The Philosophical Writings of Descartes

VOLUME I

Translated by
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1. *The arguments that lead to the certain knowledge of the existence of material things.*

Everyone is quite convinced of the existence of material things. But earlier on we cast doubt on this belief and counted it as one of the preconceived opinions of our childhood.[1] So it is necessary for us to investigate next the arguments by which the existence of material things may be known with certainty. Now, all our sensations undoubtedly come to us from something that is distinct from our mind. For it is not in our power to make ourselves have one sensation rather than another; this is obviously dependent on the thing that is acting on our senses. Admittedly one can raise the question of whether this thing is God or something different from God. But we have sensory awareness of, or rather as a result of sensory stimulation we have a clear and distinct perception of, some kind of matter, which is extended in length, breadth and depth, and has various differently shaped and variously moving parts which give rise to our various sensations of colours, smells, pain and so on. And if God were himself immediately producing in our mind the idea of such extended matter, or even if he were causing the idea to be produced by 41
something which lacked extension, shape and motion, there would be no way of avoiding the conclusion that he should be regarded as a deceiver. For we have a clear understanding of this matter as something that is quite different from God and from ourselves or our mind; and we appear to see clearly that the idea of it comes to us from things located outside ourselves, which it wholly resembles. And we have already noted that it is quite inconsistent with the nature of God that he should be a deceiver.[2] The unavoidable conclusion, then, is that there exists something extended in length, breadth and depth and possessing all the properties which we clearly perceive to belong to an extended thing. And it is this extended thing that we call 'body' or 'matter'.

1 See Part 1, art. 4. 2 Above, Part 1, art. 29.

2. *The basis for our knowledge that the human body is closely conjoined with the mind.*

By the same token, the conclusion that there is a particular body that is more closely conjoined with our mind than any other body follows from our clear awareness that pain and other sensations come to us quite unexpectedly. The mind is aware that these sensations do not come from itself alone, and that they cannot belong to it simply in virtue of its being a thinking thing; instead, they can belong to it only in virtue of its being joined to something other than itself which is extended and moveable – namely what we call the human body. But this is not the place for a detailed explanation of its nature.

3. *Sensory perception does not show us what really exists in things, but merely shows us what is beneficial or harmful to man's composite nature.*

It will be enough, for the present, to note that sensory perceptions are related exclusively to this combination of the human body and mind. They normally tell us of the benefit or harm that external bodies may do to this combination, and do not, except occasionally and accidentally,
42 show us what external bodies are like in themselves. If we bear this in mind we will easily lay aside the preconceived opinions acquired from the senses, and in this connection make use of the intellect alone, carefully attending to the ideas implanted in it by nature.

4. *The nature of body consists not in weight, hardness, colour, or the like, but simply in extension.*

If we do this, we shall perceive that the nature of matter, or body considered in general, consists not in its being something which is hard or heavy or coloured, or which affects the senses in any way, but simply in its being something which is extended in length, breadth and depth. For as regards hardness, our sensation tells us no more than that the parts of a hard body resist the motion of our hands when they come into contact with them. If, whenever our hands moved in a given direction, all the bodies in that area were to move away at the same speed as that of our approaching hands, we should never have any sensation of hardness. And since it is quite unintelligible to suppose that, if bodies did move away in this fashion, they would thereby lose their bodily nature, it follows that this nature cannot consist in hardness. By the same reasoning it can be shown that weight, colour, and all other such qualities that are perceived by the senses as being in corporeal matter, can be removed from it, while the matter itself remains intact; it thus follows that its nature does not depend on any of these qualities.

5. *This truth about the nature of body is obscured by preconceived opinions concerning rarefaction and empty space.*

But there are still two possible reasons for doubting that the true nature of body consists solely in extension. The first is the widespread belief that many bodies can be rarefied and condensed in such a way that when rarefied they possess more extension than when condensed. Indeed, the subtlety of some people goes so far that they distinguish the substance of a body from its quantity, and even its quantity from its extension.[1] The second reason is that if we understand there to be nothing in a given place 43
but extension in length, breadth and depth, we generally say not that there is a body there, but simply that there is a space, or even an empty space; and almost everyone is convinced that this amounts to nothing at all.

6. *How rarefaction occurs.*

But with regard to rarefaction and condensation, anyone who attends to his own thoughts, and is willing to admit only what he clearly perceives, will not suppose that anything happens in these processes beyond a change of shape. Rarefied bodies, that is to say, are those which have many gaps between their parts – gaps which are occupied by other bodies; and they become denser simply in virtue of the parts coming together and reducing or completely closing the gaps. In this last eventuality a body becomes so dense that it would be a contradiction to suppose that it could be made any denser. Now in this condition, the extension of a body is no less than when it occupies more space in virtue of the mutual separation of its parts; for whatever extension is comprised in the pores or gaps left between the parts must be attributed not to the body itself but to the various other bodies which fill the gaps. In just the same way, when we see a sponge filled with water or some other liquid, we do not suppose that in terms of its own individual parts it has a greater extension than when it is squeezed dry; we simply suppose that its pores are open wider, so that it spreads over a greater space.

7. *This is the only intelligible way of explaining rarefaction.*

I really do not see what has prompted others to say that rarefaction occurs through an increase of quantity, in preference to explaining it by means of this example of the sponge.[2] It is true that when air or water is rarefied, we do not see any pores being made larger, or any new body 44

1 Cf. *The World*, above p. 92.

2 Scholastic philosophers explained rarefaction in terms of a given amount of matter occupying a larger quantity or volume of space: for Descartes, however, this is unintelligible, since there is no real distinction between the notions of 'quantity', 'matter' and 'space'. See below, art. 8–12.

coming to fill them up. But to invent something unintelligible so as to provide a purely verbal explanation of rarefaction is surely less rational than inferring the existence of pores or gaps which are made larger, and supposing that some new body comes and fills them. Admittedly, we do not perceive this new body with any of our senses; but there is no compelling reason to believe that all the bodies which exist must affect our senses. Moreover, it is very easy for us to see how rarefaction can occur in this way, but we cannot see how it could occur in any other way. Finally, it is a complete contradiction to suppose that something should be augmented by new quantity or new extension without new extended substance, i.e. a new body, being added to it at the same time. For any addition of extension or quantity is unintelligible without the addition of substance which has quantity and extension. This will become clearer from what follows.

