

The Excellence of Theology, compared with Natural Philosophy

Discoursed of in a letter to a friend

Robert Boyle

1674

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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. Every 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. Unnumbered subsection-headings are not in the original. —This version rather radically alters much of Boyle’s wording. **See *The Excellencies of Robert Boyle*, edited by J.J.MacIntosh (Broadview Press, 2008), for a *much* more lightly edited version and for a superb apparatus of explanatory notes, including all the biblical references that are omitted here.** —Boyle has a Latin epigraph to the work, meaning: ‘Philosophers search for happiness, theologians find it, but only the sincerely religious possess it.’

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Glossary

adore, adorable: Worship, worthy of being worshipped.

agenda: Things requiring to be done.

antiperistasis: Resistance or reaction aroused—according to Aristotelian physics—by the action of an opposite force or quality.

arbitrary: In early modern uses, this means ‘chosen’, resulting from someone’s decision, or the like. There’s no implication that there weren’t good reasons for the choice.

canonical: The ‘single volume of canonical Scripture’ is the officially recognised Bible.

compare: On page ?? comparing prophecies with the natural world is just aligning them in one’s mind to see how they relate; there may be no question of their being alike.

couched: For something to be ‘couched’ in a biblical text is for it to be somewhat hidden or buried there, not so thoroughly that it cannot be discovered.

credenda: Things requiring to be believed.

curious, curiosity: In the present work these words are used wholly favourably. They refer to the spirit of scientific or theological inquiry, the desire to *know more*.

featureless matter: Replacing Boyle’s ‘adiaphorous matter’, this means ‘matter that has no qualities except size, shape and motion’.

gross: On page ??, ‘gross’ bodies are lumpy visible ones like pebbles and human bodies, ‘spirituous’ bodies are very finely divided, like air.

intellectual: On page ?? the ‘three intellectual communities’ are the three groups of creatures—humans, good angels, bad angels—that can think.

justification: The justification of humans towards God is their being freed from the penalty of sin and accounted righteous by God.

moral certainty: A degree of certainty that is high enough for practical purposes, high enough to make practical doubt unreasonable. (In this phrase ‘moral’ is being used in its old sense of ‘having to do with human behaviour’.

naturalist: Natural scientist, suggesting physics and chemistry rather than (as in today’s sense of the word) biology.

patience: On page ?? and perhaps a few other places it means ‘ability to put up with hardship without losing one’s equanimity’.

pathetic: This is used on page ?? in its old sense of ‘producing an effect on the emotions’.

philosophy: In early modern times this was standardly used to cover natural science as well as what counts as philosophy these days; similarly ‘philosopher’; sometimes with the adjective ‘natural’.

Physeophilus: It means ‘lover of nature’. Boyle uses it once in the Preface as a general term, then on page ?? and in Part II chapter 5 as a *name* for the person otherwise referred to as ‘your friend’ or ‘Mr N.’.

physiology: The study of nature, especially physics.

satisfaction: On page ?? this refers to Christ’s atonement for the world’s sins by his suffering.

supralapsarian: Someone who holds that God’s decision to choose only some for everlasting life was made before the creation and the fall.

virtuoso: In the present work a virtuoso is someone who is intelligently dedicated to practical and theoretical work in the natural sciences.

vulgar: Commonplace, run-of-the-mill, drearily ordinary.

wit: High intelligence; a person possessed of high intelligence.

Part II

Comparing the advantages of natural philosophy and theology

1. The delights and drawbacks of natural philosophy

Preliminaries

I shall without preamble begin this part of the work by considering the delightfulness of physics as the main thing that seduces your friend and various other virtuosi away from relishing—as they *ought*, and otherwise *would*—the pleasantness of theological discoveries. And to be open with you I shall not scruple to acknowledge that although my courting of nature has lasted several years and has been laborious enough and not inexpensive, I have been pleased enough with the favours (such as they are) that nature has from time to time granted me not to complain of having been unpleasantly employed. But though I readily admit that the attainments of naturalists can give philosophical souls sincerer pleasures than those that the more undiscerning part of mankind is so fond of, I must not therefore accept that they surpass—or even that they *equal*—the contentment that can come to a soul qualified by religion to get the best enjoyment from some kind of theological contemplations.

I presume that this will sufficiently appear if I show you in the first subsection that the study of physiology [see Glossary] is attended with considerable inconveniences, and in the second and third subsections that the pleasantness of it can be enjoyed with endearing circumstances by a person who is *also* studious of divinity.

But before I name any of the particular reasons that I am

to present, I'm afraid I need to interpose a few words—one long paragraph—to block a mistake which, if not prevented, may lead to a misunderstanding not only of this section but of a great deal of Part II. I know that it may be said that whereas I allege various things to lessen the delightfulness of the study of physics, and to depreciate some other advantages by which the following sections would recommend it, some of the same things may be objected against the delightfulness of the study of divinity. But I presume that this objection will not much move you if you consider the argument and scope of the two Parts of this letter. For I have shown by positive proofs in Part I that the study of theology is accompanied by various advantages, some belonging to it and to nothing else, and some belonging to it much more than to anything else. And now I come to consider in Part II whether what is alleged on behalf of the study of philosophy deserves to counter-balance those prerogatives or advantages. So I do not need, and do not intend, to compare (for instance) the delightfulness of the two studies, theology and physics; my aim is only to weaken the argument that is drawn from the delightfulness of physics to conclude that it is preferable to the study of theology—weakening it by showing the inconveniences that are mixed in with the delightfulness of physics. So that my work in this and the following sections is not so much to institute comparisons as to block or answer allegations. Because I have in Part I based the excellence of the study of divinity chiefly on the great advantages that are exclusive to it, my reasonings would not be frustrated if it appeared that in respect of

•delightfulness, •certainty, etc. that study was in many cases open to the same objections as the study of nature, because I recommended divinity not mainly for •those qualities but for other excellences that are exclusive to it. Thus, even if the delightfulness etc. of theology and of physics were weakened by the same or equal inconveniences or imperfections, that would not stop the scales from being swayed in favour of divinity, because of the advantages that are unquestioned and that belong exclusively to it. I do not know whether I need add this: You are not to expect me to give philosophy the wounds of an enemy. My aim is not to discourage you or any able man from

- courting it at all, or from
- courting it much, but from
- courting it too much, and despising divinity for it.

So I employ against it not a **sword** to wound it but a **balance** to show that its excellences, though solid and weighty, are less so than the preponderating ones of theology. And this attitude and purpose of mine makes my task difficult enough to have perhaps some *right to* your pardon—as well as some *need for* it—if I do not everywhere steer so exactly as to avoid ·on one side· injuring the cause I am to plead for and ·on the other· disparaging a study that I am so far from depreciating that I allow it a great part of my inclinations and not a little share of my time. Having said this to keep the design of this work from being misunderstood, I hope we may now proceed to the particulars whose scope I have been declaring.

The laboriousness of true physics

Returning then to what I was about to say before this long but needed preliminary explanation interrupted me, I shall resume my discussion of the delightfulness of the study of physics, about which I was going in the first place to tell you

that I know you and your friend will freely grant me that the knowledge of the empty and barren physiology that is taught in the schools demands not much trouble to be acquired and provides little satisfaction when attained. And as I know you will give me leave to say this, so I shall take leave to say also—being warranted by considerable experience of my own—that **(1)** the study of the experimental philosophy of which your friend is so much enamoured is, if done properly, a very troublesome and laborious employment. To mention just one aspect of this: the great variety of objects that the naturalist is obliged—not only by his curiosity but also by their secret dependences on one another—to *consider* and to *handle* in various ways will involve him in needing and consequently hiring such a variety of mechanic people (as distillers, drugsters, tinsmiths, lathe-operators etc.) that a great part of his time and perhaps all his patience will be spent in waiting on tradesmen,

the next phrase: and repairing the losses he sustains by their disappointments,

presumably meaning: fixing the experimental apparatus after they have botched it,

which is a drudgery greater than can be imagined by anyone who has not experienced it, and which—being as inevitable as it is unwelcome—very much counter-balances and weakens the delightfulness of the study I am discussing, in which so great a part of a man's care and time must be laid out in providing the apparatuses necessary for conducting experiments.

(2) But this is not all. For when you have brought an experiment to a result, though the outcome may often be one you are pleased with, it will seldom prove to be one you can acquiesce in. For the experience of an inquisitive mind studying the book of nature is not like that of someone

reading Aesop's *Fables* or some other collection of assorted moral tales that are independent of one another, where

when you have read as many at one time as you think fit you may leave off when you please and go away with the pleasure of understanding those you have read, without being solicited by any troublesome itch of curiosity to read the rest, as though they were needed for the better understanding of the ones already read, which can hardly be explained without them.

In the book of nature, as in a well-constructed work of fiction, the parts are so connected and inter-related, and the things we want to know are so darkly or incompletely knowable through those that precede them, that the mind is never satisfied till it comes to the end of the book. Until then everything that is discovered in one's progress through the book is unable to keep the mind from being molested with impatience to find what is still concealed, which will not be known till one does at least make some further progress. Whereas the full discovery of *nature's* mysteries is so unlikely to fall to any man's share in this life that the situation of the pursuers of them is at best like that of someone who comes across some excellent romance of which he will never see the later parts. For indeed (to speak now without a simile) there is such a relation between natural bodies—they can in so many ways (and many of them unobserved) affect or be affected by one another—that someone who makes a new experiment or discovers a new phenomenon must not immediately think that he has discovered a new truth or detected an old error. If he is a considering man, he will often find reason to wonder whether the experiment or observation has been so skillfully and warily made in every detail as to provide him with such an account of the matter of fact as a severe naturalist would desire. And even if the historical part—the matter-of-fact account of what actually happened

in that experiment—is in no way defective, there are many other cases in which many different agents may produce the exhibited phenomenon or have a great influence on the experiment or observation; so many of them that anyone to whom experiments do not often •suggest new doubts as much as •present new phenomena must be less vigilant than is appropriate for a philosopher.

(3) And even the trials that end in real discoveries do—because of the connection of physical truths and the relations that natural bodies have to one another—give such hopes and such desires of applying what we have already learned to •solving other difficulties or •making further discoveries that an inquisitive naturalist finds his work to increase daily on his hands, and the outcome of his past labours, whether it be good or bad, only engages him in new ones, either to (2) free himself from his scruples or (3) improve his successes.

So that although the pleasure of making physical discoveries is in itself very great, it is considerably impaired by the fact that the same attempts which provide that delight also frequently create both (2) anxious doubts and (3) a disquieting curiosity. So that if knowledge is as some philosophers have styled it the food of the rational soul, I fear I may too truly say that the naturalist usually has to live on salads and sauces, which though they yield some nourishment arouse more appetite than they satisfy. They give us indeed the pleasure of eating with a good stomach, but then force us always to rise hungry from the table.

Of various things that lessen the delightfulness of physiological studies I have written at such length in other papers that I might well refer you to them; but indeed it is not necessary that I should insist on this argument any further. It is true that such a reference might be very proper if theology related to physics as it does to necromancy or some other part of unlawful magic, where theology could

not be enjoyed without an abhorrence of the other. But as the two great books—of nature and of Scripture—have the same author, the study of the latter does not at all hinder an inquisitive man's delight in the study of the former. The doctor I am pleading for [see pages ?? and ??] may enjoy a physical discovery as much as Physeophilus does; indeed, by being devoted to theology and religion he is so far from being incapable of the contentments arising from the study of nature that beside the things that recommend it to others there are several things that endear it to him in particular. I shall describe two of them.

