

The New Organon or: True Directions Concerning the Interpretation of Nature

Francis Bacon

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[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. Any four-point ellipsis. . . . indicates the omission of a brief passage that seems to present more difficulty than it is worth. Longer omissions are reported between brackets in normal-sized type. ‘Organon’ is the conventional title for the collection of logical works by Aristotle, a body of doctrine that Bacon aimed to replace. His title *Novum Organum* could mean ‘The New Organon’ or more modestly ‘A New Organon’; the tone of the writing in this work points to the definite article.

First launched: January 2005

Last amended: May 2007

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PREFACE

Those who have taken it on themselves to lay down the law of nature as something that has already been discovered and understood, whether they have spoken in simple confidence or in a spirit of professional posturing, have done great harm to philosophy and the sciences. As well as succeeding in •producing beliefs in people, they have been effective in •squashing and stopping inquiry; and the harm they have done by spoiling and putting an end to other men's efforts outweighs any good their own efforts have brought. Some people on the other hand have gone the opposite way, asserting that absolutely nothing can be known—having reached this opinion through dislike of the ancient sophists, or through uncertainty and fluctuation of mind, or even through being crammed with some doctrine or other. They have certainly advanced respectable reasons for their view; but zeal and posturing have carried them much too far: they haven't •started from true premises or •ended at the right conclusion. The earlier of the ancient Greeks (whose writings are lost) showed better judgment in taking a position between

- one extreme: presuming to pronounce on everything, and

- the opposite extreme: despairing of coming to understand anything.

Often they complained bitterly about how hard investigation is and how dark everything is, and were like impatient horses champing at the bit; but they did pursue their objective and came to grips with nature, apparently thinking that the way to settle this question of whether anything can be known was not by arguing but by trying—testing, experimenting. Yet they too, trusting entirely to the power of their intellect, didn't bring any rules to bear and staked everything on hard

thinking and continuous mental effort.

My method is hard to practice but easy to explain. I propose to •establish *degrees* of certainty, to •retain •the evidence of• the senses subject to certain constraints, but mostly to •reject ways of thinking that track along after sensation. In place of that •rejected procedure•, I open up a new and certain path for the mind to follow, starting from sense-perception. The need for this •switch• was felt, no doubt, by those who gave such importance to dialectics; their emphasis on dialectics showed that they were looking for aids to the intellect, and had no confidence in the innate and spontaneous process of the mind. [Bacon's *dialectica*, sometimes translated as 'logic', refers more narrowly to the formalized and rule-governed use of logic, especially in debates.] But this remedy did no good, coming as it did *after* the processes of everyday life had filled the mind with hearsay and debased doctrines and infested it with utterly empty idols. (•I shall explain 'idols' in **39–45** below•.) The upshot was that the art of dialectics, coming (I repeat) too late to the rescue and having no power to set matters right, was only good for fixing errors rather than for revealing truth. [Throughout this work, 'art' will refer to any human activity that involves techniques and requires skills.] We are left with only one way to health—namely to start the work of the mind all over again. In this, the mind shouldn't be left to its own devices, but right from the outset should be guided at every step, as though a machine were in control.

Certainly if in mechanical projects men had set to work with their naked hands, without the help and power of tools, just as in intellectual matters they have set to work with little but the naked forces of the intellect, even with their best collaborating efforts they wouldn't have achieved—or even

attempted—much. . . . Suppose that some enormous stone column had to be moved from its place (wanted elsewhere for some ceremonial purpose), and that men started trying to move it with their naked hands, wouldn't any sober spectator think them mad? If they then brought in more people, thinking that that might do it, wouldn't he think them even madder? If they then weeded out the weaker labourers, and used only the strong and vigorous ones, wouldn't he think them madder than ever? Finally, if they resolved to get help from the art of athletics, and required all their workers to come with hands, arms, and sinews properly oiled and medicated according to good athletic practice, wouldn't the onlooker think 'My God, they are trying to show *method* in their madness!'

Yet that is exactly how men proceed in intellectual matters—with just the same kind of mad effort and useless combining of forces—when they hope to achieve great things either through their individual brilliance or through the sheer number of them who will co-operate in the work, and when they try through dialectics (which we can see as a kind of athletic art) to strengthen the sinews of the intellect. With all this study and effort, as anyone with sound judgment can see, they are merely applying the naked intellect; whereas in any great work to be done by the hand of man the only way to increase the force exerted by each and to co-ordinate the efforts of all is through instruments and machinery.

Arising from those prefatory remarks, there are two more things I have to say; I want them to be known, and not forgotten. ·One concerns ancient *philosophers*, the other concerns modern *philosophy*.

(1) If I were to declare that I could set out on ·the same road as the ancient philosophers and come back with something better than they did, there would be no disguising the fact that I was setting up a rivalry between

them and me, inviting a comparison in respect of our levels of excellence or intelligence or competence. There would be nothing new in that, and nothing *wrong* with it either, for if the ancients got something wrong, why couldn't I—why couldn't *anyone*—point it out and criticise them for it? But that contest, however right or permissible it was, might have been an unequal one, casting an unfavourable light on my powers. So it is a good thing—good for avoiding conflicts and intellectual turmoil—that I can leave untouched the honour and reverence due to the ancients, and do what I plan to do while gathering the fruits of my modesty! There won't be any conflict here: my aim is to open up ·a new road for the intellect to follow, a road the ancients didn't know and didn't try. I shan't be taking a side or pressing a case. My role is merely that of a guide who points out the road—a lowly enough task, depending more on a kind of luck than on any ability or excellence.

(2) That was a point about persons; the other thing I want to remind you of concerns the topic itself. Please bear this in mind: I'm not even slightly working to overthrow the philosophy [here = 'philosophy and science'] that is flourishing these days, or any other more correct and complete philosophy that has been or will be propounded. I don't put obstacles in the way of this accepted philosophy or others like it; ·let them go on doing what they have long done so well—let them give philosophers something to argue about, provide decoration for speech, bring profit to teachers of rhetoric and civil servants! Let me be frank about it: the philosophy that I shall be advancing isn't much use for any of *those* purposes. It isn't ready to hand; you can't just pick it up as you go; it doesn't fit with preconceived ideas in a way that would enable it to slide smoothly into the mind; and the vulgar won't ever get hold of it except through its practical applications and its effects. [In this work, 'vulgar' means 'common,

ordinary, run-of-the-mill' (as in 'vulgar induction' **17**) or, as applied to people, 'having little education and few intellectual interests'.]

So let there be two sources of doctrine, two disciplines, two groups of philosophers, and two ways of doing philosophy, with the groups not being hostile or alien to each other, but bound together by mutual services. In short, let there be one discipline for cultivating the knowledge we have, and another for discovering new knowledge. This may be pleasant and beneficial for both. Most men are in too much of a hurry, or too preoccupied with business affairs, to engage with my way of doing philosophy—or they don't have the mental powers needed to understand it. If for any of those reasons you prefer the other way—prefer cultivation to discovery—I wish you all success in your choice, and I hope you'll get what you are after. But if you aren't content to stick with the knowledge we already have, and want

- to penetrate further,
- to conquer nature by works, not conquer an adversary by argument,
- to look not for nice probable opinions but for sure proven knowledge,

I invite you to join with me, if you see fit to do so. [In this context, 'works' are experiments.] Countless people have stamped around in nature's outer courts; let us get across those and try to find a way into the inner rooms. For ease of communication and to make my approach more familiar by giving it a name, I have chosen to call one of these approaches 'the mind's **anticipation** of nature', the other

'the **interpretation** of nature'. [Throughout this work, 'anticipation' means something like 'second-guessing, getting ahead of the data, jumping the gun'. Bacon means it to sound rash and risky; no one current English word does the job.]

I have one request to make, namely that my courtesies towards you, the reader, shall be matched by your courtesies to me. I have put much thought and care into ensuring that the things I say will be not only true but smoothly and comfortably accepted by your mind, however clogged it is by previous opinions. It is only fair—especially in such a great restoration of learning and knowledge—for me to ask a favour in return, namely this: If you are led by the evidence of your senses, or by the jostling crowd of 'authorities', or by arguments in strict logical form (which these days are respected as though they were the law of the land), to want to pass judgment on these speculations of mine, don't think you can do this casually, while you are mainly busy with something else. Examine the matter thoroughly; go a little distance yourself along the road that I describe and lay out; make yourself familiar with the *subtlety* of things that our experience indicates; give your deeply-rooted bad mental habits a reasonable amount of time to correct themselves; and *then*, when you have started to be in control of yourself, use your own judgment—if you want to. [Bacon doesn't ever in this work address the reader at length. This version sometimes replaces 'If anybody...' by 'If you...', 'Men should...' by 'You should...' and so on, to make the thought easier to follow.]

APHORISMS CONCERNING THE INTERPRETATION OF NATURE: BOOK 1: 1–77

[In **86** below, Bacon explains ‘aphorisms’ as meaning ‘short unconnected sentences, not linked by any method’. His ‘aphorisms’ vary from three lines to sixteen pages, but his label ‘aphorism’ will be allowed to stand.]

- 1.** Man, being nature’s servant and interpreter, is limited in what he can do and understand by what he has observed of the course of nature—directly observing it or inferring things from what he has observed. Beyond that he doesn’t know anything and can’t do anything.
- 2.** Not much can be achieved by the naked hand or by the unaided intellect. Tasks are carried through by tools and helps, and the intellect needs them as much as the hand does. And just as the hand’s tools either •give motion or •guide it, so in a comparable way the mind’s tools either •point the intellect in the direction it should go or •offer warnings.
- 3.** Human knowledge and human power meet at a point; for where the cause isn’t known the effect can’t be produced. The only way to command nature is to obey it; and something that functions as the •cause in thinking about a process functions as the •rule in the process itself.
- 4.** All that man can do to bring something about is to put natural bodies together or to pull them away from one another. The rest is done by nature working within.
- 5.** The mechanic, the mathematician, the physician, the alchemist and the magician have all rubbed up against nature in their activities; but so far they haven’t tried hard and haven’t achieved much.
- 6.** If something has never yet been done, it would be absurd and self-contradictory to expect to achieve it other than through means that have never yet been tried.
- 7.** If we go by the contents of •books and by •manufactured products, the mind and the hand seem to have had an enormous number of offspring. But all that variety consists in very fine-grained special cases of, and derivatives from, a few things that were already known; *not* in a large number of fundamental propositions.
- 8.** Moreover, the works that have already been achieved owe more to chance and experiment than to disciplined sciences; for the sciences we have now are merely pretty arrangements of things already discovered, not ways of making discoveries or pointers to new achievements.
- 9.** Nearly all the things that go wrong in the sciences have a single cause and root, namely: while wrongly admiring and praising the powers of the human mind, we don’t look for true helps for it.
- 10.** Nature is much subtler than are our senses and intellect; so that all those elegant meditations, theorizings and defensive moves that men indulge in are crazy—except that no-one pays attention to them. [Bacon often uses a word meaning ‘subtle’ in the sense of ‘fine-grained, delicately complex’; no one current English word will serve.]
- 11.** Just as the sciences that we now have are useless for devising new inventions, the logic that we now have is useless for discovering new sciences. [Bacon here uses *inventio* in two of its senses, as = ‘invent’ and as = ‘discover’.]
- 12.** The logic now in use serves to •fix and stabilize errors based on the ideas of the vulgar, rather than to •search for truth. So it does more harm than good.

13. The syllogism isn't brought to bear on the •basic principles of the sciences; it *is* applied to •intermediate axioms, but nothing comes of this because the syllogism is no match for nature's subtlety. It constrains what you can *assent* to, but not what can *happen*.

14. A •syllogism consists of •propositions, which consist of •words, which are stand-ins [*tesserae*, literally = 'tickets'] for •notions. So the root of the trouble is this: If the notions are confused, having been sloppily abstracted from the facts, nothing that is built on them can be firm. So our only hope lies in true induction.

15. There is no soundness in ·our· notions, whether in logic or in natural science. These are not sound notions:

substance, quality, acting, undergoing, being;

And these are even less sound:

heavy, light, dense, rare, moist, dry, generation, corruption, attraction, repulsion, element, matter, form and so on; all of those are fantastical and ill-defined. ['Rare' = 'opposite of dense'. Generation is the coming into existence of living things; corruption is rotting or falling to pieces, and so refers to the going out of existence of living things. For the next sentence: a 'lowest species' is one that doesn't further divide into subspecies.]

16. ·Our· notions of the lowest species (*man, dog, dove*) and of the immediate perceptions of the senses (*hot, cold, black, white*) don't seriously mislead us; yet even they are sometimes confusing because of how matter flows and things interact. As for all the other notions that men have adopted—they are mere aberrations, not being caused by things through the right kind of abstraction.

17. The way •axioms are constructed is as wilful and wayward as the abstractions through which •notions are formed. I say this even about the principles that result from

vulgar induction, but much more about the axioms and less basic propositions that the syllogism spawns.

18. The discoveries that have been made in the sciences up to now lie close to vulgar notions, scarcely beneath the surface. If we are to penetrate into nature's inner and further recesses, we'll need •a safer and surer method for deriving notions as well as axioms from things, as well as •an altogether better and more certain way of conducting intellectual operations.

19. There are and *can be* only two ways of searching into and discovering truth. **(1)** One of them starts with the senses and particular events and *swoops* straight up from them to the most general axioms; on the basis of these, taken as unshakably true principles, it proceeds to judgment and to the discovery of intermediate axioms. This is the way that people follow now. **(2)** The other derives axioms from the senses and particular events in a gradual and unbroken ascent, ·going *through* the intermediate axioms and· arriving *finally* at the most general axioms. This is the true way, but no-one has tried it.

20. When the intellect is left to itself it takes the same way—namely **(1)**—that it does when following the rules of dialectics. For the mind loves to leap up to generalities and come to rest with them; so it doesn't take long for it to become sick of experiment. But this evil, ·though it is present both in natural science and in dialectics·, is worse in dialectics because of the ordered solemnity of its disputations.

21. When the intellect of a sober, patient, and grave mind is left to itself (especially in a mind that isn't held back by accepted doctrines), it ventures a little way along **(2)** the right path; but it doesn't get far, because without guidance and help it isn't up to the task, and is quite unfit to overcome the obscurity of things.

22. Both ways set out from the senses and particular events, and come to rest in the most general propositions; yet they are enormously different. For one of them **(1)** merely glances in passing at experiments and particular events, whereas the other **(2)** stays among them and examines them with proper respect. One **(1)** proceeds immediately to laying down certain abstract and useless generalities, whereas the other **(2)** rises by step by step to what is truly better known by nature. [In calling something ‘known to nature’ Bacon means that it is a general law of nature; ‘better known by nature’ could mean ‘a more general law of nature’ or ‘a generality that is more completely lawlike’.]

23. There is a great difference between •the *idols* of the human mind and •the *ideas* of God’s mind—that is, between •certain empty beliefs and •the true seals [= ‘signs of authenticity’] and marks that we have found in created things.

24. There’s no way that axioms •established by argumentation could help us in the discovery of new things, because the subtlety of nature is many times greater than the subtlety of argument. But axioms •abstracted from particulars in the proper way often herald the discovery of new particulars and point them out, thereby returning the sciences to their active status.

25. The axioms that are now in use are mostly made so that they *just* cover the items from which they arise, namely thin and common-or-garden experiences and a few particulars of the commonest sorts, so it is no wonder if they don’t lead to new particulars. •And it’s not only the axioms, but also the way they are handled, that is defective•. If some unexpected counter-example happens to turn up, the axiom is rescued and preserved by some frivolous distinction, rather than (the truer course) being amended.

26. To help me get my ideas across, I have generally used different labels for human reason’s two ways of approaching

nature: the customary way I describe as *anticipating nature* (because it is rash and premature) [see note on ‘anticipation’ on page 3 above]; and the way that draws conclusions from facts in the right way I describe as *interpreting nature*.

27. Anticipations are a firm enough basis for consent, for even if men all went mad in the same way they might agree one with another well enough.

