ELEMENTARY MECHANICS, OR FIRST LESSONS IN NATURAL PHILOSOPHY: 2D YEAR'S COURSE

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ELEMENTARY MECHANICS;

OR,

FIRST LESSONS IN NATURAL PHILOSOPHY.

BY

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1. Introduction.—Let us consider what is meant by the word *force*, and what are the nature and character of the various forces at work around us, of which we often speak collectively under the name of the "forces of nature."

Day by day we see those forces at work, acting in various ways, and producing many and different results; but they very rarely excite our curiosity, for we have grown accustomed to them from seeing them so often. A storm excites our wonder, and we are curious to know more about that wonderful and mighty force which causes the vivid lightning and the deafening thunder. But how many of us think, even for a moment, about the ever-acting and far more important force which causes all substances to fall towards the ground, and which enables our bodies and all things around them to maintain their place upon the surface of the Earth?

This force of *gravitation* acts so constantly and so unchangingly, always producing the same unvarying results, that we do not recognize anything wonderful in it; and it is only by looking very closely into the results which this force produces, and by thinking long and deeply about them, that we are at last enabled to recognize how wonderful and beautiful even the commonest of such occurrences really is.

2. **Examples of Force.**—If we take a piece of paper, set it upon edge against some object, as a book, and then pull it by means of a piece of thread attached to it, we notice that the paper falls. To pull the paper down we had to bring into use a power—the power of the muscles of the arm; and this power, carried along by the thread, caused the paper to fall. Or we may give the paper a push, and again it falls. This time we also use the power of our muscles, but in a different way. But we can cause the paper to fall by means of a very different power. Let us take a piece of sealing-wax, and, having well dried and warmed it, rub it with a piece of warm dry flannel or fur, and bring it within an inch or two of the paper. Now, although nothing touches the paper, we see it move towards the sealing-wax and fall. In the first case we pulled the paper over by means of the power of our muscles, which was transmitted by the string; in the next, the sealing-wax must have exercised a power to cause the paper to fall. Now, this power to set matter in motion, whether exerted by the hand or by the wax, is an instance of what we mean by the word *force*.

But power or force may be used for other purposes than moving a piece of paper. When a cannon is fired, the gunpowder with which it is loaded exerts force to propel the cannon-ball; and the target of iron against which the cannon-ball strikes must exert force to stop it. So also a boy playing cricket exerts force in striking the cricket-ball with his bat, causing it to fly swiftly across the field; and the boy who catches the ball exerts force in stopping it. Let us suppose, however, that the cricket-ball were a very large and very heavy one: the boy with the bat might try to move it, but fail; yet he would have exerted *force* in *trying* to move it; and were such a ball made to move, the other boy would expend force in *trying* to stop it, although he again might fail.

3. **Definition of Force.**—Thus we see that *force is that which moves or tries to move a body, or which changes or tries to change the motion of a body.*

4. **Kinds of Motion.**—We have seen that force frequently produces motion, and always tends to do so. We must now pause for a moment in order that we may learn something about motion. When a cannon is fired, we know that the gunpowder exerts a force which compels the cannon-ball to fly from the cannon, and to continue in motion until it comes to rest again perhaps a mile from the cannon. Here the cannon-ball *as a whole* moves a distance of one mile. Again, a locomotive engine may start from London, and at the end of about three hours may have arrived at Birmingham. Here again we notice that the *whole body* of the engine moves from one

place to another. Motion of this kind we speak of as *motion of the body as a whole.*

5. Molecular Motion.—Let us now take the cannon-ball of which we have already spoken, and place it on a large fire. After a time it will become white hot, and will glow with heat. The body *as a whole* is perfectly still; it remains where we placed it on the fire. But is there any motion at all there? Yes, we think there is. We suppose that all bodies in the world, and the cannon-ball amongst them, are made up of an immense number of tiny pieces, too small to be seen, called *molecules.* When we place the cannon-ball on the fire, we think that these molecules are made to move by the heat—to swing backwards and forwards, as it were; and that the more we heat the ball the faster we make the molecules move, so that when the ball is white hot each molecule moves backwards and forwards with immense quickness. Thus, although the ball *as a whole* is perfectly at rest, every little molecule in it is swinging to and fro with almost inconceivable rapidity. This kind of motion we call *motion of the molecules of a body.* Thus we have two kinds of motion:—(1.) Motion of the body as a whole; (2.) Motion of the molecules of a body, or molecular motion. Now, whether the piece of matter be large or small—whether it be a *body* or a *molecule*—it will never move of itself. If it be moving, something must have acted on it to set it in motion, and the power which produces that motion is called a *force.*

6. Distinction between Matter and Force.—When