Principles of Philosophy

René Descartes

[Brackets] enclose editorial explanations. Small ·dots· enclose material that has been added, but can be read as though it were part of the original text. Occasional •bullets, and also indenting of passages that are not quotations, are meant as aids to grasping the structure of a sentence or a thought. The basis from which this text was constructed was the translation by John Cottingham (Cambridge University Press), which is strongly recommended. Each four-point ellipsis . . . . indicates the omission of a short passage that seemed to be more trouble than it is worth. Longer omissions are reported between square brackets in normal-sized type.—Descartes wrote this work in Latin. A French translation appeared during his life-time, and he evidently saw and approved some of its departures from or additions to the Latin. A few of these will be incorporated, usually without sign-posting, in the present version.—When a section starts with a hook to something already said, it's a hook to •the thought at the end of the preceding section, *not* to •its own heading. In the definitive Adam and Tannery edition of Descartes's works, and presumably also in the first printing of the *Principles*, those items were not headings but marginal summaries.

First launched: March 2008 Last amended: January 2012 (a confusion relating to II.15)

Contents

Part 4: The earth

1. The false hypothesis that I have been using must be retained to provide an explanation of the true natures of things.

I gave you clear notice that I don't actually *believe* my hypothesis about how the bodies in this visible universe were first produced, but I'm still holding onto it as an aid to explaining what we observe here on earth. I hope to show clearly that this is the only way to supply causes for all natural objects; if I succeed in that, I'll be entitled to infer that although the world wasn't initially made like this but was created ready-made by God, the nature of these objects is exactly as it *would* have been if they *had* been produced in the way I have described.

2. How, according to this hypothesis, the earth was produced.

3–5. The division of the earth into three regions. Descriptions of them.

[The first region is the earth's innermost core, which is pretty much like the sun. The second is a very dense and opaque shell around that, entirely composed of third-element matter. The third region is the earth's outer crust. Descartes doesn't say how thick it is; but he does say that the first two regions won't concern him because 'no-one has ever reached them alive'. See also section 75.]

6. The particles of the third element that are in this third region must be fairly large.

7. These particles can be changed by the action of the first and second elements.

8. They are bigger than the globules of the second element but less solid and less agitated.

9. From the beginning they have formed successive layers around the earth.

10. Various gaps have been left around them, which are filled with matter of the first and second elements.

11. The globules of the second element were originally smaller, the nearer they were to the centre of the earth.

12. And they had narrower passages to pass through.

13. The thicker particles were not always below the thinner.

14. The original formation of various bodies in the third region of the earth.

15. The forces which caused these bodies to be produced. First, the general motion of the celestial globules.

·First force: motion·

16. The first effect of this first force is to make bodies transparent.

17. How a solid and hard body can have enough passages to transmit rays of light.

18. The second effect of this first force is to separate one body from another and to purify liquids.

19. The third effect is to make drops of liquid round.

·Second force: weight·

20. Explanation of the second force, which is called 'weight'.

The force of weight doesn't differ much from the third action of the celestial globules. These globules, purely through their random motion in all directions, exert an equal pressure on all the particles of each drop of liquid, thus pressing them towards the centre of the drop and making the drop itself round. And through that same ·random· motion, when the globules are prevented from moving in a straight line by encountering the entire mass of the earth, they propel all the earth's particles towards the centre, and that's what the 'weight' of terrestrial bodies consists in.

21. All the parts of the earth, taken individually, are not heavy but light.

Suppose that these two things were the case:

> •All the spaces around the earth that don't have terrestrial matter in them are 'empty' in the sense of containing only bodies that wouldn't help or hinder the motion of other bodies

(that being the only way to make *any* sense of the term 'empty'),

> •The earth turns on its axis, unaided, once every twenty-four hours.

If that were the case, all the terrestrial particles that weren't *very* firmly joined together would leap off in all directions towards the heavens. (You can see the same effect by throwing sand onto a spinning top.) Thus the earth would have to be called light rather than heavy.

22. What the lightness of the celestial matter consists in.

But those two suppositions are false: no spaces are 'empty', even in that special sense; and what drives the earth ·to spin on its axis· isn't its own motion but rather the celestial matter that surrounds it and fills all its pores; so that the earth's behaviour is that of a body at rest. Now, celestial matter considered as single mass that goes along with the earth as it drives it ·around the sun· has no force of weight or lightness. But the particles of celestial matter don't use up all their agitation in driving the earth; there is some left over, that is used in straight-line motions; and when these motions are blocked by an encounter with the earth, those celestial particles move away from the earth as far as they can, and that's what their lightness consists in. [Two ·dotted· interpolations in this section have implied that Descartes talks **(1)** about the earth's daily rotation on its axis and then silently switches to **(2)** its annual revolution around the sun. This is uncomfortable, but the connection with section 21 requires **(1)** and the phrase 'goes along with the earth' seems to require **(2)**.]