8. *The distinction between quantity or number and the thing that has quantity or number is merely a conceptual distinction.*

There is no real difference between quantity and the extended substance; the difference is merely a conceptual one, like that between number and the thing which is numbered. We can, for example, consider the entire nature of the corporeal substance which occupies a space of ten feet without attending to the specific measurement; for we understand this nature to be exactly the same in any part of the space as in the whole space. And, conversely, we can think of the number ten, or the continuous quantity *ten feet*, without attending to this determinate substance. For the concept of the number ten is exactly the same irrespective of whether it is referred to this measurement of ten feet or to anything else; and as for the continuous quantity *ten feet*, although this is unintelligible without some extended substance of which it is the quantity, it can be understood apart from this determinate substance. In reality, however, it is impossible to take even the smallest fraction from the quantity or extension without also removing just as much from the substance; and conversely, it is impossible to remove the smallest amount from the substance without taking away just as much from the quantity or extension.

9. *If corporeal substance is distinguished from its quantity, it is conceived in a confused manner as something incorporeal.*

Others may disagree, but I do not think they have any alternative perception of the matter. When they make a distinction between substance and extension or quantity, either they do not understand anything by the term 'substance', or else they simply have a confused idea of incorporeal substance, which they falsely attach to corporeal substance; and they relegate the true idea of corporeal substance to the category of extension, which, however, they term an accident. There is thus no correspondence between their verbal expressions and what they grasp in their minds.

10. *What is meant by 'space', or 'internal place'.*

There is no real distinction between space, or internal place,[1] and the corporeal substance contained in it; the only difference lies in the way in which we are accustomed to conceive of them. For in reality the extension in length, breadth and depth which constitutes a space is exactly the same as that which constitutes a body. The difference arises as follows: in the case of a body, we regard the extension as something particular, and thus think of it as changing whenever there is a new body; but in the case of a space, we attribute to the extension only a generic unity, so that when a new body comes to occupy the space, the extension of the space is reckoned not to change but to remain one and the same, so long as it retains the same size and shape and keeps the same position relative to certain external bodies which we use to determine the space in question.

11. *There is no real difference between space and corporeal substance.* 46

It is easy for us to recognize that the extension constituting the nature of a body is exactly the same as that constituting the nature of a space. There is no more difference between them than there is between the nature of a genus or species and the nature of an individual. Suppose we attend to the idea we have of some body, for example a stone, and leave out everything we know to be non-essential to the nature of body: we will first of all exclude hardness, since if the stone is melted or pulverized it will lose its hardness without thereby ceasing to be a body; next we will exclude colour, since we have often seen stones so transparent as to lack colour; next we will exclude heaviness, since although fire is extremely light it is still thought of as being corporeal; and finally we will exclude cold and heat and all other such qualities, either because they are not thought of as being in the stone, or because if they change, the stone is not on that account reckoned to have lost its bodily nature. After all this, we will see that nothing remains in the idea of the stone except that it is something extended in length, breadth and depth. Yet this is just what is

1 The scholastics distinguished between *locus internus*, or 'internal place' (the space occupied by a body), and *locus externus*, or 'external space' (the external surface containing a body). Descartes employs the traditional terminology here and at art. 13 below, but puts it to his own use.

comprised in the idea of a space – not merely a space which is full of bodies, but even a space which is called 'empty'.[1]

12. *The difference between space and corporeal substance lies in our way of conceiving them.*

There is, however, a difference in the way in which we conceive of space and corporeal substance. For if a stone is removed from the space or place where it is, we think that its extension has also been removed from that place, since we regard the extension as something particular and inseparable from the stone. But at the same time we think that the extension of the place where the stone used to be remains, and is the same as before, although the place is now occupied by wood or water or air or some other body, or is even supposed to be empty. For we are now considering extension as something general, which is thought of as being the same, whether it is the extension of a stone or of wood, or of water or
47 of air or of any other body – or even of a vacuum, if there is such a thing – provided only that it has the same size and shape, and keeps the same position relative to the external bodies that determine the space in question.

13. *What is meant by 'external place'.*

The terms 'place' and 'space', then, do not signify anything different from the body which is said to be in a place; they merely refer to its size, shape and position relative to other bodies. To determine the position, we have to look at various other bodies which we regard as immobile; and in relation to different bodies we may say that the same thing is both changing and not changing its place at the same time. For example, when a ship is under way, a man sitting on the stern remains in one place relative to the other parts of the ship with respect to which his position is unchanged; but he is constantly changing his place relative to the neighbouring shores, since he is constantly receding from one shore and approaching another. Then again, if we believe the earth moves,[2] and suppose that it advances the same distance from west to east as the ship travels from east to west in the corresponding period of time, we shall again say that the man sitting on the stern is not changing his place; for we are now determining the place by means of certain fixed points in the heavens. Finally, if we suppose that there are no such genuinely fixed points to be found in the universe (a supposition which will be shown below to be probable[3]) we shall conclude that nothing has a permanent place, except as determined by our thought.

1 Lat. *vacuum*. See below, art. 16.
2 '. . . turns on its axis' (French version).
3 The French version has 'demonstrable' instead of 'probable'. Cf. Part 3, art. 29, p. 252 below.

