forests, no unmistakable specimen of that date has yet been discovered.

The concluding chapters are devoted to vascular cryptogams, over 140 pages being assigned to the Equisetales, chiefly to the remarkable group of Calamites, which must have been so conspicuous an element of carboniferous vegetation. Though cryptogamic, they formed large trees forty or fifty feet high, with woody trunks of exogenous growth. For this reason a section of the Calamites named Camelodendron have been and are even yet regarded as Gymnosperms by some French writers. The genera and species of this group are peculiarly difficult to diagnose, every organ being detached and preserved in a different manner. Internal casts of pith cavities in sandstone are the most familiar objects, but the more valuable specimens are those which preserve their internal structure, so ably deciphered by Williamson and others. The foliary organs are found separately in the shales and ironstone nodules; and the strobili in various conditions, which have permitted their internal and external structure to be examined. The roots of several kinds are also found detached from the stems. The author, without attempting to unite these scattered organs into specific wholes, has grouped the facts in the clearest manner. The variety presented prove that several distinct generic types existed, and as each variety of each separate organ was first described in ignorance of its probable relationship to the other, a complicated nomenclature has resulted. The Calamites, well represented in the Devonian, did not survive the Permian, though represented in the newer rocks by the closely related Equisetum.

The second important carboniferous group, Sphenophyllum, is also placed in a separate class, the Sphenophyllales, as a type that cannot be assigned to any existing group. Its leaves are wedge-shaped, with one or several veins and disposed in whorls, the strobili long and narrow, and the stem slender and woody. It was possibly a climbing plant, and is regarded as linking the Calamites and Lycopods.

In so brief a notice it is difficult to do justice to a work so full of matter and observation. Botanists and geologists must equally congratulate themselves on having so obscure and difficult a subject put before them for the first time in a really lucid and comprehensive manner.

J. S. G.

INFINITESIMAL CALCULUS.

Infinitesimal Analysis. By William Benjamin Smith. Vol. i. Pp. xvi+352. (London: Macmillan and Co., Ltd., 1898.)

IT may be assumed that the contents of this volume represent, on the whole, the author's conception of a reasonable first course for the average University student. Judged from this point of view, the work certainly deserves approval, and is a favourable specimen of the class to which it belongs.

In the first two chapters the processes of differentiation and integration are explained, with appropriate graphical illustrations. No attempt is made to discuss all the subtleties which modern function-theory has shown to be involved in the assumption of the possibility of differentiation and integration, but the analysis, so far as it goes, is sound, and something is done to guard the student from making false generalisations.

The next four chapters deal mainly with applications. These have been judiciously selected, and are of practical importance as well as theoretical interest. Kinematical applications might have been advantageously included; in fact, considering the general character of the book, it is strange that kinematical considerations have been almost entirely ignored.

Chapter vii., on partial integration, concludes with Green's theorem; it is a pity that Stokes's theorem was not also included. A short but useful chapter on definite integrals, and another on curve-tracing, conclude the volume.

On pp. 18-20 there are some remarks about velocity with which we profoundly disagree. After allowing that "according to the most familiar notions" $\Delta s/\Delta t$ "is the *average speed* (or velocity) during the time Δt," and that "if the space be a function of the time" (it is difficult to see how any other assumption could be made) then in general $\Delta s/\Delta t$ has a definite limit ds/dt when Δt becomes infinitesimal, Prof. Smith proceeds:—

"Mechanically, however, this limit is not itself an average speed at all, it is not of the same nature as the variable difference-quotient $\Delta s/\Delta t$. For this quotient *never* assumes this limiting value, no matter how small Δt be made. And this is quite what we should expect and what the nature of the case demands. For motion implies duration, however small, of time, and change, however small, of place. When there is no lapse of time and no displacement there is no motion, and hence no speed (or velocity). In all strictness, there can be *no motion at an instant* and hence no *speed* (or velocity) *at* an instant. The concept of speed (or velocity) or motion will not combine with the concept of instant (or point of time) to form a compound concept."

Surely Prof. Smith has here confounded the concepts of motion and displacement. If we allow that motion at an instant is impossible, how are we to escape Zeno's paradoxical conclusion that all motion is impossible? How can I move from one place to another during a minute, say, if *at every instant* of that interval motion is impossible? The remark, later on, that "this limit of the average velocity, characterises not the action but the state of the body, and is itself *not* a velocity though everywhere named so," does not improve matters, and is really irrelevant. The definition of velocity is quite independent of such question-begging terms as "action" and "state." Each of these terms, as applied to velocity, is just as good and just as bad as the other: it is when we add the words "of the body" that the metaphysical difficulty comes in, on account of the relativity of motion. But assuming that we can form a clear concept of a continuous displacement expressed by a law $s=f(t)$, there is neither a logical nor a metaphysical difficulty in proceeding to $\dot{s}=f'(t)$ and saying that this is the velocity at time t, if we have already agreed that when $s=at+b$, the velocity is a (a, b being constants): that is, in whatever sense a measures the velocity for the law $s=at+b$, then *in precisely the same sense* $f'(t)$ measures the velocity at time t for the law $s=f(t)$.

Another passage to which we feel bound to call attention is example 18, p. 229. Here the analysis really solves the problem of finding when $(a+1)(\beta+1)\ldots(\lambda+1)$ is a maximum subject to the condition that $a^{\alpha}b^{\beta}\ldots l^{\lambda}=N$; $a, b, \ldots l$, N being given quantities. But the heading of the article is, "How must the prime factors of a number enter into it that it may have as many divisors as possible? (Waring)," a question from which we have vainly tried to extract any meaning whatever, and with which, in any case, Prof. Smith's analysis cannot have anything to do. G. B. M.