23. How all the parts of the earth are driven downwards by the celestial matter, and so become heavy.

The power that the individual particles of celestial matter have to move away from the earth can't achieve its effect unless the particles in moving upwards displace various terrestrial particles, thus pushing them downwards. Now all the spaces around the earth are occupied either by particles of terrestrial bodies or by celestial matter. The globules of the celestial matter have an equal tendency to move away from the earth, so no individual one of them has the force to displace any other. But the particles of terrestrial bodies don't have this tendency so strongly; so whenever any celestial globules have terrestrial particles above them they must exert all their force to displace them. Thus, the weight of any terrestrial body is not strictly produced by all the celestial matter surrounding it, but only by the portion of celestial matter that rises into the space left by the body as it descends, and hence equals it in size. [Descartes then goes through this again with a diagram of an example.]

24. How much heaviness there is in each body.

If we are correctly to calculate the weight of an individual body—let's call it 'B'—we must observe that **(1)** B's pores contain some celestial matter, which is opposed to an equal quantity celestial matter contained in the mass of air that is to take B's place; and **(2)** that this mass of air contains some terrestrial parts that are opposed to an equal number of the terrestrial parts of B. In respect of each of these, the matter in the air and the corresponding matter in B cancel out, and have no effect on B's weight. What B's weight consists in is the action of the non-opposed celestial matter in the air on the non-opposed terrestrial matter in B.

25. Weight does not correspond to the quantity of matter in each body.

The **(1)** matter of the first element, other things being equal, has more force to drive terrestrial bodies downward than do **(2)** the globules of the second element, and **(2)** have greater force than ·a similar quantity of· **(3)** terrestrial particles of air that they move with them. The reason is the same in each case: **(1)** has more agitation than **(2)**, which have more agitation than **(3)**. So there's no easy way to estimate just from its weight how much terrestrial matter a body contains. . . .

26. Why bodies don't gravitate downwards when they are in their own natural places.

27. Weight pushes bodies down towards the centre of the earth.

·Third force: light·

28. The third force, which is light. How it moves the particles of air.

·Fourth force: heat·

29. The fourth force, which is heat. What it is and how it persists even when light is removed.

30. Why it penetrates further than light.

31. Why heat rarefies almost all bodies and condenses some.

·Different kinds of body·

32. How the highest region of the earth was first divided into two different bodies.

33. The three-part classification of principal kinds of terrestrial particle.

34. How a third body was formed in between the first two.

35. The particles contained in this body are of one kind only.

36. And they are of only two specific types.

37. How the lowest body was divided into many others.

38. The formation of another, fourth, body above the third.

39. The accretion of this fourth body, and the purification of the third.

40. How the bulk of this third body was reduced, so as to leave a space between it and the fourth body.

41. How there were many fissures produced in the fourth body.

42. How it was broken into many pieces.

43. How the third body has partly moved above the fourth and partly remained below.

44. This is the reason why mountains, plains, seas, etc. were produced on the surface of the earth.

·Air·

45. The nature of air.

46. Why it is easily rarefied and condensed.

47. How it can be forcibly compressed in certain machines.

·Water·

48. The nature of water, and how it easily turns either into air or into ice.

49. The ebb and flow of the tides.

50. Why the tide rises for 6.2 hours and falls for 6.2 hours.

51. Why the tides are greater when the moon is full or new.

52. Why they are greatest at the equinoxes.

53. Why air and water always flow from east to west.

54. Why regions having sea to the east are more temperate than others at the same latitude.

55. Why there is no ebb and flow in lakes or swamps; and why it occurs at different hours on different shores.

56. How we should investigate the particular causes of this on the individual shores.

·MISCELLANEOUS·

57. The nature of the earth's interior.

58. The nature of quicksilver.

59. The variation in the heat pervading the earth's interior.

60. The action of this heat.

61. The bitter juices and acids from which vitriol, alum etc. are formed.

62. The oleaginous matter of bitumen, sulphur etc.

63. The basic elements of the chemists; and how metals come up into mines.

64. The exterior of the earth, and the origin of springs.

65. Why the sea doesn't increase as a result of the rivers flowing into it.

·SALTS·

66. Why springs are not salt, and seawater doesn't become fresh.

67. Why the water in certain wells is brackish.

68. Why salt is also dug out of certain mountains.

69. Nitre, and other salts that are different from sea salt.

70. Vapours, acrid spirits and exhalations that come up and out from the earth's interior.

·MINERALS·

71. How the various mixtures of these produce different kinds of stones and other minerals.

72. How metals reach the exterior of the earth from its interior; and how minium is formed.

73. Why metals are not found everywhere on earth.

74. Why they are found especially at the base of mountains towards the south and east.

75. All mines are in the exterior of the earth; the interior can never be reached by digging.

76. Sulphur, bitumen, clay and oil.

·EARTHQUAKES AND VOLCANOES·

77. How an earthquake occurs.

78. Why fire erupts from certain mountains.

79. Why there are usually several tremors in an earthquake, so that it sometimes lasts for several hours or days.

·FIRE·

80. The nature of fire, and the difference between fire and air.

81. How fire is first kindled.

82. How it is kept going.

83. Why it needs fuel.

84. How fire is sparked off by striking flints.

85. How it is kindled from dry twigs. . .

86. . . . or by focussing the rays of the sun. . .