14. *The difference between place and space.*

The difference between the terms 'place' and 'space' is that the former designates more explicitly the position, as opposed to the size or shape, 48
while it is the size and shape that we are concentrating on when we talk of space. For we often say that one thing leaves a given place and another thing arrives there, even though the second thing is not strictly of the same size and shape; but in this case we do not say it occupies the same space. By contrast, when something alters its position, we always say the place is changed, despite the fact that the size and shape remain unaltered. When we say that a thing is in a given place, all we mean is that it occupies such and such a position relative to other things; but when we go on to say that it fills up a given space or place, we mean in addition that it has precisely the size and shape of the space in question.

15. *How external place is rightly taken to be the surface of the surrounding body.*

Thus we always take a space to be an extension in length, breadth and depth. But with regard to place, we sometimes consider it as internal to the thing which is in the place in question, and sometimes as external to it. Now internal place is exactly the same as space; but external place may be taken as being the surface immediately surrounding what is in the place. It should be noted that 'surface' here does not mean any part of the surrounding body but merely the boundary between the surrounding and surrounded bodies, which is no more than a mode. Or rather what is meant is simply the common surface, which is not a part of one body rather than the other but is always reckoned to be the same, provided it keeps the same size and shape. For if there are two bodies, one surrounding the other, and the entire surrounding body changes, surface and all, the surrounded body is not therefore thought of as changing its place, provided that during this time it keeps the same position relative to the external bodies which are regarded as immobile. If, for example, we suppose that a ship on a river is being pulled equally in one direction by the current and in the opposite direction by the wind, so that it does not 49
change its position relative to the banks, we will all readily admit that it stays in the same place, despite the complete change in the surrounding surface.

16. *It is a contradiction to suppose there is such a thing as a vacuum, i.e. that in which there is nothing whatsoever.*

The impossibility of a vacuum, in the philosophical sense of that in which there is no substance whatsoever, is clear from the fact that there is no difference between the extension of a space, or internal place, and the extension of a body. For a body's being extended in length, breadth and depth in itself warrants the conclusion that it is a substance, since it is a complete contradiction that a particular extension should belong to nothing; and the same conclusion must be drawn with respect to a space that is supposed to be a vacuum, namely that since there is extension in it, there must necessarily be substance in it as well.

17. *The ordinary use of the term 'empty' does not imply the total absence of bodies.*

In its ordinary use the term 'empty'[1] usually refers not to a place or space in which there is absolutely nothing at all, but simply to a place in which there is none of the things that we think ought to be there. Thus a pitcher made to hold water is called 'empty' when it is simply full of air; a fishpond is called 'empty', despite all the water in it, if it contains no fish; and a merchant ship is called 'empty' if it is loaded only with sand ballast. And similarly a space is called 'empty' if it contains nothing perceivable by the senses, despite the fact that it is full of created, self-subsistent matter; for normally the only things we give any thought to are those which are detected by our senses. But if we subsequently fail to keep in mind what ought to be understood by the terms 'empty' and 'nothing', we may suppose that a space we call empty contains not just nothing perceivable by the senses but nothing whatsoever; that would be just as mistaken as thinking that the air in a jug is not a subsistent thing on the grounds that a jug is usually said to be empty when it contains nothing but air.

18. *How to correct our preconceived opinion regarding an absolute vacuum.*

Almost all of us fell into this error in our early childhood. Seeing no necessary connection between a vessel and the body contained in it, we reckoned there was nothing to stop God, at least, removing the body which filled the vessel, and preventing any other body from taking its place. But to correct this error we should consider that, although there is no connection between a vessel and this or that particular body contained in it, there is a very strong and wholly necessary connection between the concave shape of the vessel and the extension, taken in its general sense, which must be contained in the concave shape. Indeed, it is no less contradictory for us to conceive of a mountain without a valley than it is for us to think of the concavity apart from the extension contained within it, or the extension apart from the substance which is

1 Lat. *vacuum*, from *vacuus*, 'void', 'unoccupied'; cf. art. 18.

extended; for, as I have often said, nothingness cannot possess any extension. Hence, if someone asks what would happen if God were to take away every single body contained in a vessel, without allowing any other body to take the place of what had been removed, the answer must be that the sides of the vessel would, in that case, have to be in contact. For when there is nothing between two bodies they must necessarily touch each other. And it is a manifest contradiction for them to be apart, or to have a distance between them, when the distance in question is nothing; for every distance is a mode of extension, and therefore cannot exist without an extended substance.

19. *The preceding conclusion confirms what we said regarding rarefaction.*

We have thus seen that the nature of corporeal substance consists simply 51
in its being something extended; and its extension is no different from what is normally attributed to space, however 'empty'. From this we readily see that no one part of it can possibly occupy more space at one time than at another, and hence that rarefaction cannot occur except in the way explained earlier on.[1] Similarly, there cannot be more matter or corporeal substance in a vessel filled with lead or gold or any other body, no matter how heavy and hard, than there is when it contains only air and is thought of as empty. This is because the quantity of the parts of matter does not depend on their heaviness or hardness, but solely on their extension, which is always the same for a given vessel.

20. *The foregoing results also demonstrate the impossibility of atoms.*

We also know that it is impossible that there should exist atoms, that is, pieces of matter that are by their very nature indivisible <as some philosophers have imagined>. For if there were any atoms, then no matter how small we imagined them to be, they would necessarily have to be extended; and hence we could in our thought divide each of them into two or more smaller parts, and hence recognize their divisibility. For anything we can divide in our thought must, for that very reason, be known to be divisible; so if we were to judge it to be indivisible, our judgement would conflict with our knowledge. Even if we imagine that God has chosen to bring it about that some particle of matter is incapable of being divided into smaller particles, it will still not be correct, strictly speaking, to call this particle indivisible. For, by making it indivisible by any of his creatures, God certainly could not thereby take away his own power of dividing it, since it is quite impossible for him to diminish his

1 See above, art. 6, p. 225.

52 own power, as has been noted above.[1] Hence, strictly speaking, the particle will remain divisible, since it is divisible by its very nature.