OUR BOOK SHELF.

Die Optik der elektrischen Schwingungen. (Experimental Investigations on Electro-magnetic Analogies of the most important Optical Phenomena.) By Prof. A. Righi. Translated into German, with additions by the author, by B. Dessau. Pp. xi + 267; with 40 illustrations and figures. (Leipzig: O. R. Reisland, 1898.)

THOSE to whom Prof. Righi's Italian edition of last year was not accessible, will welcome this German translation of his interesting book. The reproduction, by means of electro-magnetic waves, of some of the more complex optical phenomena, necessitates the use of an oscillator which gives out a series of waves that do not decrease too rapidly in intensity, and that are considerably shorter than those used by Hertz in his experiments.

Prof. Righi has carried on a number of investigations with such oscillators which emitted waves ranging upwards from 2·6 cms. in length, and the present volume is devoted for the most part to an account of this work.

The first part deals with a detailed account of the construction and use of his oscillators and resonators, and with the secondary waves due to the presence of the receiver and neighbouring bodies. These effects are studied first, in order that they may not lead to misinterpretations in the later results.

In the second part the electro-magnetic analogies of many optical phenomena are considered.

The working details of the experiments are given, and the difficulties attending them are pointed out, thus enabling one to reproduce the effects with the least amount of trouble.

Two investigations which have appeared since the publication of the Italian edition are then appended, and the last part of the book consists of mathematical additions on various topics connected with the subject in hand.

The book is written in an able manner, and conveys to the reader a clear idea of the properties of electrical waves, and Prof. Righi's method of manipulating them.

J. Z.

Calculations in Hydraulic Engineering. By T. Claxton Fidler, M.Inst.C.E., Professor of Engineering, University College, Dundee. Part i. Pp. xii + 155. (London: Longmans, Green, and Co., 1898.)

THIS is the first part of an extended treatise, and it discusses Fluid Pressure and the Calculation of its Effect in Engineering Structures. The treatment of the subject is refreshing and stimulating, by contrast with the arid methods of our scholastic text-books. The illustrations of the abstract theory are taken from actual problems on a large scale, which appeal to the engineering student, to whom this treatise is addressed. A striking novelty is the discussion in Chapters iv. and vi. of the buckling tendency in straight pipes under uniform fluid pressure. Although the material of the pipe carries no longitudinal thrust, the conditions of stability are exactly the same as in Euler's theory of the bending of a column. This paradoxical fact is discussed theoretically, and its experimental verification is described in an Appendix. Chapter v. is on Fluid Arches, and shows how the pressure in a main, forming a tubular arch, can be used to assist the stability. We are reminded of Prof. Fitzgerald's suggestions of inflated structures and columns, and the pneumatic system of architecture, in which the strength is kept up by compressed air, pumped in at intervals as required, as in the tires of our bicycles. A short account of Prof. Fitzgerald's theory will be found in the recent edition of Perry's "Applied Mechanics." Chapters viii. and ix. treat of the equilibrium and stability and bending stresses of floating bodies, not from the point of view of the Naval Architect, but as required by the Civil Engineer in the design of pontoons, bridge-caissons, and gas-holders.

The diagrams are carefully drawn to represent some real actual construction, and the illustrative examples are worked out to their numerical conclusions, an essential part of the theory for the engineering student, although so completely ignored in our academic treatises. G.

Birds of the British Isles. By John Duncan. Pp. xvi + 448; illustrated. (London and Newcastle: Walter Scott, Ltd., 1898.)

THE excellent illustrations and brief descriptions of British birds published in the *Newcastle Weekly Chronicle* met with such a favourable reception, that the author has considered it advisable to reproduce them in book-form. And in their new guise they form a volume which can scarcely fail to be acceptable to readers with limited purses, since, while every species is figured, the published price of the work is only five shillings. Neither can it be said that the volume is "cheap and nasty"; the type being clear and good, and the illustrations for the most part of high merit. Perhaps, indeed, they lack the pictorial elegance of photogravures, but as good specimens of wood-engraving they leave little to be desired; and there are many reasons why that style of illustration should not disappear from works of natural history. In many respects Mr. Duncan appears to be a disciple of Bewick; and in the case of the cuckoo (p. 142) so closely has he followed his master that his figure is merely a reversed replica of the original cut, with some additional details of surroundings. Generally, however, the figures are original, and they are often in advance of those of Bewick.

Although brief, the descriptions appear sufficient to identify the species. In the introduction, by Mr. C. Dixon, criticism of the work from a literary standpoint is deprecated; but the author might have ascertained that the British Isles form part of the Palaearctic region (p. 191), and also that the word *palaios* contains four vowels. As a whole, the volume is a highly creditable and artistic production. R. L.

Railway "Block" Signalling. By James Pigg, A.I.E.E. Pp. 387. (London: Biggs and Co.)

THIS account of the development and details of the "block" system of railway signalling brings together a large amount of interesting information upon a method of regulating railway traffic which has assisted very considerably in bringing about the present state of precision and safety in railway work. The system has been in use for about thirty years, and it now represents the most extensive of all the adaptations of electricity to railway work. Mr. Pigg describes clearly the principles of train signalling and the apparatus employed; he also includes in his work the codes, regulations, and rules relating to railway signals of various kinds. With regard to the lines along which developments will probably be made he remarks:—"Railway signalling appears to have now reached a stage at which some departure from the present methods seems probable. The lines upon which changes will be made will, in all probability, result in a greater degree of automatic control than obtains at present."

The volume is an instructive contribution to an important subject.