87. . . . or simply by very violent motion. . .

88. . . . or by the mixing of various bodies.

89. Fire in lightning and shooting stars . . .

90. . . . in things that shine and don't burn, such as falling stars. . .

91. . . . . in drops of seawater, in rotten wood and the like. . .

92. . . . in things that grow hot but don't shine, such as stored hay. . .

93. . . . in lime sprinkled with water, and other cases.

94. How fire is kindled in cavities of the earth.

95. How a candle burns.

96. How the fire in a candle is kept going.

97. Why its flame is pointed and smoke comes out of it.

98. How air and other bodies feed the flame.

99. The movement of air towards a fire.

100. What extinguishes fire.

101. What is needed for a body to be suitable for fuelling a fire.

102. Why the flame from alcohol doesn't burn a linen cloth.

103. Why alcohol burns very easily.

104. Why it is very difficult for water to burn.

105. Why the force of great fires is increased by throwing water or salt on them.

106. What kinds of bodies burn easily.

107. Why certain bodies are inflammable and others not.

108. Why fire is kept going for a considerable time in live coals.

109. How gunpowder is made from sulphur, nitre and charcoal. First, the nature of sulphur.

110. Nitre.

111. The combination of sulphur and nitre.

112. The motion of the particles of nitre.

113. Why the flame from this powder is greatly dilated and its principal action is towards bodies that are above it.

114. Charcoal.

115. The grains of this powder, and what its principal force consists in.

116. Lanterns that burn for a very long time.

117. The remaining effects of fire.

118. The bodies that liquefy and boil when brought near to fire.

119. The bodies that dry up and become hard.

120. Three kinds of waters: burning, insipid, and acidic.

121. Sublimates and oils.

122. Alterations in the effect of fire when its intensity is altered.

123. Lime.

·GLASS·

124. How glass is made.

125. How its particles are joined together.

126. Why it is liquid when it is white hot and easily takes on any shape.

127. Why it is very hard when cold.

128. Why it is very fragile.

129. Why its fragility decreases if it is cooled slowly.

130. Why it is transparent.

131. How it becomes coloured.

132. Why it is elastic, like a bow; and why when elastic bodies are bent they spontaneously return to their former shape.

·MAGNETISM·

133. Magnetic ore. Repetition of the points made above that are required to explain it.

134. There are no passages in air or water suitable for receiving striated particles.

135. There are none in any bodies belonging to the earth's exterior, except for iron.

136. Why there are such passages in iron.

137. Why such passages exist even in single iron filings.

138. How the passages are made suitable for receiving striated particles coming from either direction.

139. The nature of a magnet.

140. How steel and any kind of iron is made by smelting.

141. Why steel is very hard, rigid and fragile.

142. The difference between steel and other iron.

143. How steel is tempered.

144. The difference in the passages found in a magnet, in steel, and in iron.

145. Enumeration of the properties of magnets.

146. How striated particles flow through the passages of the earth.

147. It is harder for them to move through the air, the water and the exterior part of the earth than through the interior.

148. It is easier for them to go through a magnet than through other bodies on the earth's exterior.

149. What the poles of a magnet are.

150. Why these poles turn towards the earth's poles.

151. Why they are also inclined at a certain angle towards its centre.

152. Why one magnet turns and inclines itself towards another magnet in the same way as it does towards the earth.

153. Why two magnets attract each other, and the sphere of action of each.

154. Why they sometimes repel each other.

155. Why the parts of the segments of a magnet which were previously joined also repel each other.

156. Why, if a magnet is broken up, two previously contiguous but now separated points are poles with opposite powers.

157. Why there is the same power in any part of a magnet as there is in the whole magnet.

158. Why a magnet imparts its power to a piece of iron that is made to touch it.

159. Why the piece of iron receives this power in various ways corresponding to the different ways in which it touches the magnet.

160. Why an oblong piece of iron can receive the power only along its length.

161. Why a magnet loses none of its power by imparting it to the iron.

162. Why this power is imparted to the iron very quickly, although it takes some time for it to be firmly fixed in it.

163. Why steel is better fitted to receive the power than baser types of iron.

164. Why more power is imparted by a more perfect magnet than by a less perfect one.

165. Why the earth itself imparts magnetic power to the iron.

166. Why the magnetic power in the earth is weaker than that in small magnets.

167. Why needles touched by a magnet always have their magnetic poles at their extremities.

168. Why magnetic poles do not always point accurately to the earth's poles, but diverge from them at various angles.

169. Why this divergence alters in time.

170. Why the divergence can be smaller when the magnet is made to stand on one of its poles than when its poles are equidistant from the earth.