21. *Similarly, the extension of the world is indefinite.*
What is more we recognize that this world, that is, the whole universe of corporeal substance, has no limits to its extension. For no matter where we imagine the boundaries to be, there are always some indefinitely extended spaces beyond them, which we not only imagine but also perceive to be imaginable in a true fashion, that is, real. And it follows that these spaces contain corporeal substance which is indefinitely extended. For, as has already been shown very fully, the idea of the extension which we conceive to be in a given space is exactly the same as the idea of corporeal substance.

22. *Similarly, the earth and the heavens are composed of one and the same matter; and there cannot be a plurality of worlds.*
It can also easily be gathered from this that celestial matter is no different from terrestrial matter.[2] And even if there were an infinite number of worlds, the matter of which they were composed would have to be identical; hence, there cannot in fact be a plurality of worlds, but only one. For we very clearly understand that the matter whose nature consists simply in its being an extended substance already occupies absolutely all the imaginable space in which the alleged additional worlds would have to be located; and we cannot find within us an idea of any other sort of matter.

23. *All the variety in matter, all the diversity of its forms, depends on motion.*
The matter existing in the entire universe is thus one and the same, and it is always recognized as matter simply in virtue of its being extended. All the properties which we clearly perceive in it are reducible to its divisibility and consequent mobility in respect of its parts, and its resulting capacity to be affected in all the ways which we perceive as being derivable from the movement of the parts. If the division into parts occurs simply in our thought, there is no resulting change; any variation
53 in matter or diversity in its many forms depends on motion. This seems to have been widely recognized by the philosophers, since they have stated that nature is the principle of motion and rest. And what they meant by

1 Cf. Part 1, art. 60, above p. 213.
2 Descartes here rejects the scholastic doctrine of a radical difference in kind between 'sublunary' or terrestrial phenomena and the incorruptible world of the heavens.

'nature' in this context is what causes all corporeal things to take on the characteristics of which we are aware in experience.

24. *What is meant by 'motion' in the ordinary sense of the term.*
Motion, in the ordinary sense of the term, is simply *the action by which a body travels from one place to another.* By 'motion', I mean local motion; for my thought encompasses no other kind, and hence I do not think that any other kind should be imagined to exist in nature.[1] Now I pointed out above that the same thing can be said to be changing and not changing its place at the same time;[2] and similarly the same thing can be said to be moving and not moving. For example, a man sitting on board a ship which is leaving port considers himself to be moving relative to the shore which he regards as fixed; but he does not think of himself as moving relative to the ship, since his position is unchanged relative to its parts. Indeed, since we commonly think all motion involves action, while rest consists in the cessation of action, the man sitting on deck is more properly said to be at rest than in motion, since he does not have any sensory awareness of action in himself.

25. *What is meant by 'motion' in the strict sense of the term.*
If, on the other hand, we consider what should be understood by *motion*, not in common usage but in accordance with the truth of the matter, and if our aim is to assign a determinate nature to it, we may say that *motion is the transfer of one piece of matter, or one body, from the vicinity of the other bodies which are in immediate contact with it, and which are regarded as being at rest, to the vicinity of other bodies.* By 'one body' or 'one piece of matter' I mean whatever is transferred at a given time, even 54
though this may in fact consist of many parts which have different motions relative to each other. And I say 'the transfer' as opposed to the force or action which brings about the transfer, to show that motion is always in the moving body as opposed to the body which brings about the movement. The two are not normally distinguished with sufficient care; and I want to make it clear that the motion of something that moves is, like the lack of motion in a thing which is at rest, a mere mode of that thing and not itself a subsistent thing, just as shape is a mere mode of the thing which has shape.

26. *No more action is required for motion than for rest.*
It should be noted that in this connection we are in the grip of a strong preconceived opinion, namely the belief that more action is needed for

1 See note to Part I, art. 69, p. 217. 2 Above, art. 13, p. 228.

motion than for rest. We have been convinced of this since early childhood owing to the fact that our bodies move by our will, of which we have inner awareness, but remain at rest simply in virtue of sticking to the earth by gravity,[1] the force of which we do not perceive through the senses. And because gravity and many other causes of which we are unaware produce resistance when we try to move our limbs, and make us tired, we think that a greater action or force is needed to initiate a motion than to stop it; for we take *action* to be the effort we expend in moving our limbs and moving other bodies by the use of our limbs. We will easily get rid of this preconceived opinion if we consider that it takes an effort on our part not only to move external bodies, but also, quite often, to stop them, when gravity and other causes are insufficient to arrest their movement. For example, the action needed to move a boat which is at rest in still water is no greater than that needed to stop it suddenly when
55 it is moving – or rather it is not much greater, for one must subtract the weight of the water displaced by the ship and the viscosity of the water, both of which could gradually bring it to a halt.

27. *Motion and rest are merely various modes of a body in motion.*
We are dealing here not with the action which is understood to exist in the body which produces or arrests the motion, but simply with the transfer of a body, and with the absence of a transfer, i.e. rest. So it is clear that this transfer cannot exist outside the body which is in motion, and that when there is a transfer of motion, the body is in a different state from when there is no transfer, i.e. when it is at rest. Thus motion and rest are nothing else but two different modes of a body.

28. *Motion in the strict sense is to be referred solely to the bodies which are contiguous with the body in motion.*
In my definition I specified that the transfer occurs from the vicinity of contiguous bodies to the vicinity of other bodies; I did not say that there was a transfer from one place to another. This is because, as explained above,[2] the term 'place' has various meanings, depending on how we think of it; but when we understand motion as a transfer occurring from the vicinity of contiguous bodies, then, given that only one set of bodies

1 Lat. *gravitas*, literally 'heaviness'. In scholastic physics this term was used to refer to the supposed inherent tendency of terrestrial bodies to downward motion. For Descartes' own use of the term, and his purely mechanistic explanation of heaviness, see below Part 4, art. 20–3. It should be remembered that neither for the scholastics nor for Descartes did the term 'gravity' have its modern (post-Newtonian) connotation of a universal attractive force.

