basic acids, and on the production of aldol and its beautiful derivatives.

The classical investigations with which Wurtz enriched science form but a small part of his work. He was one of the few French chemists who founded a school, and the greater number of the present generation of French chemists were his students.

It might well be supposed that the labours of this great investigator and teacher who had, in addition to his professional work, much official business and a considerable social position, would have left him neither energy nor leisure for other work. But he found time for much else. Besides being a brilliant lecturer and laboratory teacher, he excelled as a writer. The ease and rapidity with which he wrote induced him to undertake various literary works. He brought out his "Dictionnaire de Chimie" in a marvellously short time, with the aid of friends and pupils. The elegantly written little book "La Théorie Atomique" has long since been translated into all the chief modern languages. The "Leçons Élémentaires de Chimie Moderne" is a model of lucid exposition.

The fundamental feature of Wurtz's character was a love of truth. With this love of truth was combined a modest estimate of his own merits, accompanied by the most heartfelt and generous appreciation of the labours of others.

A. W. W.

William Spottiswoode was born in London on January 11th, 1825. He was descended from an old and distinguished Scottish family, of whom, perhaps, the most notable character was John Spotiswood, the Archbishop of St. Andrew's, who crowned Charles I at Holyrood, and was the author of "A History of the Church of Scotland." Andrew Spottiswoode, the father of William, was himself a man of no ordinary attainments; he represented Colchester for some time in Parliament, and in 1831 was admitted into partnership with George Eyre as one of Her Majesty's printers. His wife, William's mother, was of the Longman family, well known from its connexion with the celebrated publishing firm.

Of the early days of William Spottiswoode there is but little to tell. His school life began at Laleham under a brother of Dean Buckland. From Laleham he went to Eton, but his stay there was short, as the first recorded development of his scientific tastes resulted in an explosion which, though effecting no damage to his moral reputation, was deemed inconsistent with sound discipline. He was accordingly moved to Harrow, then under Dr. Wordsworth, and was there placed in the upper "shell." After continuing three years at Harrow, where he had the reputation for being studious and thoughtful, he in 1842 obtained a Lyon Scholarship and went to Balliol College, Oxford.

His mathematical tutors there were Dr. Temple, the present Bishop of London, and afterwards the Rev. Bartholomew Price, who had the highest opinion of his industry and power of work. His range of reading is said to have been very extensive. In 1845 he took his B.A. degree as a first-class in mathematics, and in 1846–7 gained successively the Senior University and the Johnson's Mathematical Scholarships.

In 1846 Mr. Spottiswoode left Oxford to take his father's place as Queen's printer, but he kept up his connexion with the University, delivering a course of lectures at his college on solid geometry, and acting in 1857–8 as Examiner in the Mathematical Schools.

The business of the Queen's Printing Office continued to occupy his close attention until his death. The great powers which he possessed as an organiser and master of detail ensured the advancement and complete commercial success of this great establishment, and rendered of real efficiency his unceasing efforts to promote the physical and moral welfare of his workpeople.

Mr. Spottiswoode began to communicate to the world the results of his mathematical researches in 1847, when he issued a series of five pamphlets, which he entitled "Meditationes Analyticæ." These contained thirteen essays on a variety of mathematical topics, including the curvature of surfaces, virtual velocities, infinitesimal analysis, physical astronomy, and the calculus of variations. After a pause of three years, he in 1850 sent three brief papers to the "Philosophical Magazine" on quaternions, and from that time forward his communications to the leading English and foreign mathematical societies and journals were poured out in an almost continuous stream. In a list of his publications which is before the writer, four years only of his subsequent life, viz., 1858, 1867, 1869, and 1878, appear without some record of mathematical work committed to the press. Much of this no doubt was of a slight and fugitive character, consisting merely of new proofs by elegant methods of known theorems, or notes of ideas suggested by the papers of others which the wide range of his college reading enabled him to follow without difficulty, so that but few were allowed to escape his attention. But of important and original work there was an abundance. The interesting series of communications on the contact of curves and surfaces which are contained in the "Philosophical Transactions" of 1862 and subsequent years, would alone account for the high rank he obtained as a mathematician. It would not be possible to discuss in any detail the various mathematical writings which have established the reputation of Mr. Spottiswoode without the use of complex symbolical expressions quite inconsistent with the objects of a brief obituary notice. In truth, the mastery which he had obtained over the mathematical symbols was so complete that he never shrank from the use of

expressions, however complicated, nay, the more complicated they were the more he seemed to revel in them, provided they did not sin against the ruling spirit of all his work—symmetry.