171. Why a magnet attracts iron.

172. Why an armed magnet lifts much more iron than an unarmed one.

173. Why its poles, although they are mutual opposites, help each other in the lifting of the iron.

174. Why the rotation of an iron wheel is not hindered by the magnet from which it is hung.

175. How and why the power of one magnet increases or decreases the power of another.

176. Why a magnet, however strong, cannot pull iron from a weaker magnet if it is not touching the iron.

177. Why a weak magnet or iron can, if it touches a piece of iron, drag it away from a stronger magnet.

178. Why in these northern regions the south pole of a magnet is stronger than the north pole.

179. What can be observed if iron filings are scattered round a magnet.

180. Why an iron plate sticking to the pole of a magnet reduces its power of attracting or turning iron.

181. Why this power is not reduced when any other body is interposed.

182. Why the unsuitable position of a magnet gradually diminishes its strength.

183. Why rust, humidity and damp diminish its strength, and a vigorous fire destroys it.

184. The force of attraction in amber, wax, resin and similar things.

185. The cause of this attraction in glass.

186. The same cause can be observed in other cases too.

187. From all this we can understand how all the remarkable effects that are usually attributed to occult qualities can be explained in terms of ·plain down-to-earth· causes.

Consider how amazing are the properties of magnets and of fire, and how different they are from the properties we commonly observe in other bodies: •how a huge flame can instantly flare up from a tiny spark, and how great its power is; •how great the distance is over which the fixed stars radiate their light; and all the other things for which I have given pretty obvious causal explanations through sources of power that are known and acknowledged by everyone, namely the shape, size, position and motion of particles of matter. Think about all this and you'll readily be convinced that these same power-sources can explain everything that occurs in material nature, leaving no powers of stones and plants that are so mysterious ·that we can only wonder at them·, and no marvels that we need to 'explain' in terms of influences of 'sympathy' and 'hostility'!

188. To complete our knowledge of material things we need some of the results in my ·planned· treatises on animals and on man.

I would have stopped this fourth part of my *Principles of Philosophy* right here if I had kept to my original plan to write two further parts—a fifth part on animals and plants, and a sixth part on man. But I'm not yet completely clear about all the matters I want to deal with in parts 5 and 6, and I don't know if I'll *ever* have enough free time to complete them. [He didn't. He lived for only six years after the completion of this work as we have it.] So as not to delay the publication of parts 1–4 any longer, and to make sure there are no gaps caused by my keeping material back for 5 and 6, I'll add here a few remarks about the objects of the senses. Up to this point in the present work I have described this earth and indeed the whole visible universe as if it were a machine: I have considered only the various shapes and movements of its parts. But our senses show us much else besides—namely colours, smells, sounds and such-like; and if I were to say nothing about these you might think I had left out the most important part of the explanation of the things in nature.

189. What sensation is and how it operates.

The human soul, while united to the entire body, has its principal seat in the brain. That is where it not only understands and imagines but also has sensory awareness. Sensory awareness comes about by means of nerves that stretch like threads from the brain to all the limbs, and are joined together so that hardly any part of the human body can be touched without producing movement in several of the nerve-ends that are scattered around in that area. This movement is then transmitted to the other ends of the nerves which are all grouped together in the brain around the seat of the soul, as I explained very fully in my *Optics* chapter 4. The result of these movements' being set up in the brain by the nerves is that the soul or mind, being closely joined to the brain, is affected in various ways, corresponding to the various different sorts of movements. And the various different states of mind (i.e. thoughts) that are the immediate result of these movements are called 'sense-perceptions', or in ordinary speech 'sensations'. [Remember that for Descartes *every* mental state or event is a 'thought'.]

190. Classifying the kinds of sensation, starting with internal sensations, i.e. emotional states of the mind and natural appetites.

The wide variety in sensations comes from differences in the nerves themselves and from differences in the sorts of motion that occur in individual nerves. It's not that each individual nerve produces a particular kind of sensation; indeed, there are only seven principal groups of nerves, two for internal sensations and five for external sensations. **(1)** The nerves that go to the stomach, oesophagus, throat, and other internal parts keep our natural wants supplied, and produce one kind of internal sensation, which is called 'natural appetite'. **(2)** The little nerves running to the heart and the surrounding area produce the other kind of internal sensation, a kind that includes all the disturbances or passions and emotions of the mind such as joy, sorrow, love, hate and so on. For example, when the blood has the right consistency so that it expands in the heart more readily than usual, it relaxes the nerves scattered around the openings, and sets up a movement leading to a subsequent movement in the brain producing a natural feeling of joy in the mind; and other causes produce the same sort of movement in these tiny nerves, thereby giving the same feeling of joy. When you imagine yourself enjoying something good, that act of imagination doesn't itself contain the feeling of joy, but it

- causes the ·animal· spirits to travel from the brain to the muscles in which these nerves are embedded;

which

- causes the openings of the heart to expand,

which in turn

- produces the movement in the tiny nerves of the heart

which inevitably

- results in the feeling of joy.