2 See above, Part 2, art. 10, p. 227.

can be contiguous with the same moving body at any one time, we cannot assign several simultaneous motions to this body, but only one.

29. *And it is to be referred only to those contiguous bodies which are regarded as being at rest.*

I further specified that the transfer occurs from the vicinity not of *any* contiguous bodies but from the vicinity of those which 'are regarded as being at rest'. For transfer is in itself a reciprocal process: we cannot understand that a body AB is transferred from the vicinity of a body CD without simultaneously understanding that CD is transferred from the vicinity of AB. Exactly the same force and action is needed on both sides. 56
So if we wished to characterize motion strictly in terms of its own nature, without reference to anything else, then in the case of two contiguous bodies being transferred in opposite directions, and thus separated, we should say that there was just as much motion in the one body as in the other. But this would clash too much with our ordinary way of speaking. For we are used to standing on the earth and regarding it as at rest; so although we may see some of its parts, which are contiguous with other smaller bodies, being transferred out of their vicinity, we do not for that reason think of the earth itself as in motion.

30. *Why, if there are two contiguous bodies which are separated from each other, motion is attributed to one of them rather than the other.*

The principal reason for this is that motion is understood to belong to the whole body in motion. Now it cannot be understood to belong to the whole earth, in virtue of the transfer of some of its parts from the vicinity of smaller contiguous bodies; for often we may observe several such transfers occurring on the earth in opposite directions. Let the body EFGH be the earth [see Fig. 1], and suppose that on its surface the body AB is transferred from E towards F, and simultaneously the body CD is transferred from H to G. Now this very fact means that the parts of the earth contiguous with AB are transferred from B towards A; and to

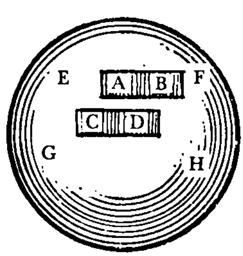

Fig. 1

produce this transfer, the action in these parts must be just as great as that in the body AB, and must be of an identical nature. But for all that, we do not understand the earth to be in motion from B towards A, or from east to west;[1] for, if so, the fact that those of its parts which are contiguous with the body CD are being transferred from C to D would, by the same reasoning, require us to understand the earth to be moving in
57 the other direction, from west to east – which contradicts the former supposition. Hence, to avoid too great a departure from the ordinary way of speaking, we shall say in this case not that the earth moves, but merely that the bodies AB and CD move; and similarly in other cases. But meanwhile we will remember that whatever is real and positive in moving bodies – that in virtue of which they are said to move – is also to be found in the other bodies which are contiguous with them, even though these are regarded merely as being at rest.

31. *How there may be countless different motions in the same body.*
Each body has only one proper motion, since it is understood to be moving away from only one set of bodies, which are contiguous with it and at rest. But it can also share in countless other motions, namely in cases where it is a part of other bodies which have other motions. For example, if someone walking on board ship has a watch in his pocket, the wheels of the watch have only one proper motion, but they also share in another motion because they are in contact with the man who is taking his walk, and they and he form a single piece of matter. They also share in an additional motion through being in contact with the ship tossing on the waves; they share in a further motion through contact with the sea itself; and lastly, they share in yet another motion through contact with the whole earth, if indeed the whole earth is in motion. Now all the motions will really exist in the wheels of the watch, but it is not easy to have an understanding of so many motions all at once, nor can we have knowledge of all of them. So it is enough to confine our attention to that single motion which is the proper motion of each body.

32. *How even the proper motion unique to each body may be considered as a plurality of motions.*
The single motion that is the proper motion of each body may also be considered as if it were made up of several motions. For example, we may distinguish two different motions in a carriage wheel – a circular motion
58 about the axle and a rectilinear motion along the line of the road. But

1 The original texts (both Latin and French) have the terms 'east' and 'west' transposed throughout this article. The corrections adopted here and three lines lower down seem necessary to make sense of the diagram.

that these are not really distinct is clear from the fact that every single point on the moving object describes only one line. It does not matter that the line is often very twisted so that it seems to have been produced by many different motions; for we can imagine any line at all – even a straight line, which is the simplest of all – as arising from an infinite number of different motions. Thus if the line AB travels towards CD [see Fig. 2], and at the same time the point A travels towards B, the straight

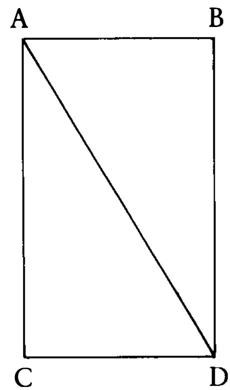

Fig. 2

line AD described by the point A will depend on two rectilinear motions, from A to B and from AB to CD, in just the same way as the curve described by any point of the wheel depends on a rectilinear motion and a circular motion. Although it is often useful to separate a single motion into several components in this way in order to facilitate our perception of it, nevertheless, absolutely speaking, there is only one motion that should be counted for any given body.

