

occupies. First as last, it is directly through ideals and indirectly through administrative provisions that further ideals, that the welfare of academic concerns is determined.

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#### SCIENTIFIC BOOKS.

*Elements of Mechanics*; Forty Lessons for Beginners in Engineering. By MANSFIELD MERRIMAN, Professor of Civil Engineering in Lehigh University. New York, John Wiley and Sons. 1905.

*Elements of the Kinematics of a Point and the Rational Mechanics of a Particle*. By G. O. JAMES, Ph.D., Instructor in Mathematics and Astronomy, Washington University.

Professor Merriman believes that "there should be given in every engineering college two courses in rational mechanics, an elementary one during the freshman year in which only as much mathematics is employed as is indispensably necessary, and an advanced one after the completion of the course in calculus." The forty lessons contained in this book on the 'Elements of Mechanics' are intended to cover the suggested elementary course. Its seven chapters are entitled Concurrent Forces, Parallel Forces, Center of Gravity, Resistance and Work, Simple Machines, Gravitation and Motion, Inertia and Rotation. The treatment of these topics is characterized by the simplicity of statement and illustration which are familiar to users of the author's numerous other text-books for students of engineering. His aim seems to be to give the student working rules in the quickest and most direct manner, and to this end strict logical rigor and accuracy of definition and statement are sometimes sacrificed.

There is no formal statement of the laws of motion in their ordinary form, but ten 'axioms' are given which presumably are designed to appeal more directly to the experience of the beginner. It is to be feared that certain of these are stated with too little care as regards accuracy (for example, 'when

only one force acts upon a body it moves in a straight line in the direction of that force'), and that others will be found too vague to be of much service. This vagueness is due in part to the failure to give definiteness to the conception of force. No student can think clearly and correctly about force until he has grasped the elementary notion that every force is exerted *by* one body or portion of matter *upon* another, and that a force exerted by *A* upon *B* is always accompanied by an equal and opposite force exerted by *B* upon *A*, the two forces constituting the action and reaction of Newton's third law. This fundamental principle is not expressed nor even implied in the ten axioms given in this book; on the contrary, the author's explanation of his third axiom involves a wholly erroneous statement of the law of action and reaction.

It is, however, to the practically minded student rather than to the stickler for logical rigor that Professor Merriman addresses himself primarily, and from his point of view such defects as are here criticized are of minor importance in comparison with simplicity and directness in the presentation of working rules. With this point of view many teachers of mathematical subjects to students of engineering will largely sympathize, and they will find in this book the merits which are conspicuous in the author's previous text-books. Not the least of these merits is the large number of examples, mostly numerical, to be solved by the student.

The book of Dr. James is designed as an introductory course in rational mechanics, but it is addressed not to students of engineering but to those whose interest is in pure science. It contains little of application, but aims at a rigorous and thoroughly sound formulation of fundamental principles.

The treatment of kinematics, which occupies Part I., is clear and concise throughout. This conciseness is aided by the free use of the notions and language of vectors, especially the notion of the geometric time-derivative in the treatment of curvilinear motion. The use of the term displacement to designate the position-vector of a moving particle seems, however, singularly inappropriate.

The opening chapter of Part II. gives the author's formulation of the axioms or fundamental principles of mechanics. His point of view here is that of those critics who reject force as a physical reality and state the fundamental laws simply in terms of acceleration. The term force is afterward introduced and defined as a convenient name for the product of mass into acceleration. In the statement and explanation of the second of the three 'principles' the term 'field of force' is, however, used in advance of the formal definition of force.

The three 'principles of mechanics' are stated as follows:

An isolated particle has no acceleration with respect to the absolute axes.

The acceleration which a particle takes in a resultant field of force is the geometric sum of the accelerations produced by the component fields, and is independent of the particle and of its motion.

Two isolated particles under their mutual actions take accelerations in opposite directions along the line joining them, and these accelerations are in a constant ratio.

Regarding this formulation and the accompanying explanations two matters invite comment. The first is the definition of the absolute axes, the second the explanation of the meaning of 'component fields' in the second principle.

The notion of the fixed axes is first introduced at p. 23:

But while, in kinematics, the choice of the *absolutely fixed system* is perfectly arbitrary, it is *no longer so in mechanics*, and there we shall see that the fixed stars *must* be chosen as the system of reference.

Again on p. 104:

In kinematics the choice of the absolute axes was arbitrary. The state of affairs in mechanics is different. The principles just spoken of are asserted true of the motion of a particle referred to a particular set of axes *invariably connected with the so-called fixed stars*. These I term the *absolute axes*. Referred to any other set the principles must be modified.

This method of defining the absolute axes has been adopted by several critics who are unwilling to accept Newton's doctrine of ab-

solute space and time. To call the axes determined by the fixed stars 'absolutely fixed axes' is, however, to evade rather than to avoid whatever difficulty there is in Newton's conception. From the Newtonian point of view axes thus defined are not really absolutely fixed, but are merely the axes most nearly fixed in direction which it is possible to specify practically. We can not doubt that the stars move relatively to one another, and that the line joining the centers of two stars really changes in direction, although observation does not detect such motions; and we thereby implicitly assume the reality of a more fundamental base of reference than the fixed stars. Whether or not we are willing to adopt Newton's language and speak of absolute space and time, we are driven to substantially his position when we attempt to define the axes of reference for which the fundamental principles of mechanics are true.