Things are better for a devout Christian physicist (1)

He has the contentment to look on the wonders of nature not only as the productions of an admirably wise author of things but of one he entirely honours and loves, and *to whom he is related*. Someone who reads an excellent book or sees some rare piece of machinery will be otherwise affected by the reading or the seeing if he knows it to have been made by a friend or a relative than if he considers it only as made by a stranger whom he has no particular reason to be concerned for. And if Rehoboam did not fall away from the sentiments of mankind as well as from his family he could not help looking on that magnificent temple of Solomon differently from the throngs of strangers who came only to gaze at it as an admirable piece of architecture, while he considered that it was his father who built it. And if (as we see)

the same heroic actions that we read in history of some great monarch, which strangers barely and unconcernedly admire, the natives of his country not only venerate but affectionately interest themselves in because they are his countrymen and their ancestors were his subjects,

how much may we suppose the same actions would affect them if they had the honour to be that prince's children? So we may well presume that it is with a singular satisfaction that the contemplator of nature whom I am speaking of discovers in all the wonders of nature how wise, potent, and bountiful the author of nature is—the author in whom he has a great interest, such a great one that he is admitted into the number of his friends and adopted into the number of his sons, and is thereby to some extent concerned in all the admirations and praises that are paid by himself or by others to the adorable [see Glossary] attributes that God has displayed in that great masterpiece of power and wisdom, the world. And when he makes greater discoveries in these expressions and adumbrations [= 'faint indications'] of the divine perfections, the delightfulness of his contemplation is proportionally increased for a reason like

that which endears to the passionate lover of some charming beauty an especially fine picture of her; because that the same things that •make him (like other viewers) look on it as a finer piece also •make him look on it as the more like his mistress, and thereby •entertain him with sublimer ideas of the beloved original, to whose transcendent excellences he supposes that the noblest representations must be the most resembling.

Things are better for a devout Christian physicist (2)

And there is a further reason why our contemplator should find a great deal of contentment in these discoveries. For we have in our nature so much imperfection, and yet so much inclination to self-love, that we too confidently proportion our ideas of what God can do for us to what we have already the knowledge or the possession of. And although when we

set ourselves to it we are able with much fuss and trouble to enlarge somewhat our apprehensions and raise our expectations beyond their usual level, they will not be much promoted and heightened if the things we are satisfied with surpassing are themselves mean and ordinary. A country villager, born and bred in a homely cottage, cannot have any suitable idea of the pleasures and magnificence of a great monarch's court. And if he should be asked to screw up his imagination to form ideas of them, they would be borrowed from the best tiled house he had seen in the market-towns where he had sold his turnips or corn, and the wedding-feast of some neighbouring farmer's daughter. A child in the mother's womb, even if it had the perfect use of reason, could not in that dark cell have any ideas of the sun or moon, or beauties or banquets, or algebra or chemistry, and many other things that his older brothers—who breathe fresh air, freely behold the light, and are in a more mature estate—are capable of knowing and enjoying. Now, among thinking men whose thoughts run much upon the future state that they must shortly enter into but shall never pass out of there will frequently and naturally arise a suspicion which, though seldom admitted to, often proves disquieting enough. Such men are apt to question how the future condition that the gospel promises can provide them with as much happiness as it claims to, because they in heaven will only contemplate the works of God, and praise him, and converse with him, all of which they think can—though not immediately—be done by men here below without being happy. But he who by telescopes and microscopes, dexterous dissections, and well employed furnaces etc. discovers the wondrous power and skill of him who built such a vast and immense mass of matter into such an intricate piece of workmanship as this world will pleasingly be convinced of the boundless power and goodness of the great Architect. And when he sees and

considers

how admirably every animal is equipped with the parts required for its individual nature, and that particular care is taken that a single animal (e.g. a man) has differing provisions made for him according to his differing states within the womb and out of it—a human egg and an embryo being otherwise nourished and fitted for action than is a (complete) man—

and observes the stupendous providence and excellent contrivances that the curious piers into nature (and only they) can discover, he will be able to, and invited to, reason thus within himself [the reasoning runs to the end of this paragraph]: God

(a) who has with such admirable artifice formed silkworms, butterflies, and other insects, and with such wonderful providence made sure that the nobler animals should also not lack anything required for completing their natures, and

(b) who can when he pleases provide some things with properties quite different from those that the knowledge of his other works could have made us imagine (e.g. the lodestone and quicksilver among minerals, the sensitive plant among vegetables, the chameleon among animals),

must surely be (a) fully able to provide those he delights to honour with objects suitable to their improved faculties and with all that is required for the happiness he intends them to have in their glorified state; and be (b) able to bring this about by amazing contrivances that perhaps will be quite unlike any that the things we have yet seen give us any ideas of. And he who has in so immense, intricate and magnificent a fabric made provision for men,

who are at best only very imperfectly good, and in a state where they are not to *enjoy* happiness but by obedience and sufferings to *fit themselves* for it,

can, surely, be safely be trusted to find for them in heaven employments and delights suitable for the felicity he intends them to have there; as we see that here below he provides as well for the soaring eagle as for the creeping caterpillar (and can keep the ocean as fully supplied with rivers as lakes or ponds are with springs and brooks).

And as a state of celestial happiness is so great a blessing that things that give us greater assurances or greater foretastes of it are among the greatest contentments and advantages we can enjoy, short of that blessing itself; so it is hard for any divine to receive as much of this kind of satisfaction as someone who by skillfully looking into the wonders of nature has his apprehensions of God's 'power and manifold wisdom' (as an apostle calls it) elevated and enlarged. As when the queen of Sheba had seen in detail the astonishing prudence that Solomon displayed in the ordering of his magnificent court, she rapturously concluded that the servants of his who were allowed the honour and privilege of constant and immediate attendance on him were happy enough to deserve a monarch's envy.

2. Practical goods resulting from natural philosophy and from theology

No doubt you have too good an opinion of your friend not to think that you can allege in his favour that what mainly makes him prefer physiology to all other kind of knowledge is that it enables those who are proficient in it to do a great deal of good, both by improving trades and by promoting physic [here = 'medical practice'] itself. I . . . do not deny that it can assist a man to advance physic and trades, or that in so doing he may highly advantage mankind. And this I (who want not to lessen your friend's esteem for physics but only his partiality) willingly acknowledge to be such a permissible

endearment of experimental philosophy that I do not know anything that ought more to recommend the study of nature to men of a human as well as a decent disposition—except the opportunity it gives men to be just and grateful to the author of nature and of man. So I do not deny that the true naturalist may very much benefit mankind; but I affirm that if men are not untrue to themselves the divine may benefit them much more.

Two routes to better bodily health

It may be appropriate and relevant for me to tell you on this occasion that •someone who effectively teaches men to subdue their lusts and passions contributes as much as •the physician does to the preservation of their bodies, by freeing them from

those vices whose usual effects are wars, duels, rapines, desolations, as well as the pox, surfeits, and all the train of other diseases that accompany gluttony and drunkenness, idleness and lust; which are enemies to man's life and health not merely on a physical account but on a moral one, because they provoke God to punish them with temporal as well as spiritual judgments, such as plagues, wars, famines and other public calamities that sweep away a great part of mankind;

as well as from

those personal afflictions of bodily sickness and disquiets of conscience that shorten men's lives, and embitter them.

Because piety has (as the Scripture assures us) promises both for this life and for the life to come, those teachers who make men virtuous and religious, thereby making them temperate, chaste, inoffensive, calm, and contented, not only

•provide them with great and excellent dispositions to those blessings, both of the right hand and of the left,¹ which God's goodness makes him eager to bestow on those who by grace and virtue are made fit to receive them, but also •help them to the qualifications which lengthen and sweeten their lives by preserving the mind in a calm and cheerful temper, as well as by providing the body with everything that temperance can confer. I repeat that it would not be irrelevant to insist on these things, but I choose instead to represent to you that the benefits men may receive from the •divine surpass those they receive from the •naturalist, both in the nobleness of the advantages and in their duration.

Be it granted then that the naturalist may much improve both physic and trades; but these were devised for the service of the body (one to preserve or restore its health, the other to provide it with conveniences or delights), so the boasted use of natural philosophy—its advancing trades and physic—will still be to serve the body; which is merely the lodging and instrument of the soul, and which I am sure you—and I presume your friend—will be far from thinking the noblest part of man.

Minor brief advantages versus major durable ones

I know it may be said—and I do not deny it—that various mechanical arts are highly beneficial, not only to the inventors but also to the places and perhaps the states where such improvements are found out and cherished. But though I most willingly grant that this consideration ought to recommend experimental philosophy to states as well as to private persons, there are four considerations that detract somewhat from this. (a) Many of these improvements transfer rather

than increase mankind's goods, and harm one group of men as much as they advantage another (as when the Portuguese and Dutch by their later navigations took over the trade in the eastern spices, depriving the Venetians of it). (b) Or they merely increase something which, though very beneficial to the producers, is not really so to mankind in general. We have an example of that in the invention of extracting gold and silver out of the ore with mercury. This has vastly enriched the Spaniards in the West Indies, but it is not of any solid advantage to the world; any more than is the discovery of the Peruvian and other American mines, by which (especially taking account of the multitudes of unhappy men who are made miserable and destroyed in working them) mankind is not put into a better condition than it was before. And if the philosopher's stone itself (supposing there were such a thing) were not an incomparable medicine but only something that could transmute other metals into gold, I doubt whether the discoverer of it would much advantage mankind, because there is already enough gold and silver to maintain •trade and commerce among men; and for all •other purposes I do not know why an abundance of iron, brass, and quicksilver—far more useful metals—should not be more desirable. (c) These advancements of enriching trades bring advantages only to the •outward man, and the many arts and inventions that aim at the heightening the pleasures of the senses belong only to the •body; and even in gratifying *that* they are not so requisite and important as many suppose, because education, custom, etc. have a greater role than most imagine in men's enjoyment even of the pleasures of the senses. As for physic, not to remind you that it has been loudly. . . .complained of that the new philosophy has made far greater promises to it than have yet been

¹ [This echoes Proverbs 3:16, which says of wisdom 'Length of days is in her right hand; and in her left hand riches and honour.']

performed, I shall only point out that since physic usually claims only to preserve health or to restore it, there are multitudes in the world who have no need of the assistance the naturalist would give the physician. A healthy man, as such, is already in a better condition than the philosopher can hope to place him in, and is no more advantaged by the naturalist's contribution to physic than a sound man who sleeps in a whole skin is helped by all the fine tools of a surgeon's case of instruments and the various mixtures in his medicine-chest.

And just as the benefits that may be derived from theology much surpass those that come from physics in the nobleness of the subject they relate to, so also they have a great advantage in point of duration. **(d)** All the service that medicines and engines and improvements can do for a man relate only to this life and therefore end with it. Physic and chemistry do indeed—one more faintly, the other more boldly—claim sometimes not only to cure diseases but to prolong life; but of course the masters of those parts of knowledge would employ their utmost skill to protract their own lives, yet Solomon and Helmont lived no longer than millions who were strangers to philosophy; and even Paracelsus himself, for all his boasted 'arcana', is confessed by Helmont and other chemists to have died some years short of 50; so we may very justly fear that nature will not be so kind to its greatest devotees as to give them much more time than other men for the payment of the last debt all men owe her. And if a few further years of life could be obtained by a scrupulous and troublesome use of diet and remedies, that is not at all considerable in comparison with the eternity that is to follow. But whereas

- within no great number of years. . . all the remedies and reliefs and pleasures and accommodations that philosophical improvements can provide to a man will

not keep him from the grave (which within very few days will make the body of the greatest virtuoso as hideous a carcass as that of any ordinary man),

- the benefits that may come to us through the study of divinity, as they relate chiefly (though not only) to the other world, so they will follow us out of this world and prove then incomparably greater than ever, when they alone can be enjoyed.