33. *How in every case of motion there is a complete circle of bodies moving together.*

I noted above[1] that every place is full of bodies, and that the same portion of matter always takes up the same amount of space, <so that it is impossible for it to fill a greater or lesser space, or for any other body to occupy its place while it remains there>. It follows from this that each body can move only in a <complete> circle <of matter, or ring of bodies which all move together at the same time>: a body entering a given place expels another, and the expelled body moves on and expels another, and so on, until the body at the end of the sequence enters the place left by the

1 Art. 18 and 19, pp. 230f.

first body at the precise moment when the first body is leaving it. We can easily understand this in the case of a perfect circle, since we see that no
59 vacuum and no rarefaction or condensation is needed to enable part A of the circle [see Fig. 3] to move towards B, provided that B simultaneously moves towards C, C towards D and D towards A. But the same thing is intelligible even in the case of an imperfect circle however irregular it may be, provided we notice how all the variations in the spaces can be compensated for by variations in speed. Thus all the matter contained in the space EFGH [see Fig. 4] can move in a circle without the need for

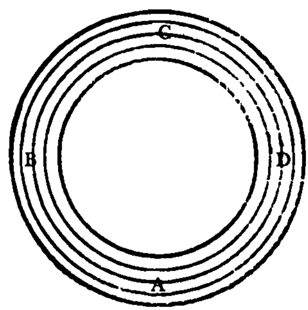

Fig. 3

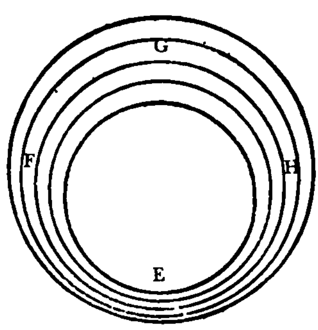

Fig. 4

any condensation or vacuum, and the part that is around E can move towards G while the part that is around G simultaneously moves towards E, with this sole proviso: if the space in G is supposed to be four times as wide as the space at E and twice as wide as the space at F and H, then the speed of the motion at E must be four times greater than that at G and twice as great as that at F or H; and at every other location an increase in speed must similarly compensate for a narrower space. In this way, the amount of matter passing through any given part of the circle in any given time will always be equal.

34. *From this it follows that the number of particles into which matter is divided is in fact indefinite, although it is beyond our power to grasp them all.*

It must, however, be admitted that in the case of this motion we come upon something the truth of which our mind perceives, while at the same time being unable to grasp exactly how it occurs. For what happens is an infinite, or indefinite,[1] division of the various particles of matter; and the resulting subdivisions are so numerous that however small we make a 60
particle in our thought, we always understand that it is in fact divided into other still smaller particles. For it is impossible for the matter which now fills space G successively to fill all the spaces between G and E, which get gradually smaller by countless stages, unless some part of that matter adjusts its shape to the innumerable different volumes of those spaces. And for this to come about, it is necessary that all its imaginable particles, which are in fact innumerable, should shift their relative positions to some tiny extent. This minute shifting of position is a true case of division.

35. *How this division comes about; and the fact that it undoubtedly takes place, even though it is beyond our grasp.*

It should be noted, however, that I am not here speaking of the whole of this matter, but merely of some part of it. We may suppose that two or three of its parts at G are as wide as the space at E, and that there are also several smaller parts which remain undivided; but nevertheless we can still understand them to move in a circle towards E, provided they have mixed up with them various other particles which somehow bend and change shape in such a way as to join onto them. Now the former group do not change their own shape, but merely adapt their speed depending on the place they are to occupy, while the latter group exactly fill all the crevices which the former do not occupy. We cannot grasp in our thought how this indefinite division comes about, but we should not therefore doubt that it occurs. For we clearly perceive that it necessarily follows from what we <already> know most evidently of the nature of matter, and we perceive that it belongs to the class of things which are beyond the grasp of our finite minds.

1 See above, Part 1, art. 26, pp. 201f.

61 36. *God is the primary cause of motion; and he always preserves the same quantity of motion in the universe.*

After this consideration of the nature of motion, we must look at its cause. This is in fact twofold: first, there is the universal and primary cause – the general cause of all the motions in the world; and second there is the particular cause which produces in an individual piece of matter some motion which it previously lacked. Now as far as the general cause is concerned, it seems clear to me that this is no other than God himself. In the beginning <in his omnipotence> he created matter, along with its motion and rest; and now, merely by his regular concurrence, he preserves the same amount of motion and rest in the material universe as he put there in the beginning. Admittedly motion is simply a mode of the matter which is moved. But nevertheless it has a certain determinate quantity; and this, we easily understand, may be constant in the universe as a whole while varying in any given part. Thus if one part of matter moves twice as fast as another which is twice as large, we must consider that there is the same quantity of motion in each part; and if one part slows down, we must suppose that some other part of equal size speeds up by the same amount. For we understand that God's perfection involves not only his being immutable in himself, but also his operating in a manner that is always utterly constant and immutable. Now there are some changes whose occurrence is guaranteed either by our own plain experience or by divine revelation, and either our perception or our faith shows us that these take place without any change in the creator; but apart from these we should not suppose that any other changes occur in God's works, in case this suggests some inconstancy in
62 God. Thus, God imparted various motions to the parts of matter when he first created them, and he now preserves all this matter in the same way, and by the same process by which he originally created it;[1] and it follows from what we have said that this fact alone makes it most reasonable to think that God likewise always preserves the same quantity of motion in matter.

37. *The first law of nature: each and every thing, in so far as it can, always continues in the same state; and thus what is once in motion always continues to move.*

From God's immutability we can also know certain rules or laws of nature, which are the secondary and particular causes of the various motions we see in particular bodies. The first of these laws is that each

1 There is for Descartes no real distinction between God's action in creating the universe and his action in preserving it or maintaining it in existence. See below, art. 42, p. 243, and Med. III: vol. II, p. 33.

thing, in so far as it is simple and undivided, always remains in the same state, as far as it can, and never changes except as a result of external causes. Thus, if a particular piece of matter is square, we can be sure without more ado that it will remain square for ever, unless something coming from outside changes its shape. If it is at rest, we hold that it will never begin to move unless it is pushed into motion by some cause. And if it moves, there is equally no reason for thinking it will ever lose this motion of its own accord and without being checked by something else. Hence we must conclude that what is in motion always, so far as it can, continues to move. But we live on the Earth, whose composition is such that all motions occurring near it are soon halted, often by causes undetectable by our senses. Hence from our earliest years we have often judged that such motions, which are in fact stopped by causes unknown to us, come to an end of their own accord. And we tend to believe that what we have apparently experienced in many cases holds good in all cases – namely that it is in the very nature of motion to come to an end, 63
or to tend towards a state of rest. This, of course, <is a false preconceived opinion which> is utterly at variance with the laws of nature; for rest is the opposite of motion, and nothing can by its own nature tend towards its opposite, or towards its own destruction.

