everything coloured yellow, or when stars or other very distant bodies appear to us much smaller than they are. For after all, whether we are awake or asleep, we ought never to let ourselves be convinced except by the evidence of our reason. It will be observed that I say ‘our reason’, not ‘our imagination’ or ‘our senses’. Even though we see the sun very clearly, we must not judge on that account that it is only as large as we see it; and we can distinctly imagine a lion’s head on a goat’s body without having to conclude from this that a chimera exists in the world. For reason does not insist that what we thus see or imagine is true. But it does insist that all our ideas or notions must have some foundation of truth; for otherwise it would not be possible that God, who is all-perfect and all-truthful, should have placed them in us. And our reasonings are never so evident or complete in sleep as in waking life, although sometimes our imaginings in sleep are as lively and distinct as in waking life, or more so. Hence reason also demands that, since our thoughts cannot all be true because we are not wholly perfect, what truth they do possess must inevitably be found in the thoughts we have when awake, rather than in our dreams.

Part Five

I would gladly go on and reveal the whole chain of other truths that I deduced from these first ones. But in order to do this I would have to discuss many questions that are being debated among the learned, and I do not wish to quarrel with them. So it will be better, I think, for me not to do this, and merely to say in general what these questions are, so as to let those who are wiser decide whether it would be useful for the public to be informed more specifically about them. I have always remained firm in the resolution I had taken to assume no principle other than the one I have just used to demonstrate the existence of God and of the soul, and to accept nothing as true which did not seem to me clearer and more certain than the demonstrations of the geometers had hitherto seemed. And yet I venture to say that I have found a way to satisfy myself within a short time about all the principal difficulties usually discussed in philosophy. What is more, I have noticed certain laws which God has so established in nature, and of which he has implanted such notions in our minds, that after adequate reflection we cannot doubt that they are exactly observed in everything which exists or occurs in the world. Moreover, by considering what follows from these laws it seems to me that I have discovered many truths more useful and important than anything I had previously learned or even hoped to learn.

I endeavoured to explain the most important of these truths in a
treatise which certain considerations prevent me from publishing, and I
know of no better way to make them known than by summarizing its
contents.¹ My aim was to include in it everything I thought I knew about
the nature of material things before I began to write it. Now a painter
cannot represent all the different sides of a solid body equally well on his
flat canvas, and so he chooses one of the principal ones, sets it facing the
light, and shades the others so as to make them stand out only when
viewed from the perspective of the chosen side. In just the same way,
fearing that I could not put everything I had in mind into my discourse, I
undertook merely to expound quite fully what I understood about light.
Then, as the occasion arose, I added something about the sun and fixed
stars, because almost all light comes from them; about the heavens,
because they transmit light; about planets, comets and the earth, because
they reflect light; about terrestrial bodies in particular, because they are
either coloured or transparent or luminous; and finally about man,
because he observes these bodies. But I did not want to bring these
matters too much into the open, for I wished to be free to say what I
thought about them without having either to follow or to refute the
accepted opinions of the learned. So I decided to leave our world wholly
for them to argue about, and to speak solely of what would happen in a
new world. I therefore supposed that God now created, somewhere in
imaginary spaces, enough matter to compose such a world; that he
variously and randomly agitated the different parts of this matter so as to
form a chaos as confused as any the poets could invent; and that he then
did nothing but lend his regular concurrence to nature, leaving it to act
according to the laws he established. First of all, then, I described this
matter, trying to represent it so that there is absolutely nothing, I think,
which is clearer and more intelligible, with the exception of what has just
been said about God and the soul. In fact I expressly supposed that this
matter lacked all those forms or qualities about which they dispute in the
Schools, and in general that it had only those features the knowledge of
which was so natural to our souls that we could not even pretend not to
know them. Further, I showed what the laws of nature were, and without
basing my arguments on any principle other than the infinite perfections
of God, I tried to demonstrate all those laws about which we could have
any doubt, and to show that they are such that, even if God created many
worlds, there could not be any in which they failed to be observed. After
this, I showed how, in consequence of these laws, the greater part of the
matter of this chaos had to become disposed and arranged in a certain
way, which made it resemble our heavens; and how, at the same time,