[Descartes accepted and helped to popularize the view that human physiology involves 'animal spirits'—an *extremely* finely divided fluid that transmits pressures through tiny cracks and tunnels—the body's 'hydraulic system', as it has been called.] In the same way, when you hear good news, what happens first is that

- your mind makes a judgment about it and rejoices with the kind of intellectual joy that occurs without any bodily disturbance which is why the Stoics allowed that a wise man, though free of all passion, could experience joy of that kind). Later on when the good news is pictured in your imagination,

•the spirits flow from the brain to the muscles around the heart

and

•move the tiny nerves there,

which

•causes a movement in the brain,

which

•produces in the mind a feeling of animal joy.

Another example: Your blood is too thick, flows sluggishly into the ventricles of the heart, and doesn't expand enough inside it. This

•produces a different movement in those same small nerves around your heart;

and when this movement is transmitted to your brain it

•produces a feeling of sadness in your mind,

perhaps without your having the least idea of *why* you are sad. [Descartes might have quoted this::

> In sooth, I know not why I am so sad.
> It wearies me; you say it wearies you;
> But how I caught it, found it, or came by it,
> What stuff 'tis made of, whereof it is born,
> I am yet to learn.

(the opening lines of Shakespeare's *The Merchant of Venice*]

Various other causes could produce the same feeling by starting up the same kind of movement in these nerves. Other movements in these tiny nerves produce love, hatred, fear, anger and so on—I'm taking these to be merely emotions or passions of the soul, i.e. •confused thoughts that occur in the mind not through its own activity but through events in the body with which it is closely conjoined. Utterly different from these emotions are the •clear thoughts that we have concerning what is to be embraced or desired or shunned—·for example, the clear thought that it would be bad to be attacked by that tiger is different from the confused thought that consists in terror of being attacked by the tiger·. The same applies to the natural appetites such as hunger and thirst, which depend on the nerves of the stomach, throat etc. They're completely different from the volition to eat, drink and so on. . . .

191. The external senses, starting with (1) touch.

The external senses are standardly divided into five, corresponding to the five kinds of objects stimulating the sensory nerves, and the five kinds of confused thoughts that the resulting motions produce in the soul. First of all there are the nerves ending in the skin all over the body. •External bodies touch these nerves via the skin, stimulating the nerves in various different ways depending on whether •they are hard, heavy, hot, wet, and so on. Various different sensations are produced in the mind corresponding to the different ways in which movements are started or stopped in the nerves, and it's from those sensations that the various tactile qualities ·of external bodies· get their names. We call these qualities 'hardness', 'weight', 'heat', 'wetness' and so on, but all we mean by these terms is that the external bodies have whatever it takes to get our nerves to arouse in the soul the sensations of hardness, weight, heat and so on. Another point: When the nerves are stimulated with unusual force but without harming the body, this causes a kind of thrill [*titillatio*, literally = 'tickling'] which is naturally agreeable to the mind because it's a sign of robust health in the body with which it is closely conjoined. But when such an unusual stimulation does harm the body, there's a sensation of pain in the soul, even if the stimulus is only marginally stronger than one that causes pleasure. This explains why bodily pleasure and pain arise from such very similar objects, although the sensations are completely opposite.

192. (2) Taste.

Nerves scattered through the tongue and neighbouring areas are also affected by external bodies, but whereas with touch an external body acts as a whole, with taste it acts by being split up into particles that float in the saliva from the mouth. Such particles stimulate these nerves in various different ways, depending on their many different shapes, sizes or movements, thereby producing the sensations of various tastes.

193. (3) Smell.

The organs of the sense of smell are two other nerves (or appendages to the brain, because they don't go outside the skull) which are stimulated by separate particles of the same bodies, floating in the air. The particles have to be sufficiently light and energetic to be drawn into the nostrils and through the pores of the ethmoid bone, thus reaching the two nerves. The various movements of the nerves produce the sensations of various smells. [The ethmoid bone is a soft bone that separates the nasal cavity from the brain.]

194. (4) Hearing.

The object of hearing is simply various vibrations in the ear. There are two other nerves, found in the inmost chambers of the ears, which receive tremors and vibrations from the whole body of surrounding air. When the air strikes the eardrum it produces a disturbance in the little chain of three small bones attached to it; and the sensations of different sounds arise—·via those two nerves·—from the various different movements in these bones.

195. (5) Sight

The optic nerves are the organs of the subtlest of all the senses, that of sight. The extremities of these nerves, which make up the coating inside the eye called the 'retina', are moved not by air or any terrestrial bodies entering the eye but simply by globules of the second element which pass through the pores and all the fluids and transparent membranes of the eye. This is the origin of the sensations of light and colours, as I have already explained adequately in my *Optics* and *Meteorology*.