38. *The motion of projectiles.*
Indeed, our everyday experience of projectiles completely confirms this first rule of ours. For there is no other reason why a projectile should persist in motion for some time after it leaves the hand that throws it, except that what is once in motion continues to move until it is slowed down by bodies that are in the way.[1] And it is clear that projectiles are normally slowed down, little by little, by the air or other fluid bodies in which they are moving, and that this is why their motion cannot persist for long. The fact that air offers resistance to other moving bodies may be confirmed either by our own experience, through the sense of touch if we beat the air with a fan, or by the flight of birds. And in the case of any other fluid, the resistance offered to the motion of a projectile is even more obvious than in the case of air.

39. *The second law of nature: all motion is in itself rectilinear; and hence any body moving in a circle always tends to move away from the centre of the circle which it describes.*
The second law is that every piece of matter, considered in itself, always tends to continue moving, not in any oblique path but only in a straight

1 Cf. *The World*, ch. 7: above p. 95.

line. This is true despite the fact that many particles are often forcibly deflected by the impact of other bodies; and, as I have said above,[1] in any motion the result of all the matter moving simultaneously is a kind of circle. The reason for this second rule is the same as the reason for the first rule, namely the immutability and simplicity of the operation by which God preserves motion in matter. For he always preserves the
64 motion in the precise form in which it is occurring at the very moment when he preserves it, without taking any account of the motion which was occurring a little while earlier. It is true that no motion takes place in a single instant of time; but clearly whatever is in motion is determined, at the individual instants which can be specified as long as the motion lasts, to continue moving in a given direction along a straight line, and never in a curve . . .[2]

(65) 40. *The third law: if a body collides with another body that is stronger than itself, it loses none of its motion; but if it collides with a weaker body, it loses a quantity of motion equal to that which it imparts to the other body.*

The third law of nature is this: when a moving body collides with another, if its power of continuing in a straight line is less than the resistance of the other body, it is deflected so that, while the quantity of motion is retained, the direction is altered; but if its power of continuing is greater than the resistance of the other body, it carries that body along with it, and loses a quantity of motion equal to that which it imparts to the other body. Thus we find that when hard projectiles strike some other hard body, they do not stop, but rebound in the opposite direction; when, by contrast, they encounter a soft body, they are immediately halted because they readily transfer all their motion to it. All the particular causes of the changes which bodies undergo are covered by this third law – or at least the law covers all changes which are themselves corporeal. I am not here inquiring into the existence or nature of any power to move bodies which may be possessed by human minds, or the minds of angels, since I am reserving this topic for a treatise *On Man* <which I hope to produce>.[3]

41. *The proof of the first part of this rule.*

The first part of this law is proved by the fact that there is a difference between motion considered in itself <the motion of a thing> and its

1 Art. 33, p. 237.

2 Descartes proceeds to illustrate the point by the example of a stone shot from a sling. Cf. Part 3, art. 57, p. 259.

3 This treatise, originally planned to form Part 6 of the *Principles* (see below Part 4, art. 188, p. 279, was never written. It is not to be confused with the earlier *Treatise on Man* (pp. 99–108 above).

determination in a certain direction; for the determination of the direction can be altered, while the motion remains constant. As I have said above, everything that is not composite but simple, as motion is, always persists in being <as it is in itself and not in relation to other things>, so long as it is not destroyed by an external cause <by meeting another object>. Now if one body collides with a second, hard body <in its path which it is quite incapable of pushing>, there is an obvious reason why its motion should not remain fixed in the same direction, <namely the resistance of the body which deflects its path>; but there is 66
no reason why its motion should be stopped or diminished, <since it is not removed by the other body or by any other cause, and> since one motion is not the opposite of another motion. Hence it follows that the motion in question ought not to diminish at all.

42. *The proof of the second part of this rule.*

The second part of the law is proved from the immutability of the workings of God, by means of which the world is continually preserved through an action identical with its original act of creation. For the whole of space is filled with bodies, and the motion of every single body is rectilinear in tendency; hence it is clear that when he created the world in the beginning God did not only impart various motions to different parts of the world, but also produced all the reciprocal impulses and transfers of motion between the parts. Thus, since God preserves the world by the selfsame action and in accordance with the selfsame laws as when he created it, the motion which he preserves is not something permanently fixed in given pieces of matter, but something which is mutually transferred when collisions occur. The very fact that creation is in a continual state of change is thus evidence of the immutability of God.[1]

43. *The nature of the power which all bodies have to act on, or resist, other bodies.*

In this connection we must be careful to note what it is that constitutes the power of any given body to act on, or resist the action of, another body. This power consists simply in the fact that everything tends, so far as it can, to persist in the same state, as laid down in our first law. Thus what is joined to another thing has some power of resisting separation from it; and what is separated has some power of remaining separate. Again, what is at rest has some power of remaining at rest and consequently of resisting anything that may alter the state of rest; and

1 '... is no way incompatible with the immutability of God, and may even serve as evidence to establish it' (French version).

what is in motion has some power of persisting in its motion, i.e. of
67 continuing to move with the same speed and in the same direction. An estimate of this last power must depend firstly on the size of the body in question and the size of the surface which separates it from other bodies, and secondly on the speed of the motion, and on the various ways in which different bodies collide, and the degree of opposition involved.