So that philosophy, in the capacity we are here considering it, merely provides us with some little conveniences for our passage (like some accommodations for a cabin which does not out-last the voyage), whereas religion provides us with a vast and durable estate—or as the Scripture styles it, an 'unshaken kingdom'—when we arrive at our journey's end. And therefore the benefits coming from religion may well be concluded to be preferable to their competitors because they not only reach to the mind of man but reach beyond the end of time itself; whereas all the variety of inventions that philosophy so much boasts of, because they were (while they were in season) devised for the service of the body, they make us busy with and proud of things that within a short time will not. . . at all concern us.

3. The supposed certainty and clearness of physics versus the darkness and uncertainty of theological matters

I expect you will here urge on your friend's behalf that the study of physics has one prerogative above that of divinity, which, as it is otherwise a great excellence, adds much to the delightfulness of it. I mean the certainty and clearness—and the resulting satisfactoriness—of our knowledge of physical matters, in comparison with any we can have of theological matters, whose darkness and uncertainty are sufficiently

shown by •the nature of the things themselves and •the numerous controversies of differing sects about them.

But on this subject various things are to be considered.

First, as to the fundamental and necessary articles of religion, I do not admit the allegation; I take those articles to be both •evident and capable of a moral [here = ‘utterly convincing’] demonstration. And if there are any articles of religion for which a rational and compelling proof cannot be brought, I shall for that very reason conclude that such articles are not absolutely necessary to be believed; because it seems entirely unreasonable to imagine that God,

having been pleased to send not only his prophets and his apostles but his only son into the world to promulgate the Christian religion to mankind, and both •to cause it to be consigned to writing so that it may be known, and •to alter the course of nature by numerous miracles so that it might be believed,

should not present the truths that he in so wonderful and so solemn a manner recommended, with at least enough clearness for studious and well-disposed readers to grasp such as of them are necessary for them to believe.

Secondly, though I will not here enter into a discussion of the various kinds (or, if you please, *degrees*) of demonstration. . . ., I must tell you that just as a moral certainty [see Glossary] (such as we may attain about the fundamentals of religion) is enough in many cases for a wise man and even a philosopher to acquiesce in, so the physical certainty that is claimed for the truths demonstrated by naturalists is, even where it is rightfully claimed, only an inferior kind or degree of certainty, as moral certainty also is. For even physical demonstrations can generate only

•a physical certainty, i.e. a certainty on the supposition that the principles of physics are true, and not

•a metaphysical certainty, in which it is absolutely impossible that the thing believed should be other than true.

For instance, all the physical demonstrations of the ancients about the causes of particular phenomena of bodies presuppose that *ex nihilo nihil fit*—i.e. that nothing comes from nothing—and this may readily be accepted in a physical sense, because according to the course of nature no body can be produced out of nothing; but speaking universally it may be false, as Christians generally (and even the Cartesian naturalists) asserting the creation of the world must believe that *de facto* it is. And so whereas Epicurus does, I remember, prove that a body once dead cannot be made alive again because of the dissipation and dispersal of the atoms it was composed of when alive, though all men will allow this assertion to be physically demonstrable its contrary may be true if God’s omnipotence intervenes,

•as all the philosophers who acknowledge the authority of the New Testament, where Lazarus and others are recorded to have been raised from the dead, must believe actually did happen, and
•all unprejudiced reasoners must allow it to be possible, because there is no contradiction implied in the nature of the thing.

But now to affirm that *things that are indeed contradictories cannot be both true*, or that *what has been done cannot be undone*, are metaphysical truths which cannot possibly be other than true, and consequently create a metaphysical and absolute certainty. And your master Descartes was so conscious of the dependence of •physical demonstrations on metaphysical truths that he would not allow any certainty to •them or even to geometrical demonstrations until he had shown that there is a God and that he cannot deceive men who make use of their faculties rightly.

Don't confuse high probability with absolute certainty

To which I may add that even in many things that are looked on as physical demonstrations there is really only moral certainty. For instance, when Descartes and other modern philosophers undertake to demonstrate that there are various comets that are not meteors because they have a parallax less than that of the moon, and are of such-and-such a size, and some of them move in such-and-such a line, etc. it is clear that many of these learned men had never the opportunity to observe a comet in their lives, and take these details on the credit of the astronomers who did have such opportunities. And though the *inferences* as such may have •demonstrable certainty, the premises they are drawn from have only •historical certainty; so the presumed physico-mathematical demonstration cannot produce in an intellectually cautious mind anything but moral certainty, and not even the greatest certainty of that kind that is possible to be attained. This will be readily agreed to by anyone who knows from experience how much harder it is than most men imagine to make observations about such nice subjects—i.e. subjects requiring or involving so much precision, accuracy, or minuteness—with the exactness that is required for building an undoubted theory on them. And there are I don't know how many things in physics that men presume they believe on physical and compelling arguments where they really have only a moral assurance. . . . I have been invited to take more particular notice of these things in other papers, written purposely to show the doubtfulness and incompleteness of natural philosophy; and since they are available I do not hesitate to refer you to those papers of mine for my reasons for affirming here that most virtuosi—most even of the modern ones—are apt to fancy more clearness and certainty in their physical theories than

a critical examiner will find in them. But so that you won't see this as a put-off rather than a reference, I will here touch on two subjects that men usually believe to be—and that indeed *ought* to be—the most thoroughly understood: •the nature of body in general and •the nature of sensation.

We don't know whether matter is infinitely divisible

Whichever way we turn, we are everywhere surrounded and incessantly touched by corporeal substances; so one would think that so familiar an object,

which so busily and variously affects our senses, and for the knowledge of which we need not inquire into the distinct nature of particular bodies or into the properties of any one of them,

should be very perfectly known to us. And yet the notion of *body in general*, i.e. what it is that makes a thing to be a corporeal substance and discriminates it from all other things, has been very hotly disputed over, even among the modern philosophers, and it is still *sub judice*. And though your favourite Descartes, in making the nature of a body consist in extension in three dimensions, has a notion of it that is easier to find fault with than to replace by something better, I fear it will appear to bring with it not only the inconvenience of implying that

God cannot, within the compass of this world in which if any body vanishes into nothing, the place or space left behind it must have the three dimensions and so be a true body

annihilate the least particle of matter without at the same instant and place creating as much—which does not square with the necessary and continual dependance that he asserts that matter itself has on God for its very being—

but such other inconveniences that some friends of yours, otherwise very inclinable to the Cartesian philosophy, do not know how to accept it. Yet I need not tell you how fundamental a notion the deviser of it asserts it to be.

Neither do I see how this ·Cartesian· notion of a corporeal substance will—any more than any of the formerly received definitions of it—extricate us from the difficulties of the controversy about *the composition of the continuum*, a controversy as perplexed as it is famous. And though

some able men who perhaps perceive better than others how intricate it is have recently tried to show that men need not be concerned to settle this controversy because the question was not rightly posed by the schoolmen who started it,

and though

I think that natural philosophy may perhaps be daily advanced without settling this question, because there is a multitude of considerable things to be discovered and performed in nature without so much as dreaming of this controversy,

until the difficulties are removed they will spread a thick night over the notion of *body in general*—I mean the difficulties raised by the question as I would pose it.

Either a corporeal and extended substance is (either really or mentally) divisible into parts endowed with extension, and each of these parts is divisible also into other corporeal parts, lesser and lesser, in infinitum; or else this subdivision must stop somewhere (for there is no third way between these two options); and either way the opinion pitched on will be liable to inconveniences—not to say absurdities—that are rationally urged against it by the maintainers of the opposite; the objections on both sides being so strong that some of the more fair-minded of the modern metaphysicians, after having tired themselves and their readers with arguing pro

and con, have confessed the objections on both sides to be insoluble.

We don't understand sensations

But though we do not clearly understand the nature of body in general, surely we must be perfectly acquainted with what happens *within ourselves* in reference to the particular bodies we daily see, hear, smell, taste, and touch. But alas, though we know very little except through the information of our senses, we know very little about *how* our senses inform us. And to avoid prolixity I will at present join you in supposing that the ingenious Descartes and his followers have given the best account of sensation that we yet have. Now, according to him a man's body is just a well-organized statue, so that sensation (properly so-called) is not performed by the ·sense·-organ but by the mind, which perceives the motion produced in the organ (which is why he will not allow brutes to have 'sense' properly so-called); so that if you ask a Cartesian how the soul of man, which he rightly asserts to be an immaterial substance, comes to be worked upon in so many different ways by the external bodies that are the objects of our senses, he will tell you that

- by their impressions on the sense-organs they variously move the fibres or threads of the nerves that those organs are endowed with,
- this motion is propagated to the little kernel in the brain called by many writers the 'conarion', and
- these differing motions ·in the conarion· are perceived by the soul, which resides there, and so become sensations because of the intimate union—the 'intermingling' as Descartes himself expresses it—of the soul with the body.

But now, Sir, let me remark that this union of an incorporeal with a corporeal substance (and that without a medium) is a thing so unexampled in nature, and so difficult to comprehend, that I somewhat question whether the profound secrets of theology—not to mention the adorable [see Glossary] mystery of the incarnation—are more abstruse than this. For how can I conceive, that a purely immaterial substance should be united without a physical medium (for in this case there can be none) with the body, which cannot possibly lay hold on it and which it can pervade and fly away from at pleasure, as Descartes must confess the soul actually does in death. And it is almost as difficult to conceive how any part of the body (including the animal spirits and the conarion, which are as truly corporeal as other parts of the human statue) can make impressions on a substance that is perfectly incorporeal and is not immediately affected by the motions of any other parts except the *genus nervosum* [= muscles, tendons, and other organs supplied by nerves]. Nor is it a small difficulty for a mere naturalist (who does not in physical matters take notice of revelations about angels) to conceive how a finite spirit can •move or (much the same thing) •regulate and determine the motion of a body. But what I want on this occasion to invite you to consider is this: supposing that the soul does in the brain perceive the differing motions communicated to the outward senses, this may give some account of sensation in general but does not at all show us a satisfactory reason for particular and distinct sensations. If I ask this:

Why when I look at a bell that is ringing, such a motion or impression in the conarion produces in the mind the special sort of perception *seeing*, and not *hearing*? And why another motion, coming from that bell at that time, produces the quite differing sort of perception that we call *sound* but not *vision*?

what can be answered except that **it was the good pleasure of the author of human nature to have it so**? And if the question is asked about the differing objects of any one particular sense, e.g. why the great plenty of unperturbed light that is reflected from snow, milk etc. produces a sensation of whiteness rather than redness or yellowness? Or why the smell of castor or asafoetida produces in most persons that ·sensation· which they call a stink rather than a perfume? (Especially since we know some hysterical women who think it not only a wholesome but a pleasing smell.) And if you go on to ask why melody and sweet things generally delight us, and discords and bitter things generally displease us; indeed, why a little more than enough of some objects that produce pleasure will produce pain (e.g. holding a cold hand near enough to the fire to be warmed, then nearer still so that it is hurt); or ask any of a thousand other questions of the same kind, the answer will be merely the general one that is already given, namely that **such is the nature of man**. For to say that moderate motions are agreeable to the nature of the sense-organ they are aroused in, whereas violent and disorderly ones (like jarring sounds and scorching heat) put the organ into too violent a motion for its texture, will by no means satisfy. For one thing, this answer gives no account of the variety of sensations of the same kind, as of differing colours, tastes, etc. but reaches only to pleasure and pain; even for these it will reach only a very little way unless its sponsors can show how an immaterial substance should be more harmed by the brisker motion of a body than by a more languid one.