196. The soul has sensory awareness because of its presence in the brain.

The soul's sensory awareness of what's going on in the body's individual limbs comes not •from its being present in those limbs but •from its being present in the brain, which registers, by means of motions along the nerves, the effects of external objects on the body. Here are four facts that jointly constitute decisive proof that the soul is in the brain. **(1)** Some diseases affect only the brain, yet remove or interfere with all sensation. **(2)** Sleep occurs only in the brain, but it always deprives us of most of our ability to sense things, though this is restored to us when we wake up. **(3)** When the brain is undamaged but something is blocking a path by which some nerve transmits effects from a limb to the brain, that is enough to destroy sensation in the limb in question. **(4)** We sometimes feel pain in a limb that actually has nothing wrong with it, the pain being caused by other parts of the body that the nerves pass through en route to the brain. [Descartes now reports an episode in which a girl complained of pains in individual fingers of a hand that had—though she didn't know this—been amputated. Then:] This must have been because the nerves that used to connect the brain with that hand were being agitated by the sorts of motion that had previously •been caused by ·damage to· the hand and •caused in the soul the sensation of pain in this or that finger.

197. It's just a fact about the mind that various sensations can be produced in it simply by motions in the body.

It can also be proved that the nature of our mind is such that the mere occurrence of certain motions in the body can stimulate it to have all sorts of thoughts that aren't in any way *like* the motions that caused them. This is especially true of the confused thoughts we call 'sensations' or 'feelings'. We see that spoken or written words arouse all sorts of thoughts and emotions in our minds. With the same paper, pen and ink, •move the pen-nib across the page in one way and it will form letters that arouse in the reader's mind thoughts of battles, storms and violence, and emotions of indignation and sorrow; •move it in a slightly different way and the upshot will be thoughts of tranquillity, peace and pleasure, and emotions of love and joy. You may object:

> 'Speech or writing doesn't *immediately* arouse in the mind any emotions, or images of anything except the words themselves; it merely triggers various acts of understanding which then lead the soul to construct within itself the images of various things.'

But then what can you say about the sensations of pain and pleasure? A sword slashes your arm and pain follows just from that, ·without any mediating 'act of the understanding'·. The ensuing pain isn't remotely *like* any motion of the sword or of your arm—it's as different from them as is ·any sensation of· colour or sound or smell or taste. So it's clear that the sensation of pain is aroused in us merely by the motion of some parts of our body in contact with another body; from which we can conclude that the nature of our mind is such that it can be subject to all the other sensations merely as a result of other motions. [When Descartes says that 'the nature of our mind is such that' etc., he wants to get across that this is a *basic* fact about the mind, not something to be explained in terms of something broader and/or deeper.]

198. Our senses tell us nothing about external objects except their shapes, sizes and motions.

So far as we can tell, a nerve's effect on the brain depends purely on the motions that occur in the nerve—it's not a matter of special *kinds* of nerves delivering special kinds of input to the brain. And we see that this motion in the nerves produces not only sensations of pain and pleasure but also those of light and sound. You might see many sparks of flashing light because someone has punched you in the eye: there wasn't any light out there for you to see, just the vibrations in the nerve running from your retina to your brain. Put a finger in your ear and you'll hear a hum that comes from the movement of air trapped in the ear. And the same story holds for •heat etc. considered as qualities of external objects, and also for the basic nature of •fire etc., all of which we see consists merely in motions of particles. Now, we understand very well how the sizes, shapes and motions of the particles of one body can produce various motions in another body. But there's no way of making sense of the thesis **(1)** that size, shape and motion can produce such items as the •substantial forms and •real qualities that many philosophers think inhere in objects, or of the thesis **(2)** that these •qualities or •forms have the power to produce motions in other bodies. As well as being *unintelligible*, the notion of 'substantial form' or the like is idle, unnecessary, because we know that the nature of our soul is such that different motions suffice to produce all its sensations. . . . So we have every reason to conclude that the properties in external objects that we call 'light', 'colour', 'smell', 'taste', 'sound', 'heat', 'cold', other tactile qualities—and even 'substantial forms'!—seem to be simply various dispositions in those objects that enable them to trigger various kinds of motions in our nerves that are required to produce all the sensations in our soul.

199. No phenomenon of nature has been overlooked in this treatise.

There's no natural phenomenon that I have omitted to consider in this book—list them and you'll see! A list of natural phenomena can't include anything that isn't perceived by the senses. Well, I have dealt with all the various sizes, shapes and motions that are to be found in bodies; and the only other items that we perceive by our senses as being located outside us are light, colour, smell, taste, sound and tactile qualities. I have just demonstrated that these are nothing in the objects but certain dispositions depending on size, shape and motion, or anyway—or at least we can't perceive them [i.e. think of them] as anything but that.

200. I have used no principles in this treatise that aren't accepted by everyone; this philosophy is nothing new—it's extremely old and very common.

