any order. A good chapter on integration in series is brought in, though it might have been moved forward to let the chapter on systems of equations come closer to partial differential equations.

The book would have been improved, I think, by the addition of some easier examples. Those given work out very nicely but require some skill and accuracy in algebra. No misprints of any consequence were found save on page 15, Example 6, *ay* is put instead of *dy*. Many interesting little historical notes have been inserted and references have also been added freely. C. R. MacInnes.

Elements of the Kinematics of a Point and the Rational Mechanics of a Particle. By G. O. James. John Wiley and Sons, New York, 1905. xii + 171 pp.

On page 102 of this excellent little book the author states its object in the following words: "It is my purpose here to develop in a rigorous manner the elementary theory of the motion of a *material point* or *particle*, and to thereby furnish a point of departure for the consideration of the motion of bodies as they actually occur in the material universe. This elementary exposition will then serve as an introduction to that portion of the subject which is known as *rational mechanics*, and in which the mathematical theory of the motion of portions of matter of *ideal* forms is investigated under *ideal* conditions, leaving the special applications to the particular sciences." The first eight chapters (pages 1–100) are devoted to the kinematics of a point and the last chapters IX to XVII to the mechanics of a free particle. It is not necessary to give in detail the contents of each chapter, some of which are extremely short; it will suffice to state the general structural lines along which the author has laid out the contents of the book. These lines are kept adroitly before the eyes of the reader, who is led straight to the goal and does not lose himself in the detail of side issues. The geometric derivative of a vector and its projection on an arbitrary axis is the fundamental concept upon which velocity and acceleration and their components depend. They are studied in detail both in rectilinear and curvilinear motion, where in each case proper distinction is made between absolute and relative motion; this is next extended to angular and axial motion, where again the same notions come into use which have been developed under linear motion. Here too the peri-

odic form of motion is gone into in some detail. In the last two chapters of this preliminary kinematic study the motion is referred to coordinate axes in space, which are either fixed or movable. Before the second part of the book is discussed a few remarks concerning the first are offered: In the definition of the geometric derivative of a vector the figure 10 is somewhat misleading to a beginner inasmuch as the tangent PP' is here perpendicular to the vector AP which is not necessary. Since the parallelogram of vectors is the foundation of the entire structure it would have helped the understanding to proceed with the derivative of the vector with moving origin, as Budde and others have done. This secures to the beginner a geometric insight and guide which in the study of mechanics is all important. For this reason it would have been desirable to go into the velocities and accelerations for polar coordinates from the standpoint of movable axes and to make plain to the reader the significance of the expression $d^2r/dt^2 - r(d\theta/dt)^2$. The corollary of article 12 which plays such an important part in the book would have gained in lucidity and importance by such a geometric study. In this way the fact that the acceleration vector lies in the osculating plane would have come out with full force and not as a supplementary algebraic result (see §64). For the same geometric reason the notion of areal velocity and areal acceleration might have been replaced by their usual equivalents, especially since the dimensions of these terms differ from those of linear velocity and linear acceleration; in the same way angular velocity and acceleration are concepts which in the mechanics of a particle should have but transitory importance.

The characteristic feature of the second part of the book is found in the fact that the potential (or as the author puts it the field of force) is considered as the primary mechanical concept. Force as such is merely used as an abbreviation in the text. Newton's three fundamental principles are expressed in a fashion consistent with the four fundamental notions of space, time, mass, and field of force. It is to be supposed that the author will publish additional volumes in which the wisdom of employing the field of force as a primary concept in a rather elementary text is made more cogent than would appear from the limited material offered in this book. In conclusion it must be stated again that although the reader might differ from the author in many particulars as to choice of subject

matter and form of presentation, he cannot help enjoying the clearness, consistency, and cogency with which the author presents his case from cover to cover.

KURT LAVES.

Cours d'Astronomie. Première Partie: Astronomie théorique. By H. ANDOYER. Paris, Librairie Scientifique A. Hermann, 1906. 222 pp.

AFTER a rather prolonged lull in the publication of text-books on spherical and practical astronomy we are now about to to receive from the press two treatises on the same subject, the one by Professor W. Foerster, the former eminent director of the observatory of Berlin, the other by Professor Andoyer, the well-known scholar of the Paris observatory. The first parts of both treatises have just left the press. A review of Professor Foerster's book has been published in the *Astrophysical Journal.* In giving a short outline of Professer Andoyer's book in a journal devoted to mathematical science, an effort is made to bring out those points primarly which are of interest to mathematicians. Chauvenet's two large volumes on spherical astronomy are too voluminous to lend themselves easily to the needs of a mathematician who tries to inform himself about the application made in astronomy of a certain mathematical theorem he is interested in. Andoyer's book is much more adapted for such purposes. After an introductory chapter concerning spherical trigonometry and a short deviation into spheroidal trigonometry to the extent to which this is needed for elementary geodesic questions, the author gives in the next seven chapters a rather condensed account of refraction, parallax and aberration. Before the theory of precession and nutation is taken up, the reader is initiated in Chapter IX into the more elementary notions of celestial mechanics. This is necessary since the apparent position of a planet, after it has been corrected for refraction, parallax, and aberration, will yet have to be freed from the disturbing influences of the neighboring bodies. To quote but one example: in the definition of apparent solar time, the center of the earth is pulled out of its elliptic path by the various members of the solar system. These perturbations of the individual members must be brought into tables so that for a given value of the time the amount of pull due to each individual member can be properly added to the position of the earth in the elliptic path. Now since the