Thoughts about those two failures

You and your friend think you may justly smile at the Aristotelians for imagining that they have given a tolerable

account of the qualities of bodies when they have told us that they spring from certain 'substantial forms', though when they are asked particular questions about these incomprehensible 'forms' they can only say in general that the forms have such-and-such faculties or effects because nature or the author of nature endowed them with those. So I hope you will give me leave to think that it may keep us from boasting of the clearness and certainty of our knowledge about the operations of sensible objects when

- just as the Aristotelians cannot particularly show how their qualities are produced,
- so we cannot particularly explain how they are perceived;

the principal thing that we can say being basically this: our sensations depend on such a union or intermingling of the soul and body as we can give •no example of in all nature and •no more distinct account of than that it pleased God so to couple them together.

I beg your pardon for having detained you so long on one subject, though perhaps it will not prove time mis-spent if it has made you take notice that in spite of the clearness and certainty for which your friend so much prefers physics before theology, we are yet to seek (I say 'yet' because I do not know what time may later reveal) both for the definition of *corporeal substance* and a satisfactory account of the manner of sensation; though without the true notion of a body we cannot understand that object of physics in general, and without knowing the nature of sensation we cannot know that from which we derive almost all that we know of any body in particular.

Sources of ignorance

If after all this your friend says that Descartes's account of body and other things in physics, being the best that men can give, if they are not satisfactory that must be imputed to human nature and not to the Cartesian doctrine, I shall not stay to dispute how far this is true; especially since it will not prejudice my work even if it is true. Whatever the cause of the imperfection of our knowledge about physical matters may be, it is obvious that there is an imperfection in that knowledge, and that ought to keep us from •being puffed up by such an imperfect knowledge and •treating it as a basis for undervaluing the study of the mysteries of divinity which (because of the nobleness and remoteness of the objects) may much better than the nature of corporeal things (which we see, feel, and continually interact with) have their obscurity attributed to the weakness of our human understandings. And if it is a necessary imperfection of human nature that while we remain in this mortal condition our soul—being confined to the dark prison of the body—is capable (as even Aristotle somewhere admits) of only a dim knowledge, so much the greater value we ought to have for the Christian religion, since by its means (and *only* by its means) we may attain a condition in which, just as our nature will otherwise be highly blessed and advanced, so our faculties will be elevated and enlarged, and probably made thereby capable of attaining degrees and kinds of knowledge to which we are *here* only strangers. [He mentions a common claim about what Adam knew before the fall, as possible evidence that we in our more 'noble' condition in heaven will know even more; but says that he won't argue from that because he thinks that the claim is false. He continues:] I will rather remind you •that the sight of the proto-martyr [St. Stephen] was strengthened so as to see the

heavens opened, and Jesus standing at the right hand of God; and •that when the prophet ·Elisha· had prayed that his servant's eyes might be opened, the servant immediately saw a nearby mountain all covered with chariots and horsemen which. . . .were altogether invisible to him before. To which I shall only add, as a higher argument, a couple of passages of Scripture which seem to allow us *vast* expectations as to the knowledge our glorified nature may be advanced to. One is what St. Paul says to the Corinthians:

'For now we see through a glass darkly, but then face to face; now I know in part, but then shall I know even as also I am known.'

The other is what Christ's favourite disciple tells believers:

'Beloved, now we are the sons of God, and it doth not yet appear what we shall be; but we know that when he shall appear we shall be like him, for we shall see him as he is.'

Certainty can be over-rated

What I have said up to here contains the first consideration that I told you might be proposed about the certainty ascribed to the knowledge we are said to have of natural things; but this is not all I have to say to you on this subject. (f) For I consider further that the knowledge of things is endeared to us not only by the certainty we have of them but also by

- (a) the worthiness of the object,
- (b) the number of those who are not acquainted with it,
- (c) its remoteness of it from common apprehensions,

(d) the difficulty of acquiring it without special advantages,

(e) its usefulness when attained,

and other particulars that I need not enumerate here.

You'll be sure (I presume) that your friend very much prefers •the knowledge he has of the mysteries of nature (at many of which we still have only ingenious conjectures) to •the knowledge of someone who understands the elements of arithmetic, although he is demonstratively sure of the truth of most of his rules and operations. And no doubt Copernicus received a much higher satisfaction from •his notion about the stability of the sun and the motion of the earth—although it was not clear ·or certain· enough to prevent Tycho, Ricciolus, and other eminent astronomers from rejecting it—than •from the knowledge of various theorems about the sphere that have been *demonstrated* by Euclid, Theodosius, and other geometricians.¹ Our discovery that some comets are not (as the schools thought) sublunary meteors but celestial bodies, and the *conjectural* theory that is all we have been able to attain of them up to now, give much more pleasure to your friend and you and me than the more certain knowledge we have of the time of the rising and setting of the fixed stars. And the estimates we can make by the help of parallaxes of the heights of those comets and of some of the planets, though they are uncertain enough (as may appear by the vastly different distances that are assigned to those bodies by eminent astronomers), please us far more than our ability with the help of a geometrical quadrant or some such instrument to determine with far greater certainty the height of a tower or a steeple. And a

¹ [In his edition of this work (see opening paragraph of the present document) J. J. MacIntosh has a footnote here, including: 'Classically, spherical geometry was considered a branch of astronomy, so Boyle's contrast between the heliocentric hypothesis of Copernicus and the "theorems about the sphere" would have seemed a natural one.']

mathematician

when he *probably* conjectures the area of the terrestrial globe, and *approximately* divides its surface first into proportions of sea and land, and then into regions of such-and-such extents and bounds, and in short skillfully plays the cosmographer,

thinks himself more nobly and pleasantly employed than

when, being reduced to play the surveyor, he with far more certainty measures how many acres a field contains, and sets out what hedges and ditches it is bounded with.

Now, what I have written has very much miscarried if it have not shown that the knowledge of God and of the mysteries of theology that are (b) not known by far the greatest part of mankind has (a) more sublime and excellent objects and is (c, d) not attained to by the greatest part even of learned men and nevertheless is (e) of invaluable importance and of as much advantage towards purifying and improving of us here as towards making us perfect and happy hereafter. Therefore, just as

being admitted into the privy-council of some great monarch, and thereby be enabled to give a probable guess at the thoughts and designs of his that govern kingdoms and make the fates of nations

is judged to be preferable to

the clearer [here = 'more certain'] knowledge that a notary can have of the dying thoughts and intentions of an ordinary person whose will he makes;

and just as •the knowledge of a skillful physician whose art is nevertheless conjectural is preferable to •the knowledge of the cutler who makes his dissecting knives, although the cutler can more certainly perform what he designs in his own profession than the physician can in his; and (in short) just as

the skill of a jeweller who is conversant about diamonds, rubies, sapphires and some other sorts of small stones, which being mostly brought to us out of the Indies we must take many things about them on hearsay, is because of the nobleness of the object preferred to the skill of a mason who deals in whole quarries of common stones, and can be sure from his own experience of many things concerning them, things which, regarding jewels, we are allowed to know only by hearsay

so

a more dim and imperfect knowledge of God and of the mysteries of religion may be more desirable, and on that account more delightful, than a clearer knowledge of those inferior truths that physics ordinarily teaches.

Two satisfactions at once

(ii) I must now mention one more factor that can be added to those that especially endear physics to the divine who is studious of them. As he contemplates the works of nature not barely •for themselves but •to be better qualified and excited to admire and praise the Author of nature, so his contemplations are delightful to him not barely •as they provide a pleasing exercise to his reason but •as they give him a more welcome approval from his conscience, these distinct satisfactions being not at all inconsistent. No doubt though Esau did eventually miss his aim, while he was hunting venison for the good old patriarch who desired him to do so, he had great pleasure—in addition to his usual pleasure in deer-hunting—from the thought that he was hunting to please his father and in order to obtain an inestimable blessing from him. And when David employed his skillful hand

and voice in praising God with vocal and instrumental music he received in one act a double satisfaction by exercising his skill and his devotion; and was no less pleased with those melodies as they were *hymns* than as they were *songs*.

And this example prompts me to add that just as the devout student of nature we were speaking of [referred to as 'Dr N.' on pages ?? and ??] does intentionally refer the knowledge he seeks of created things to the glory of the creator, so what most contents him in his discoveries is that the wonders he observes in nature •heighten his admiration for the wisdom of God (admiration that he wants to raise to a level less disproportionate to that wisdom itself), and •provide him with a nobler offering to include in the sacrifices of praise he is justly ambitious to offer up to the Deity. When David invented (as the Scripture intimates that he did) new instruments of music, nothing in that invention pleased him so much as the fact that they could help him to praise God more melodiously; and similarly the pious student of nature finds nothing more welcome in his discoveries of its wonders than the help they may give him more worthily to celebrate the divine attributes shown faintly in created things. And just as a huntsman if he meets with some strange beast thinks himself much more fortunate if it happens to be near the court where he can present it to the king than if he kept it for himself or some of his companions; so our devout naturalist has his discoveries of nature's wonders endeared to him by having the Deity to present them to. . . .

4. The natural philosopher's unjustified pride of achievement

But I confess, Sir, to suspecting that what makes your friend have such detracting thoughts of theology is a certain secret pride based on the notion that the attainments of

natural philosophers are of so noble a kind, and display so transcendent an excellence of abilities in the attainer, that he can justly undervalue all other learning, theology included.

I do not think you will expect that a person who has written so much in praise of physics, and worked so hard to acquire a little skill in it, should here try to depreciate that *useful* part of philosophy. But I am not insulting it, I think, in preferring the knowledge of supernatural things to that of mere natural ones, and in thinking that

- the truths that God indiscriminately exposes to the whole race of mankind, and to the bad as well as to the good

are inferior to

- the mysterious truths whose disclosure God counts among his special favours, and the contemplation of which employs the curiosity, and in some points arouses the wonder, of the very angels.

So that I may repress a little the overweening opinion your friend has of his attainments in physics, therefore, give me leave to present a few particulars conducive to that purpose.

First, as for the nobleness of the truths taught by theology and physics, those of the former sort clearly have the advantage, being not only concerned with far nobler objects but revealing things that unaided human reason can by no means reach; as has been sufficiently declared in the earlier part of this letter.

It was easy to refute the ancients

Next: whatever may be said to excuse pride (if there was any) in Moscus the Phoenician, who is said to have first invented the atomic hypothesis, in Democritus and Leucippus (for Epicurus hardly deserves to be named with them) who greatly advanced that philosophy, and

in Monsieur Descartes who either improved or at least much innovated the corpuscularian hypothesis,

I see no great reason why pride should be allowed in such as your friend; who, though ingenious men, are neither inventors nor eminent promoters of the philosophy they would like to be admired for, but are content themselves to learn what others have taught, or at most to make some little further application of the principles that others have established and the discoveries that others have made.

