therefore, that sugar moves in the sieve tubes by a process analogous to diffusion, but that the mechanism by which such high absolute rates of movement are maintained is unknown.

In this connexion the possibilities of streaming movements in the segments of the sieve tube might be worthy of further examination. It is a well-known fact that in many elongated living cells the protoplasm of the cell rotates within its wall at speeds which would permit of movement along the cell at rates of several centimetres an hour. There is still the need of transfer from one rotating protoplast to the next on the opposite side of a cellulose wall, but the distance thus traversed by diffusion will not be more than $\frac{1}{100}$ the total distance travelled in the sieve tube. This method of transfer would then result in movement, which would obey the concentration gradient, and yet be very much more rapid than diffusion in water. Mason and Maskell apparently reject it because protoplasmic rotation is rarely seen in the adult sieve tube although it has been reported by Lecomte. On the other hand, in sections of young developing phloem, as in tangential longitudinal sections through the inner bark of trees, which are mounted in water, most lively streaming movements are usually visible. Strasburger has also shown how readily similar movement can be seen in long cells in the phloem of herbaceous plants which were very possibly developing sieve tubes.

Whilst the adult sieve tube, therefore, may act as a reservoir, which is gradually depleted by local utilisation of its contents, the streaming segment of the developing tube may be responsible for the rapid longitudinal transfer of the carbohydrates. Mason and Maskell eliminated, so far as possible, the complications introduced by growth activities by cutting down the duration of their successive experiments so far as possible. But the inner segment of the phloem in which the very high concentration of sucrose was observed would contain all the young sieve tubes developing from the cambium.

This consideration might throw some light upon a gradient of reducing sugars in the leaf being followed by an equivalent gradient of sucrose in the phloem of the axis. Any enzyme synthesis of sucrose from glucose and fructose *in vitro* has so far proved impossible, and in the light of modern knowledge of the difficulties of sucrose synthesis (NATURE, Oct. 13, 1928, p. 578), this is quite explicable. In the sieve tube it is difficult to see how the direct conversion of reducing sugar to sucrose is to be brought about, but if the reducing sugars are employed in the construction of living protoplasm, which is then utilised in the construction of a new series of sieve tubes from the cambium, in the differentiating sieve tube sucrose may be found instead of the hexoses which originally entered into the composition of the protoplasm.

J. H. PRIESTLEY.

Obituary.

DR. J. W. L. GLAISHER, F.R.S.

DR. J. W. L. GLAISHER died on Dec. 7, 1928, at the age of eighty years. At the time of his death he was the senior among the actual fellows of Trinity College, Cambridge; was the senior member of the London Mathematical Society; and was almost the senior in standing among the fellows of the Royal Society and the fellows of the Royal Astronomical Society. In his prime he ranked as one of the recognised English pure mathematicians of his generation, pursuing mainly older subjects by methods that were direct and simple. Throughout his life he was devoted to astronomy, chiefly in its mathematical developments. In the later part of his life he attained high rank as an authority on pottery, of which he had made a select collection, famous and invaluable.

Glaisher was the elder son of James Glaisher, F.R.S., himself an astronomer, a mathematician specially devoted to the calculation of numerical tables, and a pioneer in meteorology, sometimes at the risk of his life. For the father was an aeronaut of note; with Coxwell in 1862 he made the dangerous balloon ascent which reached the greatest height (about seven miles) ever recorded by survivors. This aeronautical achievement inspired a popular music-hall song of the day; and "Up in a balloon, boys," was sung by the undergraduate gallery in the Cambridge Senate-House as the aeronaut's distinguished son was being admitted to his first degree.