28. Indeed, anticipations have much more power to win assent than interpretations do. They are inferred from a few instances, mostly of familiar kinds, so that they immediately brush past the intellect and fill the imagination; whereas interpretations are gathered from very various and widely dispersed facts, so that they can’t suddenly strike the intellect, and must seem weird and hard to swallow—rather like the mysteries of faith.

29. Anticipations and dialectics have their place in sciences based on opinions and dogmas, because in those sciences the aim is to be master of •what people believe but not of •the facts.

30. Even if all the brains of all the ages come together, collaborate and share their results, no great progress will ever be made in science by means of anticipations. That is because errors that are rooted in the first moves that the mind makes can’t be cured later on by remedial action, however brilliant.

31. It is pointless to expect any great advances in science from grafting new things onto old. If we don’t want to go around in circles for ever, making ‘progress’ that is so small as be almost negligible, we must make a fresh start with deep foundations. [‘Fresh start’ translates *instauratio*, from the verb *instauro* = ‘make a fresh start (on a ceremony that has been wrongly performed)’]. Bacon planned a six-part work on science and

its philosophy and methods, which he called his *Instauratio magna*—his Great Fresh Start. There are other informal mentions of fresh starts in **38** and **129**, and the Great Fresh Start is referred to in **92** and each of **115–117**. Bacon died six years after publishing the present work. It is Part 2 of the Great Fresh Start, and the only Part he completed.]

32. This is not to attack the honour of the ancient authors or indeed of anyone else, because I am comparing not •intelligences or •competences but •ways of proceeding in the sciences; and the role I have taken on is that of a guide, not a judge.

33. This must be said outright: anticipations (the kind of reasoning that is now in use) can't pass judgment on my method or on discoveries arising from it; for I can't be called on to submit to the sentence of a tribunal which is itself on trial!

34. It won't be easy for me to deliver and explain my message, for things that are in themselves *new* will be understood on analogy with things that are *old*.

35. Borgia said that when the French marched into Italy they came with chalk in their hands to •mark out their lodgings, not with weapons to •force their way in. Similarly, I want my doctrine to enter quietly into the minds that are fit to receive it and have room for it. •Forcing my way in with weapons, so to speak, won't work because refutations—and more generally *arguments pro and con*—can't be employed when what's at stake is a difference of view about first principles, notions, and even forms of demonstration.

36. There remains for me only one way of getting my message across. It is a simple way, namely this: I must lead you to the particular events themselves, and to the order in which they occur; and you for your part must force yourself for

a while to lay aside your •notions and start to familiarize yourself with •facts.

37. Those who deny that anything can be known for sure •start off their thinking in something like my way, but where they •end up is utterly different from and opposed to where I end up. They say that *nothing can be known*, period. I say that *not much can be known about nature by the method that is now in use*. And then they go on to destroy the authority of the senses and the intellect, whereas I devise and supply helps for them.

38. The idols and false notions that now possess the human intellect and have taken deep root in it don't just •occupy men's minds so that truth can hardly get in, but also when a truth *is* allowed in they will •push back against it, stopping it from contributing to a fresh start in the sciences. This can be avoided only if men are forewarned of the danger and do what they can to fortify themselves against the assaults of these idols and false notions.

39. There are four classes of idols that beset men's minds, and to help me in my exposition I have given them names. I call the first class **idols of the tribe**, the second **idols of the cave**, the third **idols of the market place**, and the fourth **idols of the theatre**.

40. The proper way to keep idols at bay and to drive them off is, no doubt, to form ideas and axioms by true induction. But it is very useful just to point the idols out; for •the truth about the idols serves •the interpretation of nature in the way that •the truth about argumentative fallacies serves •ordinary logical argumentation.

41. The **idols of the tribe** have their foundation in human nature itself—in the tribe known as 'mankind'. It is not true that the human senses are the measure of things; for all

perceptions—of the senses as well as of the mind—reflect the perceiver rather than the world. The human intellect is like a distorting mirror, which receives light-rays irregularly and so mixes its own nature with the nature of things, which it distorts.

42. The **idols of the cave** are the idols of the individual man. In addition to the errors that are common to human nature in general, everyone has his own personal cave or den that breaks up and corrupts the light of nature. This may come from factors such as these:

- his own individual nature,
- how he has been brought up and how he interacts with others,
- his reading of books and the influence of writers he esteems and admires,
- differences in how his environment affects him because of differences in his state of mind—whether it is busy thinking about something else and prejudiced against this intake or calm and open-minded.

So that the human spirit is distributed among individuals in ways that make it variable and completely disorderly—almost a matter of luck. Heraclitus was right: men look for sciences in ·their own individual· lesser worlds, and not in the greater world that they have in common.

43. There are also idols formed by men's agreements and associations with each other (·I have in mind especially the agreements that fix the meanings of words·). I call these **idols of the market place**, because that is where men come together and do business. ·Such transactions create idols· because •men associate by talking to one another, and •the uses of words reflect common folks' ways of thinking. It's amazing how much the intellect is hindered by wrong or poor choices of words. The definitions or explanations that

learned men sometimes use to protect themselves ·against such troubles· don't at all set the matter right: words plainly force and overrule the intellect, throw everything into confusion, and lead men astray into countless empty disputes and idle fancies.

44. Lastly, there are idols that have come into men's minds from various philosophical dogmas and from topsy-turvy laws of demonstration. I call these **idols of the theatre**, because I regard every one of the accepted systems as the staging and acting out of a fable, making a fictitious staged world of its own. I don't say this only about the systems that are currently fashionable, or only about the ancient sects and philosophies; many other fables of the same kind may still be written and produced, seeing that errors can be widely different yet have very similar causes. And I'm saying this not only about whole systems but also about a good many principles and axioms in ·individual· sciences—ones that have gathered strength through tradition, credulity, and negligence. But these various kinds of idols will have to be discussed more clearly and at greater length if the human intellect is to be adequately warned against them. ·I'll start with the idols of the tribe, which will be my topic until the end of 52·.

45. The human intellect is inherently apt to •suppose the existence of more order and regularity in the world than it •finds there. Many things in nature are unique and not like anything else; but the intellect devises for them non-existent parallels and correspondences and relatives. That is how it comes about •that all the heavenly bodies are thought to move in perfect circles. . . ., •that fire. . . .has been brought in as one of the elements, to complete the square with the other three elements—·earth, air, water·—which the senses detect, and •that the 'elements' (as they are called) are arbitrarily

said to differ in density by a factor of ten to one. And so on for other dreams. And these fancies affect not only complex-propositions but also simple notions.

46. Once a human intellect has adopted an opinion (either as something it *likes* or as something generally accepted), it draws everything else in to confirm and support it. Even if there are more and stronger instances against it than there are in its favour, the intellect either overlooks these or treats them as negligible or does some line-drawing that lets it shift them out of the way and reject them. This involves a great and pernicious prejudgment by means of which the intellect's former conclusions remain inviolate.

A man was shown a picture, hanging in a temple, of people who had made their vows and escaped shipwreck, and was asked 'Now do you admit the power of the gods?' He answered with a question: 'Where are the pictures of those who made their vows and then drowned?'

It was a good answer! That's how it is with all superstition—involving astrology, dreams, omens, divine judgments, and the like. Men get so much pleasure out of such vanities that they notice the confirming events and inattentively pass by the more numerous disconfirming ones. This mischief insinuates itself more subtly into philosophy and the sciences: there, when a proposition has found favour it colours other propositions and brings them into line with itself, even when they in their undisguised form are sounder and better than it is. Also, apart from the pleasure and vanity that I have spoken of, the human intellect is perpetually subject to the special error of being moved and excited more by affirmatives than by negatives; whereas it *ought* to have the same attitude towards each. Indeed, when it is a matter of establishing a true axiom, it's the negative instance that

carries more force.

47. The greatest effect on the human intellect is had by things that strike and enter the mind simultaneously and unexpectedly; it is these that customarily fill—inflate!—the imagination; and then it feigns and supposes that everything else is somehow, though it can't see how, similar to those few things that have taken it by storm. ['Feign' translates the Latin *finigo*, which is the source for the English word 'fiction'.] But the intellect is altogether slow and unfit for the journey to distant and heterogeneous instances which put axioms to the test—like testing something by fire—unless it is forced to do so by severe laws and overruling authority.

48. The human intellect is never satisfied; it can't stop or rest, and keeps searching further; but all to no purpose. That's why we can't conceive of any end or limit to the world—why we always virtually *have* to have the thought of something beyond any candidate for the role of world's end. And we can't conceive, either, of how eternity has flowed down to the present day. A plausible story about this says that time is infinite in both directions, and the present is just a point along this infinite line. But the commonly accepted idea of infinity in time past and in time to come can't be sustained, for it implies that one infinity is greater than another, and that one infinity is getting used up and tending to become finite. The infinite divisibility of lines is a source of a similar network of difficulties arising from our thought's inability to reach a resting-place. But this inability interferes even worse in the discovery of causes, and here is how.

The most general principles in nature have to be brute facts, just as they are discovered, and can't be derived from any still more general or basic cause. Yet the restless human intellect still looks for something

Latin: *notiora* = ‘better known’

probably short for: *natura notiora* = ‘better known to nature’

actually meaning: ‘more general and/or basic’ [see note in 22]—something to explain why they are true.

Then in that ·doomed· struggle for something further off, it ·finds itself defeated, and instead· falls back on something that is nearer at hand, namely on *final causes*—i.e. on the notion of what a principle is *for*, what *purpose* explains its being true. Science has been enormously messed up by this appeal to final causes, which obviously come from the nature of man rather than from the nature of the world—that is, which project the scientist’s own purposes *onto* the world rather than finding purposes *in* it.

To look for causes of the most general principles is to do science in an ignorant and frivolous way—just as much as *not* looking for causes of subordinate and less general truths.

49. The human intellect doesn’t burn with a dry [here = ‘uncontaminated’] light, because what the person *wants* and *feels* gets pumped into it; and that is what gives rise to the ‘please-yourself sciences’. For a man is more likely to believe something if he would like it to be true. Therefore he rejects

- difficult things because he hasn’t the patience to research them,
- sober and prudent things because they narrow hope,
- the deeper things of nature, from superstition,
- the light that experiments can cast, from arrogance and pride (not wanting people to think his mind was occupied with trivial things),
- surprising truths, out of deference to the opinion of the vulgar.

In short, there are countless ways in which, sometimes

imperceptibly, a person’s •likings colour and infect his •intellect.

50. But what contributes most to the blockages and aberrations of the human intellect is the fact that the ·human· senses are dull, incompetent and deceptive. The trouble is this: things that strike the senses outweigh other things—more important ones—that don’t immediately strike them. That is why people stop *thinking* at the point where their *eyesight* gives out, paying little or no attention to •things that can’t be seen—for example, all the •workings of the spirits enclosed in tangible bodies. Nor do they pay attention to all the subtler changes of microstructure in the parts of coarser substances (which are vulgarly called ‘alterations’ though they are really extremely small-scale •movements). And yet unless these two things—the workings of spirits, and subtle changes of form in bodies—can be searched out and brought into the light, nothing great can be achieved in nature in the way of practical applications. A third example: the essential nature of our common air, and of all the many bodies that are less dense than air, is almost unknown. For the senses by themselves are weak and unreliable; and instruments for extending or sharpening them don’t help much. All the truer kind of *interpretation* of nature comes about through instances and well-designed experiments: the senses pass judgment on the experiment, and the experiment passes judgment on nature, on the facts.

[Bacon’s many uses of the word *schematismus* show that for him a body’s *schematismus* is its fine-grained structure. This version will always use ‘microstructure’, but be aware that Bacon doesn’t use a word with the prefix ‘micro’. •Also, here and throughout, ‘spirits’ are extremely finely divided gases or fluids, *not* mental items of any kind.]

51. The human intellect is inherently prone to make abstractions, and it feigns an unchanging essence for things that are in flux. But better than •abstracting from nature is •dissecting it; which is what Democritus and his followers did, getting deeper into nature than anyone since. What we should be attending to is *matter*, its microstructures and changes of microstructure, and *actus purus*, and the laws of action or motion. The alternative to studying *matter* is to study *forms*, but forms are fabrications of the human mind, unless you want to call the laws of action ‘forms’.

[Bacon doesn’t explain *actus purus*. In each of its other three occurrences he connects it with *laws*, and his meaning seems to be something like: ‘the laws governing the pure actions of individual things, i.e. the things they do because of their own natures independently of interference from anything else’. If x does A partly because of influence from something else y, then x is not purely •active in respect of A because y’s influence gives A a certain degree of •passivity. From here on, *actus purus* will be translated by ‘pure action’.]

52. Those, then, are the idols of the tribe, as I call them—the idols that arise from human nature as such. More specifically, they arise from the human spirit’s •regularity of operation, or its •prejudices, or its •narrowness, or its •restlessness, or •input from the feelings, or from the •incompetence of the senses, or from •the way the senses are affected.

53. The idols of the cave—my topic until the end of **58**—arise from the particular mental and physical make-up of the individual person, and also from upbringing, habits, and chance events. There are very many of these, of many different kinds; but I shall discuss only the ones we most need to be warned against—the ones that do most to disturb the clearness of the intellect.

54. A man will become attached to one particular science and field of investigation either because •he thinks he was its author and inventor or because •he has worked hard on it and become habituated to it. But when someone of this kind turns to *general* topics in philosophy and science he wrecks them by bringing in distortions from his former fancies. This is especially visible in Aristotle, who made his natural science a mere bond-servant to his logic, rendering it contentious and nearly useless. The chemists have taken a few experiments with a furnace and made a fantastic science out of it, one that applies to hardly anything. . . . [In this work ‘chemists’ are alchemists. Nothing that we would recognize as chemistry existed.]

55. When it comes to philosophy and the sciences, minds differ from one another in one principal and fairly radical way: some minds have more liking for and skill in •noting differences amongst things, others are adapted rather to •noting things’ resemblances. The •steady and acute mind can concentrate its thought, fixing on and sticking to the subtlest distinctions; the •lofty and discursive mind recognizes and puts together the thinnest and most general resemblances. But each kind easily goes too far: one by •grasping for unimportant differences between things, the other by •snatching at shadows.

56. Some minds are given to an extreme admiration of antiquity, others to an extreme love and appetite for novelty. Not many have the temperament to steer a middle course, not pulling down sound work by the ancients and not despising good contributions by the moderns. The sciences and philosophy have suffered greatly from this, because these attitudes to antiquity and modernity are not *judgments* but mere *enthusiasms*. Truth is to be sought not in •what people like or enjoy in this or that age, but in •the light of nature

and experience. The •former is variable, the •latter is eternal. So we should reject these enthusiasms, and take care that our intellect isn't dragged into them.

57. When you think ·hard and long and uninterruptedly· about nature and about bodies in their simplicity—i.e. think of topics like *matter as such*·—your intellect will be broken up and will fall to pieces. When on the other hand you think ·in the same way· about nature and bodies in all their complexity of structure, your intellect will be stunned and scattered. The difference between the two is best seen by comparing the school of Leucippus and Democritus with other philosophies. For the members of that school were so busy with the ·general theory of· particles that they hardly attended to the structure, while the others were so lost in admiration of the structure that they didn't get through to the simplicity of nature. What we should do, therefore, is alternate between these two kinds of thinking, so that the intellect can become *both* penetrating *and* comprehensive, avoiding the disadvantages that I have mentioned, and the idols they lead to.

58. Let that kind of procedure be our prudent way of keeping off and dislodging the idols of the cave, which mostly come from

- intellectual· favouritism (**54**),
- an excessive tendency to compare or to distinguish (**55**),
- partiality for particular historical periods (**56**), or
- the largeness or smallness of the objects contemplated (**57**).

Let every student of nature take this as a general rule for helping him to keep his intellect balanced and clear: when your mind seizes on and lingers on something with special satisfaction, treat it with suspicion!