The meaning of component and resultant fields in the statement of the second principle is explained substantially as follows: If a system of particles  $n$  is made up of systems  $p$  and  $q$ , the field due to  $n$  is the resultant of two component fields, one of which is the field which  $p$  would produce if  $q$  were absent, the other the field which  $q$  would produce if  $p$  were absent. The 'principle' affirms that the acceleration of a particle due to  $n$  is the geometric sum of the acceleration which  $p$  would cause in the absence of  $q$  and that which  $q$  would produce in the absence of  $p$ .

The second principle as thus explained affirms more than should really be included in the law of composition. An accurate formulation of this law involves the law of action and reaction. The essence of the two laws may be stated as follows: Considering any system of particles, the actual acceleration of any one particle due to the influence of all the others may be vectorially resolved into components regarded as 'due to' the several other particles; and these components may always be taken in such a way that the law of action and reaction is satisfied, *i. e.*, that the acceleration of any particle  $A$  due to  $B$  and the acceleration of  $B$  due to  $A$  are in the inverse ratio of the masses of  $A$  and  $B$  and

oppositely directed along the line  $AB$ . This is all that the laws of motion imply. They do not imply that the acceleration of  $A$  due to  $B$  is the same when a third particle  $C$  is present as when it is absent, although this implication is often read into them.

The supposition that the mutual action between two particles  $A$  and  $B$  may depend in part upon the influence of a third particle  $C$  has been called the hypothesis of modified action. Pearson,<sup>1</sup> while emphasizing the possibility that such a hypothesis may represent the truth for molecular or ethereal actions if not for actions between particles of gross matter, states that 'one of Newton's laws of motion distinctly excludes this hypothesis.' To thus interpret Newton's laws seems, however, a mistake. The essence of these laws may be summed up in the principles of the constancy of linear and of angular momentum for any isolated system. These principles do not exclude the hypothesis of modified action.

The second principle of Dr. James also goes too far in asserting that the acceleration of a particle in a field of force is 'independent of the particle' (*i. e.*, of its mass). That this is true in a particular case such as that of gravitational fields is a consequence not simply of the laws of motion but of the law of gravitation, and the possibility of cases in which it is not true may be admitted without thereby questioning the universal validity of the Newtonian laws.

The foregoing comments have been made because of the intrinsic interest of the questions raised, rather than from any desire to criticize adversely the presentation of Dr. James, which in the main is admirably clear and logical. The remainder of the book is devoted mainly to a discussion of the direct and inverse problems of the mechanics of a particle—*i. e.*, the determination of the law of force when the motion is known, and the determination of the motion when the law of force and the initial conditions are known. These problems are treated for both the case of fixed axes and that of moving axes. In particular considerable space is given to motion relative to the earth.

<sup>1</sup> 'Grammar of Science,' second edition, p. 319.

On the whole, the book is one that is well worthy the attention of any one who is interested in the rigorous treatment of the fundamental principles and problems of mechanics.

L. M. HOSKINS.

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#### THE OTHER SIDE OF EVOLUTION.<sup>1</sup>

Books are rare which, in their last sentence 'look hopefully to God for that only which will deliver the church from this [evolution] and all other pestilent evils, theoretical and practical,' and I owe, perhaps, an apology to the readers of *SCIENCE* for not sooner calling their attention to 'The Other Side of Evolution.'

The scope of the book is given in the preface:

It will be shown that evolution is not accepted by all scientists and scholars; that it is rejected by some of the greatest of these; that it is admittedly an unproven theory; that it has never been verified and can not be; that not a single case of evolution has ever been presented, and that there is no known cause by which it could take place. Its arguments will be considered one by one and their fallacy shown. It will be shown to be, by its own principles, unscientific and unphilosophical, and simply a revamping of the old doctrine of chance clothed in scientific terms. Finally, it will be shown that it is violently opposed to the narrative and doctrines of the Bible and destructive of all christian faith; that it originated in heathenism and ends in atheism.

A sharp distinction is not always drawn in this volume between evolution in general and organic evolution, but in the 'Foreword' we are told (p. 2): "The theory of evolution asserts that from a nebulous mass of primeval substance, whose origin it never attempts to account for, there came by natural processes, as a flower from a bud, and fruit from flower, all that we see and know in the heavens above and the earth beneath"; and on page 4: "The theistic and the atheistic evolution, however,

<sup>1</sup> 'The Other Side of Evolution, an Examination of its Evidences,' by Rev. Alexander Patterson, author of, etc., with an introduction by George Frederick Wright, D.D., LL.D., F.G.S.A. The Winona Publishing Co., Chicago, Ills. Winona Lake, Ind.