Your friend is not a little proud of being able to refute several errors of Aristotle and the ancients, but it would be well for him to consider that many of the chief truths that overthrow those errors were the products of time and chance and not of his daring reasonings. No great intellect is needed to refute those who maintain •that the torrid zone is uninhabitable or •that there are no land-masses at the antipodes; because navigators have found many parts of the torrid zone well peopled, and sailing around the earth have found men living in countries diametrically opposite to ours. Nor is a man entitled to be proud of not believing •that the moon is the only planet that shines with a borrowed light, or •that the galaxy is a meteor; because the *telescope* shows us that Venus waxes and wanes like the moon, and that the milky way is made up of a vast multitude of little stars that are inconspicuous to the naked eye. And indeed of the other discoveries that overthrow the astronomy of the ancients and much of their philosophy about the celestial bodies, few or none have any cause to boast except for the excellent Galileo, who claims to have been the inventor of the telescope. Once that instrument was discovered, the ability to •reject the thesis that there are exactly seven planets through the detection of the four satellites of Jupiter, or to •talk of the mountains and valleys in the moon, requires little more excellence in your friend than it would to detect

in a ship with the help of a prospective glass the masts, sails and deck, and to perceive a boat towed at her stern, where the naked eye could discern only the body of the vessel. Though indeed Galileo himself had no great cause to boast of the invention of the telescope (though we are much obliged to him for its improvement); because no less a master of dioptrics than Descartes acknowledges—as do other writers—that perspective-glasses were first discovered not by mathematicians or philosophers but casually by one Metius, a dutch spectacle-maker. While I am on this topic, let me remind you—to hide pride from man—that various others of the chief discoveries that have been made in physics have been the products not of philosophy but of *chance*, which led to gunpowder, glass, and (for all we know to the contrary) the lodestone's directional property (to which we owe our knowledge of both the Indies); as (more recently) the milky vessels of the mesentery, the new receptacles of the chyle, and those other vessels that most men call the lymph-ducts, were found only by chance, according to the candid admission of the discoverers themselves.

Corpuscularian physicists as mere mechanics

We may further consider that the very things that are rightly urged in the praise of the corpuscularian philosophy itself ought to *lessen* the pride of those who merely make use of it. That hypothesis supposes the whole universe (the soul of man excepted) to be merely a great automaton or self-moving engine in which all things are performed by the bare motion (or rest), size, shape, and situation or texture of the parts of the universal matter it consists of; and all the phenomena in the universe result from a few fertile principles. . . .that have already been established by the inventors and promoters of the particularian hypothesis; so that all your friend and

his like are left to do is merely to investigate or guess by what kind of motions the three or four other principles are varied. So that the world being only a great piece of clock-work (as it were), the naturalist as such is only a mechanic, however much larger or smaller the parts of the engine he considers are than those of clocks or watches. And for an ordinary naturalist to despise those who study the mysteries of religion as much inferior to physical truths is as unreasonable as it would be for a watch-maker, because he understands his own trade, to despise privy-counsellors who are acquainted with the secrets of monarchs and mysteries of state. . . .

That great restorer of physics, the illustrious Francis Bacon, who has traced out a most useful way to make discoveries in the 'intellectual globe', as he calls it, confesses that his work was 'a child of time rather than of intellect'. And though I am not of his opinion when he says in another place that his way of philosophising 'equalises intellects', I am inclined to think that once

- the fertile principles of the mechanical philosophy have been settled,
- the methods of inquiring and experimenting have been found out, and
- the physico-mechanical instruments of working on the products of nature and of art have been happily invented,

the use of such facilitating helps to make several lesser improvements—especially by correcting some almost obvious or lazy errors of the schools—may fall to the lot of persons not endowed with any extraordinary sagacity or acuteness of abilities. And though the investigation and clear establishment of the true principles of philosophy, and the devising the instruments of knowledge, are things that may be allowed to be the proper work of higher intellects, if a man is provided

with such assistances not every work that he makes or thing that he does with the help of them is difficult enough to raise him to that illustrious rank! And indeed some of the common errors of scholars as well as of other men were mainly grounded on •the mere (and often mistaken) authority of Aristotle, and perhaps on •some frivolous reasons of his scholastic interpreters of such precarious and ungrounded things; so that to demolish them often requires more boldness than skill. It may perhaps be said of your friend, in relation to his philosophical successes against such common errors as I am speaking of, what a Roman said of Alexander's triumph over the effeminate Asiatics, that 'all he needed was to show a just contempt for emptiness'. And in some cases when a grand truth or a happy way of experimenting has been found, and various phenomena of nature that had been left unexplained or were left mis-explained by the schools were at last unriddled and explained, this in my opinion has required a far less straining exercise of the mind than must have been required to dispel the darkness that attended various theological truths that are now cleared up, and perhaps less than I have myself sometimes employed in some of those attempts to illustrate theological matters, attempts that you may have met in some papers that I have presumed to write on such subjects. And indeed the improvements that such virtuosi as your friend are accustomed to make of the fertile theorems and hints that have been presented to them by the founders or prime benefactors of true natural philosophy are so poor and slender, and so much oftener •come from industry and chance than •show transcendent sagacity or elevated reason, that though such persons may have cause enough to be delighted with what they have done they have none to be proud of it. Their performances may deserve our thanks, and perhaps some of our praise, but do not reach high enough to merit our admiration, which is

to be reserved for those who have been either •formers or grand promoters of true and comprehensive hypotheses or else •authors of other noble and useful discoveries that have many different applications.

Small scope of our physical knowledge

It will not perhaps be improper to add here that just as our knowledge is not very deep, not reaching with any certainty to the bottom of things or penetrating to their intimate or innermost natures, so its extent is not very wide, not being able to give us with any clearness and particularity an account of the celestial and deeply subterranean parts of the world, of which all the other parts make but a very small (not to say contemptible) portion.

As to the very globe that we inhabit—not to mention how many plants, animals and minerals we are still wholly ignorant of, and how many others we are only slenderly acquainted with—I consider that the objects that our experiments and inquiries deal with all belong to the superficial parts of the terrestrial globe, of which the earth that we know seems to be merely the crust, as it were. What the internal part of this globe is made up of is no less disputable than what substance composes the remotest stars we can detect. Even among the modern philosophers some think the internal portion of the earth to be pure and elementary *earth*, which (they say) must be found there or nowhere. Others imagine it to be fiery, and to be the receptacle of either natural or hellish flames. Others maintain that the body of the terrestrial globe is a great and solid magnet. And the Cartesians on the other side (though they all admit store of subterranean lodestones) teach that this same globe was once a fixed star, and that although it has since degenerated into a planet the internal part of it is still of the same nature

that it was before, the change it has received coming only from having had its outward parts covered over with thick spots (like those to be often observed about the sun) by the condensation of which the firm earth we inhabit was formed. And the mischief is that each of these jarring opinions is almost as difficult to be demonstratively proved false as true. According to the most modest account of our recent cosmographers the distance to the centre of the earth is more than 3,500 miles; and my inquiries among navigators and miners have not yet satisfied me that men's curiosity has actually reached more than a mile or two at most downwards (and that in not more than three or four places) either into the earth or into the sea. So our experience so far has hardly scratched deep into *the husk* (if I may so speak) and has not at all reached *the kernel* of the terraqueous globe.

And alas! what is this globe of ours of which itself we know so little, in comparison to those vast and luminous globes that we call the fixed stars, of which we know much less? Earlier astronomers have been pleased to tell us their distances and sizes, with a seeming precision as if they had certain ways of measuring them; but later and better mathematicians will (I know) allow me to doubt what those •earlier astronomers• have told us. It is admitted that we can observe no parallax in the fixed stars (or perhaps in the highest planets), so men have yet to find a method to measure the distance of those bodies. And not only the Copernicans make it to be I know not how many hundred thousands of miles greater than the Ptolemeans, and very much greater than even Tycho; but Ricciolus himself, though a great anti-Copernican, makes the distance of the fixed stars vastly greater not only than Tycho but (if I mis-remember not) than some of the Copernicans themselves. Nor do I wonder at these vast discrepancies (though some may amount to millions of miles) when I consider that astronomers do not

•measure the distance of the fixed stars by their instruments but •accommodate it to their particular hypotheses. And from this uncertainty about the distance to the fixed stars you will easily gather that we are not very sure of their size, even in comparison with one another; since it remains doubtful whether the differing sizes they appear to us to have come from a real inequality of bulk or only from an inequality of distance, or partly from one of those causes and partly from the other.

But it is not my design to take notice of things that the famous disputes among the modern astronomers show to be dubious. I am thinking about various things relating to the stars that are so remote from our knowledge that the causes of them are not even disputed over or inquired into. For example:

- Why is the number of the stars neither greater nor lesser than it is?
- Why are so many of those celestial lights placed so that they are not visible to our naked eyes, or even through ordinary telescopes? (which extraordinarily good ones have assured me of)
- Why among the familiarly visible stars are there so many in some parts of the sky and so few in others?
- Why are their sizes so different, and yet not more different?
- Why are they not placed in a more orderly way so as to make up constellations of regular or handsome figures (of which the triangle is perhaps the single example), but seem to be scattered in the sky as it were by chance, and have configurations as confused as the drops that fall on one's hat in a shower of rain?

To these questions about the stars we might add various others about the interstellar part of heaven. Several of the modern Epicureans hold that it is empty except where the

beams of light (and perhaps some other celestial effluvia) pass through it; and the Cartesians on the contrary think it to be full of an ethereal matter, which some who otherwise favour their philosophy confess they are reduced to accepting merely as an hypothesis.

Thus our knowledge is much short of what many think, not only (to put it in scholastic terms) intensively but also extensively. There is so great a disproportion between the heavens and the earth that some moderns think the earth to be little better than a *point* in comparison even with the orb of the sun; and the Cartesians and other Copernicans think that the great orb itself (which is equal to what the Ptolemeans called the sun's orb) is a mere *point* in comparison with the firmament; and all our astronomers agree with at least this: the earth is but a physical point in comparison with the starry heaven. How little extent our knowledge must have, which •leaves us ignorant of so many things concerning the vast bodies above us, and •penetrates such a short way even into the earth beneath us, that it seems to be confined to a small share of the superficial part of a physical point! The natural result of this will be that •though what we call our 'knowledge' may be allowed to count as a large reward for our minds, it ought not to puff them up; and •that what we know of the system and the nature of corporeal things is not so perfect and satisfactory as to justify our despising the discoveries of spiritual things.

God himself tells us which to prefer

One of the earlier parts of this letter [on page ???] may furnish me with one thing more to show the excellences and prerogatives of the knowledge of the mysteries of religion; and that one thing is such that I hope I shall not need to add anything more, because it is not possible to add anything

higher. It is the preeminence of divine truths over all other knowledge according to the judgment of a judge above all exception and above all comparison, namely God himself.

Having already shown this, I shall not now repeat it but rather *apply* it. If he who determines in favour of divine truths •knew less than our over-weening naturalists of the secrets of their idolised physics, or if he •were (like an angel) a mere contemplator of what we call the ‘works of nature’ without having any interest in their productions, your friend’s not acquiescing in his estimate of things might have, though not a fair excuse, yet a stronger temptation.

But when he by whose direction we prefer the higher truths revealed in the Scripture to those which reason alone teaches us concerning those comparatively lowly subjects, corporeal things, is the same God who not only **understands** the whole universe and all its parts far more perfectly than a watch-maker can understand one of his own watches

(in which he can give an account only of the structure, and not of the cause of the spring or the nature of the gold, steel and other bodies his watch consists of)

but **made** both this great automaton, the world, and man in it, we have not the faintest excuse for imagining that he would be ignorant of his own workmanship, or injuriously disparage it, or mislead his favourite creature, man, in telling him what sort of knowledge he ought most to covet and prize. So since it is he who framed the world and all the things in it we most admire who would have us prefer •the knowledge he has granted us in his word to •the knowledge he has allowed us of his works, it is surely very unreasonable and unnatural to make the excellences of the workmanship a disparagement to the author, and to make the effects of his wisdom a motive against accepting the decisions of his judgment! . . .