59. The idols of the market place are the most troublesome of all—idols that have crept into the intellect out of the contract concerning words and names [Latin *verborum et nominum*, which could mean 'verbs and nouns'; on the contract, see **43**]. Men think that their reason governs words; but it is also true that words have a power of their own that reacts back onto the intellect; and this has rendered philosophy and the sciences sophisticated and idle. Because words are usually adapted to the abilities of the vulgar, they follow the lines of division that are most obvious to the vulgar intellect. When a language-drawn line is one that a sharper thinker or more careful observer would want to relocate so that it suited the true divisions of nature, words stand in the way of the change. That's why it happens that when learned men engage in high and formal discussions they often end up arguing about words and names, using definitions to sort them out—thus •ending where, according to mathematical wisdom and mathematical practice, it would have been better to •start! But when it comes to dealing with natural and material things, definitions can't cure this trouble, because the definitions themselves consist of words, and those words beget others. So one has to have recourse to individual instances. . . .

60. The idols that words impose on the intellect are of two kinds. (1) There are names of things that don't exist. Just as there are things with no names (because they haven't been observed), so also there are names with no things to which they refer—these being upshots of fantastic ·theoretical· suppositions. Examples of names that owe their origin to false and idle theories are 'fortune', 'prime mover', 'planetary orbits', and 'element of fire'. This class of idols is fairly easily expelled, because you can wipe them out by steadily rejecting and dismissing as obsolete all the theories ·that beget them·.

(2) Then there are names which, though they refer to things that do exist, are confused and ill-defined, having been rashly and incompetently derived from realities. Troubles of this kind, coming from defective and clumsy abstraction, are intricate and deeply rooted. Take the word 'wet', for example. If we look to see how far the various things that are called 'wet' resemble one other, we'll find that 'wet' is nothing but than a mark loosely and confusedly used to label a variety of states of affairs that can't be unified through any constant meaning. For something may be called 'wet' because it

- easily spreads itself around any other body,
- has no boundaries and can't be made to stand still,
- readily yields in every direction.
- easily divides and scatters itself,
- easily unites and collects itself,
- readily flows and is put in motion,
- readily clings to another body and soaks it,
- is easily reduced to a liquid, or (if it is solid) easily melts.

Accordingly, when you come to apply the word, if you take it in one sense, flame is wet; if in another, air is not wet; if in another, fine dust is wet; if in another, glass is wet. So that it is easy to see that the notion has been taken by abstraction only from water and common and ordinary liquids, without proper precautions.

Words may differ in *how* distorted and wrong they are. One of the •least faulty kinds is that of names of substances, especially names that

- are names of lowest species, •i.e. species that don't divide into sub-species•, and
- have been *well* drawn •from the substances that they are names of•.

•The drawing of substance-names and -notions from the sub-

stances themselves *can* be done well or badly. For example•, our notions of chalk and of mud are good, our notion of earth bad. •More faulty are names of events: 'generate', 'corrupt', 'alter'. •The most faulty are names of qualities: 'heavy', 'light', 'rare', 'dense', and the like. (I exclude from this condemnation names of qualities that are immediate objects of the senses.) Yet in each of these categories, inevitably some notions are a little better than others because more examples of them come within range of the human senses.

61. The idols of the theatre •which will be my topic until the end of **68**• are not innate, and they don't steal surreptitiously into the intellect. Coming from the fanciful stories told by philosophical theories and from upside-down perverted rules of demonstration, they are openly proclaimed and openly accepted. Things I have already said imply that there can be no question of *refuting* these idols: where there is no agreement on premises or on rules of demonstration, there is no place for argument.

•AN ASIDE ON THE HONOUR OF THE ANCIENTS•

This at least has the advantage that it leaves the honour of the ancients untouched •because I shall not be *arguing against* them. I shall be *opposing* them, but• there will be no disparagement of them in this, because the question at issue between them and me concerns only *the way*. As the saying goes: a lame man on the right road outstrips the runner who takes a wrong one. Indeed, it is obvious that a man on the wrong road goes further astray the faster he runs. •You might think that in claiming to be able to do better in the sciences than they did, I must in some way be setting myself up as brighter than they are; but it is not so•. The course I propose for discovery in the sciences leaves little to the acuteness and strength of intelligence, but puts all intelligences nearly on a level. My plan is exactly like

the drawing of a straight line or a perfect circle: to do it free-hand you need a hand that is steady and practised, but if you use a ruler or a compass you will need little if anything else; and my method is just like that.

·END OF ASIDE·

But though particular counter-arguments would be useless, I should say something about •the classification of the sects whose theories produce these idols, about •the external signs that there is something wrong with them, and lastly •about the causes of this unhappy situation, this lasting and general agreement in error. My hope is that this will make the truth more accessible, and make the human intellect more willing to be cleansed and to dismiss its idols.

62. There are many idols of the theatre, or idols of theories, and there can be and perhaps will be many more. For a long time now two factors have militated against the formation of new theories ·in philosophy and science·.

- Men’s minds have been busied with religion and theology.
- Civil governments, especially monarchies, have been hostile to anything new, even in theoretical matters; so that men have done that sort of work at their own peril and at great financial cost to themselves—not only unrewarded but exposed to contempt and envy.

If it weren’t for those two factors, there would no doubt have arisen many other philosophical sects like those that once flourished in such variety among the Greeks. Just as many hypotheses can be constructed regarding the phenomena of the heavens, so also—and even more!—a variety of dogmas about the phenomena of philosophy may be set up and dug in. And something we already know about plays that poets put on the stage is also true of stories presented on the philosophical stage—namely that fictions invented for the

stage are more compact and elegant and generally liked than true stories out of history!

What has gone wrong in philosophy is that it has attended in great detail to a few things, or skimpily to a great many things; either way, it is based on too narrow a foundation of experiment and natural history, and decides on the authority of too few cases. **(1)** Philosophers of the reasoning school snatch up from experience a variety of common kinds of event, without making sure they are getting them right and without carefully examining and weighing them; and then they let meditation and brain-work do all the rest. **(2)** Another class of philosophers have carefully and accurately studied a few experiments, and have then boldly drawn whole philosophies from *them*, making all other facts fit in by wildly contorting them. **(3)** Yet a third class consists of those who are led by their faith and veneration to mix their philosophy with theology and stuff handed down across the centuries. Some of these have been so foolish and empty-headed as to have wandered off looking for knowledge among spirits and ghosts. So there are the triplets born of error and false philosophy: philosophies that are **(1)** sophistical, **(2)** empirical, and **(3)** superstitious.

[To explain Bacon’s second accusation against Aristotle in **63**: A word ‘of the second intention’ is a word that applies to items of thought or of language (whereas things that are out there in the world independently of us are referred to by words ‘of the first intention’). Now Aristotle in his prime held that the soul is not *a substance* but rather *a form*: rather than being an independently existing thing that is somehow combined with the rest of what makes up the man, the soul is a set of facts about how the man acts, moves, responds, and so on. Bacon has little respect for the term ‘form’: in **15** he includes it among terms that are ‘fantastical and ill-defined’, and in **51** he says that ‘forms are fabrications of the human mind’. This disrespect seems to underlie the second accusation; the class of *forms* is not a class of independently existing *things* but

rather a class of muddy and unfounded *ways of thinking and talking*, so that ‘form’ is a word of the second intention.]

63. The most conspicuous example of **(1)** the first class was Aristotle, whose argumentative methods spoiled natural philosophy. He

- made the world out of categories;
- put the human soul, the noblest of substances, into a class based on words of the second intention;
- handled the issues about density and rarity (which have to do with how much space a body takes up) in terms of the feeble distinction between what does happen and what could happen;
- said that each individual body has one proper motion, and that if it moves in any other way this must be the result of an external cause,

and imposed countless other arbitrary restrictions on the nature of things. He was always less concerned about the inner truth of things than he was about providing answers to questions—*saying* something definite. This shows up best when his philosophy is compared with other systems that were famous among the Greeks. For

- the homogeneous substances of Anaxagoras,
- the atoms of Leucippus and Democritus,
- the heaven and earth of Parmenides,
- the strife and friendship of Empedocles, and
- Heraclitus’s doctrine of bodies’ being reduced to the perfectly homogeneous condition of fire and then remolded into solids,

all have a touch of natural philosophy about them—a tang of the nature of things and experience and bodies. Whereas in Aristotle’s physics you hear hardly anything but the sounds of logical argument—involving logical ideas that he reworked, in a realist rather than a nominalist manner, under the

imposing name of ‘metaphysics’. Don’t be swayed by his frequent mentions of experiments in his *On Animals*, his *Problems*, and others of his treatises. For he didn’t consult experience, as he should have done, *on the way to* his decisions and first principles; rather, he first *decided* what his position would be, and *then* brought in experience, twisting it to fit his views and making it captive. So on this count Aristotle is even more to blame than his modern followers, the scholastics, who have abandoned experience altogether.

64. The **(2)** empirical school of philosophy gives birth to dogmas that are more deformed and monstrous than those of the sophistical or reasoning school. The latter has as its basis the •light of vulgar notions; it’s a faint and superficial light, but it is in a way •universal, and applies to many things. In contrast with that, the empirical school has its foundation in the •narrowness and •darkness of a few experiments. Those who busy themselves with these experiments, and have infected their imagination with them, find such a philosophy to be probable and all but certain; everyone else finds them flimsy and incredible. A notable example of this •foolishness• is provided by the alchemists and their dogmas; these days there isn’t much of it anywhere else, except perhaps in the philosophy of Gilbert. Still, I should offer a warning relating to philosophies of this kind. If my advice ever rouses men to take experiments seriously and to bid farewell to sophistical doctrines, then I’m afraid that they may—I foresee that they *will*—be in too much of a hurry, will leap or fly •from experiments straight• to generalizations and principles of things, risking falling into just the kind of philosophy I have been talking about. We ought to prepare ourselves against this evil now, •well in advance•.

65. The corruption of philosophy by **(3)** superstition and input from theology is far more widespread, and does the

greatest harm, whether to entire systems or to parts of them. Systems thus afflicted are just nonsense judged by ordinary vulgar standards, but that doesn't protect men from accepting them, because the human intellect is open to influence from the imagination as much as from vulgar notions, and in these philosophies it is the imagination that wields the power. Whereas the contentious and sophisticated kind of philosophy combatively *traps* the intellect, this superstitious kind, being imaginative and high-flown and half-poetic, *coaxes* it along. For men—especially intelligent and high-minded ones—have intellectual ambitions as well as ambition of the will.

A striking example of this sort of thing among the Greeks is provided by Pythagoras, though his form of it wasn't so dangerous, because the superstition that he brought into it was coarser and more cumbrous than many. Another example is provided by Plato and his school, whose superstition is subtler and more dangerous. Superstition turns up also in parts of other philosophies, when they

introduce abstract forms—i.e. forms that aren't the forms of anything,

and when they do things like

speaking of 'first causes' and 'final causes' and usually omitting *middle* causes.

[Bacon's point is: They discuss the first cause of the whole universe, and the end or purpose for which something happens (its 'final cause'), but they mostly ignore ordinary *causes* such as spark's causing a fire. Putting this in terms of first-middle-final seems to be a quiet joke]. We should be *extremely* cautious about this. There's nothing worse than the *deification* of error, and it is a downright plague of the intellect when empty nonsense is treated with veneration. Yet some of the moderns have been so tolerant of this emptiness that they have—what a shallow performance!—tried to base a system of natural philosophy

on the first chapter of Genesis, on the book of Job, and other parts of the sacred writings, 'seeking the living among the dead' [Luke 24:5]. This makes it more important than ever to keep down this kind of philosophy, because this unhealthy mixture of human and divine gives rise not only to fantastic philosophy but also to heretical religion. It is very proper that we soberly give our faith only to things that *are* the faith.

66. So much for the mischievous authority of systems founded on vulgar notions, on a few experiments, or on superstition. I should say something about bad choices of what to think *about*, especially in natural philosophy. In the mechanical arts the main way in which bodies are altered is by composition or separation; the human intellect sees this and is infected by it, thinking that something like it produces all alteration in the universe. This gave rise to the fiction of *elements* and of their coming together to form natural bodies. Another example: When a man surveys nature working freely, he encounters different species of things—of animals, of plants, of minerals—and that leads him smoothly on to the opinion that nature contains certain *primary forms* which nature intends to work with, and that all other variety comes from nature's being blocked and side-tracked in her work, or from conflicts between different species—conflicts in which one species turns into another. To the first of these theories we owe such intellectual rubbish as *first qualities of the elements*; to the second we owe *occult properties* and *specific virtues*. Both of them are empty short-cuts, ways for the mind to come to rest and not be bothered with more solid pursuits. The medical researchers have achieved more through their work on the second qualities of matter, and the operations of attracting, repelling, thinning, thickening, expanding, contracting, scattering, ripening and the like;

and they would have made much greater progress still if *it weren't for a disaster that occurred. The two short-cuts that I have mentioned (elementary qualities and specific virtues) snared the medical researchers, and spoiled what they did with their correct observations in their own field. [The passage flagged by asterisks expands what Bacon wrote, in ways that the small-dots system can't easily indicate.] It led them either •to treating second qualities as coming from highly complex and subtle mixture of first or elementary qualities, or •to breaking off their empirical work prematurely, not following up their observations of second qualities with greater and more diligent observations of third and fourth qualities.*
 •This is a bigger disaster than you might think, because—something like—I don't say *exactly* like—the powers involved in the self-healing of the human body should be looked for also in the changes of all other bodies.

But something much worse than that went wrong in their work: they focussed on

- the principles governing things at rest, not on •the principles of change; i.e. on
- what things are produced *from*, not •*how* they are produced; i.e. on
- topics that they could talk about, not •ones that would lead to results.

The vulgar classification of •kinds of• motion that we find in the accepted system of natural philosophy is no good—I mean the classification into

generation,
 corruption,
 growth,
 diminution,
 alteration, and
 motion.

Here is what they mean. If a body is moved from one

place to another without changing in any other way, this is •motion; if a body changes qualitatively while continuing to belong to the same species and not changing its place, this is •alteration; if a change occurs through which the mass and quantity of the body don't remain the same, this is •growth or •diminution; if a body is changed so much that it changes substantially and comes to belong to a different species, this is •generation or •corruption. But all this is merely layman's stuff, which doesn't go at all deeply into nature; for these are only *measures* of motion. . . .and not *kinds* of motion. They [= the notions involved in the classification into generation, corruption etc.] signify that the motion went this way or that, but not *how* it happened or what *caused* it. They tell us nothing about the appetites of bodies [= 'what bodies are naturally disposed to do'] or about what their parts are up to. They come into play only when the motion in question makes the thing grossly and obviously different from how it was. Even when •scientists who rely on the above classificatory system• do want to indicate something concerning the *causes* of motion, and to classify motions on that basis, they *very* lazily bring in the •Aristotelian• distinction between 'natural' motion and 'violent' motion, a distinction that comes entirely from vulgar ways of thinking. In fact, 'violent' motion is natural motion that is called 'violent' because it involves an external cause working (naturally!) in a different way from how it was working previously. [Bacon himself sometimes describes a movement as *violens*, but this is meant quite casually and not as a concept belonging to basic physics. These innocent occurrences of *violens* will be translated as 'forceful'.]

Let us set all this aside, and consider such observations as that bodies have an appetite for

mutual contact, so that separations can't occur that would break up the unity of nature and allow a vacuum to be made;

or for

resuming their natural dimensions. . . ., so that if they are compressed within or extended beyond those limits they immediately try to recover themselves and regain their previous size;

or for

gathering together with masses of their own kind—e.g. dense bodies ·moving· towards the earth, and light and rare bodies towards the dome of the sky.

These and their like are truly *physical* kinds of motion; and comparison of them with the others that I mentioned makes clear that the others are entirely *logical* and *scholastic*.

An equally bad feature of their philosophies and their ways of thinking is that all their work goes into investigating and theorizing about the

- fundamental· principles of things. . .—so they keep moving through higher and higher levels of abstraction until they come to *formless potential matter*—and
- the ultimate parts of nature—so they keep cutting up nature more and more finely until they come to *atoms*, which are too small to contribute anything to human welfare—

whereas everything that is useful, everything that can be worked with, lies between ·those two extremes·.

67. The intellect should be warned against the intemperate way in which systems of philosophy deal with the giving or withholding of assent, because intemperance of this kind seems to establish idols and somehow prolong their life, leaving no way open to reach and dislodge them.