James Whitbread Lee Glaisher was born at Lewisham, in Kent, on Nov. 5, 1848. He was sent to St. Paul's School in London, which in 1867 he left as the Campden Exhibitioner. In that year he went into residence at Trinity College, Cambridge; and that was his home for the rest of his life. He was duly elected a scholar in 1868. He graduated as Second Wrangler in 1871, the Senior Wrangler being John Hopkinson, also a Trinity scholar, later the distinguished engineer. He was elected a fellow of his College in that same year; the election was doubly notable, for it was the first held after the parliamentary removal of dissenters' disability of fellowship tenure, and all the three successful candidates (the other two being Hopkinson and the present Dean of Ely) were elected at their earliest date of candidature.

Glaisher was appointed assistant tutor of his College on Oct. 12, 1871, an office that qualified for the lay retention of his fellowship, though celibate restrictions existed for another eleven years. He was tutor from 1883 until 1893, for the then customary normal period. He remained a lecturer on the mathematical staff until 1910, having been continued beyond the normal maximum period by the College Council.

Glaisher never held any permanent appointment outside Cambridge. It was currently believed that, on Airy's retirement in 1881, he refused the office of Astronomer Royal which had been offered to him; the duty would, of course, have exacted residence at Greenwich. He remained a bachelor. When first a fellow, he lived in Whewell's Court; his rooms then resembled a rather cheerless set of chambers, with pigeon-holes and cabinets for documents, pamphlets, notes of calculations, and book-cases for his growing library. In 1885 he changed into a spacious set of rooms, with a view down the lime avenue across the river away to the Coton fields; with the change, there came a change in the appearance of his surroundings. His library naturally continued to increase. But he began to collect objects of beauty and rarity, in arts of several kinds. Once begun, his collection never ceased to grow, always under his unlimited and unstinted care; yet his favourite working-corner between the fireplace and the window, remembered by every visitor, remained his mathematical shrine of duty to the very end of his life; and, there, a jealously reserved portion of each working day in Cambridge was spent in his mathematical researches with a regularity that never failed.

His personal pursuits, outside his teaching, his research, his attendances at scientific meetings, and his passion for collecting, were varied. He was a vigorous walker, and covered ground at an amazing pace. In his youthful donnish days he rode a bicycle of the 'penny-farthing' type, his tall lean frame lending itself to the claims of that forgotten machine; and he was an active president of the Cambridge University Bicycle Club. In his middle years he often went to the United States to spend vacations with his friends Prof. and Mrs. Woolsey Johnson and their sons; or when they crossed the Atlantic he would have them in Cambridge, or would travel with them on the Continent. He maintained a wonderful vitality and a surprising appearance of comparative youth, even in his early seventies. It was only in the last few years that his health gave way, and it broke badly; but the spirit remained.

In 1875 Glaisher was elected a fellow of the Royal Society. His first original paper, full of cognate historical matter, dealt with the non-evaluable sine-integral, cosine-integral, and exponential-integral, and contained elaborate tables of those integrals, calculated by himself; it had been written by 1870, while he still was an undergraduate, and was communicated by Cayley. He served on the Council of the Society for three periods, 1883–84, 1890–2, 1917–19, during the last of which he was one of the vice-presidents. In 1913 he was awarded the Sylvester medal of the Society.

He had joined the Royal Astronomical Society in 1871, and became a member of the Council in 1874; he remained a member of that Council for the rest of his life, and his fifty-four full years of continuous membership may be a 'record,' to use a popular word of to-day. He held the office of secretary from 1877 until 1883. He was president of the Society in two distinct periods of office, 1886–88, and 1901–3; during those tenures, it became his duty to present the Medal of the Society to G. W. Hill (1887), to Auwers (1888), to Kapteyn (1902), and to Struve (1903), delivering masterly summaries of the original work of the several recipients on the respective occasions.