To a mind imbued with the love of mathematical symmetry the study of determinants had naturally every attraction. In 1851 Mr. Spottiswoode published, in the form of a pamphlet, an account of some elementary theorems on the subject. This having fallen out of print, permission was sought by the editor of "Crelle" to reproduce it in the pages of that journal. Mr. Spottiswoode granted the request, and undertook to revise his work. "The subject had, however, been so extensively developed in the interim, that it proved necessary not merely to revise it, but entirely to rewrite the work," which became a memoir of 116 pages. To this, the first elementary treatise on determinants, much of the rapid development of the subject is due. The effect of the study on Mr. Spottiswoode's own methods was most pronounced; there is scarcely a page of his mathematical writings that does not bristle with determinants.

Two communications made by Mr. Spottiswoode in 1860 and 1863 to the Royal Asiatic Society upon mathematical subjects, should be specially referred to. In a brief note in the Journal of that Society (vol. xvii, pp. 221—222) he discusses the claims of Bhóskaráchary, an Indian astronomer, to the discovery of the principle of the differential calculus; and in a more lengthy article in vol. xx, pp. 345—370, of the same publication, he translates into modern symbols the formulæ made use of by the Hindoos in calculating eclipses, contained in the "Súrya Siddhánta." The acquaintance which he had with this work was formed by reading it in the original tongue, for among his varied acquirements he possessed a remarkable knowledge of several European and Oriental languages.

Mr. Spottiswoode was not a traveller in the usual extensive meaning of the term, but he has left us an interesting record of a journey which he made in 1856 through Eastern Russia, entitled "A Tarantasse Journey through Eastern Russia in the Autumn of 1856;" and in 1860, in company with his brother and a sister, he accomplished an expedition through Croatia and Hungary.

In 1861 Mr. Spottiswoode was married to the eldest daughter of the late William Urquhart Arbuthnot, a distinguished member of the Indian Council.

In 1871 Mr. Spottiswoode turned his attention to experimental physical science. The resources at his command enabled him to furnish his laboratory on a scale which rendered it in some respects unique. The gain to the scientific world was not due merely to his own experiments, as, with characteristic generosity, he was always ready to advance the discoveries of others by the loan of the costly and beautiful apparatus with which he had surrounded himself, and

in the perfecting of which he had spent much care and ingenuity. His earliest researches bore on the phenomena of the polarisation of light, upon which he wrote an admirable little handbook, published in the "Nature Series." At a later period he made a number of communications to the "Proceedings of the Royal Society" on the electric discharge in rarefied gases. In 1879 he was joined in his researches on this subject by Mr. J. F. Moulton, and in conjunction with him entered upon an investigation of the sensitive state of the discharge. An important paper in the "Philosophical Transactions" of 1879 (pp. 165—229), and some shorter notes subsequently published in the Society's "Proceedings," give in detail the singular and elegant results which were arrived at.

The great beauty of the experiments involved in Mr. Spottiswoode's physical researches led to demands from his friends that they should be laid before the public in a popular form. The lectures which he delivered to crowded audiences at the Royal Institution and elsewhere were characterised by a remarkable clearness of exposition, and by a depth of poetic feeling which excited much surprise among those who knew of him only as an abstruse mathematician. Perhaps the most interesting example of his powers as a lecturer is to be found in a discourse on "Sunlight, Sea, and Sky," delivered to working men at the British Association Meeting in Brighton in 1872 ("Nature," vol. vi, pp. 333—336). The reputation he acquired in these essays excited high expectations with regard to the address which, as President of the British Association, he had to deliver in Dublin in 1878. These expectations were fully justified by the result. The stores of a mind imbued with the spirit of a philosopher, a mathematician, a physicist, and a poet, were drawn upon with no niggard hand, and matters usually regarded as beyond the ken of others than experts were explained to the unversed in language as interesting as it was simple, clear, and precise. The judgment of his fellow-workers could now be unhesitatingly approved by others.

The honours which were bestowed on Mr. Spottiswoode were many. He was LL.D. of Cambridge, Dublin, and Edinburgh, and D.C.L. of Oxford. He was elected correspondent of the Institute (Académie des Sciences) for the Geometrical Section, after a sharp contest with M. Borchardt. He was Fellow of the Royal Society of Edinburgh, the Royal Astronomical Society, the Royal Asiatic Society, the Royal Geographical Society, the Society of Antiquaries, and the Ethnological Society. He occupied the Presidential Chair of Section A of the British Association in 1865, of the London Mathematical Society in 1870–2, of the British Association in 1878, of which latter body he acted as Treasurer from 1861 to 1874. Of the Royal Institution he was Treasurer from 1865 to 1873, and Secretary from 1871 up to his death. He was also a Trustee of the British Museum.

