and bold as the great thermo-dynamical and electro-chemical generalisations of the American and Continental savants, which hitherto had almost monopolised the term. It initiated a widening of the domain that was to grow apace. The human mind seems incapable in its initial processes of grasping thoroughly more than one fundamental point of view at a time. Each has to be grasped separately before both eyes can be opened without the image becoming blurred. The phlogistonists had a single eye for what we now call energy, Lavoisier for what we now call mass. The first physical chemists found the thermo-dynamical point of view so clear-cut and complete that some of them sought to banish from their conceptions the molecular and atomic viewpoints as unnecessary, unproved, and unprovable hypotheses. Ramsay, confronted with a type of element utterly devoid of chemical properties and forced to rely entirely on their physical properties to put them in their proper relation to the whole, solved the problem completely and correctly by the aid of the molecular and atomic conceptions alone, though it is only lately that opposition to his views has entirely died down. Before he died he had the satisfaction of seeing this his own side of physical chemistry developed, by the discoveries in connection with radio-activity and the Brownian movement, to an amazing extent. The physical reality of atoms and molecules has been demonstrated by methods of great directness and power; and these, incidentally, applied to the case of his own gases, confirmed his earlier interpretation of their monatomic character in a way that made further cavil impossible.

But now we must go back to 1896, to the year of the discovery of helium and to the year that Henri Becquerel in Paris discovered the radio-activity of uranium, but a few months after Röntgen had given to the world a sixth sense. In Becquerel's footsteps M. and Mme. Curie were starting on the quest which led to radium. Rutherford had come from the mirror image of our islands in the Southern Seas to learn at the Cavendish Laboratory under Sir J. J. Thomson, and with him to forge the weapons of measurement and discrimination which, in the new sciences that the dying century had called forth, were to prove their sufficiency. His specific recognition of the α-rays was one of the first-fruits of the new methods, which, a little later, in Canada, at the McGill University, in the fine Macdonald science laboratories, were to play such an important part in the amazing succession of discoveries that followed, and which culminated in the complete and satisfying explanation of radio-active phenomena which is accepted to-day.

Then, by one of the strangest combinations of destiny, the centre of interest shifts again for the moment back to the laboratory where helium was discovered, as the associate of uranium and thorium in minerals, seven years before, to Sir William's private laboratory at University College. Word had passed along the underground corridors below, and the room had swiftly and silently filled with a throng of staff and students, clustering round those fortunate enough to possess a pocket spectroscope, all making the one short remark, "Yes! it's helium." For that was the room where was being put the coping-stone to the arch that in seven short years had sprung up from the twin discoveries of the rare gases and of radio-activity, and Sir William was witnessing with the spectroscope the first ocular proof of the genesis of helium from radium, which had been predicted from the theory of atomic disintegration. Nobody can deny that destiny, so frequently erratic, here made a happy choice, not only because the original discovery of helium was made by Ramsay, but also because in his laboratory had been worked out those delicate methods of gas manipulation which alone were equal to dealing with the minute amounts of helium involved in this investigation.

In another direction there was an intimate connection between the discovery of the inert gases and radio-activity. The "radio-active emana-

tions" discovered by Rutherford were shown to be inert gases of the argon type, and Ramsay, having satisfied himself of this, enthusiastically took up the study of the radium emanation, and made an exhaustive study of its physical properties, largely in conjunction with Whytlaw Gray. In his research on xenon his methods of gas manipulation had had a severe test, two or three cubic centimetres of gas being the total stock available after working up an enormous quantity of air. But in the case of the radium emanation, only a small fraction of a cubic millimetre at most can be obtained at a time, and the methods were tried to the uttermost. The extraordinary amount of information which these workers and also Rutherford were enabled to obtain about the physical constants of the new gas in approximately pure condition is one of the triumphs in the investigation of minute amounts of matter. In this research also the extraordinarily delicate micro-balance, devised by Steele, found something worthy of its powers.

For many of the latter years of his life Ramsay brought forward evidence to show that the energy liberated in radio-active transformations was sufficiently powerful to bring about the transmutation of one element into another. But these and similar attempts to produce artificial transmutation by radio-active and electrical agencies are not yet accepted by the majority. The subject is undermined with pitfalls, and to history must be left the final judgment on this thorny question.