¹ The treatise of which The World and the Treatise on Man are parts. See pp. 79–108
above.
some of its parts had to form an earth, some planets and comets, and others a sun and fixed stars. Here I dwelt upon the subject of light, explaining at some length the nature of the light that had to be present in the sun and stars, how from there it travelled instantaneously across the immense distances of the heavens, and how it was reflected from the planets and comets to the earth. To this I added many points about the substance, position, motions and all the various qualities of these heavens and stars; and I thought I had thereby said enough to show that for anything observed in the heavens and stars of our world, something wholly similar had to appear, or at least could appear, in those of the world I was describing. From that I went on to speak of the earth in particular: how, although I had expressly supposed that God had put no gravity into the matter of which it was formed, still all its parts tended exactly towards its centre; how, there being water and air on its surface, the disposition of the heavens and heavenly bodies (chiefly the moon), had to cause an ebb and flow similar in all respects to that observed in our seas, as well as a current of both water and air from east to west like the one we observe between the tropics; how mountains, seas, springs and rivers could be formed naturally there, and how metals could appear in mines, plants grow in fields, and generally how all the bodies we call ‘mixed’ or ‘composite’ could come into being there. Among other things, I took pains to make everything belonging to the nature of fire very clearly understandable, because I know nothing else in the world, apart from the heavenly bodies, that produces light. Thus I made clear how it is formed and fuelled, how sometimes it possesses only heat without light, and sometimes light without heat; how it can produce different colours and various other qualities in different bodies; how it melts some bodies and hardens others; how it can consume almost all bodies, or turn them into ashes and smoke; and finally how it can, by the mere force of its action, form glass from these ashes — something I took particular pleasure in describing since it seems to me as wonderful a transmutation as any that takes place in nature.

Yet I did not wish to infer from all this that our world was created in the way I proposed, for it is much more likely that from the beginning God made it just as it had to be. But it is certain, and it is an opinion commonly accepted among theologians, that the act by which God now preserves it is just the same as that by which he created it. So, even if in the beginning God had given the world only the form of a chaos, provided that he established the laws of nature and then lent his concurrence to enable nature to operate as it normally does, we may believe without impugning the miracle of creation that by this means alone all purely material things could in the course of time have come to
be just as we now see them. And their nature is much easier to conceive if we see them develop gradually in this way than if we consider them only in their completed form.

From the description of inanimate bodies and plants I went on to describe animals, and in particular men. But I did not yet have sufficient knowledge to speak of them in the same manner as I did of the other things — that is, by demonstrating effects from causes and showing from what seeds and in what manner nature must produce them. So I contented myself with supposing that God formed the body of a man exactly like our own both in the outward shape of its limbs and in the internal arrangement of its organs, using for its composition nothing but the matter that I had described. I supposed, too, that in the beginning God did not place in this body any rational soul or any other thing to serve as a vegetative or sensitive soul, but rather that he kindled in its heart one of those fires without light which I had already explained, and whose nature I understood to be no different from that of the fire which heats hay when it has been stored before it is dry, or which causes new wine to seethe when it is left to ferment from the crushed grapes. And when I looked to see what functions would occur in such a body I found precisely those which may occur in us without our thinking of them, and hence without any contribution from our soul (that is, from that part of us, distinct from the body, whose nature, as I have said previously, is simply to think). These functions are just the ones in which animals without reason may be said to resemble us. But I could find none of the functions which, depending on thought, are the only ones that belong to us as men; though I found all these later on, once I had supposed that God created a rational soul and joined it to this body in a particular way which I described.

But so that you might see how I dealt with this subject, I shall give my explanation of the movement of the heart and the arteries. Being the first and most widespread movement that we observe in animals, it will readily enable us to decide how we ought to think about all the others. But first, so there may be less difficulty in understanding what I shall say, I should like anyone unversed in anatomy to take the trouble, before reading this, to have the heart of some large animal with lungs dissected before him (for such a heart is in all respects sufficiently like that of a man), and to be shown the two chambers or cavities which are present in it. First, there is the cavity on the right, to which two very large tubes are connected: these are the vena cava, which is the principal receptacle of the blood and is like the trunk of a tree of which all the other veins of the body are the branches; and the arterial vein (ill-named because it is really an artery), which originates in the heart and after leaving it divides into
many branches that spread throughout the lungs. Then there is the cavity on the left, likewise connected to two tubes which are as large as the others or even larger: the venous artery (also ill-named because it is nothing but a vein), which comes from the lungs where it is divided into many branches intertwined with those of the arterial vein and with those of the windpipe (as it is called) through which the air we breathe enters; and the great artery which goes out from the heart and sends its branches throughout the body. I should also like the reader to be shown the eleven little membranes which, like so many little doors, open and close the four openings within these two cavities. Three are situated at the entrance to the vena cava in such a way that they cannot prevent the blood contained in it from flowing into the right-hand cavity, and yet they effectively prevent it from flowing out. Three at the entrance to the arterial vein do just the opposite, readily permitting the blood in the right-hand cavity to pass into the lungs, but not permitting the blood in the lungs to return into it. Likewise two others at the entrance to the venous artery allow the blood in the lungs to flow into the left-hand cavity of the heart, but block its return; and three at the entrance to the great artery permit blood to leave the heart but prevent it from returning. There is no need to seek any reason for the number of these membranes beyond the fact that the opening to the venous artery, being oval because of its location, can easily be closed with two of them, whereas the other openings, being round, can be closed more effectively with three. I should like the reader also to observe that the great artery and the arterial vein have a much harder and firmer composition than the venous artery and the vena cava, and that the latter widen out before entering the heart to form two pouches, called the auricles, which are composed of flesh similar to that of the heart. He will observe that there is always more heat in the heart than in any other place in the body, and finally, that this heat is capable of causing a drop of blood to swell and expand as soon as it enters a cavity of the heart, just as liquids generally do when they are poured drop by drop into some vessel which is very hot.

