AN ELEMENTARY TREATISE ON MECHANICS: INTENDED FOR THE USE OF COLLEGES AND UNIVERSITIES

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AN

ELEMENTARY TREATISE

ON

MECHANICS:

INTENDED FOR THE USE OF COLLEGES AND UNIVERSITIES.

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ON

MECHANICS.

INTRODUCTION.

1. *Mechanics is a science which treats of the motion and rest of bodies as produced by Force.*

Force is any cause which moves or tends to move a body, or which changes or tends to change its motion.

Every science involves certain ideas, by means of which we give unity and connection to our sensations, and in virtue of which we are able to reason concerning the facts which we perceive by our senses. Thus Geometry involves the idea of Space, Arithmetic, the idea of Number; and conditions resulting from the nature of Space and of Number are applicable to all the objects of our external experience. In like manner, the science of Mechanics involves the idea of Cause; which idea, when applied to the facts of motion and equilibrium, gives rise to the conception of Force.

The appearances and occurrences of the material world suggest to us the conception of motion, and of changes of motion. Moreover, we find that we can often, by our own volition and exertion, influence the motions of bodies, and occasion changes of motion. We perceive too, that bodies appear to influence each other's motion in the same manner. By considering these occurrences in a general and abstract manner we obtain the conception of *Force*. Force is conceived as that general and abstract property by which one body causes, changes, or prevents motion in another body.

Thus, when a man supports a stone in his hand, his hand is said to exert force upon the stone: and in the same manner, if he move a machine by turning a winch, he is said to exert force on the winch, and, by this, on the machine. If the machine be moved by the weight of a heavy body, this heavy

body is said to exert force. When a stone falls, it is said to be moved by the force of gravity, or of the Earth's attraction.

2. *Body or Matter is any thing extended and possessing the power of resisting the action of force.*

In the conception of force exerted, there is involved the notion of a certain power of resistance, residing in the object on which the force is exerted. This power of resistance shews itself by the object excluding other bodies from the space it occupies; by its transmitting force to other bodies; by its requiring a larger force to produce a quicker motion; and in other ways.

In this manner the solid bodies which are treated of in Mechanics differ from the solids treated of in Geometry. In the last-mentioned science we conceive figures to possess extension only, without tangible solidity; they are mere modifications and limitations of our notion of space; they occupy space without excluding other figures from the same space; they have no material substance or mechanical attributes. In Mechanics we consider bodies as they really exist; not only as extended, but as impenetrable, stiff or flexible, inert, heavy.

3. The difference of the kinds of extension treated of in Geometry and in Mechanics is sometimes expressed by calling the lines and planes which we have to do with in Mechanics, *material* or *physical* lines and planes. Thus a physical line is a linear body, as a fine wire or rod, of which we do not say, as in geometry, that it has length, and no breadth or thickness; but of which we do not consider the breadth and thickness in our reasoning, although we suppose the line to have rigidity, weight, and inertia, which without breadth and thickness it could not have. And in the same manner, a material plane has weight and inertia, and may have rigidity. A material point or particle also has weight and inertia, even although we do not consider its extension. A material solid has weight, inertia, impenetrability, none of which are attributes of mere geometrical solids. It may also have either complete rigidity, or flexibility with a greater or less amount of elasticity.

4. Material lines may be considered as *made up* of material points; material planes, as made up of material points or of

material lines; material solids as made up of material points, or lines or planes. The thickness of the planes, the breadth of the lines, the length of the points thus introduced as elements, is never considered as finite; and our reasonings are always so conducted, that in the sequel these dimensions disappear; but in the course of our reasonings, we must needs conceive material bodies thus made up of material elements.

5. We cannot conceive force to be exerted without conceiving matter as that on which and by which it acts. Thus if we push at a stone with a staff, we exert force upon the stone by means of the properties which belong to the staff as matter—its rigidity and coherence. And if we exert force by means of the hand alone, we no less produce the effect by means of the material instrument which we use, namely, the hand itself.

6. We conceive force as necessarily acting *on* matter, but not as necessarily residing in matter and acting by means of matter. The pressure or the fall of a heavy body is conceived as produced by the force of gravity, this force not residing in any material vehicle, or operating on the body by material contact; but being an immaterial influence,—a mere attraction. And in like manner any other attraction, as that of a magnet on iron, is conceived as an immaterial influence, producing in the body pressure or motion, as material pressure or impulse might do.

There have been controversies whether these attractions of gravity and magnetism are or are not really transmitted by some material substance which acts upon bodies directly by contact: but however these controversies be decided, it is often necessary, in the science of Mechanics, to *conceive* attractions as immaterial influences, which, when they act upon matter, become sensible to us as force.

7. ***Bodies are capable of motion of various kinds.***

We possess the conception of motion, which we constantly see exemplified among the bodies which we observe about us. These change their places and positions by moving in various ways; as when a stone falls to the ground, or a heavy body slides down a slope, or a carriage is overturned. And these cases may exemplify three different kinds of motion. The