There are two kinds of excess: •the excess of those who are quick to come to conclusions, and make sciences dogmatic and lordly; and •the excess of those who deny that we can know anything, and so lead us into an endlessly

wandering kind of research. The •former of these subdues the intellect, the •latter deprives it of energy. The philosophy of Aristotle ·is of the former kind·. Having destroyed all the other philosophies in argumentative battle. . . Aristotle laid down the law about everything, and then proceeded to raise new questions of his own and to dispose of them likewise, so that everything would be certain and settled—a way of going about things that his followers still respect and practice.

The ·Old Academy·, the school of Plato, introduced acatalepsy—the doctrine that nothing is capable of being understood·. At first it was meant as an ironical joke at the expense of the older sophists—Protagoras, Hippias, and the rest—whose greatest fear was to seem *not* to doubt something! But the New Academy made a dogma of acatalepsy, holding it as official doctrine. They did allow of some things to be followed as probable, though not to be accepted as true; and they said they didn't ·mean to· destroy all investigation; so their attitude was better than. . .that of Pyrrho and his sceptics. (It was also better than undue freedom in making pronouncements.) Still, once the human mind has despaired of finding truth, it becomes less interested in everything; with the result that men are side-tracked into pleasant disputations and discourses, into *roaming*, rather than severely sticking to a single course of inquiry. But, as I said at the start and continue to urge, the human senses and intellect, weak as they are, should not be •deprived of their authority but •given help.

68. So much for the separate classes of idols and their trappings. We should solemnly and firmly resolve to deny and reject them all, cleansing our intellect by freeing it from them. Entering the kingdom of man, which is based on the sciences, is like entering the kingdom of heaven, which one can enter only as a little child.

69. But the idols have defences and strongholds, namely defective demonstrations; and the demonstrations we have in dialectics do little except make •the world a slave to •human thought, and make human thought a slave to •words. Demonstrations are indeed incipient philosophies and sciences: how good or bad a demonstration is determines how good or bad will be the system of philosophy and the thoughts that follow it. Now the demonstrations that we use in our whole process of getting from the •senses and •things to •axioms and conclusions are defective and inappropriate. This process has four parts, with a fault in each of them. **(1)** The impressions of the senses itself are faulty, for the senses omit things and deceive us. Their omissions should be made up for, and their deceptions corrected. **(2)** Notion are abstracted *badly* from the impressions of the senses, and are vague and confused where they should be definite and clearly bounded.

(3) Induction goes wrong when it infers scientific principles by simple enumeration, and doesn't, as it should, take account of the exceptions and distinctions that nature is entitled to. **(4)** The method of discovery and proof in which you *first* state the most general principles and *then* bring the intermediate axioms into the story, 'proving' them from the general principles, is the mother of errors and a disaster for all the sciences. At this stage I merely touch on these matters. I'll discuss them more fully when, after performing these cleansings and purgings of the mind, I come to present the true way of interpreting nature.

70. The procedure that starts with experience and *sticks close to it* is the best demonstration by far. A procedure that involves transferring a result to other cases that are judged to be similar is defective unless the transfer is made by a sound and orderly process. The way men conduct experiments

these days is blind and stupid. Wandering and rambling with no settled course and only such 'plans' as events force on them, they cast about and touch on many matters, but don't get far with them. Sometimes they are eager, sometimes distracted; and they always find that some further question arises. They usually conduct their experiments casually, as though this were just a game; they slightly vary experiments that are already known; and if an experiment doesn't come off, they grow weary and give up the attempt. And even if they worked harder at their experiments, applying themselves more seriously and steadfastly, they *still* wouldn't get far, because they work away at some *one experiment*, as Gilbert did with the magnet and the chemists do with gold. That is a way of proceeding that is as unskilful as it is feeble. For no-one successfully investigates the nature of a thing taken on its own; the inquiry needs to be enlarged so as to become more general.

And even when they try to draw some science, some doctrines, from their experiments, they usually turn aside and rashly embark on premature questions of practical application; not only for the practical benefits of such applications, but also because they want to *do* things that will •assure them that it will be worth their while to go on, and •show themselves in a good light to the world and so •raise the credit of the project they are engaged in. They are behaving like Atalanta in the legend from ancient Greece: she turned aside to chase a golden ball, interrupting her running of the race and letting victory slip through her fingers. But in using the true course of experience to carry out new works, we should model our behaviour on the divine wisdom and order. On the first day of creation God created light and nothing else, devoting an entire day to a work in which no material substance was created. We should follow suit: with experience of any kind, we should first try to discover true causes

and axioms, looking for •enlightening experiments rather than for •practically fruitful ones. For axioms don't *singly* prepare the way for practical applications, but *clusters of* rightly discovered and established axioms do so, bringing in their wake streams—*crowds!*—of practical works. The paths of experience are just as rocky and jammed as the paths of judgment, and I'll discuss that later. I have mentioned ordinary experimental work at this stage only in its role as a bad kind of demonstration. But considerations of order now demand that I take up next ·two linked topics·: •the signs or omens (mentioned a little way back) that current systems of philosophy and of thought are in a bad condition; and •the causes of ·this badness, which· seems at first so strange and incredible. When you have seen •the signs you will be more likely to agree ·with me about the badness·; and my explanation of •its causes will make it seem less strange. These two together will greatly help to render the process of wiping the idols from the intellect easier and smoother. ·My discussion of •the signs will run to the end of 77, and •the causes will run from there to the middle of 92·. [In the next seven sections, the Latin *signa* will be translated sometimes as 'signs' and sometimes as 'omens'.]

71. The sciences that we have come mostly from the Greeks. For the additions by Roman, Arabic and later writers are neither plentiful nor important, and such as they are they have been built on the foundation of Greek discoveries. Now, the wisdom of the Greeks was that of teachers of rhetoric, and it spawned disputations, which made it the worst kind of inquiry for finding the truth. Those who wanted to be thought of as philosophers contemptuously gave the label 'sophists' to the ancient rhetoricians Gorgias, Protagoras, Hippias and Polus; but really the label fits the whole lot of them: Plato, Aristotle, Zeno, Epicurus, Theophrastus, and

their successors Chrysippus, Carneades and so on. There was this just difference: •the rhetoricians were wandering and mercenary, going from town to town, offering their wisdom for sale, and taking a price for it; whereas •the others were more ceremonial and 'proper'—men who had settled homes, and who opened schools and taught their philosophy without charging for it. But although the two groups of philosophers were in other ways unlike, they had one thing in common: both lots were teachers of rhetoric; both turned everything into a matter for disputations, and created sects that they defended against heresies. They turned it all into •the talk of idle old men to ignorant youths' (Dionysius's jibe against Plato, a not unfair one!). But the earlier of the Greek philosophers—Empedocles, Anaxagoras, Leucippus, Democritus, Parmenides, Heraclitus, Xenophanes, Philolaus and so on (omitting Pythagoras because he was a mystic)—didn't open schools, as far as we know. What they did was to *apply themselves to the discovery of truth*, doing this

•more quietly, severely and simply—that is, with less affectation and parade—
than the others did. And in my judgment they also performed
•more successfully,
·or would have done so· if it weren't for the fact that their works were in the course of time obscured by less substantial people who offered more of what suits and pleases the capacity and tastes of the vulgar. Time is like a river, bringing lightweight floating stuff down to us and letting heavier and solider things sink. Still, not even they—Empedocles and the rest—were entirely free of the Greek fault: they leaned too far in the direction of ambition and vanity, founding sects and aiming for popular applause. The inquiry after •truth has no chance of succeeding when it veers off after •trifles of this kind. And I ought to mention the judgment, or rather the prediction, that an Egyptian priest made about the Greeks,

namely that ‘they are always *boys*, with no •long-established knowledge and no •knowledge of ancient times’ [neater in Latin: •*antiquitatem scientiae* and •*scientiam antiquitatis*]. Assuredly they were like boys in their readiness to chatter, and in their inability to father anything—for their wisdom is full of words but sterile in works. So when we consider the currently accepted philosophy in the light of its place of origin and its family tree, the omens are not good!

72. And the omens provided by the character of the time and age aren’t much better than the ones from the character of the place and the nation. For knowledge at that period concerned only a short stretch of time and a small part of the world, and that’s the worst state to be in, especially for those who base everything on experience. For the preceding thousand years they had no *history* worthy of the name, but only fables and verbal traditions. And they knew only a small portion of the regions and districts of the world; they indiscriminately called everyone to the north of them ‘Scythians’. and those to the west ‘Celts’; they knew nothing of Africa beyond the nearest part of Ethiopia, or of Asia beyond the Ganges. They knew even less about the provinces of the New World. . . .and declared to be uninhabitable a multitude of climates and zones where actually countless nations live and breathe. . . . (Contrast that with the present day: we know many parts of the New World as well as the whole of the Old World, and our stock of experience has grown infinitely.) So if like astrologers we take omens •for contemporary systems of philosophy• from the facts about *when* they were born, we can’t predict anything great for them.

73. Of all the signs •we can have of the value of a field of endeavour•, none are more certain or more conspicuous than those based on the *upshots* •of the endeavour•. For

upshots and useful practical applications are like sponsors and guarantors of the truth of philosophies. [Throughout this work, ‘philosophies’ include ‘sciences’.] Now, from all those systems of the Greeks and the particular sciences derived from them, you can hardly name a single experiment that •points the way to some improvement in the condition of man, and that •really does come from the speculations and theories of philosophy. Hardly one, after all those years! And Celsus honestly and sensibly admits as much, when he tells us that •the practical part of medicine was discovered first, and that *then* •men philosophized about it and hunted for and assigned causes; rather than the reverse process in which •philosophy and the knowledge of causes led to •the discovery and development of the practical part. So it isn’t strange that among the Egyptians, who rewarded inventors with divine honours and sacred rites, there were more images of the lower animals than of men; for the lower animals have made many discoveries through their natural instincts, whereas men have given birth to few or none through their discussions and rational inferences.

The work of chemists has produced a little, but only •accidentally and in passing or else •by varying previous experiments (just as a mechanic might do!), and not by any skill or any theory. For the theory that they have devised does more to confuse the experiments than to help them. And the people who have busied themselves with so-called ‘natural magic’ have come up with nothing but a few trifling and apparently faked results. In religion we are warned to *show our faith by our works*; the same rule applies in philosophy, where a system should be judged by its fruits, and pronounced frivolous if it turns out to be barren, especially when it bears the thorns and thistles of dispute and contention rather than the fruits of grape and olive.

74. The growth and progress of systems and sciences provides signs ·as to their value·. Something that is grounded in nature grows and increases, while what is based on opinion *alters* but doesn't *grow*. If those doctrines ·of the ancient Greeks· hadn't been so utterly like a plant torn up by its roots, and had remained attached to and nourished by the womb of nature, the state of affairs that we have seen to obtain for two thousand years—namely

the sciences stayed in the place where they began, hardly changing, not getting any additions worth mentioning, thriving best in the hands of their first founders and declining from then on

—would never have come about. This is the opposite of what happens with the mechanical arts, which are based on nature and the light of experience: they (as long as they find favour with people) continually thrive and grow, having a special kind of *spirit* in them, so that they are at first rough and ready, then manageable, from then onwards made smoothly convenient by use—and *always growing*.

75. Admissions made by the very authorities whom men now follow constitute another sign ·that today's sciences are in trouble·—if it is all right to apply the label 'sign' to what is really testimony, indeed the most reliable of all testimony. Even those who so confidently pronounce on everything do intermittently pull themselves together and complain of the subtlety of nature, the obscurity of things, and the weakness of the human mind. ·These complaints are not just a sign of trouble in the sciences; they are worded in such a way that they cause further harm·. If these people merely *complained*, some cowards might be deterred from searching further, while others with livelier minds and a more hopeful spirit might be spurred and incited to go on. But the complainers don't merely speak for themselves: if something is beyond

their knowledge or reach, and of their master's, they declare it to be beyond the bounds of possibility, something that can't be known or done; so that their lofty ill-nature turns the weakness of their own 'discoveries' into a libel against nature herself and a source of despair for the rest of the world. •Thus the school of the New Academy, which doomed men to everlasting darkness by maintaining as a matter of doctrine that nothing at all could be known. •Thus the opinion that men can't possibly discover the *forms*, i.e. the real differentiae of things ·that put things into different species· (really they are laws of pure action [see note on page 11]). •Thus also certain opinions in the field of action and operation, e.g. that the heat of the sun is quite different in kind from the heat of fire, so that no-one will think that the operations of fire could produce anything like the works of nature ·that are produced by the sun·. •That's the source of the view that...

Latin: ... *compositionem tantum opus hominis, mistionem vero opus solius naturae esse*

literal meaning: ... men are capable only of composition, and mixing has to be the work of nature

intended meaning? ... men are capable only of assembling things into physical mixtures (e.g. salt and pepper), and the subtler kind of combination involved in something's being gold or water or salt or the like must be the work of nature

—lest men should hope to develop techniques for generating or transforming natural bodies, ·e.g. creating water or turning lead into gold·. ·I point out· this sign ·of second-rateness· to warn you not to let your work and your career get mixed up with dogmas that are not merely discouraging but are *dedicated* to discouragement.

76. Here is another sign ·of something's being wrong· that I oughtn't to pass over: the fact that formerly there existed

among philosophers such great disagreement, and such differences between one school and another. This shows well enough that the road from the senses to the intellect was not well defended ·with walls along each side·, when the same raw material for philosophy (namely the nature of things) has been taken over and used to construct so many wandering pathways of error. These days, most of the disagreements and differences of opinion on first principles and entire ·philosophical· systems have been extinguished; but there are still endless questions and disputes concerning some *parts* of philosophy, which makes it clear that there is nothing certain or sound in the systems themselves or in the modes of demonstration ·that they employ·.

77. Some men think this:

There *is* great agreement in philosophy these days, because there is ·widespread agreement in assenting to the philosophy of Aristotle; as witness the fact that once it was published the systems of earlier philosophers fell into disuse and withered away, while in the times that followed nothing better was found. Thus, it seems to have been so well laid out and established that it has drawn both ages—·ancient and modern·—to itself.

I start my reply to this by remarking that the general opinion that the old systems stopped being used or consulted when Aristotle's works were published is *false*. In fact, long afterwards—even down to the times of Cicero and later centuries—the works of the old philosophers still remained. But in the times that followed, when the flood of barbarians pouring into the Roman empire made a shipwreck of human learning, *then* the systems of Aristotle and Plato, like planks

of lighter and less solid material, floated on the waves of time and were preserved. As for the point about agreed assent: if you look into this more carefully you'll see that the view I am discussing is wrong about that too. For genuine *agreement* is based on people's having duly examined some matter and reached, freely ·and independently·, the same opinion about it. But the great majority of those who have assented to the philosophy of Aristotle have delivered themselves over to it on the strength of the prejudices and the authority of others; so that this is less a case of *agreement* than of *moving together as a crowd*. But even if it had been a real and widespread agreement, that is so far from being •solid confirmation of the truth ·of Aristotle's philosophy· that it actually creates a •strong presumption of its falsity. For in intellectual matters the *worst* of all auguries is ·general· consent, except in theology (and in politics, where there is a right to vote!). This is because of something I have already mentioned: that nothing pleases the multitude unless it appeals to the imagination or ties the intellect up with knots made from the notions of the vulgar. Something that Phocion said about morals can very well be re-applied to intellectual matters, namely that if the multitude accept ·what you say· and are united in their applause, you should immediately check yourself to see where you have gone wrong. So *this* sign is one of the *least* favourable.

That brings me to the end of what I have to say to make my point that the signs of health and truth in the currently accepted philosophical systems and sciences are *not good*, whether they be drawn from their origins (**71–2**), their upshots (**73**), their progress (**74**), the admissions of their founders (**75**), or agreed acceptance (**77**).

APHORISMS CONCERNING THE INTERPRETATION OF NATURE: BOOK 1: 78–130

78. I now come to the *causes* of these errors—so many of them, and such bad ones!—that have continued on through all those centuries. My discussion of thirteen of them will run on through **92**. You may have been wondering how the points I have made could have escaped men’s notice until now; my account of the causes should stop you wondering about that. When you understand the causes, you may have something else to be surprised by, namely the fact that someone *has* now seen through the errors, thought about them, and come up with my points against them. As for that, I see it as coming from my good luck rather than from my superior talents; it’s not that I am so clever, but rather that I was born at the right time.