The writer's personal acquaintance with Ramsay dates only from 1898, and his association with him only from the time when his great work on the rare gases of the atmosphere was completed. His views, therefore, can only be partial, and as regards one of the most fruitful periods of his life indirect. In 1898 a group of honours candidates in white ties outside the chemical laboratories at Oxford was joined by the distinguished examiner from London, whose discoveries were upon everyone's lips. We were chaffed at the state of our hands, yellow from a nitrification set upon the previous day's examination, and we were assured that we need not scruple to accept an invitation to dinner, as the stains were quite invisible by artificial light!

The instant popularity of such a man with his juniors and students is not difficult to account for. At University College he was looked up to by them in a way that can scarcely be expressed. He was at once genial, approachable, and great—any of which alone is an infallible passport to the student's heart—and he repaid their trust and affection with a loyalty to them as complete as that of a Scottish chieftain to his clan. But even among those who, at one time or other, may have been sharply in conflict with him—and among contemporary chemists none probably have been the centre of so much controversy—there must be few who did not feel the fascination of his personality, and are not now among the multitude of friends and admirers who feel his loss as personal and irreplaceable. It may be worth recording, seeing the stormy time through which he passed, that one who had known him well all his life could say to the writer that he had never heard a really unkind thing said by Ramsay of any of his colleagues or opponents. Not only his personal friends and whole-hearted admirers are to-day among those who are feeling that "they loved the man and revere his memory."

FREDERICK SODDY.

IT was in 1880 or 1881, very soon after Ramsay had come to the Bristol Chair of Chemistry, that late one very hot and sultry summer evening a newly made friend, tennis-racquet in hand, came to seek him in his private laboratory. "Ah, I'm glad you've come. No, I'd not forgotten, but I've had trouble with this and a long day of it, but it is all right now, and I'll come." Across the window of the narrow make-shift room of the old building that served as the first home of the University College stretched the long length of a complicated system of glass bulbs and tubes and mercury pumps in which he was conducting a distillation for one of his vapour pressure investigations. At that moment some ill-annealed junction, perhaps too near a flame, cracked and gave way; air entered with a hiss and reversed the flow of hot liquid; another crack and then a crash—for, though he sprang to save it, a large mercury receiver broke and discharged its contents over the edge of the table on to the floor, where most of it disappeared between the ill-fitting boards. "Well," thought the friend, "that will be the end of this day's work." But he did not yet know Ramsay, who, looking up with a rueful smile, said: "I'm afraid this means no tennis for me to-day." "What are you going to do?" "Take up the floor and recover the mercury—and a dirty job it will be." And so it proved; but by next morning the mercury had been recovered and the apparatus had been rebuilt and was at work again. That was Ramsay at the age of twenty-eight, this my first glimpse of the indomitable energy which was one of the secrets of his noble career. In the thirty-six years that have elapsed since then it seemed to me that his instinct and practice were always the same: so soon as any demand for action came, to make up his mind what to do and then to act at once. Ask any of the hundreds of friends who have sought and received his help and you will hear from all sides how quickly as well as how generously the help was given.

This energy in action was the outcome of a remarkably healthy and vigorous physique, which he knew how to attend to; and any challenge to which in a feat of skill was accepted as an intentional exercise. A fifty-mile bicycle ride left him quite willing to walk another twenty miles. This tireless physical vigour without doubt contributed to the attainment of his well-known mechanical skill in glass-blowing and to the steadiness of hand and eye which underlay many of his great experimental achievements. So, too, his quickness in picking up foreign languages was partly due to his fine and acute musical ear. Even the sense of smell was for him an instrument of analysis the

use of which he had learnt to push far beyond the limits of ordinary expectation, and was the subject of more than one scientific communication.

Such was the happy physical endowment at the command of the eager and affectionate spirit which, wherever he went, made William Ramsay so extraordinarily lovable and acceptable to all classes of men. A man so harmoniously constituted is not often met, and there have been many moments when, watching my friend in the midst of his ideally happy family surroundings, I have said to myself that I have never seen an expression so beautiful and radiant on any human countenance. "Radiant energy" is the phrase that best recalls and summarises his personal characteristics.