5. The value of the fame that scientific attainments bring

I would be guilty of a most important omission if I forgot to consider one thing that I’m afraid has a large part in the partiality your friend expresses in his preference of physics to theology—namely his supposing that through physics he will acquire a fame that is more certain and more durable than can be hoped for from the theology.

I acknowledge readily, and indeed with some pleasure in the felicity of this age, that there is hardly any sort of knowledge more in vogue than the sort natural philosophy claims to teach; and that among the awakened and inquiring part of mankind as much reputation and esteem can be gained by an insight into the secrets of nature as •can be gained• by being entrusted with the secrets of princes or dignified with the most splendid marks of their favour.

But though I readily confess that much, and though I may be thought to have had—I know not by what fate—as great a share of applause (that perfumed smoke!) as at least some of those writers who are now alive and whom your friend seems most to envy for it, yet I shall not scruple to tell you, partly from observation of what has happened to others and partly too on some experience of my own, that **(i)** it is not as easy as your friend seems to believe to get by the study of nature a sure and lasting reputation, and **(ii)** the expectation of it is not a sound reason for men to undervalue the study of divinity. It is no use arguing by way of counter-attack that the difficulties and impediments of acquiring and securing reputation lie in the way of divines as much as of philosophers, since this objection has been already considered at the beginning of Part II of this present letter [on page 37?]. Besides that, my coming discussion will show that the naturalist aspiring to fame is liable to

some inconveniences which the divine is not so much, if at all, liable to. So I shall take no further notice of this counter-attacking allegation, and shall proceed to defend part (i) of the assertion that preceded it. . . .

Fame, intellectual theft, and misrepresentation

First, if your Physeophilus should think to secure a great reputation by forbearing to report any of his thoughts or experiments in writing, he may find himself not a little mistaken in this. For once he has gained a reputation (for whatever reason) for knowing some things that may be useful to others or that studious men are usually anxious to know, he will not avoid the visits and questions of the curious. If he retreats into solitude, hiding himself so as to hide the things he knows, he will not escape the solicitations that will be made him by letters. And if these ways of tempting him to disclose himself do not bring him to do so, he will provoke the persons who have employed them; finding themselves disobliged by being defeated of their desires if not also their expectations, they will for the most part try to revenge themselves on him by giving him the character of a discourteous and ill-natured person; and they will try—perhaps successfully enough—to decry his abilities by suggesting that his deliberate concealments come from his awareness that the things he is presumed to possess would cease to be valued if they began to be known.

You may say that so much reservedness is a fault. I shall not argue with you about that; but if he is open and communicative in work to the strangers who come to pump him, such is the dishonest temperament of all too many men that he will be in great danger of having his notions or experiments arrogated [= 'claimed as their own'] by those to whom he imparts them, or at least by others to whom

those. . . .happen to speak of them. And then if Physeophilus, or any of his friends who know him to be the author of what is thus usurped, mention him as such, the usurpers and their friends will at once become his enemies; and to secure their own reputation they will be solicitous to lessen and blemish his.

You might now tell me:

'My friend might take a middle way—the one that in most cases is thought to be the best—by speaking of his discoveries in a way that somewhat gratifies those who have a curiosity to learn them, but not speaking so clearly as divest himself of his ownership of them.'

I reply that this expedient is not a sure one, or free from inconveniences. For most men are so self-opinionated that they will easily believe themselves to be masters of things that they only half understand. And even if the persons to whom the work is immediately made known do not have too great an opinion of themselves. . . ., they may easily, by repeating what they heard and observed, give some abler person sufficient to enable him to make out the whole notion or discovery, which he will then without scruple—and with almost no possibility of being disproved—claim as his own. But if it happens (as it often will in extemporaneous work) that a philosopher is not rightly understood, either because

- he has not the leisure, any more than the intention, to explain himself fully, or because
- the persons he converses with do not bring to the conversation a competent capacity and attention,

he then runs a greater danger than before. For the pride most men take in being known to have conversed with eminent philosophers makes them eager to repeat what they heard the famous man say; and—often being sure of not being contradicted—ignorantly to misreport it or knowingly to wrench it around so that it favours the opinion they want

it to support. So that whereas by the formerly mentioned frankness of work he is only in danger of having the truths he discovered arrogated by others, this reservedness exposes him to having fathered on him opinions and errors that he never dreamed of. And once a man's opinions or discoveries come to be publicly talked about without being proposed by himself or some friend well instructed by him, he knows not what errors or extravagances may be attributed to him. . . .by the mistake of the weak, or the dishonesty of the biased, or the tricks of the malicious. And even the greatness of a man's reputation sometimes gives plausibility to vain reports and surmises—so much plausibility that that reputation is gradually shaken, if not ruined. As we see that Roger Bacon and Trithemius and Paracelsus—who for their times were *knowing* as well as *famous* men—had ascribed to them feats which, by appearing fabulous to most of the judicious, have tempted many to think that all the great things that were said about them were fabulous too.

The problems of scientific publication

Those are some of the inconveniences that a naturalist may be liable to if he abstains from communicating his thoughts and discoveries himself. But if Physeophilus should, to avoid these, aim at fame by the usual method of writing books, he may indeed avoid *these* but perhaps not without running into *other* inconveniences and hazards that are nearly as bad. Whether he

- (i) writes in a systematic way, as they have done who have published entire bodies of natural philosophy or methodical treatises on a considerable part of it, or
- (ii) writes in a more loose and unconfined way about any particular subject that belongs to physics,

he will find that, either way, his choice between these two ways of writing books will be liable to inconvenience enough.

(i) If he writes systematically, (a) he will be obliged (so as not to omit anything necessary) to say various things that have already been said (perhaps many times) by others, which is bound to be unpleasant to the reader and (if he is competent) to the writer. (b) There are so many things in nature of which we know little or nothing, and so many more of which we do not know enough, that our systematic writer—even if he is very learned—*must* either •leave various things that belong to his theme undiscussed or •discuss them slightly and often (in likelihood) erroneously. So that in books of this kind there is always much said that the reader did know, and commonly not a little that the writer does not know. And to this I must add (c) that because natural philosophy is such a vast and pregnant subject that (especially in such an inquisitive age as this) almost every day reveals some new thing about it, it is hardly possible for a method that is adapted only to what is already known to continue for long to be the most proper; as the same clothes will not for long fit a child whose age will make him quickly out-grow them. So later writers will have a fair claim to compile new systems that may be more adequate to philosophy improved since the publication of the earlier work. And even if there is little that is new to be added, and it would be easier to alter than to mend the method of our supposed author, novelty itself is so pleasing and inviting to the generality of men that it often recommends things that have nothing else to recommend them. . . .

(ii) But if someone declines the systematic way and chooses the other way—writing loose tracts and works—he may indeed avoid some of the above-mentioned inconveniences, but he will hardly avoid being plundered by systematic writers. For these will be apt to cull out the things they

like best and insert them in their methodical books (perhaps much curtailed or otherwise injured in the repeating), and will place them not as their own author did •where they may best confirm or adorn his work and be illustrated or upheld by it, but •where it may best serve the purposes of the compiler. And these methodical books promise so much more compendious a way than others to the attainment of the sciences they deal with that most readers take it for granted that if earlier writers had anything considerable to offer it has all been carefully extracted and digested in an orderly way by the later compilers. In fact, the methodical books for the most part give more help to the memory than to the the understanding; but most readers—through lack of judgment or lack of patience—see them differently. And though I take their view to be a very erroneous and prejudicial misconception, it is so widespread that just as

- goldsmiths who only give shape and lustre to gold are far more esteemed, and in a better financial-condition, than
- miners who find the ore in the bowels of the earth and with great pains and industry dig it up and refine it into metal, so also

- those who with great study and toil successfully penetrate into the hidden recesses of nature and discover latent truths are usually less regarded or taken notice of by the general run of men than
- those who by plausible methods and a neat style reduce the truths that others have found out into systems that are attractively ordered and of a convenient size.

I consider in the **second** place that not only the method of the books one writes can prove prejudicial to the naturalist who aspires to fame but so also can their size. If he writes large books he is likely to write in them many things that are inaccurate if not irrelevant, or to be obliged to repeat many things that others have said before; and if

he writes only small tracts—as is the custom of the most judicious authors who want to publish only what is new and considerable—their excellence will speed up their spread but their smallness will put them in danger of being quickly lost. Experience shows us various excellent little tracts which, though published not many years ago, are already ‘out of print’ (as they say) and not to be met with except by chance in stationers’ shops. So that these writings (which deserve a better fate) come after a while either •to be lost (which has been the fate of many) or •to have their memory preserved only in the larger volume of some compiler whose industry is better than his judgment. For it is it is observable that (by I know not what unlucky fate) very few (I do not say *none*) who devote themselves to making collections out of the works of others have the judgment to pick out the choicest things in them; and the small tracts I am speaking of, being preserved only by such a quoter or abridger, will run a very great danger of being conveyed to posterity only in a form that pleases the compiler.

The danger of misrepresentation

This leads on to my **third** consideration. The fame of a naturalist who publishes only small tracts may be made uncertain not only because of

- the lack of judgment that (I repeat) is too often observable in compilers, whereby they often leave far better things than they take, but also because of
- the compilers’ lack of skill to understand the author they cite and summarise or of candour to treat him fairly.

For sometimes men’s physical opinions and several passages of their writings are so misrepresented by mistake or design—especially if those who report their opinions do not share

them—that they are made to teach or deliver things quite different from their sense and perhaps quite contrary to it. I myself have had some unwelcome experience of this: a learned writer claimed, I know not how often, that I asserted an opinion which I had explicitly rejected. Another noted writer—not maliciously but through not being acquainted with mechanics and the subject I wrote about—commended me for having, by a new experiment, proved something the opposite of what I intended the experiment to show (and I am not the only one who thinks that it *did* show it). I have met with other naturalists whose writings compilers have traduced out of hatred for their persons or their religion; as if truth could in nothing be a friend to one who is the traducer’s enemy! or as if—despite all the truths we owe to Aristotle, Epicurus and the other heathen philosophers—a man who falls into an error in religion could not come upon a good notion in philosophy! Indeed, there are some who will set themselves to decry a man’s writings not because they are directly his enemies but because he is esteemed by their enemies; as you may remember the example of a servant of yours who had various things written against him for this very reason. And a worthy writer’s reputation may be prejudiced not only by the citations of professed adversaries or opponents but also—as quite often happens—by those who mention him with praise and seem disposed to honour him. For I have observed it to be the trick of certain writers to name an author with much compliment for *one or a few* of the *least* considerable things they borrow from him; by which artifice they try to conceal their being plagiarists of *more* and *better*; though this is more excusable than the conduct of some who proceed to that pitch of dishonesty that they will rail at an author so as not to be thought to be beholden to him, when in fact they owe him too much.

Various other hazards

And I must add **fourthly** that besides these dangers that a naturalists’ reputation with posterity may run because of men’s ignorance or perverseness, it is vulnerable to various other hazards from the very nature of men, of opinions, and of things.