(1) The first point about how long the errors went undetected is this: If you look hard at ‘all those centuries’ you’ll see that they shrink into something quite small. We have memories and records of twenty-five, and of those you can hardly pick out *six* that were fertile in the sciences or favourable to their development. (There are wastelands and deserts in times just as in regions of the earth!) We can properly count only *three* periods when learning flourished, and they lasted barely *two* centuries each: that of •the Greeks, the second of •the Romans, and the last among us—•the nations of western Europe. The intervening ages of the world were not flourishing or fertile for the growth of knowledge. (Don’t cite the Arabs or the schoolmen as counter-examples to that; for they spent the intervening times not •adding to the weightiness of the sciences but crushing them with the weight of their books!) So there is one cause for the lack of progress in the sciences, namely the brevity of the periods that can properly be said to have

been favourable to them.

79. (2) Here is a second cause, and one of great all-around importance: Precisely at the times when human intelligence and learning have flourished most, or indeed flourished at all, men *didn’t* work at natural philosophy [here = ‘natural science’]. Yet it should have been regarded as the great mother of the sciences; because all arts and all sciences, though they may be polished and shaped and made fit for use, won’t *grow* at all if they are torn from this root of natural philosophy. It is clear that after the Christian religion was generally accepted and grew strong, the vast majority of the best minds applied themselves to theology, that this offered the best promise of reward and the most abundant research support of all kinds, and that this focus on theology was the chief occupation of able people in western Europe during the **third** period of the three I have named—all the more so because at about the same time literacy began to be more widespread and religious controversies sprang up. During the Roman period—the **second** of my trio—philosophers mostly worked on and thought about moral philosophy, which was to the pagans what theology is to us. Also, in those times the best intelligences usually devoted themselves to public affairs, because the sheer size of the Roman empire required the services of a great many people. And—moving back to the **first** of my trio—there was only a tiny portion of time when natural philosophy was seen to flourish among the Greeks; for in earlier times all except Thales of the so-called ‘seven wise men’ applied themselves to morals and politics; and in later times, when Socrates had drawn philosophy from heaven down to earth, moral philosophy became more fashionable than ever and diverted men’s minds from the

philosophy of nature.

And right at the time when inquiries into nature *were* carried on energetically, they were spoiled and made useless by controversies and the ambitious display of new opinions. During those three periods, then, natural philosophy was largely neglected or impeded, so it's no wonder that men made so little progress with something that they weren't attending to. [This is the first of eleven remarks along the lines of 'No wonder science hasn't progressed, given the fact that. . . '—one for each of Bacon's causes of non-progress except the first and last.]

80. (3) I would add that especially in recent times natural philosophy, even among those who *have* attended to it, has scarcely ever had anyone's complete and full-time attention (except perhaps a monk studying in his cell, or an aristocrat burning the midnight oil in his country house); it has usually been treated as merely a bridge leading to something else. And so *natural philosophy*, that great mother of the sciences, has been subjected to the astonishing indignity of being degraded to the role of a servant, having to *help* medicine or mathematics in their affairs, and to give the immature minds of teen-agers a first dip in a sort of dye, to make them better able to absorb some other dye later on. Meanwhile don't look for much progress in the sciences—especially in their practical part—unless natural philosophy is applied to particular sciences, and particular sciences are applied back again to natural philosophy. It is because this hasn't been done that many of the sciences have no *depth* and merely glide over the surface of things. What sciences? Well, astronomy, optics, music, many of the mechanical arts, even medicine itself—and, more surprisingly, moral and political philosophy and the logical sciences. Because once these particular sciences have become widespread and established, they are no longer nourished by natural philosophy, which

could have given them fresh strength and growth drawn from the well-springs—from true thoughts about

- motions, rays, sounds and textures, and
- microstructures of bodies [see note on page 10], and
- feelings and intellectual processes.

So it's not at all strange that the sciences don't grow, given that they have been cut off from their roots.

81. (4) Another great and powerful cause why the sciences haven't progressed much is this: You can't run a race properly when the finishing-post hasn't been properly positioned and fixed in place. Now the true and lawful finishing-post of the sciences is just *new discoveries and powers in the service of human life*. But the great majority of the mob of supposed scientists have no feeling for this, and are merely hired lecturers. Well, occasionally some ambitious practitioner who is abler than most spends his own resources on some new invention; but most men are so far from aiming to *add* anything to the arts and sciences that they don't even *attend* to what's already there or *take* from it anything that they can't use in their lectures or use in the pursuit of money or fame or the like. And when one of that multitude *does* pay court to science with honest affection and for her own sake, even then it turns out that what attracts him is not the stern and unbending search for truth so much as the richness of the array of thoughts and doctrines. And if there should happen to be one who pursues the truth in earnest, even he will be going after *truths* that will satisfy his intellect by explaining the causes of things long since discovered, and not *truths* that hold promise of new practical applications or *the new light of axioms*. If the *end* of the sciences hasn't yet been placed properly, it isn't strange that men have gone wrong concerning the *means*.

82. (5) So men have mislocated the end and finishing-post of the sciences; but even if they hadn't, their *route* to it is completely wrong and impassable. When you think about it carefully, it is amazing that •no mortal has *cared* enough or *thought hard* enough to lay out a securely walled road leading to the human intellect directly from the senses and experiment, and that •everything has been left either to the mists of tradition, or the whirl and eddy of argument, or the waves and mazes of random and fragmentary experience. Think about this soberly and carefully: What route *have* men customarily travelled in investigating and discovering things? No doubt what you will first come up with is a very simple and naive discovery procedure, the most usual one, namely this:

A man is bracing himself to make a discovery about something: first he seeks out and surveys **everything that has been said about it by others**; then he starts to think for himself; shaking up his mind and, as it were, praying to it to give him oracular pronouncements

—a 'method' that has no foundation at all, rests only on opinions, and goes where they go. Another man may perhaps call on **dialectics** to make his discovery for him, but the discoveries that dialectics is good for are irrelevant to what we are discussing—there's nothing in common except the word 'discovery'. [Regarding the passage between *asterisks*: Bacon writes of 'arts' but doesn't give examples (medicine and ship-building). This text also expands his in other ways that ·dots· can't easily indicate.] *Arts such as medicine and ship-building are made up of principles and axioms, and dialectics doesn't discover these; all it can 'discover', given that you have the principles and axioms from some other source, is what else is consistent with them. If we try to insist on more than that, demanding that dialectics tell us what the •principles and axioms are,

we all know that it will fling the demand back in our faces: 'For •*them* you must trust the art in question. For the foundations of medicine, for example, don't ask *dialectics*, ask *medicine!*'* ·Setting aside the opinions of others, and dialectics·, there remains **simple experience**—which we call 'experiment' if we were trying to produce it, and 'chance' if we weren't. But such experience is no better than a broom with loose bristles, as the saying is—·those who steer by it are· like men in the dark, patting the walls as they go along hoping to find their way, when they'd have done much better to wait for daylight, or light a candle, and *then* set off. But **experience managed in the right •order** first lights the candle and then uses it to show the way. It starts with experience that is ordered and classified, not jumbled or erratic; from that it derives axioms, and from established axioms it moves on to new experiments; just as God proceeded in an •orderly way when he worked on matter. So don't be surprised that science hasn't yet reached the end of its journey, seeing that men have gone altogether astray, either abandoning experience entirely, or getting lost in it and wandering around as in a maze. Whereas a rightly ordered method leads by an unbroken route through the thickets of experience to the open ground of axioms.

83. This trouble ·concerning not-finding-the-way· has been greatly increased by an old and *harmful* opinion or fancy, namely the self-important view that it is beneath the dignity of the human mind to be closely involved with experiments on particular material things given through the senses—especially as they are

- hard work to investigate,
- trivial to think about,
- nasty to report on,
- not suitable things for a gentleman to perform,

- infinite in number, and
- full of extremely small-scale details.

So that it has finally come to this: the true way is not merely departed from but blocked off. It's not that experience has been abandoned or badly handled; rather, it has been fastidiously kept at arm's length.

84. (6) Men have been kept back from making progress in the sciences, as though by a magic spell, by •their reverence for antiquity, by •the authority of men of high standing in philosophy, and then by •the general acceptance of certain propositions. I have spoken of the last of these in **77** above.

As for 'antiquity', the opinion that men have about it is a lazy one that does violence to the meaning of the word. For really what is *antique* is •the world in its old age, that is the world *now*; and •the earlier age of the world when the ancients lived, though in relation to us it was the elder, in relation to the world it was the younger. We expect •an old man to know more about the human condition than •a young man does, and to make more mature judgments about it, because of his experience and the number and variety of things he has seen, heard and thought about. In the same way, more could be fairly expected from •our age (if only we knew and chose to employ its strength) than from •ancient times, because ours is a more advanced age of the world, and has accumulated countless experiments and observations.

It is also relevant that through long voyages many things in nature will be discovered that may let in new light on philosophy (and such voyages will be increasingly frequent in our age). And given that the regions of the •material domain—i.e. of the earth, the sea and the stars—have been opened up and brought to light, it would surely be disgraceful if the •intellectual domain remained shut up within the narrow limits of old discoveries.

And with regard to authority: there is something feeble about granting so much to •authors while denying •time its rights—time, which is the author of authors, or rather of all authority. For the saying is 'Truth is the daughter of time', not '... the daughter of authority'!

We shouldn't be surprised, then, when we find that the enchantments of •antiquity and •authority and •general agreement have tied up men's powers—as though putting them under a spell—making them unable to rub shoulders with •*things themselves*.

85. (7) What brings man's work to a halt in face of the discoveries that have already been made is not merely his admiration for antiquity, authority and general agreement, but also his admiration for the long-time achievements of the human race. When you look at the variety and beauty of the devices that the mechanical arts have assembled for men's use, you'll surely be more inclined to admire man's wealth than to have any sense of his poverty! You won't take into account the fact that

the original human observations and natural processes (which are the soul and first mover of all that variety)

are not many and didn't have to be dug deeply for; and that apart from them it has been merely a matter of

patience, and the orderly and precise movements of hands and tools.

For example, it certainly takes precise and accurate work to make a clock, whose wheels seem to imitate the heavenly bodies and, in their alternating and orderly motion, to imitate the pulse of animals; but there isn't much scientific content in this, because the entire mechanism depends on only a couple of axioms of nature.

[Bacon next writes about ‘the refinement of the liberal arts’ and of the ‘art’ that goes into ‘the mechanical preparation of natural substances’, and lists the achievements in astronomy, music, language, the alphabet (‘still not used in China’), the making of beer, wine and bread, and so on. His point is that these achievements took centuries of tinkering, and that they involve very little in the way of genuinely scientific knowledge. So they—like the clock—make it less appropriate to wonder at how *much* we know than to wonder at how *little*. Then:]

If you turn from the workshop to the library, and wonder at the immense variety of books you see there, just look carefully into their contents and your amazement will be *flipped*: having seen their endless repetitions, and seen how men are always saying and doing what has been said and done before, you’ll pass from •admiration at the variety to •astonishment at the poverty and scantiness of the subjects that have so far possessed the minds of men.

[Next Bacon comments derisively on the intellectual poverty of alchemy. Then:] The students of natural magic, who explain everything by ‘sympathies’ and ‘antipathies’, have in their lazy conjectures credited substances with having wonderful powers and operations. If they have ever they produced any results, they have been more productive of astonishment than of anything useful. [Followed by a slap at ‘superstitious magic’; Bacon expresses some embarrassment at even mentioning this, as he does with alchemy. Finally:] It isn’t surprising that the belief that one has a great deal has been a cause of our having very little.

86. (8) Furthermore, men’s feeble and almost childish admiration for doctrines and arts has been increased by the tricks and devices of those who have practised and taught the sciences. For they produce them with so much fuss and

flourish, putting them before the world all dressed up and masked and seemingly ready to go, as though they were wholly complete and finished. Just look at the structure and the classifications they bring with them! They seem to cover everything that could come up in that subject, and to the minds of the vulgar they present the form and plan of a perfected science; but really the classificatory units are little more than empty bookshelves. The earliest seekers after truth did better than this. Their thoughts about things resulted in knowledge that they want to set down for later use, and they did this in *aphorisms*—i.e. short unconnected sentences, not linked by any method—and didn’t pretend or profess to cover the entire art. But given the way things are these days, it’s not surprising that men don’t try to make further progress in matters that have been passed down to them as long since perfect and complete.

87. (9) The •ancient systems have also gained considerably in their reputation and credit from the empty-headed foolishness of those who have propounded •new ones, especially in the area of applied science. There has been no shortage of talkers and dreamers who—partly believing what they say and partly not—have loaded mankind with promises, offering the means to

prolong life,
 slow down the aging process,
 lessen pain,
 repair natural defects, . . .
 control and arouse affections,
 sharpen and heighten the intellectual faculties,
 turn substances into other substances (•e.g. lead into
 gold•),
 make things move, or move faster, at will,
 make changes in the air,

arrange for influence from the stars,
 prophesy the future,
 make things visible from a long way off,
 reveal things that are hidden,

and many more. With regard to these ‘benefactors’ it wouldn’t be unfair to say that •their absurdities differ as much from •true arts (in the eyes of the philosopher) as •the exploits of Julius Caesar or Alexander the Great differ from •those of •such fictional characters as Amadis of Gaul or the Knights of the Round Table. . . . It isn’t surprising that prejudice is raised against new propositions, especially ones that are said to have practical implications, because of those impostors who have tried something similar. . . .

88. (10) Far more harm has been done to knowledge by pettiness, and the smallness and triviality of the tasks that men have tackled. It is made worse by the fact that this pettiness comes with a certain air of arrogance and superiority. A now-familiar general device that is found in all the arts is this: the author blames *nature* for any weakness in his art, declaring—on the authority of his art!—that whatever his art can’t achieve is intrinsically impossible. [‘Art’ refers to any human activity that involves techniques and requires skills.] If arts are to be their own judges, then clearly none will be found guilty! Moreover, the philosophy that is now in play hugs to itself certain tenets whose purpose. . . . is to persuade men that we can’t expect art or human labour to come up with any results that are hard to get, requiring that nature be commanded and subdued. The doctrine that the sun’s heat and fire’s heat differ in kind is an example of this, and another is the doctrine about mixture—both mentioned earlier, in **75**. If you think about it carefully you’ll see that all this involves a wrong limiting of human power; it tends—and is *meant to tend*—to produce an unnatural despair; and this not only

messes up the auguries that might give hope but also cuts the sinews and spurs of industry, and loads the dice against experience itself. And all for the sake of having us think that their art has been completed, and for the miserable ‘triumph’ of getting us to believe that whatever *hasn’t yet* been discovered and understood *can’t ever* be discovered or understood.

And when someone *does* get in touch with reality and try to discover something new, he will confine himself to investigating and working out some *one* topic, such as

the nature of the magnet,
 the tides,
 mapping the heavens,

and things like that, which seem to be somewhat isolated from everything else and have hitherto been tackled without much success; whereas really it is an ignorant mistake to study something in isolation. Why? Because a nature that seems to be •latent and hidden in some things is •obvious and (as it were) palpable in others, so that people puzzle over it in •the former while nobody even notices it in •the latter. Consider the *holding-together* of material things. Wood and stones hold together, but people pay no attention to that fact, merely saying of wood and stone that ‘they are *solid*’ and giving no further thought to why they don’t fall apart, breaking up their continuity; while with water-bubbles—in which a sort of hemispherical skin is formed, fending off for a moment the breaking up of the continuity—the holding-together seems to be a subtle matter.

In fact, what in some things is regarded as special to them •and not present in the rest of nature• also occurs elsewhere in an obvious and well-known form, but it won’t be recognized *there* as long as the experiments and thoughts of men are engaged only on the former, •i.e. on the less obvious and supposedly ‘special’ cases•. But generally speaking, in

mechanics all that is needed for someone to pass off an old result as something new is •to refine or embellish it, •to combine it with some others, •to make it handier for practical application, •to produce the result on a larger or a smaller scale than had been done before, or the like.