In trying to explain the general nature of material things I haven't used any principle that wasn't accepted by Aristotle and all other philosophers of every age. So this philosophy, far from being new, is the oldest and most common of all. I have considered the shapes, motions and sizes of bodies and examined what has to result from their interactions in accordance with laws of mechanics that are confirmed by reliable everyday experience. Who ever doubted that bodies move and have various sizes and shapes, and that how they move depends on their sizes and shapes. Who doubts that when bodies collide, the bigger bodies are split into many smaller ones and change their shapes? We pick up these facts through several senses—sight, touch and hearing; and we can also •depict them clearly in our imaginations and •understand them intellectually. ·I'm saying this about size, shape and motion·; it doesn't hold for colour, sound or the other characteristics each of which is perceived by only one sense, because our images of them are not clear but confused, and ·we have no intellectual understanding of them because· we don't know what they really are.

201. Some corporeal particles can't be perceived by the senses.

But I do allow that each body contains many particles that are too small to be perceived through any of our senses; and this may upset those who take their own senses as the measure of what can be known. But who can doubt that many bodies are too minute to be detectable by our senses? Think about a tree that is constantly growing larger: it doesn't make sense to say that it is larger now than it was this morning unless one means that some body was added to it during the day. And who has ever detected with his senses the tiny bodies that are added to a growing tree in one day? It must be admitted, at least by the philosophers who accept that quantity is indefinitely divisible—·implying that any portion of matter, however small, is divisible·—that the parts of a portion of matter could be made so tiny as to be imperceptible by any of the senses. And there's nothing surprising ·or suspect· about our inability to perceive very small bodies through our senses. Why not? Because we can't have a sensation unless our nerves are set in motion by external objects, and the nerves themselves are not very tiny, which implies that they can't be set in motion by bodies that *are* very tiny. I don't believe anyone who is really *thinking* will deny the advantage of

> •using what happens in large bodies, as perceived by our senses, as a model for our ideas about what happens in tiny bodies that elude our senses merely because they are tiny.

This is much better than

> •explaining matters by inventing all sorts of strange objects with no resemblance to what is perceived by the senses

—objects such as ‘prime matter’, ‘substantial forms’ and the rest of the items in the absurd parade of qualities that people habitually introduce, all of which are harder to understand than the things they’re supposed to explain.

202. The philosophy of Democritus differs from mine just as much as it does from the standard view of Aristotle and others.

Democritus also imagined certain small bodies having various sizes, shapes and motions, and supposed that every sense-perceptible body is the upshot of assemblage and mutual interaction of these little corpuscles; yet his method of philosophizing has met with total rejection ·by Aristotle and· by the general run of philosophers ·who have followed him·. Was that because it deals with particles so tiny as to elude the senses, and credits them with having sizes, shapes and motions? Of course not!—no-one can doubt that there are many such particles, as I have just shown. Here are the four reasons why the philosophy of Democritus has been rejected. **(1)** He supposed his corpuscles to be indivisible—a thesis that puts me in the ‘rejection’ camp. **(2)** He imagined there to be a vacuum around the corpuscles, whereas I show that there couldn’t be. **(3)** He attributed weight to these corpuscles, whereas I think of a body’s weight as •an upshot of its position and the motion of other bodies, not as •something the body has in isolation. **(4)** He didn’t show how particular events arose purely from the interaction of corpuscles; or if he did explain some of them, his explanations didn’t hang together properly—or so it seems, going by the little we know about his opinions. (I leave it to others to judge whether what I have written so far in philosophy [here mainly = ‘science’] hangs together well enough, and is sufficiently fertile in the results that can be deduced from it.) As for the business of shapes, sizes and motions ·of corpuscles·: I agree with Democritus about that, but so did Aristotle and all the philosophers who came after him. I reject the rest of Democritus’s philosophy, but then I also reject nearly everything in the systems of those other philosophers. So it’s obvious that my way of philosophizing has no more affinity with the Democritean method than with any of the other philosophical sects.

203. How we know the shapes, ·sizes· and motions of imperceptible particles.

You may want to ask:

> ‘Given that you are talking about particles that can’t be perceived, how can you know what specific shapes, sizes, and motions to attribute to them? You write as though you had *seen* them!’

My reply is this. [The next two sentences are from the French version of the work.] I started by looking for all the vivid and clear notions that our understanding can have regarding material things, and all I found were •our notions of shapes, sizes and motions, and •the rules in accordance with which these three can be modified by each other—rules that are the principles of geometry and mechanics. This led me to the judgment that all human knowledge of the natural world *must* be derived from those three, because the only other notions we have of sense-perceptible things are confused and obscure, and so can only hinder—not help—us in our pursuit of knowledge of things outside ourselves. [Descartes or his translator here takes the antonym of the phrase *claires et distinctes* to be *confuses et obscures*, rather than *obscures et confuses*. Such occasional switches don’t refute the thesis advanced in the long note at the end of 1:47.] Next, I took the simplest and most obvious principles—the ones that nature implants in our minds—and working from these I considered, in general terms, •what principal differences there can be between the sizes, shapes and positions of bodies that are too small to be perceptible by the senses, and •what observable effects would result from their various interactions. When I later observed in sense-perceptible objects the very same effects ·that had been predicted by my theoretical approach·, I judged that they *were* indeed effects of just such an interaction of bodies that aren't sense-perceptible; and I was strengthened in this by the apparent impossibility of coming up with any other explanation for them. In thinking about these matters I was greatly helped by considering artefacts. I don't recognize any difference between artefacts and natural bodies except that artefacts mostly work through mechanisms that are big enough to be easily perceivable by the senses (they *have* to be, if humans are to be able to manufacture them!). In contrast with that, the effects produced in nature almost always depend on structures that are so tiny that they completely elude our senses. And anyway mechanics [*mechanica*] is just a division or special case of natural science [*physica*], and all the explanations belonging to the former also belong to the latter; so the fact that