After that, I need say little in order to explain the movement of the heart. When its cavities are not full of blood, some blood necessarily flows from the vena cava into the right-hand cavity and from the venous artery into the left-hand cavity, for these two vessels are always full of blood and their entrances, which open into the heart, cannot be blocked. But as soon as two drops of blood have entered the heart in this way, one in each of its cavities, these drops, which must be very large because the openings through which they enter are very wide and the vessels from which they come are very full of blood, are rarified and expand because of the heat they find there. In this way they make the whole heart swell,
and they push against and close the five little doors at the entrance to the two vessels from which they come, thus preventing any more blood from descending to the heart. Continuing to become more and more rarefied, they push open the six other little doors at the entrance to the other two vessels, going out through them and thereby causing all the branches of the arterial vein and of the great artery to swell almost at the same instant as the heart. Immediately afterwards, the heart contracts, as do these arteries as well, because the blood that entered them grows cold, and their six little doors close again while the five doors of the vena cava and the venous artery reopen and allow the passage of two further drops of blood, which immediately makes the heart and the arteries swell, exactly as before. And it is because the blood thus entering the heart passes through the two pouches called the auricles that their movement is contrary to that of the heart, and they contract when it swells. Now those who are ignorant of the force of mathematical demonstrations and unaccustomed to distinguishing true reasons from probable may be tempted to reject this explanation without examining it. To prevent this, I would advise them that the movement I have just explained follows from the mere arrangement of the parts of the heart (which can be seen with the naked eye), from the heat in the heart (which can be felt with the fingers), and from the nature of the blood (which can be known through observation). This movement follows just as necessarily as the movement of a clock follows from the force, position, and shape of its counterweights and wheels.

One may ask, however, why the blood in the veins is not used up as it flows continually into the heart, and why the arteries are never too full of blood, since all the blood that passes through the heart flows through them. To this I need give no reply other than that already published by an English physician, who must be praised for having broken the ice on this subject.¹ He is the first to teach that there are many small passages at the extremities of the arteries, through which the blood they receive from the heart enters the small branches of the veins, from there going immediately back to the heart, so that its course is nothing but a perpetual circulation. He proves this very effectively by reference to the normal practice of surgeons, who bind an arm moderately tightly above a vein they have opened, so as to make the blood flow out more abundantly than if they had not bound the arm. But just the opposite happens if they bind the arm below, between the hand and the opening, or even if they bind it very tightly above the opening. For it is obvious that a moderately tight tourniquet can prevent the blood that is already

¹ William Harvey (1578–1657), whose book on the circulation of the blood, *De Motu Cordis*, was published in 1628 and read by Descartes in 1632.
in the arm from returning to the heart through the veins, but does not prevent fresh blood from coming through the arteries. There are two reasons for this: first, the arteries are situated below the veins and their walls are harder and hence less easily compressed; and second, the blood which comes from the heart tends to flow through the arteries to the hand with more force than it does in returning to the heart through the veins. And since this blood comes out of the arm through an opening in one of the veins, there must necessarily be some passages below the tourniquet (that is, towards the extremity of the arm) through which it may flow from the arteries. Harvey also proves very soundly what he says about the circulation of the blood by pointing to certain small membranes which are arranged in various places along the veins in such a way that they do not permit the blood to pass from the middle of the body towards the extremities but only let it return from the extremities towards the heart. He proves his theory, moreover, by an experiment which shows that all the blood in the body can flow out of it in a very short time through a single artery, even if the artery is tightly bound close to the heart and cut between the heart and the tourniquet so that no one could have any reason to imagine that the blood drained off comes from anywhere but the heart.