So it is no wonder that no important discoveries worthy of mankind have been brought to light, when men have been satisfied—indeed *pleased*—with such trifling and puerile tasks, and have even fancied that in them they were trying for something great, if not achieving it.

89. (11) Bear in mind also that in every period natural philosophy has had a troublesome and recalcitrant adversary in superstition and blind religious extremism. Among the Greeks those who first proposed *natural* causes for lightning and for storms were condemned for disrespect towards the gods. And some of the fathers of the early Christian church were not much milder in their attitude to those who, on most convincing grounds that no sane person would question today, maintained that the earth is round and thus that the antipodes exist.

Even today it is harder and more dangerous ·than it ought to be· to talk about nature, because of the procedures of the theological schoolmen. They regularized theology as much as they could, and worked it into the shape of an art [here = ‘academic discipline’], and then incorporated into the body of religion more of Aristotle’s contentious and thorny philosophy than would properly fit there. The same result is apt to arise, though in a different way, from the theories of those who have been so bold as to infer the truth of the Christian religion from the principles of •philosophers, and to confirm it by •their authority. They have solemnly and ceremonially celebrated this union of the senses with faith as a lawful marriage, entertaining [*permulcentes*] men’s minds

with a pleasing variety things to think about but also mixing [*permiscentes*] the human with the divine in an unseemly fashion. In such mixtures of theology with philosophy only the accepted doctrines of philosophy are included, while •new ones—which may be changes for the better—are driven off and wiped out.

Lastly, you will find that some ignorant divines close off access to any philosophy, however ‘purified’ it may be. •Some are feebly afraid that a deeper search into nature would take one beyond the limits of what is proper; and they take what is said in the Scriptures against those who pry into

sacred mysteries,

wrenching it away from there and transferring it to

the hidden things of *nature*,

which are not fenced off by any prohibition ·in the Bible·.

•Other divines are more complex and thoughtful: they think that if middle causes [see note in **65**] aren’t known then it will be easier to explain *everything* in terms of God’s hand and rod; and they think that this is greatly in the interests of religion, whereas really it’s nothing but *trying to gratify God by a lie*. •Others are led by past examples to fear that movements and changes in philosophy will end in attacks on religion. And •others again—·bringing us to the end of my list·—seem to be afraid that if nature is investigated something may be found to subvert religion or at least to shake its authority, especially with the unlearned. But these two last fears strike me as having come from thinking at the level of the lower animals, ·like a dog cowering in fear when it hears an unfamiliar noise·; it’s as though these men in their heart of hearts weren’t sure of the strength of religion and of faith’s domination of the senses, and were therefore scared that the investigation of truth in nature might be dangerous to them. But in point of fact natural philosophy is second only to the Bible as the best antidote

to superstition and the most approved nourishment for faith. So natural philosophy deserves its place as religion's most faithful handmaid: religion displays God's •will, while natural philosophy displays his •power. . . . •Summing up: it isn't surprising that •natural philosophy is stunted in its growth when religion, the thing that has most power over men's minds, has been pulled into the fight *against* •it by the stupidity and incautious zeal of certain people.

90. (12) Moving on now: in the customs and institutions of schools, academies, colleges, and similar bodies whose role is to house learned men and to develop learning, *everything* turns out to work against the progress of the sciences. Their lectures and tests are devised in such a way that it would be hard for anyone to think or speculate about anything out of the common rut. And if one or two have the courage to *judge freely*, they'll have to do it all by themselves with no help from the company of others. And if they can put up with that too, they will find that their hard work and breadth of mind are a considerable hindrance to their careers! For the studies of men in these places are confined—as it were *imprisoned*—in the writings of certain authors, and if anyone disagrees with them he is immediately accused of being a trouble-maker and a revolutionary. But •this is all wrong, because• the situation of the •arts is quite different from that of the •state, and the coming of •new light •in the arts• is not like the coming of •new events •in the state•. In matters of state any change—even a change for the better—is under suspicion of making trouble, because politics rests on authority, consent, fame and opinion, not on demonstration. But arts and sciences should be like quarries, where the noise of new works and further advances is heard on every side. That is how things stand according to right reason, but it's not what actually happens; and the things I have reported in the

administration and government of learning severely restrain the advancement of the sciences.

91. Indeed, even if that hostility •towards new work• stopped, the growth of the sciences would still be held back by the fact that high aims and hard work in this field go unrewarded. For the *rewarding* of scientific achievement and the *performing* of it are not in the same hands. The growth of the sciences comes from high intelligence, while the prizes and rewards of them are in the hands of the common people, or of 'great' persons who are nearly all quite ignorant. Moreover, not only do scientific advances bring no rewards or other benefits, they don't even get popular applause. For the common run of people aren't up to the task of understanding such matters, so that news about them is apt to be blown away by the gales of popular opinions. And it's not surprising that endeavours that are not honoured don't prosper.

92. (13) By far the greatest obstacle to the progress of science—to the launching of new projects and the opening up of new fields of inquiry—is that men despair and think things impossible. For in these matters it's the careful, serious people who have no confidence at all, and are taken up with such thoughts as that

nature is dark,
life is short,
the senses are deceptive,
judgment is weak,
experiments are hard to do,

and the like. They think that •throughout the centuries the sciences have their ebbs and flows, sometimes growing and flourishing and at others withering and decaying, but that •a time will come when the sciences are in a state from which no further progress will be possible. •And they evidently think that that time lies in the *very* near future•. So if anyone

expects or undertakes to make further discoveries, they set this down to his immature irresponsibility. Such endeavours, they think, start well, become harder as they go on, and end in confusion. This is a way of thinking that sober intelligent men are likely to fall into, and we mustn't let *their* charms and attractions lead us to relax or mitigate our judgment of their line of thought. We should carefully note what gleams of hope there are and what direction they come from; and—changing the metaphor—we should disregard the lighter breezes of hope but seriously and attentively follow the winds that seem to be steadier. We must also look to political prudence for advice, and to *take* the advice it gives; it is distrustful on principle, and takes a dim view of human affairs. So my topic here and to the end of **114** is *hope*; for I don't trade in promises, and don't want to affect men's judgments by force or by trickery; rather, I want to lead them by the hand without coercion. The best way to inspire hope will be to bring men to *particulars*, especially ones that are set out in an orderly way in the Tables of Discovery (partly in this work (²**12–13** and ²**18**), but much more in the fourth part of my Great Fresh Start [see note in **31**], because this isn't merely a •hope for the thing but •the thing itself. But I want to come at things gently, so instead of jumping straight to the Tables I shall proceed with my plan of *preparing* men's minds, for **hope** is a significant part even of preparation. If all the other inducements aren't accompanied by **hope**, their effect on men is not to •ginger them up and get them busy but rather to •make them depressed by giving them an even darker view of how things now stand and making them even more fully aware of the unhappiness of their own condition. So there is a point in my revealing and recommending the views of mine that make **hope** in this matter reasonable. It's like what Columbus did *before* his wonderful voyage across the Atlantic, giving reasons for his belief that hitherto

unknown lands and continents might be discovered. His reasons were rejected at first, but later they were vindicated by experience, and were the causes and beginnings of great events.

93. We have to assume that the force behind everything is God; for our subject matter—namely nature—is good in such a way that it plainly comes from God, who is the author of good and the father of light. Now in divine operations even the smallest beginnings lead unstoppably to their end. It was said of spiritual things that 'The kingdom of God cometh not with observation' [*Luke* 17:20], and it is the same with all the greater works of divine providence: everything glides on smoothly and noiselessly, and the work is well under way before men are aware that it has begun. And don't forget Daniel's prophecy concerning the last ages of the world: 'Many shall run to and fro, and knowledge shall be increased' [*Daniel* 12:4], clearly indicating that the thorough exploration of the whole world is fated to coincide with the advancement of the sciences. (By 'fated' I mean 'destined by •God's• providence'. I would add that there have been so many distant voyages that 'the thorough exploration of the whole world' seems to have reached completion or to be well on the way to it.)

94. Next topic: the best of all reasons for having **hope**, namely *the errors of the past, the wrong roads so far taken*. In the course of censuring a poorly run government the critic said something excellent:

The worst things in the past ought to be regarded as the best for the future. For if you had conducted yourself perfectly yet still ended up in your present •miserable• condition, you would have not even a **hope** of improvement. But as things stand, with your misfortunes being due not to the circumstances but to

your own errors, you can **hope** that by abandoning or correcting these errors you can make a great change for the better.

Similarly, if throughout many years men had gone the right way about discovering and cultivating the sciences, and the sciences had still been in the state they are now actually in, it would have been absurdly bold to think that further progress was possible. But if the wrong road has been taken, and men have worked on things that weren't worthwhile, it follows that the troubles have arisen not from •circumstances that weren't in our power but from •the human intellect—and the use and application of *that* can be remedied. So it will be really useful to expound these errors; because every harm they have done in the past gives us reason to **hope** to do better in the future. I have already said a little about these errors, but I think I should set them out here in plain and simple words.

95. Those who have been engaged in the sciences divide into *experimenters* and *theorists*. The experimenters, like •ants, merely collect and use •particular facts•; the theorists, like •spiders, make webs out of themselves. But the •bee takes a middle course: it gathers its material from the flowers of the garden and the field, but uses its own powers to transform and absorb this material. A true worker at philosophy is like that:

- he doesn't rely solely or chiefly on the powers of the mind •like a theorist = spider•, and
- he doesn't take the material that he gathers from natural history and physical experiments and store it up in his memory just as he finds it •like an experimenter = ant•. Instead,
- he stores the material in his intellect, altered and brought under control.

So there is much to **hope** for from a closer and purer collaboration between these two strands in science, experimental and theoretical—a collaboration that has never occurred before now.

96. We have never yet had a natural philosophy that was pure. What we have had has always been tainted and spoiled: in Aristotle's school by logic; in Plato's by natural theology; in the second school of Platonists (Proclus and others) by mathematics, which ought only to set natural philosophy's limits, not generate it or give it birth. From a pure and unmixed natural philosophy we can **hope** for better things •than can be expected from any of those impure systems•.

97. No-one has yet been found who was sufficiently firm of mind and purpose to decide on *and to carry out* this programme:

Clean right out all theories and common notions, and apply the intellect—thus scrubbed clean and evenly balanced—to a fresh examination of particulars.

For want of this, the human knowledge that we have is a mish-mash, composed of •childish notions that we took in along with our mothers' milk, together with •the results of much credulity and many stray happenings. So if someone of mature years, with functioning senses and a well-purged mind, makes a fresh start on examining experience and particular events, better things may be **hoped** for from him. In this respect, I pledge myself to have good fortune like that of Alexander the Great. Don't accuse me of vanity until you have heard me out, because what I am getting at—taken as a whole—goes *against* vanity. Aeschines said of Alexander and his deeds: 'Assuredly we don't live the life of mortal men. What we were born for was that in after ages wonders might be told of us', as though Alexander's deeds seemed to him miraculous. But •what I am saying about myself is not like

that, but rather like this: in the next age Livy took a better and a deeper view of the matter, saying of Alexander that ‘all he did was to have the courage to neglect sources of fear that were negligible’. I think that a similar judgment may be passed on me in future ages: that I did no great things, but simply cut down to size things that had been regarded as great. . . .

98. We can’t do without experience; but so far we haven’t had any foundations for experience, or only very weak ones. No-one has searched out and stored up a great mass of particular events that is adequate

in number,
in kind,
in certainty, or
in any other way

to inform the intellect. On the contrary, learned men—relaxed and idle—have accepted, as having the weight of legitimate evidence for constructing or confirming their philosophy, bits of hearsay and rumours about experience. Think of a kingdom or state that manages its affairs on the basis not of •letters and reports from ambassadors and trustworthy messengers but of •street-gossip and the gutter! Well, the way philosophy has managed its relations with experience has been *exactly* like that.

Nothing examined in enough careful detail,
nothing verified,
nothing counted,
nothing weighed,
nothing measured

is to be found in natural history. And observations that are loose and unsystematic lead to ideas that are deceptive and treacherous. Perhaps you think that this is a strange thing to say. You may want to comment:

Your complaint is unfair. Aristotle—a great man, supported by the wealth of a great king—composed an accurate natural history of animals; and others, with greater diligence though making less fuss about it, made many additions; while yet others compiled rich histories and descriptions of metals, plants, and fossils.

If so, it seems that you haven’t properly grasped what I am saying here. For the rationale of a •natural history that is composed for its own sake is not like the rationale of a •natural history that is collected to supply the intellect with the concepts it needs for building up philosophy. They differ in many ways, but especially in this: the former attends only to the variety of natural species •as they are found in nature•, not to •deliberately constructed• experiments in the mechanical arts. In the business of life, the best way to discover a man’s character, the secrets of how his mind works, is to see how he handles trouble. In just the same way, nature’s secrets come to light better when she is artificially shaken up than when she goes her own way. So we can **hope** for good things from natural philosophy when natural history—which is its ground-floor and foundation—is better organized. Then, but not until then!

99. Furthermore, even when there are plenty of mechanical experiments, there’s a great scarcity of ones that do much to enlarge the mind’s stock of concepts. The experimental technician isn’t concerned with discovering the truth, and isn’t willing to raise his mind or stretch out his hand for anything that doesn’t bear on his •practical• project. There will be grounds for **hope** of scientific advances when •and only when• men assemble a good number of natural-history experiments that •are in themselves of no •practical• use but simply •serve to discover causes and axioms. I call these ‘ex-

periments of light', to distinguish them from the 'practically useful but theoretically sterile' ones that I call 'experiments of fruit' [here 'fruit' = 'practical results']. Now, experiments of this kind have one admirable property: they never miss or fail! Their aim is not to •produce some particular effect but only to •discover the natural cause of something; and such an experiment succeeds equally well however it turns out, for either way it settles the question.

100. Many more experiments should be devised and carried out, and ones of an utterly different kind from any we have had up to now. But that is not all. There should also be introduced an entirely different method, order, and procedure for carrying through a programme of experiments. To repeat something I have already said [82]: when experimentation wanders around of its own accord, it merely gropes in the dark and confuses men rather than instructing them. But when there is a firmly regulated, uninterrupted *series* of experiments, there is **hope** for advances in knowledge.

101. Even after we have acquired and have ready at hand a store of natural history and experimental results such as is required for the work of the intellect, or of philosophy, *still* that is not enough. The intellect is far from being able to retain all this material in memory and recall it at will, any more than a man could keep a diary all in his head. Yet until now there has been more *thinking* than *writing* about discovery procedures—experimentation hasn't yet become *literate*! But a discovery isn't worth much if it isn't 'planned and reported' in writing; and when this becomes the standard practice, better things can be **hoped** for from experimental procedures that have at last been made literate.

102. The particulars 'that have to be studied' are very numerous, and are like an army that is dispersed across a wide

terrain, threatening to scatter and bewilder the intellect 'that tries to engage with them'. There's not much to be **hoped** for from intellectual skirmishing 'with these particulars', dashing here and there among them in a disorderly way. What is needed is first •to get the relevant particulars drawn up and arranged, doing this by means of tables of discovery that are well selected, well arranged, and *fresh* (as though living); and •to put the mind to work on the prepared and arranged helps that these tables provide.

103. But after this store of particulars has been laid before our eyes in an orderly way, we shouldn't pass straight on to the investigation and discovery of new particulars or new discoveries; or anyway if we *do* do that we oughtn't to stop there. I don't deny that when all the experiments of all the arts have been collected and ordered and brought within the knowledge and judgment of one man, new useful things may be discovered through taking the experimental results of one art and re-applying them to a different art (using the approach to experiments that I have called 'literate', 'meaning that the results are properly recorded in writing'). But nothing much can be **hoped** for from that procedure. Much more promising is this: from those particular results derive axioms in a methodical manner, then let the light of the axioms point the way to new particulars. For our road does not lie on a level, but goes up and down—up to axioms, then down again to scientific practice.

