

Chapter 4.

On Persistence as the third General Property of Bodies.

26. A body, once at rest, will remain at rest, unless it is disturbed from this state by an external cause, and is set in motion.

When a body is at rest, and there is nothing external that could act on it, then it cannot be understood how the body could be set into motion. If it should start to move, then this would have to be in some direction. There is however no reason why it should move in one direction rather than in a different one, and in the absence of any sufficient reason for this, we can conclude with certainty that a body, once at rest, will remain in that state, unless an external cause arises that can set it in motion. This principle teaches us that in the body itself there is no cause for bringing it from rest into motion. This eliminates all imaginary forces, that some teachers of Natural Science ascribe to bodies, forces through which these bodies are supposed to strive into motion. This property, through which a body, once at rest, remains in that state, is in the nature of a body, and must be grounded in its essence. As applied to a body at rest, I call this property its persistence, which consists in the fact that the body will remain at rest as long as no external causes arise that can disturb this state and set it in motion.

27. The state of rest of a body cannot be explained by ascribing to the body an attempt to move in all directions at the same time, so that because of the equality of all these attempts the body remains at rest.

It is not denied that a body, that is simultaneously pushed by equal external forces in all directions, will remain at rest, because all these pushes are in equilibrium, and the effect of one push is neutralized by an opposing one. This is similar to the case of a body immersed in water remaining at rest, although it is acted upon in all directions by the pressure of the water. But it cannot be maintained that a body has within it internal forces that push it equally in all directions. If each part of a body had internal tendencies pushing it equally forwards and backwards, then these tendencies would neutralize each other, which is equivalent to the tendencies not existing. Some scientists have proposed such internal tendencies, because they could not understand how during impact one body could act on another and set it in motion. They sought to explain the matter by saying that through the impact the internal tendency in one direction is eliminated, giving the oppositely directed internal tendency the upper hand, so that it actually sets the body into motion. But these people do not seem to have considered the fact that the same force is required to neutralize the tendency of a body to move in a direction, as is required to move the body in that direction, and this force would have to derive from an equal oppositely directed tendency, so that the explanation

of movement imparted through impact would not be made any easier. Such imaginary forces are thus easily put aside by recognising that a body at rest must, by its very nature always remain at rest. This excludes bodies that have spring properties, in which a tendency to move is present. But this stems from the very particular structure of these bodies, the explanation of which requires a far deeper insight into the Science of Movement. But here we speak of the general properties of all bodies, with which we have of necessity to start.

28. A body that is in motion, must because of its nature continue this motion always in the same direction, that means it must continue to move in a straight line, as long as its direction is not altered by an external cause.

Here the question is not yet whether the bodies continue their motion, or whether they are suddenly arrested. If one wanted to assert the latter, this would also not contradict our statement; for since in rest there is no room for direction, one could not argue that the direction had been altered. We shall now demonstrate the former, and there, with regard to direction, the question is whether a body in motion continues in a straight line or in a curve. Here we regard the body as a point; for since the movement of a body can be regarded as nothing other than the movement of all the points we can conceive in it, we must begin our investigation with these, which, through their movement describe a line that is either straight or curved. Since we put all external circumstances aside, one sees at once, that within the body itself there could not be a cause to veer towards one or some other direction. If we notice that a body changes its direction, and moves along a curve, we can conclude with certainty that there is an external cause to which this change in direction must be ascribed. Because of its nature, a body always maintains its direction of motion: this maintenance of the direction of motion is a second consequence of the property to which we here give the name of persistence. It will soon be shown that we are justified in using this name, rather than the otherwise usual name of inertia, since the latter has given rise to inaccurate concepts. (See §31.)

29. A body in motion must, because of its nature, not only continue its motion in a straight line, but must also maintain its speed, and therefore traverse equal paths in equal times, unless this uniformity is disturbed by external causes.

Here we discuss only what must go on within a moving body because of its own nature, and all external causes are put aside. The nature of the body must contain a certain instruction that determines the continuance of the movement, or it must contain a reason why the movement continues in one way rather than another. The movement is however determined by its direction and speed, and remains unchanged as long as direction and speed are not changed. Since it has been shown that, because of its nature, a moving body must always maintain its direction, it remains to be decided what happens to the speed, whether it

undergoes change or remains the same. One can however not think of anything within the body that could produce a change in its speed, and in the absence of any cause for such a change one must conclude that because of its nature a body also always maintains its speed. But although this conclusion is on a firm logical foundation, it seems to be contradicted by experience, since we observe that all movements that we produce gradually get less and ultimately stop altogether. However the reason for this lies evidently in an extraordinary resistance by the air, or the friction on an other body, from which we can conclude with certainty that if no such resistance existed, the movement would not suffer any diminution of speed. The maintenance of speed is therefore just as natural for a body as the maintenance of direction, and if in either of them a change occurs, its cause must be sought outside the moving body. Consequently all bodies have the property that they tend to maintain their movement at any speed in any direction.

30. One says that a body remains in the same state, when it remains at rest, or when it continues its movement in the same direction at the same speed.