Throughout his scientific life Glaisher devoted much attention to the affairs of the London Mathematical Society. He was elected a member on Feb. 8, 1872, and he became a member of the Council in the succeeding November; he retired from that body in 1906, after a continuous service between those dates. He was vice-president in 1880, 1881, 1886, 1887; and president in 1884–85. Thus his own experience gave him full knowledge of the development of the Society almost from its beginning. At a meeting in 1926 to celebrate a belated jubilee of its existence, he gave a charmingly genial account of its activity, particularly of its early stages, and of the personal inspiration of members like Cayley, Sylvester, H. J. S. Smith, and Clifford. In that account there was one defect, characteristic of the man: it ignored his own contributions to the Society's influence upon mathematical science. He was awarded the De Morgan medal in 1908. There is no record of his reply of thanks on the presentation; but, as later in 1926, his words—he would have disdained to call them a speech or an address—were the expression of a friendly retrospective review of the Society, of which (so little did he say of himself) he might at the moment have been the least known member, instead of the most honoured.

In early and middle years Glaisher was a frequent attendant at the annual meetings of the British Association. He took an active part in its work, as secretary of Section A for a considerable period, and as a member of several committees dealing with tables of numbers, or with reports upon the progress of various branches of mathematical science. He was president of Section A at the Leeds meeting in 1890: his address dealt with relations between applied mathematics and pure mathematics, at a time when it still was not unnecessary in England to plead occasionally for a fuller recognition of pure mathematics.

It was a matter of course that he was a member of the Cambridge Philosophical Society. He often served on its Council in various capacities, frequently contributed papers to its *Proceedings*, and was in regular demand as a referee upon papers contributed by others. He was president of the Society in 1882–84.

Glaisher proceeded to the newly established degree of doctor of science at Cambridge in 1887; at the time of his death he had come to be the senior in standing among his fellow doctors. He was made an honorary doctor of science by Dublin on the occasion of the tercentenary celebrations of Trinity College; and, later, he received the same honorary degree from the Victoria University. He was one of the British honorary fellows of the Royal Society of Edinburgh, as also of the Manchester Literary and Philosophical Society; and he was a foreign member of the National Academy of Sciences of Washington. He was also president of the Cambridge Antiquarian Society in 1899–1901, an office that is uncommon for a man so actively engaged in mathematical teaching and research and in the current administration of scientific societies (in the most restricted sense of the term). But, as already indicated, the study of pottery was one of his hobbies: what began as a hobby developed into one of the absorbing interests of his life; and he became[1] ". . . one of the leading pottery collectors of his time. His attention in this direction was at first occupied by Delft ware, but from the Dutch pottery he was led to take an interest in the English wares made in emulation of it, and so in other types of English pottery of early date. The collection which he had been forming through a long period of years is, as regards the 17th and early 18th centuries, the largest collection of English pottery ever made; and it is satisfactory to reflect that, by becoming the permanent possession of the Fitzwilliam Museum, in which a large part of it has already been for many years on view, it will be accessible to all who wish to study it. . . ." It may be added that he had made (and at the time of his death was still engaged in) a catalogue of his collection in nearly forty manuscript volumes, which may well prove a valuable addition to the literature of ceramics.

When he was a lecturer at Trinity, Glaisher had his share of work that belonged to the ordinary round, such as astronomy or hydrostatics for the Tripos range, even a 'poll' lecture. His happiest efforts were devoted to subjects such as differential equations, combination of observations, elliptic functions. In each of these subjects his lectures in the late 'seventies were a revelation to students. The Tripos was never mentioned: the subject was expounded. His exposition was the more illuminating because concurrently (though unknown to his class) he was writing paper after paper dealing with details unmentioned in the text-books (if any); and enterprising students were encouraged to proceed to original sources. Such lectures were an intellectual treat. Then his course on combination of observations was at once critical, synthetic, constructive; he was singularly clear in setting forth assumptions made and the restrictions imposed by the assumptions. But, above all, he revelled in elliptic functions. It was not that he was opening unknown regions of new theories; at that date he never even mentioned the more comprehensive general theory of functions, scarcely known in Cambridge, even by title; but his results were a sheer development of Jacobi's work, the calculations being made with the ease of a controlling master. Some of us who were members of his class used to believe that he had discovered all possible formulæ in elliptic functions and q-series, which were being incorporated in an expected treatise in the grand style. His enthusiasm was infectious; in his lectures there was a human note, something of the nature of the man, a little fun, a little whimsical touch now and then, not untypical of that geniality which marked his intercourse with fellow-men.