104. But the intellect mustn't be allowed •to jump—to *fly*—from particulars a long way up to axioms that are of almost the highest generality (such as the so-called 'first principles' of arts and of things) and then on the basis of them (taken as unshakable truths) •to 'prove' and thus secure middle axioms. That has been the practice up to now, because the intellect has a natural impetus to do that

and has for many years been trained and habituated in doing it by the use of syllogistic demonstration. Our only **hope** for good results in the sciences is for us to proceed thus: using a valid ladder, we move up gradually—not in leaps and bounds—from particulars to lower axioms, then to middle axioms, then up and up until at last we reach the most general axioms. The two ends of this ladder are relatively unimportant because the lowest axioms are not much different from reports on bare experience, while the highest and most general ones—or anyway the ones that we have now—are notional and abstract and without solid content. It's the middle axioms that are true and solid and alive; they are the ones on which the affairs and fortunes of men depend. Above them are the most general axioms, which also have value, but I am talking not about abstract axioms but rather about ones of which the middle axioms are limitations and which thus get content from the middle axioms. So the human intellect should be supplied not with wings but rather weighed down with lead, to keep it from leaping and flying. This hasn't ever been done; when it is done we'll be entitled to better **hopes** of the sciences.

105. For establishing axioms we have to devise a different form of induction from any that has been use up to now, and it should be used for proving and discovering not only so-called 'first principles' but also the lesser middle axioms—indeed *all* axioms. The induction that proceeds by simply listing positive instances is a childish affair; its conclusions are precarious and exposed to peril from a contradictory instance; and it generally reaches its conclusions on the basis of too few facts—merely the ones that happen to be easily available. A form of induction that will be useful for discovery and demonstration in the sciences and the arts will have to separate out a nature through appropriate rejections and

exclusions, and then, after a sufficient number of negatives, to reach a conclusion on the affirmative instances. [Bacon will start to explain this in ²15.] No-one has ever done this, or even *tried to*, except for Plato who does indeed make some use of this form of induction for the purpose of discussing definitions and ideas. But for this kind of induction (or demonstration) to be properly equipped for its work, *many* things have to be done that until now no mortal has given a thought to; so that much more work will have to be spent on this than has ever been spent on the syllogism. And this induction should be used not only in the discovery of axioms but also in drawing boundaries around notions. It is in this induction that our chief **hope** lies.

106. When establishing an axiom by this kind of induction, we must carefully note whether the axiom is shaped so as to fit only the particulars from which it is derived, rather than being larger and wider. And if it *is* larger and wider, we must see whether its greater scope is confirmed and justified by new particulars that it leads us to. Such a justified increase of scope saves us from being stuck with things that are already known (but if it isn't justified then we are over-stretching, loosely grasping at shadows and abstract forms rather than at solid things in the world of matter). When we do things in this way we shall at last have justified **hope**.

107. At this point I should remind you of what I said earlier [80] about extending the range of natural philosophy so that the particular sciences can be grounded in it, and the branches of knowledge don't get lopped off from the trunk. For without that there will be little **hope** of progress.

108. That's all I have to say about getting rid of despair and creating **hope** by banishing or fixing past errors. Now, what other ways are there of creating **hope**? Here's a thought that

occurs at once: Many useful discoveries have been made accidentally by men who weren't looking for *them* but were busy about other things; so no-one can doubt that if men seek for something and are busy about *it*, proceeding in an orderly and not a slapdash way, they will discover far more. Of course it can happen occasionally that someone accidentally stumbles on a result that he wouldn't have found if he had searched hard for it, but on the whole the opposite is the case—things are discovered by methodical searching that couldn't have been found by accident. So, far better things, and more of them, and at shorter intervals, are to be **hoped** for from •hard thinking, hard focussed work and concentration than from •lucky accidents, undisciplined whims and the like, which until now have been the main source of discoveries.

109. Here is another ground for **hope**: Discoveries have sometimes been made that would have been almost unthinkable in advance, and would have been written off as impossible. Men think about the *new* in terms of the *old*: to questions about what the •future holds they bring an imagination indoctrinated and coloured by the •past. This is a terrible way of forming opinions, because streams fed by nature's springs don't run along familiar channels.

Suppose that before gunpowder was invented someone described it in terms of its effects—"There is a new invention by means of which the strongest towers and walls can be demolished from a long way off. That would no doubt have set men thinking about how to increase the power of *catapults* and *wheeled ramming devices* and the like. The notion of a fiery blast suddenly and forcefully expanding and exploding would hardly have entered into any man's mind or imagination, because nothing closely analogous to that had ever been seen. Well, except perhaps in earthquakes

and lightning, but *they* wouldn't have been seen as relevant because they are mighty works of *nature* which *men* couldn't imitate.

Or suppose that before the discovery of silk someone had said: 'They've discovered new a kind of thread for use in clothing and furniture-coverings; it is finer, softer, more beautiful and *stronger* than linen or wool.' Men would have begun to think of some silky kind of plant or of very fine hair of some animal or of the feathers and down of birds; they would *not* have thought of a web woven by a tiny worm in great quantities and renewing itself yearly. If anyone *had* said anything about a worm, he'd have been laughed at as dreaming of a new kind of cobweb! [Bacon then gives a third example: the magnet.] Yet these things and others like them lay concealed from men for centuries, and when they did come to light it wasn't through science or any technical skill but by accident and coincidence. As I have remarked, they were so *utterly* different in kind from anything previously known that they couldn't possibly have been discovered through a preconceived notion of them.

So there are strong grounds for **hoping** that nature has concealed in its folds many wonderfully useful •things that aren't related to or parallel with anything that is now known, and lie right outside our imaginative reach. As the centuries roll on, •they too will doubtless come to light of their own accord in some roundabout way, as did gunpowder and the others; but by the method I am discussing they can be presented and anticipated speedily, suddenly and all at once.

110. Other discoveries prove that this can happen: splendid discoveries are lying at our feet, and we step over them without seeing them. The discoveries of

gunpowder,
silk,

the magnet,
sugar,
paper,

or the like may seem to depend on certain properties of things of and nature—properties that might have been hard to discover. But there is nothing in *printing* that isn't wide open and almost easy. All that was needed was to see that

- although it is harder to arrange letter-types than to write by hand, the two procedures differ in that once the types have been arranged any number of impressions can be made from them, whereas hand-writing provides only a single copy,

and to see that

- ink can be so thickened so that it does its job but doesn't run, especially when the type faces upwards and the ink is rolled onto it from above.

It was merely because they didn't notice *these* obvious facts that men went for so many ages without this most beautiful invention which is so useful in the spreading of knowledge.

But the human mind is such a mess when it comes to this business of discoveries that it first distrusts and then despises itself:

- before the discovery: it is not credible that any such thing can be found,
- afterwards: it is incredible that the world should have missed it for so long!

And this very thing entitles us to some **hope**, namely the hope that there is a great mass of discoveries still to be made—not just ones that will have to be dug out by techniques that we don't yet have, but also ones that may come to light through our transferring, ordering and applying things that we do know already, this being done with the help of the experimental approach that I call 'literate' [101].

111. Another ground of **hope** should be mentioned. Let men reflect on their infinite expenditure of intellect, time, and means on things of *far* less use and value than the discoveries I am talking about. If even a small part of this were directed to sound and solid studies, there is no difficulty that couldn't be overcome. I mention this matter of the use of resources because a collection of Natural and Experimental History, as I envisage it and as it ought to be, is a great—as it were, a *royal*—work, and I freely admit that it will involve much labour and expense. [It will appear in ²11 that the 'collection' Bacon talks of is an orderly written account of phenomena, experiments and their results, not a physical museum.]

112. In the meantime, don't be put off by *how many* particulars there are; rather, let this give you **hope**. The fact is that you will be in worse trouble if you *don't* engage with them; for the particular phenomena of nature are a mere handful compared to the great multitudes of things that human ingenuity can fabricate if it cuts itself off from the clarifying effects of reality. And this road through the study of *real* events soon leads to open ground, whereas the other—the route through *invented* theories and thought-experiments—leads to nothing but endless entanglement. Until now men haven't lingered long with experience; they have brushed past it on their way to the ingenious theorizings on which they have wasted unthinkable amounts of time. But if we had someone at hand who could answer our questions of the form 'What are the *facts* about this matter?', it wouldn't take many years for us to discover all causes and complete every science [the Latin literally means 'to discover all causes and sciences'].

113. Men may take some **hope**, I think, from my own example (I'm not boasting; just trying to be useful). If you are discouraged about the chances of progress in the sciences, look at me!

- I am busier with affairs of state than any other man of my time,
- I lose a lot of time to ill-health, and
- in this ·scientific· work I am wholly a pioneer, not following in anyone’s tracks and not getting advice from anyone.

And yet I think I have pushed things on a certain amount by sticking to the true road and submitting my mind to reality. Well, then, think what might be expected (now that I have pointed out the way) from men

- with plenty of free time,
- in good health·, and
- working together, on the basis of previous work ·by others·.

Unlike the work of sheerly *thinking up* hypotheses, proper scientific work *can* be done collaboratively; the best way is for men’s efforts (especially in collecting experimental results) to be exerted separately and then brought together. Men will begin to know their strength only when they go this way—with one taking charge of one thing and another of another, instead of all doing all the same things.

114. Lastly, even if the breeze of **hope** that blows on us from that New Continent were fainter and less noticeable than it is, still we have to *try*—unless we prefer to have minds that are altogether abject! The loss that may come from •not trying is much greater than what may come from ·trying and· •not succeeding: by •not trying we throw away the chance of an immense good; by •not succeeding we only incur the loss of a little human labour. But from what I have said (and from some things that I *haven’t* said) it seems to me that there is more than enough **hope** not only •to get a vigorous man to *try* but also to make a sober-minded and wise man *believe* ·that he will succeed·.

115. That completes what I wanted to say about getting rid of the pessimism that has been one of the most powerful factors delaying and hindering the progress of the sciences. I have also finished with the signs and causes of errors, of sluggishness and of the prevailing ignorance. ·I’ve said more about this than you might think·, because the more subtle causes—the ones that aren’t generally noticed or thought about—come under what I said about the ‘idols’ of the human mind.

And this should also bring to an end the part of my Great Fresh Start [see note in **31**] that is devoted to *rejection*, which I have carried out through three refutations:

- (1) the refutation of innate human reason left to itself [see Preface at page 1];
- (2) the refutation of demonstrations [see **44** and **69**];
- (3) the refutation of the accepted philosophical doctrines [see **60–62**].

I refuted these in the ·only· way I *could* do so, namely through signs and the evidence of causes. I couldn’t engage in any other kind of confutation because I differ from my opponents both on first principles and on rules of demonstration.

So now it is time to proceed to the actual techniques for interpreting nature and to the rules governing them—except that there is *still* something that has to be said first! In this first book of aphorisms my aim has been to prepare men’s minds not just for •*understanding* what was to follow but for •*accepting* it; and now that I have •cleared up and washed down and levelled the floor of the mind, I have to •get the mind into a good attitude towards the things I am laying before it—to *look kindly* on them, as it were. ·This has to be worked for·, because anything new will be confronted by prejudgments ·against it·, not only ones created by old opinions but also ones created by false ideas about what the

new thing is going to be. So I shall try to create sound and true opinions about what I am going to propose; but this is only a stop-gap expedient—a kind of security deposit—to serve until I can make the stuff itself thoroughly known.

116. First, then, don't think that I want to found a new sect in philosophy—like the ancient Greeks and like some moderns such as Telesio, Patrizzi or Severinus. For that's not what I am up to; and I really don't think that human welfare depends much on what abstract opinions anyone has about nature and its workings. No doubt many old theories of this sort can be revived and many new ones introduced, just as many theories of the heavens can be supposed that fit the phenomena well enough but differ from each other; but I'm not working on such useless speculative matters.

My purpose, rather, is to see whether I can't provide humanity's power and greatness with firmer foundations and greater scope. I have achieved some results—scattered through some special subjects—that I think to be far more true and certain and indeed more fruitful than any that have so far been used (I have collected them in the •fifth part of my Fresh Start); but I don't yet have a complete theory of everything to propound. It seems that the time hasn't come for that. I can't hope to live long enough to complete the •sixth part (which is to present science discovered through the proper interpretation of nature); but I'll be satisfied if in the middle parts I conduct myself soberly and usefully, sowing for future ages the seeds of a purer truth, and not shying away from the start of great things. [See note in **31**.]

117. Not being the founder of a sect, I am not handing out bribes or promises of particular works. You may indeed think that because I talk so much about 'works' or 'results' and drag everything over to *that*, I should produce some myself as a down-payment. Well, I have already clearly said it many

times, and am happy now to say it again: my project is not to get

works from works or
experiments from experiments (like the •empirics),
but rather to get
causes and axioms from works and experiments,
and then to get
new works and experiments from those causes and
axioms (like the •legitimate interpreters of nature).

[An 'empiric' is someone who is interested in *what* works but not in *why* it works; especially a physician of that sort, as referred to by Locke when he speaks of 'swallowing down opinions as silly people do empirics' pills, without knowing what they are made of or how they will work'.] If you look at

- my Tables of Discovery that ·will· constitute the fourth part of the Fresh Start, and
- the examples of particulars that I present in the second part, ·i.e. the present work·, and
- my observations on the history that I ·will· sketch in the third part,

you won't need any great intellectual skill to see indications and outlines of many fine results all through this material; but I openly admit that the natural history that I have so far acquired, from books and from my own investigations, is too skimpy, and not verified with enough accuracy, to serve the purposes of legitimate interpretation.

To anyone who is abler and better prepared ·than I am· for mechanical pursuits, and who is clever at getting results from experiment, I say: By all means go to work snipping off bits from my history and my tables and apply them to getting results—this could serve as *interest* until the *principal* is available. But I am hunting for bigger game, and I condemn all hasty and premature interruptions for such things as these, which are (as I often say) like Atalanta's spheres. I

don't go dashing off after golden apples, like a child; I bet everything on art's winning its race against nature. [On Atalanta and the race see 70.] I don't scurry around clearing out moss and weeds; I wait for the harvest when the crop is ripe.

118. When my history and Tables of Discovery are read, it will surely turn out that some things in the experiments themselves are not quite certain or perhaps even downright false, which may lead you to think that the foundations and principles on which my discoveries rest are also false and doubtful. But this doesn't matter, for such things are bound to happen at first. It's like a mere typographical error, which doesn't much hinder the reader because it is easy to correct as you read. In the same way, my natural history may contain many experiments that are false, but it won't take long for them to be easily expunged and rejected through the discovery of causes and axioms. It is nevertheless true that if big mistakes come thick and fast in a natural history, they can't possibly be corrected or amended through any stroke of intelligence or skill. Now, my natural history has been collected and tested with great diligence, strictness and almost *religious* care, yet there may be errors of detail tucked away in it; so what should be said of run-of-the-mill natural history, which is so careless and *easy* in comparison with mine? And what of the philosophy and sciences built on that kind of sand (or rather *quicksand*)? So no-one should be troubled by what I have said.

119. My history and experiments will contain many things that are

- trivial, familiar and ordinary, many that are
- mean and low [see 120], and many that are
- extremely subtle, merely speculative, and seemingly useless [see 121].

Such things could lead men to lose interest or to become

hostile to what I have to offer. I shall give these one paragraph each.

Men should bear in mind that until now *their* activities have consisted only in explaining unusual events in terms of more usual ones, and they have simply taken the usual ones for granted, not asking what explains *them*. So they haven't investigated the causes of

weight,
rotation of heavenly bodies,
heat,
cold,
light,
hardness,
softness,
rarity,
density,
liquidity,
solidity,
life,
lifelessness,
similarity,
dissimilarity,
organicness,

and the like. They have accepted these as self-evident and obvious, and have devoted their inquiring and quarrelling energies to less common and familiar things.

But I *have to* let the most ordinary things into my history, because I know that until we have properly looked for and found the causes of common things and the causes of those causes, we can't make judgments about uncommon or remarkable things, let alone bring anything new to light. Indeed, I don't think that anything holds up philosophy more than the fact that common and familiar events don't cause men to stop and think, but are received casually with no

inquiry into their causes. A result of this we need •to pay attention to things that are known and familiar at least as often as •to get information about unknown things.