But there are many other facts which prove that the true cause of this movement of the blood is the one I have given. First, there is the difference we see between the blood which flows from the veins and that which flows from the arteries. This can result only from the fact that the blood is raresifed and, as it were, distilled in passing through the heart, and is therefore thinner, livelier and warmer just after leaving it (that is, when in the arteries) than a little before entering it (that is, when in the veins). And if you look closely you will find this difference to be more evident near the heart than in places further from it. Then there is the hardness of the membranes of which the arterial vein and the great artery are composed: this shows well enough that the blood strikes against them with more force than against the veins. And why should the left-hand cavity of the heart and the great artery be larger and wider than the right-hand cavity and the arterial vein, if not because the blood in the venous artery, having been only in the lungs after passing through the heart, is thinner and more easily raresifed than that which comes immediately from the vena cava? And what could physicians learn by feeling the pulse if they did not know that, as the nature of the blood changes, it can be raresifed by the heat of the heart more or less strongly, and more or less quickly, than before? And if we examine how this heat is

1 See Description of the Human Body (below, pp. 316ff) for Descartes' criticism of Harvey's explanation of the movement of the blood.
communicated to the other parts of the body, must we not acknowledge that this happens by means of the blood, which is re heated in passing through the heart and spreads from there through the whole body? So it is that if we remove the blood from some part of the body, we thereupon remove the heat as well; and even if the heart were as hot as glowing iron, it would not be able to reheat the feet and the hands as it does unless it continually sent new blood to these parts. Then, too, we know from this that the true function of respiration is to bring enough fresh air into the lungs to cause the blood entering there from the right-hand cavity of the heart, where it has been rarefied and almost changed into vapours, to thicken immediately into blood again before returning to the left-hand cavity. For if this did not happen the blood would not be fit to serve as fuel for the fire in the heart. This is confirmed by seeing that animals without lungs have only one cavity in their hearts, and that unborn children, who cannot use their lungs while enclosed within their mother’s womb, have an opening through which blood flows from the vena cava into the left-hand cavity of the heart, and a tube through which blood comes from the arterial vein into the great artery without passing through the lungs. Again, how would digestion take place in the stomach if the heart did not send heat there through the arteries, together with some of the most fluid parts of the blood which help to dissolve the food we have put there? And is it not easy to understand the action that converts the juice of this food into blood, if we consider that the blood passing in and out of the heart is distilled perhaps more than one or two hundred times each day? Again, what more do we need in order to explain nutrition and the production of the various humours present in the body? We need only say that as the blood is rarefied it flows with such force from the heart towards the extremities of the arteries that some of its parts come to rest in parts of the body where they drive out and displace other parts of the blood; and certain parts of the blood flow to some places rather than others according to the situation, shape, or minuteness of the pores that they encounter, just as sieves with holes of various sizes serve to separate different grains from each other. But the most remarkable of all these facts is the generation of the animal spirits: like a very fine wind, or rather a very pure and lively flame, they rise continuously in great abundance from the heart into the brain, passing from there through the nerves to the muscles and imparting movement to all the parts of the body. The parts of the blood which are the most agitated and penetrating, and hence the best suited to compose these spirits, make their way to the brain rather than elsewhere. For this we

1 See footnote 2, p. 100 above.
need suppose no cause other than the fact that they are carried there by the arteries which come most directly from the heart. For according to the laws of mechanics, which are identical with the laws of nature, when many things tend to move together towards a place where there is not enough room for all of them (as when the parts of blood coming from the left-hand cavity of the heart all tend towards the brain), the weakest and least agitated must be pushed aside by the strongest, which thus arrive at that place on their own.

I explained all these matters in sufficient detail in the treatise I previously intended to publish. And then I showed what structure the nerves and muscles of the human body must have in order to make the animal spirits inside them strong enough to move its limbs – as when we see severed heads continue to move about and bite the earth although they are no longer alive. I also indicated what changes must occur in the brain in order to cause waking, sleep and dreams; how light, sounds, smells, tastes, heat and the other qualities of external objects can imprint various ideas on the brain through the mediation of the senses; and how hunger, thirst, and the other internal passions can also send their ideas there. And I explained which part of the brain must be taken to be the 'common' sense, where these ideas are received; the memory, which preserves them; and the corporeal imagination, which can change them in various ways, form them into new ideas, and, by distributing the animal spirits to the muscles, make the parts of this body move in as many different ways as the parts of our bodies can move without being guided by the will, and in a manner which is just as appropriate to the objects of the senses and the internal passions. This will not seem at all strange to those who know how many kinds of automatons, or moving machines, the skill of man can construct with the use of very few parts, in comparison with the great multitude of bones, muscles, nerves, arteries, veins and all the other parts that are in the body of any animal. For they will regard this body as a machine which, having been made by the hands of God, is incomparably better ordered than any machine that can be devised by man, and contains in itself movements more wonderful than those in any such machine.

