kept permanently closed, or are protected by ante-chambers; and those of some marsh-plants cannot close at all. In sunny places the air in the intercellular spaces is in motion, and may be observed passing out by the stomata. During the life of the plant, two maxima of transpiration occur: (1) in youth, the air passing through the soft cuticle; (2) in adult life, when it passes by the stomata.

The suggestion of Sachs, that the narrowness of the cells of autumn wood of trees results from tension, is unsatisfactory, because the change from broad to narrow cells is sudden, and the tension upon the young wood is nearly the same in autumn as in spring. How the difference is caused is not known; but it benefits the tree by affording wide channels for a plentiful supply of water for the opening leaves of spring and for the excessive transpiration of summer, and, on the other hand, by providing thickness and strength to meet the stress of winter. G. MACLOSKIE.

TROWBRIDGE'S PHYSICS.

ALL who are interested in the improvement of elementary science-teaching must regard with no little interest the announcement that a physicist of Professor Trowbridge's deservedly high reputation and great experience has taken time to prepare a text-book in physics for secondary schools. 'The new physics' is certainly not of the common type of text-books, and it will be generally welcomed as, in many respects, a new departure.

Exercises in measurement occur from the beginning, and the student is shown the importance of 'finding out things for himself' at an early stage. The book is rich in suggestions concerning the construction and use of simple forms of apparatus, by means of which important physical constants may be determined with some precision. For linear measurement such instruments as the vernier, the spherometer, the cathetometer, and the microscope with cobweb micrometer eye-piece, which are often among the more expensive appliances of a physical laboratory, are described, and their construction so planned as to tempt any enterprising high-school teacher to undertake their manufacture. Several ingenious methods of measuring small intervals of time are introduced, and most of them are so simple that their value can be tested at little expense. By means of these methods the laws of motion are investigated experimentally: in fact, the attempt is made to discover what these laws are, and not merely to verify them. The student is taught how to construct galvanometers and electrometers, and how to use them in electrical measurement. In short, what may be termed the laboratory method of teaching elementary physics is adopted by the author without reserve.

But it is a great disappointment to find a book containing so much that is fresh and original so marred by errors, many of which are really serious. The laudable attempt has been made to put the student in possession of certain principles of prime importance which are generally to be found only in the college text-book, and not always there. In the discussion of some of these, mistakes of considerable magnitude, and statements that are very misleading, have unfortunately found their way into the text. Of these, some of the most serious are to be found in the chapter on moments of inertia. In attempting to calculate, without involving the element of time, the force with which a steel spring strikes a pendulum ball, some inconsistent and extraordinary equations are produced. A little further on the reader will be astonished to find it demonstrated (?) that in a lever the products of each force by the *square* of its distance from the fulcrum are equal; and on this proposition the principle of moments of inertia is allowed to rest. The statement is also made that the radius of gyration is the length of the equivalent simple pendulum; and this error permeates the whole treatment of simple and compound pendulums. In the definition and discussion of equipotential surfaces the false assumption is made that force is constant over such a surface. Preliminary to the consideration of the work done by an electric current will be found a brief discussion of the dimensions of force and work, which is obscure and misleading.

There will be considerable difference of opinion about the propriety of inserting in an elementary text-book such matter as the determination of the value of the ohm in absolute units, the measure of the horizontal component of the earth's magnetism, and the measure of electromotive force by the 'throw' of a galvanometer-needle.

The book is extremely suggestive, and will be found of great use in the hands of the enthusiastic teacher. A second edition will doubtless be free from the numerous mistakes of the present, which can hardly be regarded as a safe guide to one not already tolerably familiar with the underlying principles of the 'new physics.'

The new physics. By JOHN TROWBRIDGE. New York, *Appleton*, 1884. 19 + 367 p. 12°.