The Fellowship of the Royal Society was conferred upon him in 1853. After having served several times upon the Council, he in 1871 became Treasurer, a position which he held up to 1878, in November of which year he succeeded to Sir J. Hooker as President. One more fully qualified to occupy this important post it would be difficult to find. To a manner in which sweetness and dignity were singularly blended, he added an unfeigned interest in the work of others, in whatever field it lay, and a rare quickness of appreciation of its merits; while his love of society and liberal hospitality had surrounded him with a wide circle of distinguished friends both English and foreign.

Death overtook Mr. Spottiswoode while he was yet in the prime of life and in the full vigour of his intellect. A serious tricycle accident some months before had lowered his strength so that he was unable to resist an attack of Roman fever, complicated by congestion of the lungs; and thus he passed away on the morning of June 27, 1883.

His remains rest in Westminster Abbey. If further words are needed to justify the claims of William Spottiswoode, President of the Royal Society, to such an honour, none better or more eloquent could be selected than those uttered over his scarcely closed grave by the Dean of Westminster, words which supply that reference to the beauty of his character, without which this brief sketch of him would be indeed imperfect. "Those to whom his memory is dear need not blush to think that he lies near those whose thoughts have enriched, whose examples have guided, or whose lives have served mankind; that he rests there not as a thinker only, not as a student only, but as a citizen of England, as a gifted worker in the fair domain of knowledge, as a busy worker in the manifold range of active life, and that he carried into each sphere the same minute and careful and constant and untiring industry, the same rare powers, the same high aim of serving truth, of serving man, and of serving God. . . . He was emphatically by nature and by choice a man of science. His own special and more cherished studies lay in those high and abstract regions which are traversed only by the few. He moved with ease, we are told, on heights where others can scarcely draw their breath. He did not devote himself to those great fields of knowledge, success in which at once appeals to the imagination of us who stand outside the circle of the true students of science. We can point to no marked and tangible result of his labours such as comes at once to the mind of the passing visitor, or may be brought home to the comprehension of even the least instructed stranger, as he stands on the grave of a Newton, or a Herschel, or a Lyell, or a Darwin. Yet he was, in the truest sense of the words, a man of science. Devout in soul and unperplexed in faith, he never, we are told, cared for one single moment to speak of science in the sense implied in the often misused

phrase as 'the handmaid of religion.' He looked on the study of science as, I might even say, part of his religion, as the pursuit of truth, truth only, truth for her own sake; a pursuit to be followed up independently, fearlessly, faithfully, to whatever results patient and enlightened, but impartial and honest, investigation should lead the inquirer. He shrank from all attempts to divert, or to confuse, or to limit the aim of the student by putting before him any other one consideration than that of the pressing forwards to what was clear, true, and demonstrable within his own department. . . . And to all who followed truth in the same spirit he turned with an instinctive and cordial sympathy. He won men's hearts, we hear, by an unassuming and unselfish gentleness. But he did more. The variety of mental powers which enabled him to hold the threads of the many branching lines of the ever expanding studies of his age, which touched with poetry his treatment of the most abstruse themes, and gave a rigorous accuracy to his management of the smallest detail of his business, was united to an attractiveness and transparency of character, and a spotless integrity and uprightness which secured men's confidence. . . . And if he lies not far from those whose genius—very different to his own—has enlarged the bounds of human thought, and embodied sometimes in immortal clothing the various chords of human feeling and emotion, it is something to feel that rarely beneath this roof has been laid one of a purer or more spotless life."

A. B. K.

Peter William Barlow, whose death occurred on May 19th, 1885, was the eldest son of the late Professor Barlow.

He was educated at private schools, and having at an early age selected civil engineering as his profession, became a pupil of the late Mr. Henry Palmer, Member of the Institute of Civil Engineers, under whom he was engaged on the Liverpool and Birmingham Canal and the then New London Docks.

The active demand for railways which followed the opening of the Liverpool and Manchester Railway, caused him to be employed in the preliminary surveys and studies of the county of Kent, with reference to a railway to Dover, and in 1836 he acted as resident engineer under the late Sir William Cubitt, on the central division of the London and Dover Railway, which formed the nucleus of the present South Eastern system. He subsequently became resident engineer of the whole line, and afterwards the engineer-in-chief, during which period he constructed the North Kent, the Tunbridge and Hastings, and many other lines in connexion with the South Eastern system. He also constructed the Londonderry and Enniskillen, and the Londonderry and Coleraine, and other railways.