Yet Glaisher never published a volume of his own. Perhaps the sheets of that treatise on elliptic functions existed only in our undergraduate imaginations; perhaps they ceased gradually when he found that much of his presentation of the subject was only an incident in the wider theory of functions. Perhaps also, in the midst of his own researches, he was reluctant to devote the time and the labour that are demanded by the preparation of a continuous treatise; there is a germane passage in his presidential address to the London Mathematical Society which might be an autobiographical confession of his own hesitation in attempting such a task. But when others went forward, sometimes stimulated by himself, he was ever the first and the most generous in the recognition of their labour.

The tale of Glaisher's separate papers, mathematical and astronomical, was large, amounting to something like four hundred in all. They were not distributed evenly over his long scientific life. Thus, down to the end of 1873, when he was only twenty-five years of age, he had published more than sixty papers, not all of them brief. In the next ten years—with him, as with many men, the most prolific period of production—he published more than a hundred and fifty. In 1883 he became tutor of Trinity, and held that busy office for the canonical period of ten years; even so, he found leisure enough to produce some fifty papers in that time; and he continued this rate of production more or less to the end, amid the growing absorption of his pottery and, even latterly, in spite of the distractions of discomfort and pain and ill-health.

The subjects over which his published investigations range belong to certain well-defined regions. Glaisher had an unfailing interest in the history of mathematics; he would range over the historical introduction of the plus and minus signs, over the work of Napier and Briggs in the construction of logarithms, to a treatment of recent changes in the Mathematical Tripos. He was fascinated by sheer arithmetical computation and revelled in the construction of numerical tables; or he would be absorbed in the properties of certain numerical functions in the theory of numbers at large. Weird series and extracted identities were an unfailing attraction for his mental activity. Differential equations, mainly ordinary linear equations and their integration in series, absorbed much of his earlier attention. In England down to his time, progress in this subject had centred in formulæ that were 'elegant'; 'symbolic' solutions had been accumulated by the ingenuity of mathematicians like Leslie Ellis, Gaskin, Boole. Of all this lore Glaisher was the master and, in its range, a creator. Yet, wandered he never so far afield, he returned time and again to his beloved elliptic functions.

Mention also must be made of the addresses Glaisher prepared, some of them official, some of them personal tributes. Among the latter may be recorded his NATURE notice of Cayley, early in 1895: his biographical notice of J. C. Adams, prefixed to the "Scientific Papers": and the introduction to the "Collected Scientific Papers of

[1] For the following estimate, extracted from a part of the (unsigned) obituary notice of Glaisher in the *Times* of Dec. 8, 1928, I am indebted to Mr. Bernard Rackham, of the Victoria and Albert Museum.

H. J. S. Smith." He was at his appreciative and genial best in general addresses. His careful lecture, delivered in the ante-chapel of Trinity in 1887, in commemoration of the bi-centenary of the publication of Newton's "Principia," was a wonderful tribute to a great spirit. His address as the president of the London Mathematical Society in 1890 is a valuable monograph on the long history of the Senate-House Examination, more commonly called the Mathematical Tripos, since 1824. The last of his addresses, in 1926, already quoted, may continue to stand as the best authentic history of the early stages of the London Mathematical Society.

In person Glaisher was very tall, slim all his days, with an upright figure which even his long illness could only partially bend. His smile of appreciation was delightful and infectious; when appreciation waxed into admiration, his attractive eyes could glow with sympathetic delight. He was singularly fluent in speech, though he never aimed at eloquence; yet dignified passages abound in his formal addresses. He was a don, not of the old-fashioned type, scarcely indeed of any recognised type; there was no shred of pomposity; there was a persistent note of good-nature, not devoid of the occasional touch of whimsical mischief, with which he sometimes would quiz too seriously solemn persons. The deeper notes of human feeling were not wanting when, as occurred to him during his tutorship, he had to help others to face issues of life and death.