120. As for things that are low or even filthy: as Pliny says, these should be introduced with an apology, but they should be admitted into natural history just as the most splendid and costly things should. And that doesn't pollute the natural history that admits them; the sun enters the sewer as well as the palace, but isn't polluted by that! I am not building a monument dedicated to human glory or erecting a pyramid in its honour; what I'm doing is to lay a foundation for a holy temple in the human intellect—a temple modelled on the world. So I follow that model, because whatever is worthy of *being* is worthy of *scientific knowledge*, which is the image or likeness of being; and low things *exist* just as splendid ones do. And another point: just as from certain putrid substances such as musk and civet the sweetest odours are sometimes generated, so also mean and sordid events sometimes give off excellent and informative light. That is enough about this; *more* than enough, because this sort of squeamishness is downright childish and effeminate.

121. The third objection must be looked into much more carefully. I mean the objection that many things in my history will strike ordinary folk, and indeed •non-ordinary• ones trained in the presently accepted systems, as intricately subtle and *useless*. It is especially because of this objection that I have said, and should •again• say, that in the initial stages •of the inquiry• I am aiming at experiments of light, not experiments of fruit [see 99]. In this, as I have often said [see 70], I am following the example of the divine creation which on the first day produced nothing but light, and gave that a day to itself without doing any work with matter. To suppose, therefore, that things like these •'subtleties'

of mine• are useless is the same as supposing that light is useless because it isn't a *thing*, isn't solid or material. And well-considered and well-delimited knowledge of simple natures is like light: it gives entrance to all the secrets of nature's workshop, and has the power to gather up and draw after it whole squadrons of works and floods of the finest axioms; yet there is hardly anything we can *do with it* just in itself. Similarly the •letters of the alphabet taken separately are useless and meaningless, yet they're the basic materials for the planning and composition of all discourse. So again the •seeds of things have much latent power, but nothing comes of it except in their development. And •light is like scientific subtleties in another way, namely: the scattered rays of light don't do any good unless they are made to converge.

If you object to speculative subtleties, what will you say about the schoolmen [= 'mediaeval and early modern Aristotelians'], who have wallowed in subtleties? And *their* subtleties were squandered on •words (or on popular notions—same thing!) rather than on •facts or nature; and they were useless the whole way through, unlike mine, which are indeed useless right now but which promise endless benefits later on. But this is sure, and you should know it:

All subtlety in disputations and other mental bustling about, if it occurs after the axioms have been discovered, comes too late and has things backwards. The true and proper time for subtlety, or anyway the chief time for it, is when pondering experiments and basing axioms on them.

For that other •later• subtlety grasps and snatches at [*capta*] nature but can never get a grip on [*capit*] it. . . .

A final remark about the lofty dismissal from natural history of everything •common, everything •low, everything

•subtle and as it stands useless: When a haughty monarch rejected a poor woman’s petition as unworthy thing and beneath his dignity, she said: ‘Then leave off being king.’ That may be taken as an oracle. For someone who won’t attend to things like •these because they are too paltry and minute can’t take possession of the kingdom of nature and can’t govern it.

122. This may occur to you: ‘It is amazing that you have the nerve to push aside all the sciences and all the authorities at a single blow, doing this single-handed, without bringing in anything from the ancients to help you in your battle and to guard your flanks.’

Well, I know that if I had been willing to be so dishonest, I could easily have found support and honour for my ideas by referring them either •to ancient times before the time of the Greeks (when natural science may have flourished more •than it did later•, though *quietly* because it hadn’t yet been run through the pipes and trumpets of the Greeks), or even, in part at least, •to some of the Greeks themselves. This would be like the men of no family who forge genealogical tables that ‘show’ them to come from a long line of nobility. But I am relying on the evidentness of •the truth about• things, and I’ll have nothing to do with any form of fiction or fakery. Anyway, it *doesn’t matter* for the business in hand whether the discoveries being made now •were known to the ancients long ago and •have alternately flourished and withered through the centuries because of the accidents of history (just as it doesn’t matter to mankind whether the New World is the island of Atlantis that the ancients knew about or rather is now discovered for the first time). It doesn’t matter because *discoveries*—even if they are *rediscoveries*—have to be sought [*petenda*] from the light of nature, not called back [*repetenda*] from the shadows of antiquity.

As for the fact that I am finding fault with everyone and everything: when you think about it you’ll see that *that* kind of censure is more likely to be right than a partial one would be—and less damaging, too. For a partial censure would imply that the errors were not rooted in primary notions, and that there had been some true discoveries; they could have been used to correct the false results, •and the people concerned would have been to blame for not seeing this•. But in fact the errors were fundamental; they came not so much from false judgment as from not attending to things that should be attended to; so it’s no wonder that men haven’t obtained what they haven’t tried for, haven’t reached a mark that they never set up, haven’t come to the end of a road that they never started on.

As for the insolence that •you might think• is inherent in what I am doing: if a man says that

•his steady hand and good eyes enable him to draw a straighter line or a more perfect circle than anyone else,

he is certainly •making a comparison of abilities; but if he says only that

•with the help of a ruler or a pair of compasses can draw a straighter line or a more perfect circle than anyone else can by eye and hand alone,

he isn’t •making any great boast. And I’m saying this not only about these first initiating efforts of mine but also about everyone who tackles these matters in the future. For my route to discovery in the sciences puts men on the same intellectual level, leaving little to individual excellence, because it does everything by the surest rules and demonstrations. So (I repeat) I attribute my part in all this to good luck rather than to ability—it’s a product of *time* rather than of *intelligence*. For luck certainly has something to do with men’s thoughts as well as with their works and deeds.

123. Someone once said jokingly ‘It can’t be that we think alike, when one drinks water and the other drinks wine’; and this nicely fits my present situation. Other men, in ancient as well as in modern times, have done their science drinking a crude liquor—like water

(1) flowing spontaneously from a spring or (2) hauled up by wheels from a well, (1) flowing spontaneously from the intellect or (2) hauled up by logic.

Whereas I drink a toast with a liquor strained from countless grapes, ripe and fully seasoned ones that have been gathered and picked in clusters, squeezed in the press, and finally purified and clarified in the vat. No wonder I am at odds with the others!

124. This also may occur to you: ‘You say it against others, but it can be said against you, that the goal and mark that you have set up for the sciences is not the true or the best.’ ‘The accusation would develop like this:’

Contemplation of *the truth* is a worthier and loftier thing than thinking about how *big and useful* one’s practical results will be. Linger long and anxiously on •experience and •matter and •the buzz of individual events drags the mind down to earth, or rather sinks it to an underworld of turmoil and confusion, dragging it away from a much more heavenly condition—the serene tranquillity of abstract wisdom.

Now I *agree* with this line of thought; what the objectors here point to as preferable is what I too am after, above everything else. For I am laying down in the human intellect the foundations for a *true model of the world*—the world as it turns out to be, not as one’s reason would like it to be. This can’t be done unless the world is subjected to a very diligent dissection and anatomical study. As for the stupid models of the world that men have dreamed up in

philosophical systems—like the work of *apes!*—they should be utterly scattered to the winds. You need to know what a big difference there is (as I said above [23]) between the •idols of the human mind and the •ideas in the divine mind. The former are merely arbitrary abstractions; the latter are the creator’s little seals on the things he has created, stamped into matter in true and exquisite lines. In these matters, therefore, truth and usefulness are the very same thing; and practical applications of scientific results are of greater value as pledges of truth than as contributing to the comforts of life.

125. Or you may want to say this: ‘You are only doing what the ancients did before you; so that you are likely, after all this grinding and shoving, to end up with one of the systems that prevailed in ancient times.’ The case for this goes as follows:

The ancients also provided at the outset of their speculations a great store and abundance of examples and particulars, sorted out and labelled in notebooks; then out of them they constructed their systems and techniques; and when after that they had checked out everything they published their results to the world with a scattering of examples for proof and illustration; but they saw no need to take the considerable trouble of publishing their working notes and details of experiments. So they did what builders do: after the house was built they removed the scaffolding and ladders out of sight.

I’m sure they did! But this objection (or misgiving, rather) will be easily answered by anyone who hasn’t completely forgotten what I have said above. The form of inquiry and discovery that the ancients used—they declared it openly, and it appears on the very face of their writings—was simply

this:

From a few examples and particulars (with some common notions thrown in, and perhaps some of the most popular accepted opinions). they rushed to the most general conclusions, the ·would-be· first principles of ·their· science. Taking the truth of *these* as fixed and immovable, they proceeded to derive from them—through intermediate propositions—lower-level conclusions out of which they built their system. Then if any new particulars and examples turned up that didn't fit their views, they either •subtly moulded them into their system by distinctions or explanations of their rules, or •coarsely got rid of them by ·tacking· exceptions ·onto their principles·. As for particulars that weren't in conflict ·with their views·, they laboured away through thick and thin to assign them causes in conformity with their principles.

But this wasn't the experimental natural history that was wanted; far from it. And anyway dashing off to the highest generalities ruined everything.

126. This will occur to you too: 'By forbidding men to announce principles and take them as established until they have arrived at the highest generalities in the right way through intermediate steps, you are inviting them to *suspend judgment*, bringing this whole affair down to Acatalepsy.' Not so. What I have in mind and am propounding is not Acatalepsy [from Greek, = 'the doctrine that nothing can be understood'] but rather Eucatalepsy [from Greek, = 'the provision of what is needed for things to be understood']. I don't •disparage the senses, I •serve them; I don't •ignore the intellect, I •regulate it. And it is surely better that we should

know everything that we need to know, while thinking that our knowledge doesn't get to the heart of things

than that we should

think our knowledge gets to the heart of things, while we don't yet know anything we need to know.

127. You may want to ask—just as a query, not an objection—whether I am talking only about natural philosophy, or whether instead I mean that the other sciences—logic, ethics and politics—should be conducted in my way. Well, I certainly mean what I have said to apply to them all. Just as •common logic (which rules things by syllogisms) extends beyond natural sciences to all sciences, so does •mine (which proceeds by induction) also embrace everything. I am constructing a history and table of discovery for

- anger, fear, shame, and the like; for
- matters political; and for
- the mental operations of memory, composition and division, judgment and the rest,

just as much as for

- heat and cold, light, vegetative growth and the like.

But my method of interpretation ·differs from the common logic in one important respect; my method·, after the history has been prepared and set in order, concerns itself not only with •the movements and activities of the mind (as the common logic does) but also with •the nature of things ·outside the mind·. I guide the mind so that its way of engaging with any particular thing is always appropriate. That's why my doctrine of interpretation contains many different instructions, fitting the discovery-method according to the quality and condition of the subject-matter of the inquiry.

128. 'Do you want to pull down and destroy the philosophy, arts and sciences that are now practised?' There ought to be no question about that. Far from wanting to destroy them, I am very willing to see them used, developed and

honoured. I don't want to get in the way of their •giving men something to dispute about, •supplying decoration for discourse, •providing the 'experts' with an income, and •facilitating civil life—acting, in short, like coins that have value because men agree to give it to them. Let me clear about this: what I am presenting won't be much use for purposes such as those, since it can't be brought within reach of the minds of the vulgar except ·indirectly·, through effects and works. My published writings, especially my *Two Books on the Advancement of Learning*, show well enough the sincerity of my declaration of friendly good will toward the accepted sciences, so I shan't expend more words on that topic here. Meanwhile I give clear and constant warning that the methods now in use won't lead to any great progress in the theoretical parts of the sciences, and won't produce much in the way of applied-science results either.

129. All that remains for me to say are a few words about the excellence of the end in view. If I had said them earlier they might have seemed like mere *prayers*; but perhaps they'll have greater weight now, when hopes have been created and unfair prejudices removed. I wouldn't have said them even now if I had done the whole job myself, not calling on anyone else to help with the work, because ·words said in praise of the object of this exercise· might be taken as a proclamation of my own deserts. But ·I'm not going it alone·; I do want to energize others and kindle their zeal, so it is appropriate that I put men in mind of some things, ·even at the risk of seeming to boast·.

The making of great ·scientific· discoveries seems to have pride of place among human actions. That was the attitude of the ancients: they honoured the makers of discoveries as though they were *gods*, but didn't go higher than *demigods* in their honours for those who did good service in the state

(founders of cities and empires, legislators, saviours of their country from long endured evils, quellers of tyrannies, and the like). And if you think accurately about the two ·kinds of benefactor· you will see that the ancients were right about them. Why? **(1)** Because the benefits of ·scientific· discoveries can •extend to the whole of mankind, and can •last for all time, whereas civil benefits •apply only to particular places and •don't last for very long.

(2) Also, improvements in civil matters usually bring violence and confusion with them, whereas ·scientific· discoveries bring delight, and confer benefits without causing harm or sorrow to anyone.

·Scientific· discoveries are like new creations, imitations of God's works. . . . It seems to be worth noting that Solomon, the marvel of the world, though mighty in empire and in gold, in the magnificence of his works, his court, his household, his fleet, and the lustre of his name, didn't glory in any of these, but pronounced that 'It is the glory of God to conceal a thing; but the honour of kings is to search out a matter' (*Proverbs 25:2*).

If you compare how men live in the most civilized provinces of Europe with how they live in the wildest and most barbarous areas of the American continent, you will think the difference is big enough—the difference in •the condition of the people in themselves as well as in •what conveniences and comforts they have available to them—to justify the saying that 'man is a god to man'. And this difference doesn't come from the Europeans' having better soil, a better climate, or better physiques, but from the arts [see note on 'art' on page 1].

Notice the *vigour* of discoveries, their power to generate consequences. This is nowhere more obvious than in three discoveries that the ancients didn't know and whose origins (all quite recent) were obscure and humdrum. I am talking

about the arts of •printing, •gunpowder, and •the nautical compass. These three have changed the whole aspect and state of things throughout the world—the first in literature, the second in warfare, the third in navigation—bringing about countless changes; so that there seems to have been no empire, no philosophical system, no star that has exerted greater power and influence in human affairs than these mechanical discoveries.

For my next point, I need to distinguish the three kinds—three *levels*, as it were—of human ambition. **(1)** Some people want to extend their power within their own country, which is a commonplace and inferior kind of ambition. **(2)** Some work to extend the power and dominion of their country in relation to mankind in general; this is certainly not as base as **(1)** is, but it is just as much a case of greed. **(3)** If a man tries to get mankind's power and control over the universe off to a fresh start, and to extend it, *his* ambition (if it is ambition at all) is certainly more wholesome and noble than the other two. Now—this being the point I wanted to make—man's control over things depends wholly on the arts and sciences, for we can't command nature except by obeying her.

A further point: it sometimes happens that •one particular discovery is so useful to mankind that the person who made it and thus put the whole human race into his debt is regarded as superhuman; so how much higher a thing it is to discover something through which •everything else can easily be discovered! •Not that a discovery's consequences are the main thing about it. *Light* is useful in countless ways, enabling us to walk, practise our arts, read, recognize one another, and yet something that is finer and lovelier than all those uses of light is *seeing light*. Similarly, merely contemplating things as they are, without superstition or imposture, error or confusion, is in itself worthier than all

the practical upshots of discoveries.

Final point: If anyone counts it against the arts and sciences that they can be debased for purposes of wickedness, luxury, and the like, don't be influenced by that. The same can be said of all earthly goods: intelligence, courage, strength, beauty, wealth—even *light*! Just let the human race get back the right over nature that God gave to it, and give it scope; how it is put into practice will be governed by sound reason and true religion.

130. The time has come for me to present the art of interpreting nature—the art itself, •not just remarks about the need for it, its virtues, and so on. Although I think I have given true and most useful precepts in it, I don't say that this art is absolutely necessary, implying that nothing could be done without it. In fact, I think that if

•men had ready at hand a sound history of nature and of experiments, •were thoroughly practised in it, and •imposed on themselves two rules: **(1)** set aside generally accepted opinions and notions, and **(2)** for a while keep your mind away from the highest and second-to-highest generalizations,

they would arrive at my form of interpretation sheerly through their own natural intelligence, with no help from any other rules or techniques. For interpretation is the true and natural work of the mind when it is freed from blockages. It is true, however, that it can all be done more readily and securely with help from my precepts.

And I don't say, either, that my art of interpreting nature is complete so that nothing can be added to it. On the contrary: I am concerned with the mind not only in respect of its own capacities but also in respect of how it engages with things; so I have to think that the art of discovery can develop as more discoveries are made.