> •a clock with such-and-such a mechanism of wheels will tell the time

is just as *natural* as the fact that

> •a tree that grew from such-and-such a seed will produce apples.

Men who've had experience dealing with machinery can take a particular machine whose function they know and by looking at •some of its parts easily guess at the design of •the other parts, the ones they can't see. That's the kind of thing I have been doing—noting the observable effects and parts of natural bodies and trying to work out their causes at the level of imperceptible particles.

204. It's enough to explain what the nature of imperceptible things might be, even if their actual nature is different.

This method may enable us to understand how all the things in nature *could* have arisen, but we shouldn't conclude that they *were* in fact made in that way. A craftsman could make two equally reliable clocks that looked completely alike from the outside but had utterly different mechanisms inside; so also, I freely concede, the supreme maker of everything could have produced all that we see in many different ways. I'll think I have achieved enough just so long as what I have written corresponds accurately with all the phenomena of nature. That's all that is needed for practical applications in ordinary life, because medicine and mechanics—and all the other arts that can be fully developed with the help of natural science—are directed only towards the phenomena of nature, i.e. towards items that are sense-perceptible. Do you think that Aristotle achieved more than this, or at least wanted to do so? If so, you are wrong. At the start of his *Meteorology* 1:7 he says explicitly, regarding his reasons and demonstrations concerning things not manifest to the senses, that he counts them as adequate so long as he can show that such things *could* occur in accordance with his explanations.

205. Nevertheless my explanations appear to be at least morally certain. . .

Something can be morally certain, i.e. sure enough for everyday practical purposes, while still being *un*certain in relation to the absolute power of God. Without having been to Rome (let's suppose), you are sure that it is a town in Italy, but it *could* be the case that everyone who has told you this has been lying. ·And here's another example·. You are trying to read a document written in Latin but encoded; you guess that every 'a' should be a 'b', every 'b' a 'c', and so on through the alphabet, and when you decode the document on that basis it makes good sense. You won't doubt that you have detected the code and understood the letter—·you'll be morally certain of that·. But it is *possible* that you are wrong, and that the document involves some other code and means something different from what your decoding made it mean. •Possible, but hardly •credible—especially if the document is long. Well, now, look at all the many properties relating to magnetism, fire and the fabric of the entire world that I have derived in this book from just a few principles: you may think that my assumption of these principles was arbitrary and groundless, but perhaps you'll admit that if my 'principles' were false it would hardly have been possible for them to fit so many items into a coherent pattern.

206. . . . and indeed more than morally certain.

Besides, even in relation to nature there are some things that we regard as not merely •morally but •absolutely certain. (Being absolutely certain that P involves thinking that it's wholly impossible that P should be false.) This certainty has a metaphysical basis in the proposition that God is supremely good and in no way a deceiver, and hence that the faculty he gave us for distinguishing truth from falsehood can't lead us into error while we are using it properly and are thereby perceiving something clearly. Mathematical demonstrations have this kind of certainty, and so does the knowledge that material things exist, as does all evident reasoning about material things. If you think about how I have reached •my results, deriving them in an unbroken chain from the first and simplest principles of human knowledge, you may be willing to count •them among the absolute certainties. You are especially likely to do so if you have a proper grasp of two facts: **(1)** We can have no sensory awareness of •external objects unless •they make something move in our nerves; and **(2)** the fixed stars, owing to their enormous distance from us, can't produce such motion ·in our nerves· unless some motion is also occurring both in them and also throughout the entire intervening part of the heavens. [Strictly, the 'enormous distance' clause shouldn't occur in that sentence; Descartes's considered view is that something *six inches* from us can't stimulate our nerves unless there is motion in it and through the intervening space.] Once this is accepted, it seems that all the other phenomena, or at least the general features of the universe and the earth that I have described, can hardly be intelligibly explained except in my way.

207. I submit all my views to the authority of the Church.

Nevertheless, mindful of my own weakness, I make no firm pronouncements and submit all these opinions to the authority of the Catholic Church and the judgment of those wiser than myself. And I wouldn't want you to believe anything ·I have written· unless you are convinced of it by evident and irrefutable reasoning.