44. *The opposite of motion is not some other motion but a state of rest; and the opposite of the determination of a motion in a given direction is its determination in the opposite direction.*

It should be noted that one motion is in no way contrary to another of equal speed. Strictly speaking there are only two sorts of opposition to be found here. One is the opposition between motion and rest, together with the opposition between swiftness and slowness of motion (in so far, that is, as such slowness shares something of the nature of rest). And the second sort is the opposition between the determination of motion in a given direction and an encounter somewhere in that direction with another body which is at rest or moving in another direction. The degree of this opposition varies in accordance with the direction in which a body is moving when it collides with another.

45. *How to determine how much the motion of a given body is altered by collision with other bodies. This is calculated by means of the following rules.*

To enable us to determine, in the light of this, how individual bodies increase or diminish their motions or change direction as a result of collision with other bodies, all that is necessary is to calculate the power of any given body to produce or resist motion; we also need to lay it down as a firm principle that the stronger power always produces its effects. Our calculation would be easy if there were only two bodies colliding, and these were perfectly hard, and so isolated from all other bodies that no surrounding bodies impeded or augmented their motions. In this case they would obey the rules that follow.[1]

1 Descartes' seven rules for calculating the speed and direction of bodies after impact cover seven ideal cases, which are, respectively: (1) where two bodies of equal size and speed collide head on; (2) as in case (1), but where one body is larger; (3) as in (1) but where one body is travelling faster; (4) where one body is at rest and larger; (5) where one body is at rest and smaller; (6) where one body is at rest and the bodies are equal in size; and (7) where two bodies collide when travelling in the same direction. The calculations in all seven rules presuppose that 'quantity of motion', measured as the product of size (extension) and speed, is preserved. For an English version of these articles, and other material omitted below, see V. R. and R. P. Miller, *Descartes, Principles of philosophy* (Dordrecht: Reidel, 1983), pp. 64f.

46. *The first rule.* (68)

47. *The second rule.*

48. *The third rule.*

49. *The fourth rule.*

50. *The fifth rule.* (69)

51. *The sixth rule.*

52. *The seventh rule.*
... These matters do not need proof since they are self-evident <the (70)
demonstrations are so certain that even if our experience seemed to show us the opposite, we should still be obliged to have more faith in our reason than in our senses>.

53. *The application of these rules is difficult because each body is simultaneously in contact with many others.*
<In fact it often happens that experience may appear to conflict with the rules I have just explained, but the reason for this is evident.> Since no bodies in the universe can be so isolated from all others, and no bodies in our vicinity are normally perfectly hard, the calculation for determining how much the motion of a given body is altered by collision with another body is much more difficult than those given above. <So in order to judge whether the above rules are observed here or not, it is not sufficient to know how two bodies can act against one another on impact.> We have to take into account all the other bodies which are touching them on every side, and these have very different effects depending on whether they are hard or fluid. So we must now inquire what this difference consists in.

54. *What hard bodies are, and what fluid bodies are.*
... If we go on to inquire how it comes about that some bodies readily abandon their place to other bodies, while others do not, we can easily
see that a body already in motion does not prevent another body 71
occupying the place which it is spontaneously leaving; a body at rest, on the other hand, cannot be expelled from its place except by some force <coming from outside, which produces a change>. Hence we may infer that fluids are bodies made up of numerous tiny particles which are agitated by a variety of mutually distinct motions; while hard bodies are those whose particles are all at rest relative to each other.

55. *There is no glue binding together the parts of hard bodies apart from the simple fact that they are at rest <relative to each other>.*

We certainly cannot think up any kind of glue which could fix together the particles of two bodies any more firmly than is achieved simply by their being at rest. For what could such a glue be? It could not be a substance, for since the particles are themselves substances, there is no reason why another substance should join them more effectively than they join themselves together. Nor could the 'glue' be any mode distinct from their being at rest. For what mode could be more contrary to the motion that separates them than their being at rest? And we recognize no other categories of things apart from substances and their modes.

56. *The particles of fluid bodies move with equal force in all directions. And if a hard body is present in a fluid, the smallest force is able to set it in motion.*

As far as fluids are concerned, even though we cannot observe through our senses any motion of their particles, because they are too small, such motion is easily inferred from their effects, especially in the case of air and water. For air and water corrupt many other bodies; and no corporeal action – and corruption is such an action – can occur without local motion . . .

(73) 57. *The proof of the above.*

(75) 58. *If any particles of a fluid move more slowly than a hard body which is present inside it, the fluid in that area does not behave as a fluid.*

59. *If a hard body is pushed by another hard body, it does not get all its motion from it; it also gets some of its motion from the surrounding fluid.*

(76) 60. *However, it cannot acquire a greater speed from the fluid than it acquires from the hard body that strikes it.*

61. *When an entire fluid body moves in a given direction at one time it necessarily carries with it any hard body which may be contained inside it.*

(77) 62. *The fact that a hard body is carried along by a fluid in this way does not mean that it is itself in motion.*

63. *Why some bodies are so hard that, despite their small size, they cannot easily be divided by our hands.*

64. *The only principles which I accept, or require, in physics are those of geometry and pure mathematics; these principles explain all natural phenomena, and enable us to provide quite certain demonstrations regarding them.* (78)

I will not here add anything about shapes or about the countless different kinds of motions that can be derived from the infinite variety of different shapes. These matters will be quite clear in themselves when the time comes for me to deal with them. I am assuming that my readers know the basic elements of geometry already, or have sufficient mental aptitude to understand mathematical demonstrations. For I freely acknowledge that I recognize no matter in corporeal things apart from that which the geometers call quantity, and take as the object of their demonstrations, 79
i.e. that to which every kind of division, shape and motion is applicable. Moreoever, my consideration of such matter involves absolutely nothing apart from these divisions, shapes and motions; and even with regard to these, I will admit as true only what has been deduced from indubitable common notions so evidently that it is fit to be considered as a mathematical demonstration. And since all natural phenomena can be explained in this way, as will become clear in what follows, I do not think that any other principles are either admissible or desirable in physics.