I made special efforts to show that if any such machines had the organs and outward shape of a monkey or of some other animal that lacks reason, we should have no means of knowing that they did not possess entirely the same nature as these animals; whereas if any such machines bore a resemblance to our bodies and imitated our actions as closely as possible for all practical purposes, we should still have two very certain

1 See footnote p. 132, above.
means of recognizing that they were not real men. The first is that they could never use words, or put together other signs, as we do in order to declare our thoughts to others. For we can certainly conceive of a machine so constructed that it utters words, and even utters words which correspond to bodily actions causing a change in its organs (e.g. if you touch it in one spot it asks what you want of it, if you touch it in another it cries out that you are hurting it, and so on). But it is not conceivable that such a machine should produce different arrangements of words so as to give an appropriately meaningful answer to whatever is said in its presence, as the dullest of men can do. Secondly, even though such machines might do some things as well as we do them, or perhaps even better, they would inevitably fail in others, which would reveal that they were acting not through understanding but only from the disposition of their organs. For whereas reason is a universal instrument which can be used in all kinds of situations, these organs need some particular disposition for each particular action; hence it is for all practical purposes impossible for a machine to have enough different organs to make it act in all the contingencies of life in the way in which our reason makes us act.

Now in just these two ways we can also know the difference between man and beast. For it is quite remarkable that there are no men so dull-witted or stupid – and this includes even madmen – that they are incapable of arranging various words together and forming an utterance from them in order to make their thoughts understood; whereas there is no other animal, however perfect and well-endowed it may be, that can do the like. This does not happen because they lack the necessary organs, for we see that magpies and parrots can utter words as we do, and yet they cannot speak as we do: that is, they cannot show that they are thinking what they are saying. On the other hand, men born deaf and dumb, and thus deprived of speech-organs as much as the beasts or even more so, normally invent their own signs to make themselves understood by those who, being regularly in their company, have the time to learn their language. This shows not merely that the beasts have less reason than men, but that they have no reason at all. For it patently requires very little reason to be able to speak; and since as much inequality can be observed among the animals of a given species as among human beings, and some animals are more easily trained than others, it would be incredible that a superior specimen of the monkey or parrot species should not be able to speak as well as the stupidest child – or at least as well as a child with a defective brain – if their souls were not completely different in nature from ours. And we must not confuse speech with the natural movements which express passions and which can be imitated by
machines as well as by animals. Nor should we think, like some of the ancients, that the beasts speak, although we do not understand their language. For if that were true, then since they have many organs that correspond to ours, they could make themselves understood by us as well as by their fellows. It is also a very remarkable fact that although many animals show more skill than we do in some of their actions, yet the same animals show none at all in many others; so what they do better does not prove that they have any intelligence, for if it did then they would have more intelligence than any of us and would excel us in everything. It proves rather that they have no intelligence at all, and that it is nature which acts in them according to the disposition of their organs. In the same way a clock, consisting only of wheels and springs, can count the hours and measure time more accurately than we can with all our wisdom.

After that, I described the rational soul, and showed that, unlike the other things of which I had spoken, it cannot be derived in any way from the potentiality of matter, but must be specially created. And I showed how it is not sufficient for it to be lodged in the human body like a helmsman in his ship, except perhaps to move its limbs, but that it must be more closely joined and united with the body in order to have, besides this power of movement, feelings and appetites like ours and so constitute a real man. Here I dwelt a little upon the subject of the soul, because it is of the greatest importance. For after the error of those who deny God, which I believe I have already adequately refuted, there is none that leads weak minds further from the straight path of virtue than that of imagining that the souls of the beasts are of the same nature as ours, and hence that after this present life we have nothing to fear or to hope for, any more than flies and ants. But when we know how much the beasts differ from us, we understand much better the arguments which prove that our soul is of a nature entirely independent of the body, and consequently that it is not bound to die with it. And since we cannot see any other causes which destroy the soul, we are naturally led to conclude that it is immortal.