A NEW TREATISE ON MECHANICS

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ON

MECHANICS.

BY THE AUTHOR OF

" A NEW INTRODUCTION TO THE MATHEMATICS,"

" A NEW SUPPLEMENT TO EUCLID'S ELEMENTS OF GEOMETRY,"

&c. &c.

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PREFACE.

THE present work has originated in consequence of the extreme brevity of expression, and deficiency of explanation, in the treatises on this subject now in use. If it be very important to maintain conciseness in these works, it should, at least, be employed in stating all that is desirable to be known, and requisite to be explained, on a subject, not of itself difficult to be understood, if the whole of it were clearly laid before the reader, nor indeed difficult to communicate; although from the practice of these authors, it would appear to be impossible. But they are sparing, not only of their words, but of their matter. Nay, in order to avoid wasting language, they will sometimes use a word, not in its ordinary sense (in which they use it themselves in other parts of their works), but in a new meaning, unknown to the beginner; and in this manner they sometimes communicate the most important truths.

For instance, Mr. Bridge, in treating of uniform motion in the very beginning of his work (*Mechanics*, p. 7.) states, that if the space described by a body moving uniformly be *given*, the time of its motion will be in the inverse ratio of its velocity. Now, the ordinary mathematical sense of the

word "given" is "*known*;" and it seems to be made a condition in this proposition, that provided the space described is a *known* quantity, the time will be inversely as the velocity; from which the beginner would infer (what certainly is not meant), that if the space were an *unknown* quantity, the time would *not* be inversely as the velocity, and that their ratio changes, as soon as the space is known or found, from what it was before, while the space was unknown, although the space continues the same unvarying quantity, whether it be known or unknown.

But this short expression saved that author the circumlocution of stating the proposition in words at length, as follows:—"If a body moving uniformly at one time with a certain velocity, and at another time with a different velocity, describes equal spaces, the time in which the space will be described with the greater velocity will be in the inverse ratio of the velocity: the greater velocity will require less time, and the less velocity will require more time." As this truth or proposition is demonstrable from the known properties of uniform motion, it would not have been an unprofitable instruction to have added the demonstration. The reader will observe how pregnant of meaning is the word "given," as used by that author, and he will judge whether a beginner would be likely to ascribe the author's meaning to it, or to take it in its ordinary sense.

The present author, being convinced of the perplexity and mischief occasioned to the student by these sacrifices of important instruction to an overweening and meretricious leaning to brevity, has undertaken the present work, in which he has endeavoured to supply the explanation wanting. The work is, therefore, strictly elementary, and intended for beginners. It embraces the prime principles of Motion, Moving Force, and the Mechanical Powers, without attempting the higher branches usually

treated of by authors on this subject. Indeed, the necessity for such full explanation does not exist as to the higher branches, because the student, when he has acquired not merely the technical rules, but the *rationale* of the elementary parts, will not require much assistance in pursuing his studies further; which, for the most part, will consist merely of the application of the principles which he has previously acquired to other investigations.

Chapter i. part i. contains the Definition and Laws of Motion. The second law of motion is stated by most authors, as follows:—"Motion, or the change of motion, is proportional to the *force impressed*, and is produced in the right line in which that force acts." (*Bridge's Mechanics*, p. 12.) In the present work it is stated thus:—"Motion, or the change of motion, is produced uniformly in the line of direction in which the impulse or force acts, and is proportional to the excess of the force applied above the resistance;" which is materially different from the other. For it appeared to the author, that the reaction of the resistance destroyed an equal quantum of the action of the force originally applied. Thus, if the force impressed were equal to a weight of 2*lbs.*, and if the resistance of the body were equal to a weight of 1*lb.*, the remaining force, $2 - 1 = 1lb.$, would be that which moves the body. But let the force be doubled $= 4lbs.$, the resistance being 1, the remaining force $4 - 1 = 3lbs.$ would be that which moves the body; that is, this second motion would be to the first as 3 to 1, and not as 2 to 1, which is the ratio of the forces impressed. This is demonstrated in the chapter on the lever in the second part of this work. (Part ii. chap. i. § 2. art. 8 to 13.)

The third law of motion is stated in chap. i. as follows:—"When a force applied to a body is resisted, the resistance re-acts upon the body in a direction opposite to that of the

force applied, and destroys, *pro tanto*, the action of the force applied." For the usual form of expressing it, "Action and reaction are equal and in opposite directions," is not sufficiently definite, and gives the learner no distinct idea, or perhaps an erroneous one, of what is meant by it. The author has given his own construction of its meaning, which he does not find very distinctly stated in other authors, although they seem to think that the usual form of expression is too comprehensive, and requires some qualification. (*Bridge's Mechanics*, 19 and 20. *Whewell's Mechanics*, art. 187, p. 248.)

In chap. ii. part i. the author has investigated the properties of the Uniform Motion of one body; and in chap. iii. the properties comparatively of the motion of two bodies moving uniformly with different velocities: for these properties may be considered separately with less perplexity, than if they were taken together. Mr. Bridge disposes of both these heads together in less than two pages. In handling these, as well as the other subjects of the work that will admit of it, the author lays down such definitions or truths established by experience and observation as may serve for the foundation of the propositions which he proceeds to advance and to demonstrate. From these demonstrations he deduces the formulæ, by which, from the requisite data, any of the quantities that are sought may be found; and these formulæ are collected in a table in each chapter for ready reference. To which are added problems, in which the use of the different formulæ is manifested.

In chap. iv. part i. the author has, in like manner, treated of the Gravitation of Bodies near the surface of the earth; in chap. v. Gravitation augmented by perpendicular impulse; and in chap. vi. Gravitation counteracted by vertical impulse; because the subject naturally leads to

this division, and becomes less perplexing when each part is taken separately; and their respective formulæ are collected in separate tables.

In chap. vii. and viii. part i. the author has treated on Momentum in general, and the comparative momenta of two bodies moving with uniform velocities; and in treating this branch of the subject he has taken a medium course between those authors who affirm too largely that momentum is *equal* to the product of the weight into the velocity, and those authors who assert barely that the momentum *varies as, or is proportional to,* the product of the weight into the velocity. The author thinks it probable that the motion of a body may be so slow that the momentum generated by it may be less than the weight of the body; for since the body when at rest possesses no momentum whatever, *some* degree of velocity would generate a momentum equal to its weight, and a less velocity than this might be found, which, because the momenta are as the velocities, would generate a momentum less than the weight of the body. The author has therefore taken d as the symbol of that quantity of momentum which is equal to the weight of the body; whereby he has obtained an *expression* of the *value* of the momentum. The author has not ascertained the actual value of d, but he has suggested experiments for more practised hands to determine it; which, when accomplished, the theory may be easily extended to the same or analogous cases, circumstances, and results, with what has been done with respect to gravitation.

Chap. ix. part i. treats of Moving Force, which may perhaps be considered as that state of a power of which momentum is the transformed state, or that state into which moving force passes, when it is communicated to, and absorbed within, the moving body. The author has defined moving force to be the excess of the force applied above the resistance; and his investigations of the