Men’s abilities and inclinations are naturally various in reference to studies, one man passionately loving one sort of them and another being fond of quite different ones; and those inclinations are often variously and generally determined by external and accidental causes. As when some great monarch happens to be a great patron—or a despiser and perhaps an adversary—of this or that kind of learning; and when one man has gained much applause for this or that kind of study, imitation or the desire to do better often makes many others devote themselves to it. Thus though Rome under the consuls was inconsiderable for learning, the reputation of Cicero and the favour of Augustus brought learning into vogue there; whereas the small favour it met with among most of the succeeding emperors kept it far inferior to what it had been among the Greeks around the time of Alexander. And the age of that same Augustus was ennobled with many poets, not only by the favour that he and Maecenas gave them but probably also by the examples they gave to one another and the rivalry they aroused among poets. And after the decay of the Roman empire in the fourth century, natural philosophy and mathematics being very little valued and even less understood because men’s studies were by the genius of those ages applied to other subjects, every century hardly produced one improver (let alone one eminent cultivator) of mathematics or of physics. From this you can see how little certainty there is that because a man is skilled in natural philosophy and that science is now in

vogue, his reputation when the science itself has grown out of repute will be as great as it is now.

Shifts of intellectual fashion

Besides the contingencies that may happen to a naturalist's fame because the science he cultivates is—as are others—subject to wanes and eclipses in the general esteem of men, there is another uncertainty arising from the vicissitudes that are to be met with in men's estimates of different hypotheses, sects, and ways of philosophising about the same science, and particularly about natural philosophy. During those learned times when physics first and most flourished among the Greeks, almost all the naturalists who preceded Aristotle—including Democritus, Leucippus, Epicurus, Anaxagoras, Plato—were corpuscularians who tried, though not all by the same way, to give an account of the phenomena of nature and even of qualities themselves in terms of the size, shape, motion etc. of corpuscles, or the minutest active parts of matter. Whereas Aristotle,

- having tried to deduce the phenomena from the four first qualities, the four elements, and a few other barren hypotheses,
- ascribing what could not be explained by them (and consequently far the greatest part of nature's phenomena) to 'substantial forms' and 'occult qualities' (principles [here = 'causes'] that are readily named but hardly even *claimed* to be understood), and
- having on these slight and narrow principles reduced physics to a kind of system, which the judicious modesty of the corpuscularians had made them reluctant to do,

the reputation that his great pupil Alexander as well as his own learning gave him, the easiness of the way he proposed

to the attainment of natural philosophy, the good luck his writings had to survive those of Democritus and almost all the rest of the corpuscularians when Charles the Great began to establish learning in Europe—these and some other lucky accidents that concurred did for about seven or eight centuries together make the corpuscularian philosophy not only be *jostled* but even *exploded* out of the schools by the Aristotelian philosophy. In our times, with the revival of the corpuscularian philosophy, the Aristotelian one is rejected, and by more than a few derided as precarious, unintelligible, and useless. To give a particular instance (which, though mentioned earlier [page ??] deserves to be mentioned again for our present purpose), Aristotle himself somewhere confesses (not to say *brags*) that the Greek philosophers, his predecessors, unanimously taught that the world was (I do not say created, but) made, and yet he—almost by his single authority, and the subtle arguments (as some have thought them) that he employed. . . .—was able for many ages to introduce into the schools of philosophers that irreligious and ill-grounded opinion of the eternity of the world, which •the Christian doctrine later made men begin to question and which now both •that and right reason have persuaded most men to reject.

This invites me to consider further that the present success of the opinions that your Physeophilus befriends ought not to make him so sure as he thinks he is that the same opinions will be always in vogue and have the same advantages in general esteem that they now have over their rivals. Opinions seem to have their fatal seasons and vicissitudes, as well as other things; as can be seen not only from the examples I have just given but also from the hypothesis of the earth's motion:

Having been in great vogue before Pythagoras (who is commonly thought to have invented it), and having its

reputation much increased by the vote of the famous sect of the Pythagoreans (whom Aristotle himself takes notice of as the patrons of that opinion), for the next nearly 2000 years it was laughed at as not only false but ridiculous. After all that time this so long antiquated opinion, revived by Copernicus, has in a little time made so great a progress among the modern astronomers and philosophers that if it goes on like this the motion of the earth will be acknowledged by all its mathematical-ly competent inhabitants.

But though it is often the fate of an oppressed *truth* to have at length a resurrection, not only truths have this privilege; for obsolete errors are sometimes revived, as well as discredited truths. So that the general disrepute of an opinion in one age will not give us an absolute security that it will not be in vogue in another, in which it may not only revive but reign.

And we can observe inconstancy and vicissitude not only in •the acceptance of men's opinions about philosophical matters but also in •the very way and method of philosophising. Democritus, Plato, Pythagoras and others—who were some of the more sincere and able cultivators of physics among the Greeks—exercised themselves chiefly

- in making particular experiments and observations, as Democritus did in his dissections of animals, or
- in applying mathematics to explaining some particular phenomenon of nature, as can be seen...in the accounts that Democritus, Plato and others give of fire and other elements, from the shape and motion of the corpuscles they consist of.

And although this way of philosophising was so much in vogue before Aristotle that...there are manifest and considerable footsteps of it to be met with in some of his writings (particularly in his books on animals and his mechanical questions); yet for many ages his scholastic followers

neglected the way of philosophising of the ancients and (to the great prejudice of learning) introduced everywhere instead of it a quite contrary way of writing. Not only did they lay aside mathematics (of which they were for the most part very ignorant), but instead of giving us intelligible and explicit (if not accurate) accounts of **particular** subjects, based on a clear-eyed and attentive consideration of them they contented themselves with hotly disputing in general certain unnecessary—or at least unimportant—questions about the objects of physics, about

- materia prima*,
- substantial forms,
- privation,
- place,
- generation,
- corruption,

and other such **general** things. And when they had quite tired themselves and their readers with all this they usually •remained utter strangers to the **particular** productions of the nature about which they had so much wrangled, and •were not able to give a man as much true and useful information about particular bodies as even the lowest-level manual workers—mine-diggers, butchers, smiths, even dairy-maids—could do. Which made their philosophy appear so imperfect and useless not only to the general run of men but to the more elevated and philosophical intellects, that our great Francis Bacon tried with much skill and industry (and some indignation!) to restore to its former vogue the more modest and useful way practised by the ancients, of inquiring into particular bodies without hastening to make systems; in which he was considerably aided by the admirable industry of two of our London physicians, Gilbert and Harvey. And I need not tell you that since Bacon—with Descartes, Gassendi and others having taken in the application of geometrical

theorems in explaining physical problems—he and they and other restorers of natural philosophy have brought the experimental and mathematical way of inquiring into nature into at least as high and growing an esteem as ever it possessed when it was most in vogue among the naturalists who preceded Aristotle.

The likelihood of being wrong

To the considerations I have so far adduced, which might alone suffice for my purpose, I shall add one that I take to be of greater weight than any of them for showing how difficult it is to be sure that the physical opinions which at present procure veneration for a champion or promoter of them will still be in vogue at later times. As well as the inconstant fate of applauded opinions that may be imputed to the inconstancy of men there is a greater danger that threatens the aspirer's reputation from the very nature of things. For the most general causal factors of all—namely the shape, size, motion, and other mechanical features of the small parts of matter—being (as your friend believes) sufficiently and clearly established already, he must expect to grow his reputation from subordinate hypotheses and theories; and I shall not scruple to say that with *these* it is extremely difficult, even for those who are more exercised than your friend is in forming them and in making experiments, to have such a comprehensive and clear prospect of everything they need to know that they are not to be liable to have their doctrine made doubtful or disproved by something they did not discover and that may come to light later. I am sure you would easily be persuaded of this if I had leisure and convenience to transmit to you my *Sceptical Naturalist*. But without having recourse to that tract it may suffice that we consider that one of the conditions of a good hypothesis is

that it should be consistent with . . . all other phenomena of nature as well as those it is designed to explain. For this being granted (and it cannot be denied), anyone who establishes a theory that he expects to be accepted at all succeeding times and make him famous in them must have a care not only that none of the phenomena of nature that are already known contradict his hypothesis at the present but that no phenomena that may be hereafter discovered will contradict it for the future. And I very much question whether Physeophilus *does* or, on no greater a number and variety of experiments than most men build on, *can* know how incomplete the history of nature is that we now have, and how difficult it is to build an accurate hypothesis on an incomplete history of the phenomena it is to apply to; especially considering that (as I was saying) many things may be discovered later by industry or chance that are not now so much as dreamed of, and that may yet overthrow doctrines which fit, attractively enough, the observations that have been made up to now.

The ancient philosophers who thought the torrid zone to be uninhabitable did not base their opinion on wild reasonings; and after continuing uncontrolled for many ages the opinion might have been accepted for ever if the discoveries made by modern navigations had not shown it to be erroneous. The solidity of the celestial orbs was the general opinion of astronomers and philosophers for more than ten centuries, yet in the last age and in ours the observation of

- comets moving freely across from one of the supposed orbs to another,
- the intricate motions in the planet Mars (observed by Kepler and others to be sometimes nearer the earth than the sun is, and sometimes further away), and
- other phenomena undiscovered by the ancients,

have made even Tycho, as well as most of the recent astronomers, exchange the too-long-received opinion of solid orbs for the more warrantable belief in a fluid ether. And though the remoteness from us of the celestial part of the world makes it the most unlikely part to provide us with the means of overthrowing old theories by new discoveries, yet even there we may take notice of various instances to our present purpose, though I shall here name only this one: after the Ptolemaic number and order of the planets had passed uncontradicted for very many ages, and even the Tychonians and Copernicans, though dissenting from the Ptolemaic system as regards order, still accepted it as regards the number of the planets, after the happy discoveries made by Galileo of the satellites of Jupiter and by the excellent Huygens of the new planet about Saturn (which I think I had the luck to be the first who observed and showed disbelievers of it in England) the astronomers of all persuasions are brought to add to the old number 'seven' of the planets and take in five others that their predecessors did not dream of. [And he adds a second example, from human physiology.]

It would be easy to multiply instances of this kind, but I rather choose to add that it is not only about •the qualities and other attributes of things that new and often accidental discoveries may destroy the credit of long and generally approved opinions but also about •their causes. That quicklime exceedingly heats the water that is poured on to quench it because of antiperistasis [see Glossary] has been very long and universally accepted by the school-philosophers, for whom it is the grand and usual argument to establish antiperistasis; but I presume you have become aware that this proof is made wholly ineffectual (in the judgment of many of the virtuosi) by some contrary experiments of mine, and particularly that of arousing in quicklime as great an effervescence by the addition of hot water as by cold. Again, it has been generally

believed that in the freezing of water that liquid is condensed into a smaller space, whereas our recent experiments have satisfied most of the curious that ice is water *expanded*, i.e. that ice occupies more space than the water did when it remained unfrozen. And whereas the notion of nature's abhorrence of a vacuum has not only ever since Aristotle's time made a great noise in the schools but seems to be confirmed by a multitude of phenomena, the experiments of Torricelli and some of mine, showing the air has a great weight and a strong spring, have (I think) persuaded almost everyone who has impartially considered them that, whether or not there is such a thing as they call *fuga vacui* [= 'avoidance of vacuum'], the phenomena that are generally ascribed to it—such as suction and the rising of water in pumps—can be well explained without it, and are indeed caused by the weight of the atmosphere and the elastic power of the air.

The limits of much-praised practical devices

And this reminds me to take notice that even practical inventions, where one would think the matter of fact to be evident, may be brought by undreamed-of discoveries to lose the general reputation they had for completeness in their kind. ·I shall give three examples of this·. **(a)** To enhance the invention of sucking pumps and of siphons it has been generally presumed that water and any other liquid can be raised by either of these, *ob fugam vacui* [= 'to avoid a vacuum'], to whatever height one pleases; and accordingly ways have been proposed by famous authors to convey water from one side of a high mountain to the other. But the unexpected disappointments that were met with by some pump-makers, and afterwards experiments purposely made, sufficiently show that neither a pump nor a siphon will raise water more than about 35 feet or quicksilver more than 35 inches.