In mathematical science Glaisher now appears to have been a man mainly of stimulating influence upon others, and an inspiring teacher, rather than a pioneer whose manifold contributions to his science could be proclaimed as notable and memorable. The earlier years of his teaching at Cambridge were a time of transition in the mathematical thought and activity of the University. Cayley was almost a voice crying in the wilderness; and Glaisher himself described Cambridge pure mathematicians of those days as generals without armies. When he ceased teaching, Cambridge pure mathematics had gone far beyond his active vision, mainly under men whom, as his students, he had encouraged and stimulated at the beginning. His influence was rather that of the inspired preacher and herald. His voice was that of a great teacher, yet not in any way similar to the great Cambridge coaches of the past; for throughout his life he was ever a contributor to the knowledge of his science as well as a guide through ranges of knowledge outside the conventional examinational learning. He was a distinct personality in his day; a stimulus to other men, especially young men who came within the sphere of his influence; and he has left a name, high among the noted names of his own generation, in two widely different fields of constructive thought and human activity. A. R. F.

WE regret to announce the following deaths:

Sir William Boyd Dawkins, F.R.S., honorary professor of geology and palæontology in the Victoria University of Manchester, the doyen of students of prehistoric man, on Jan. 15, aged ninety-one years.

Dr. H. J. H. Fenton, F.R.S., honorary fellow of Christ's College, and formerly lecturer in chemistry in the University of Cambridge, on Jan. 13, aged seventy-four years.

Prof. Wm. North Rice, emeritus professor of geology in Wesleyan University, president in 1891 of the American Society of Naturalists and a vice-president in 1905 of the American Association for the Advancement of Science, on Nov. 13, aged eighty-three years.

News and Views.

THE paper by Prof. A. S. Eddington on the charge of an electron which appears in the January issue of the *Proceedings of the Royal Society* (vol. A, 122, p. 358), and was read and discussed at the meeting of the Society on Jan. 17, is based upon the fundamental principles of the theory of relativity and of the new mechanics. The so-called exclusion principle of the statistics of Fermi and Dirac prescribes an interaction of two electrons; this interaction is identified with their electric repulsion, and the details of the latter phenomenon can thus be predicted on essentially statistical grounds. The problem is taken to be one of a 'space' of sixteen dimensions, and it follows that the ratio $hc/2\pi e^2$ (where h, c, and e have their usual significance of Planck's constant, the velocity of light and the electronic charge respectively) should be simply the number of symmetrical terms in an array of sixteen rows and sixteen columns, which is 136. The experimental value of the ratio is 137·1, but Prof. Eddington believes that the discrepancy, although some three times the reputed probable error of experiment, does not originate with the theory. Prof. Eddington's conception of the meaning of the factor $2\pi e^2/hc$ can be best given in his own words. It "expresses a kind of property attributed to every pair of points in space; it turns space from a mathematical conception into a possible site of physical phenomena by associating with a pair of points some degree of probability that they may be the scene of this interaction. There is no room for elaborate integrations or for differential equations in the theory of such a fundamental factor." Again: "Modern theory has virtually abolished all structure of an electron," and with this, the expectation "that the value of e would depend on the singular solution of some differential equation expressing the transition from charge to field."

THE issue of the *Proceedings of the Royal Society* for Dec. 3 (Series A, vol. 121, No. A788) is especially interesting to students of quantum-mechanics; it contains no less than five papers which are excellent examples of the process of consolidation going on at both ends of the new theory. Any new theory, naturally enough, especially one developed at the rate of the theory of quantum-mechanics, is liable to be presented at first with a lack of complete-