The presentation is clear, logical, and rigorous as would be expected from a French scientist of the standing of Painlevé. The book deserves a prominent place on the reference shelf of every serious student of mechanics.

The only serious criticism I would offer could be made against almost all books on mechanics. It seems to me that the presentation of Newtonian mechanics lends itself to a degree of unity and integration comparable to that of the theory of relativity. The entire subject could be based upon a single fundamental principle from which all other principles, laws, and theorems could be derived as was done by Lagrange in his *Mécanique Analytique*. In such a presentation the geometric addition of forces, for example, would not be elevated to the status of a fundamental principle any more than the geometric addition of other vector magnitudes, such as velocities and accelerations.

H. M. DADOURIAN

Balistique Intérieure Théorique et Tables Numériques. By G. Sugot. Paris, Gauthier-Villars, 1928. xxx+130 pp.

This book falls into two parts which may be characterized respectively as formal and experimental. That is to say, the first part develops a theory in terms of certain parameters and functions which may depend upon the gun or the ammunition or both. The second part deals with the methods for determining these parameters or functions from the measurable quantities obtainable either in routine firings or in special experimental firings. It is not "experimental" in the sense of describing apparatus.

The first part begins with a chapter on the two fundamental equations of interior ballistics, namely, the energy equation and the expression of the law that the linear rate of burning of smokeless powder is proportional to a fixed power of the pressure. It is somewhat remarkable that practically all treatments of interior ballistics accept this form of the law of burning, although there is such wide diversity in the power selected, the exponent varying from unity down to one-half, or lower. At this stage Sugot makes no selection of exponent. His second chapter is a short one on ballistic similitudes. The third deals with the special case of powders of constant surface, that is, powders of such a grain form that the burning surface remains constant as the size decreases. The single perforated cylinder used in rifle powder approximates to this requirement. The fourth chapter deals with other grain forms, and is in this respect a generalization; but it is specialized in another direction by the assumption that the exponent in the law of burning is equal to unity, and by certain minor assumptions not made before. These are selected in such a way as to reduce the problem to the solution of a first-order linear differential equation. The third and fourth chapters consist largely in the discussion of the curves representing pressure, energy, fraction of powder burned, etc. as functions of projectile-travel, or a related variable, particularly as these curves are affected by changes in the conditions of loading or the design of the gun.

The subject matter of the second part, called by the author "Outillages Balistiques," may be described as dealing with the best ways of making bricks without straw. That is to say, the phenomena which actually take place inside a gun when it is fired are of such complexity that the meager data obtainable from measurable quantities leave a great part of the theory indeterminate. Thus

routine firings give muzzle velocity with some accuracy and maximum pressure with somewhat less. Special experimental work may give a time record of pressure in closed chamber firings, or of recoil in gun firings. (This book makes no mention of time records of pressure or projectile travel in gun firings.) Out of this rather scanty information one must answer not only the purely ballistic questions such as concern the law of burning, combustion temperature, composition of the powder gases, band resistance, but also various general questions of physics and chemistry, on which there are no experimental data obtainable elsewhere because of the combination of high temperature and high pressure involved. Chief among these are the characteristic equations and specific heats of the powder gases. To deal with these difficulties, two courses of procedure are open, leading on the one hand to the "outillage expérimental," on the other to the "outillage théorique." In the former, methods are selected mainly with a view to obtaining empirically the observed relations connecting conditions of loading with muzzle velocity and maximum pressure. In the latter a greater endeavor is made to formulate hypotheses which plausibly represent the actual phenomena. The difference is in a sense one of degree rather than kind. In the first method the selection of variables for empirical comparison must have some physical basis; in the second there must always be left various parameters or functions to be determined empirically. The author deals with both methods and various types of each, but devotes most attention to the "outillage théorique." The large number of numerical tables pertain to this part of the book.

In spite of the general excellence of the work it seems open to criticism for provincialism. The author makes only the most cursory reference to writers outside of France, and none to any outside the Latin countries, either in ballistics or relevant parts of general science. While it is undoubtedly true that interior ballistics has had by far the greatest development in France, nevertheless it seems unfortunate to ignore completely, for example, the German work on the conditions of chemical equilibrium in the powder gases. However, it may be said that the author omits no well-established phenomenon of major importance, and presents the principal mathematical methods that are useful.

L. S. DEDERICK

Introduction to Vector Analysis. By L. R. Shorter. London, Macmillan, 1931. xiv+355 pp.

In his preface the author says: "My object in writing this introductory book is to furnish a working knowledge of the subject, and so enable a mathematical student to continue his studies with ease in the many excellent existing textbooks. If, on the other hand, the reader is a student of Physics, this book should supply him with a sufficient working knowledge of the methods and enable him to apply them in his physical studies."

To the reviewer it seems that the book will meet both of these aims better than most books with similar purpose. The introduction to new ideas is clear and convincing though not burdened with oppressive rigor. Numerous examples worked out in full detail illustrate the theory, and it should be possible for a student to obtain from the text a working knowledge of the subject with little or no help from a teacher.

Chapters 1, 3, and 5 are entitled respectively *Addition*, *Multiplication*, and