No accession of honours or acclamation spoilt for one moment the childlike simplicity of his character. Of course he enjoyed them, but that his friends should rejoice seemed what he cared for most. They brought him new and enlarged intercourse, but the old channels of quiet and tried affection ran deep and full as ever; discussion was as free, as patient, and as fruitful. Genius of any kind he always disclaimed. "It is all pure luck and pegging away," was his phrase; or, as he insisted when revisiting the Scientific Club at the Bristol University, which he had helped to found twenty-one years before, his chief asset in any success he had attained had been a "shocking bad memory," which prevented his recollecting a chemical or physical fact of which he had been told or bad merely read, till he had forced himself to rediscover it in some phenomenon within his own experience. Then, indeed, he admitted that he never forgot it. It was, I think, a similarity of instinct for learning by an experimental appeal in which physical sensation should be involved that first drew us together.

Any mistakes he made were those inevitable to an eager and impetuous temperament. Always grateful for help, he sometimes over-estimated the abilities of the friend who gave it. Accustomed to find difficulties yield to his own labour and ingenuity, his sanguine expectation sometimes blinded him to obstacles which were destined to prove insurmountable. Unsuspicious and always approachable, and a little impatient of the limitations of scientific orthodoxy, he found that he had sometimes lent too ready an ear to representations that were to prove untrustworthy; but, being willing to follow ten false clues rather than miss one real one, he was ever more afraid of the consequences of over-caution than of over-confidence.

So wide were his sympathies and interests and so quick his ability to take in new ideas or follow a subtle argument that men of every profession and workers in every branch of science found in him an ideal listener, and were stimulated by his quick grasp and pertinent and suggestive inquiries, and so it came to pass, as it seemed to us who watched him from the ranks, that he moved among the leaders of thought in any sphere and in any country, recognised as intellectually their peer, while behind all his questionings burned continually the passionate desire to help to unravel the mystery of life and the significance of the physical universe. "Most men," he once lamented to me, "have no interest in physical facts of Nature. They pretend interest because they cannot ignore the palpable results of applying science, but the things in themselves are absolutely without interest for them." How this interest might be aroused by education was a matter that he was always ready to discuss.

Of all his most intimate friends who had already passed away, none was more deeply mourned by him than G. F. Fitzgerald, whose suggestion and counsel were ever at his disposal. *Par nobile fratrum!* let us always remember them together.

A. M. WORTHINGTON.

ROLAND TRIMEN, F.R.S.

ROLAND TRIMEN, the third son of Richard and Marianne Esther Trimen, of 3 Park Place Villas, Paddington, was born on October 29, 1840. He was educated at King's College School, which he entered in 1853, having previously been a pupil at a private school at Rottingdean. When about eighteen he took the voyage to Capetown for the benefit of his health, returning to England in 1859. In the following year he again sailed to Capetown and entered the Cape Civil Service. In 1872 he was appointed Curator of the South African Museum in succession to E. L. Layard. In 1881 he was appointed sole commissioner to the Phylloxera Congress at Bordeaux, and in 1886 a member of the Commission for extirpating this pest from the Cape vineyards. In 1892 he became a member of the Cape Fisheries Commission.

In 1883 he married Miss Blanche Bull.

In 1895 Trimen was compelled by the state of his health to resign the curatorship of the Capetown Museum and return to England. He became a Fellow of the Royal Society in 1883, and was awarded the Darwin medal in 1910. The general feeling of naturalists when this award became known was well expressed in the letter of congratulation sent by the Entomological Society of London to their past president of 1897-98:—

"Among living naturalists there are few indeed whose merits as associates and fellow-workers with Darwin can bear comparison with your own; and we feel sure that all alike, in rejoicing at this public recognition of your life-long services to biological science, will agree that the present honour could not have been more worthily bestowed."

Trimen contributed the third of the three great papers which laid the foundations of the study of insect mimicry, and were published by the Linnean Society in 1862, 1865, and 1869. The dates of the two latter are generally quoted as 1866 and 1870, the years of the *volumes* of transactions; but the papers were published in the *parts* issued in the previous years. The first, by Bates, dealt with the Lepidopterous fauna of the Amazon valley; the second, by Wallace, with that of the East; while Trimen completed the survey by extending it to Africa. In this he had perhaps the hardest task