In a body one can imagine a double state, the external and the internal one. The inner state represents the kind and composition of the parts comprising the body, but the external state, of which alone we shall be speaking here, represents the relations of the body with space. As long as a body is at rest, there is no doubt that it will remain in the same relation to space. But when a body moves, it continually changes its location, but when this occurs always in the same direction and at the same speed, then there remains in the change of location a constant sameness, so that also in this case one can say that the relation to space remains the same. In both cases one says that the body remains in the same state. But if either a body at rest is set into motion, or if in a moving body either the direction, the speed, or both simultaneously are altered, then also its state suffers a change, the cause of which can not, as we have shown, be in the body itself, but must be sought outside of it. But as long as a body remains at rest, or continues its movement in some direction at constant speed, i.e. as long as it moves uniformly in a straight line, the cause of its remaining in any state must be in the body itself. Therefore one must ascribe to any body a capability to remain steady in its state. This capability is also a general property of material bodies, a property that follows immediately and of necessity from its mobility.

31. This property of all bodies, to remain in their state, will here be called its persistence, which applies equally to motion and rest.

This property is otherwise called inertia, after the Latin word *inertia*, a name that would not be inappropriate for bodies at rest and for their ability to remain at rest, since it expresses an opposition to movement. But since this property also applies to moving bodies, and since one can not say of a body that always moves at constant speed, that it is inert, the name inertia does not seem appropriate here. For although words are irrelevant as long as one correctly understands the

concepts they represent, the associations connected with this word make it difficult to avoid the incorrect view that a body has a certain tendency to rest. But when one introduces the word persistence, then the tendency to remain in any state seems to be expressed in the best way, for whether a body is at rest or moves at constant speed in a straight line, in either case a kind of persistence is apparent. One is also accustomed to connect with the word inertia a force, and to ascribe to a body the force of inertia, thus causing great confusion. For we actually call a force something that is able to change the state of a body, so that something on which the maintenance of that same state is based, can not be regarded as a force. If instead of this seductive word one introduces another one, that expresses matters more precisely, this type of confusion is avoided.

32. If the external causes, which until now have changed the state of a body, cease to act, then the body remains in the state in which it found itself at the instant when the external causes cease to act.

Due to its persistence a body tries to remain in the state in which it actually is. However much external causes change the state of a body, it is nevertheless at every instant in a certain state, and it would remain steadfastly in the latter, if the external causes would cease to act. Consider a body that is forced by external causes to move non-uniformly along a curve, and assume that these external causes suddenly cease to act. Its persistence will then cause it to continue its movement in a straight line, in the same direction and with the same speed that it had at that instant. Thus if a body has so far been at rest, but has now been set into motion by an external cause, it will from now on continue this motion in the same way in which it would have remained in a state of rest, had it not been disturbed from the latter. The persistence is thus no more connected to one state than any other, and whatever state a body may have been placed in, it has always the same persistence to remain in it; it may be at rest or in motion, this state must be continued unchanged, unless it is disturbed by external causes.

33. Once the persistence of bodies has been accepted, it would clearly be a contradiction to assign to bodies certain additional forces that change their state.

If bodies had a force to change their state, as is maintained by some savants, it would be incorrect to say that they had the capability to persist in their state, and there is clearly a contradiction between such forces and the bodies' persistence. Since furthermore the persistence is a general property of all bodies, one cannot ascribe to a particular type of body a force, through which it should endeavour to change its state. For whenever it happens that the state of a body undergoes change, it is certain that the change stems from an external cause, and thus cannot be ascribed to an internal force of the body. If it is argued that we do not know all properties of bodies, we can nevertheless maintain with certainty that amongst these properties there cannot be any that are in manifest contradiction to the

properties of which we are aware. For just as it would be illogical to ascribe to bodies a property through which extent or mobility are eliminated, it would be equally illogical if, having demonstrated persistence, one would maintain that bodies possessed forces that aim at changing their state. One must thus be amazed at how some Natural Scientists can at the same time ascribe to bodies such forces and also the property that we here call persistence. They have been persuaded to accept the former through hasty conclusions, and since all principles of motion, the truth of which it is impossible to doubt, rest on persistence, they were forced to accept persistence, leading them, without their being aware of it, into such an obvious contradiction.

34. It is therefore certain that, whenever a change occurs in the state of a body, the cause of that change is not located within the body itself, but must be sought outside it.

When a body, that so far has been at rest, begins to move, or a moving body continues not in a straight line, or with varying speed, then its state changes, and since the cause of this change cannot be within the body, it must be looked for outside it. But this is not yet the place to inquire where one would find this cause. For this we must first arrive at a complete understanding of bodies, when the answer to the question will automatically become evident. But if some tend to conclude:

Changes occur in the world all the time, and no body remains for long in the state it has been in; therefore there must in bodies be a force that changes their state incessantly,

then this is a hasty conclusion, contradicting head on the first properties of bodies, that we clearly recognize. One attempts in this manner to find out the cause of the changes that take place in bodies, without having given sufficient consideration to the circumstances, under which these changes occur. This is a wrong approach, that must be carefully avoided in the exploration of the nature of things. The first part of the above statement, namely that nearly all bodies in the world undergo incessant change, may well be right, but from this follows by no means that the cause of this lies in the body in which the change takes place. As will be shown below, the cause lies in other bodies, which in certain circumstances must bring about changes in the former body, just because they themselves have persistence and tend to resist all change.