(b) As to the invention of weather-glasses, which has been so much and justly applauded and used, as it has been generally accepted as the truest standard of the heat and cold of the weather, so it seems to be liable to no suspicion of deceiving us, because:

Not only it is evident that in winter when the air is very cold the water rises much higher than in summer and other seasons when it is not so, but if you simply apply your warm hand to the bubble at the top the water will be visibly depressed by the rarefied air, and when your hand is removed so that the air returns to its former coldness the water will at once visibly ascend again.

And yet by **finding** that the atmosphere has a considerable weight which is not always the same but varies much, I have had the luck to satisfy many of the curious that these open thermometers are not to be safely relied on because in them the liquid is made to rise and fall not only (as men have hitherto supposed) by the cold and heat of the ambient air but (as I have shown by various new experiments) according to the varying gravity of the atmosphere, which variation has a visible and indeed a very considerable influence on the weather-glass. [Boyle builds into this sentence a caution about this **finding** of his: ‘... as far as I can yet discover, uncertainly enough...’.]

(c) To these examples I shall add only one more, from which we can learn that

despite a very attentive survey of everything that a man can at present take notice of or reasonably suspect that he ought to take into his consideration, the case may be such that having devised an instrument he may use it for many years with good success and yet—unless he could live for very many more—not be sure to out-live the danger of finding the same instrument (though not defective) to be fallacious.

He who first applied a magnetic needle to finding the meridian line, and finding that his needle pointed directly N and S or declining from that line just two or three or some other determinate number of degrees, might very plausibly conclude that he had discovered a certain and ready way, without the help of sun or stars or astronomical instruments, to describe a meridian line, and if he lived only an ordinary number of years after his observation he might probably have found his instrument not to be deceitful; but it may now *be* deceitful, because the magnetic needle not only declines in many places from the true N-S line but (as later discoveries inform us) in the course of time varies its declination in a single place.

The considerations I have presented might easily enough be increased by more to the same effect, especially if I thought fit to borrow from a work of mine purposely written about *The Partiality and Uncertainty of Fame*; but instead of adding to their number I would think myself obliged to excuse my having already mentioned so many, and insisted so much on them, if I did not strongly suspect that in your Physeophilus (as well as in many other modern naturalists) hardly anything contributes more to an undervaluation of the study of divinity than his confidence that physiology will help him to get the *certain* as well as *posthumous* fame that he is eagerly ambitious for; and therefore

next phrase: the design of his discourse

presumably meaning: the general trend of what he had to say on the occasion I am responding to

made me think it expedient to spend some time to show that it is far less easy than he thinks to be as sure that he will have the praises of future ages as ‘it is sure’ that (even if he has them) he will not hear them.

Theological seriousness does not rule out scientific fame

Those considerations have, I presume, convinced you that it is no such easy matter for a naturalist to acquire a great reputation and be sure it will prove a lasting one. Now, wanting to confirm second part of what I proposed earlier [i.e. item (ii) on page 57], I proceed to show that even if the case were otherwise he would still have no reason to slight the study of divinity.

[A] In the first place, nothing hinders a man who values and inquires into the mysteries of religion from achieving eminence in the knowledge of those of nature. Frequently men with great abilities successfully apply themselves to more than one study; and few of them have their thoughts and hours so much engrossed by that one subject or activity that they cannot find time not only to cultivate the study of nature but to excel in it, if they have a great inclination as well as fitness for it. You need not be told that Copernicus, to whom our late philosophers owe so much, was a churchman, that his champion Lansbergius was a minister, and that Gassendi himself was a doctor of divinity. Among the Jesuits you know that Clavius and various others have as prosperously devoted themselves to mathematics as to divinity. And as for physics: not only Scheiner, Aquilonius, Kircher, Schottus, Zucchius and others have very laudably cultivated the optical and some other parts of philosophy, but Ricciolus himself—the learned compiler of that voluminous and judicious work the *Almagestum Novum*, in which he has inserted some accurate observations of his own—is not only a divine but a professor of divinity. And without going out of our own country, if I were not afraid of offending the modesty of those I named or injuring the merit of those I omitted, I could name several of our English ecclesiastics who, though

they apply themselves so much to the study of the Scripture as to be not only solid divines but excellent preachers, have also been so happily conversant with nature that if they had lived in the learned times of the Greeks some of them would have rivalled if not eclipsed Pythagoras and Euclid, others of them Anaxagoras and Epicurus, and some of them even Archimedes and Democritus themselves.

Lower and higher goals for scientific inquiry

And certainly, provided enough curiosity and industry are employed in the study of nature, it is not necessary that the knowledge of nature should be the *ultimate* goal of that study. Fondness of the object is required only for engaging the mind in such a serious application; and a higher aim may sufficiently invite us to *that*, promoting rather than discouraging it. David became no less skillful in music than those who were devoted to it only to please themselves in it, though (we may reasonably suppose) such a pious author of psalms and instruments aspired to excellence in that delightful science so that he might offer it to the service of the temple and promote the celebration of God's praises with it. And as experience has shown that the heathen philosophers

- who courted moral virtue for itself

did not raise it to the pitch to which it was advanced by the heroic practices of those true Christians

- who in the highest exercise of virtue had the religious aim of pleasing and enjoying God,

I do not see why natural knowledge must be more prosperously cultivated by those selfish naturalists

- who aim only at pleasing themselves in the attainment of that knowledge

than it is by those religious naturalists

•who are invited to attention and industry not only by the pleasantness of the knowledge itself but by a higher and more engaging consideration, namely that by the discoveries they make in the book of nature both themselves and others may be excited and qualified the better to admire and praise the author, whose goodness so well matches the wisdom they celebrate that he declares in his word that he will honour those who honour him.

And just as a man who is not in love with a fair lady but has only a respect for her may have an idea of her face that is as true and perfect (though not as discomposing!) as the most passionate lover has, I do not see why a religious and inquisitive contemplator of nature may not be able to give a good account of it without preferring it so far to all other objects of his study as to make it his mistress and perhaps too his idol.

Theological study can itself bring fame

[B] Now I proceed to consider in the second place that matters of divinity, as well as those of philosophy, can provide a reputation to him who discovers or illustrates them. The fundamental articles of Christian religion are, as I have formerly declared, nearly as evident as they are important; but there are many other points in divinity and passages in the Scripture which (for reasons I have mentioned elsewhere) are exceedingly hard to be cleared, and not only •challenge ordinary readers and the common sort of scholars but will •sufficiently exercise the abilities of a high intellect, giving him opportunity enough to manifest that he is one. Many of the points I speak of are made obscure by the sublimity of the things they treat of, such as the nature, attributes, and decrees of God, which cannot be easy for the dim

understandings of us who are merely men. And many others that are not abstruse in their own nature are made obscure to us by our ignorance (or at least imperfect knowledge) of the disused languages in which they are delivered, and the great remoteness of the ages when and the countries where the things recorded were done or said. So that often a man may need and show as much learning and judgment to dispel the darkness in which •time has involved things as •to dispel• that which •nature has cast on them. And in fact we see, that St. Augustine, St. Jerome, Origen, and others of the Fathers have acquired as much reputation as Empedocles, Anaxagoras, and Zeno. And Grotius, Salmasius, Mr Mede, Dr Hamond, and some other critical expounders of difficult texts of Scripture have got as much credit through that work as Fracastorius has by his book *De sympathia & antipathia*, Levinus Lemnius by his *De occultis rerum miraculis* or Cardanus and his adversary Scaliger by what they wrote *De subtilitate*—or even Fernelius himself by his book *De abditis rerum causis*.

And it will contribute to the credit that theological discoveries and illustrations may procure for a man that the importance of the subjects and the earnestness with which men are given to busying themselves about them—

- some on grounds of piety,
- others on that of interest,
- some to learn truths,
- others to defend what they have long or publicly taught as truths

—makes greater numbers of men take notice of such matters, and concern themselves far more about them, than about almost anything else, and especially far more than about purely philosophical matters, which few think themselves fit to judge of or are concerned to trouble themselves about. And accordingly we see that the writings of Socinus, Calvin,

Bellarmino, Padre Paulo, Arminius etc. are more famous and more studied than those of Telesius, Campanella, Severinus Danus, Magnenus and various other innovators in natural philosophy. And Erastus, though a very learned physician, is much less famous for all his elaborate disputations against Paracelsus than for his little tract against particular forms of church-government. And I presume you have taken notice, as I have, that there are scarce any five new controversies in all physics that match the five ·theological· articles of the remonstrants in how many people know about them and how hotly they are contended for.

Fame is relatively unimportant

[C] It remains for me to tell you in the third place that even if it *were* the case that to prosecute the study of divinity one must of necessity neglect the acquisition of reputation, this inconvenience itself ought not to deter us from the duty in question. In any deliberation in which something is proposed to be quitted or declined in order to obey or please God, I think we may fitly apply what the prophet said to the Jewish king who—

being urged (to express his concern for God's glory) to decline the assistance of an idolatrous army of Israelites, and objecting that by complying with this advice he would lose a sum of money amounting to no less than the hire of a potent army

—received from the prophet this brisk but rational answer: 'The Lord is able to give thee far more than this.' The apostle Paul, who had been traduced, reviled, buffeted, scourged, imprisoned, shipwrecked, and stoned for his zeal to propagate the truths whose study I plead for, after he had once had a glimpse of that great recompense of reward that is reserved for us in heaven, confidently announces that on casting up

the account (for he uses the arithmetical term that is Greek for 'calculate') he finds that 'the sufferings of this present time are not worthy to be compared with the glory that is to be revealed in us'. And if all that the persecuted Christians of his time could suffer were not. . . proportional to that glory, the latter will surely far outweigh what we can now forgo or decline for it; because the loss of an advantage—and much more the mere missing of it—is usually only a negative affliction, in comparison with the actual suffering of evil. Not only did Christ tell his disciples that anyone who gave the least of his followers so much as a cup of cold water because of their relation to him would not be unrewarded, but when the same persons asked him what would be done for those who had left all to follow him, he immediately allots them *thrones*, outvaluing all that they had lost by as much as an ordinary recompense may exceed a cup of cold water. And indeed God's goodness is so great, and his treasures so unexhausted, that as he is eager to recompense even the least services that can be done him so he is able to give the greatest a proportional reward. Solomon had an opportunity—such as no mortal ever had (that we know of) either before or since—to satisfy his desires, whether for fame or anything else he could wish: 'Ask what I shall give thee' was the offer made him by Him who could give all things worth receiving; and yet the wisdom even of Solomon's choice, approved by God himself, consisted in declining •the things people have most ambition for in this life, for •things that might the better qualify him to serve and please God.

And to give you an example of someone greater than Solomon we may consider that he who

being in the form of God, thought it not robbery to be equal with God; and who by leaving heaven to dwell on earth gave up more than any inhabitant of the earth can give up to gain heaven; and who gave up

more to become capable of being tempted than he gave up when he was tempted with an offer of all the kingdoms of the world and the glory of them

—this Saviour is said in Scripture to have ‘for the joy that was set before him, endured the cross and despised the shame’; as if heaven had been a sufficient recompense for even his renouncing honours and embracing torments.

Anyone who declines the acquisition of the applause of men for the contemplation of the truths of God merely forbears to gather while it is immature something which by waiting God’s time he will more seasonably gather when it is fully ripe, wholesome and sweet. That incorruptible crown (as St. Peter calls it) which the gospel promises to those ‘who by patient continuance in well doing seek for glory and honour’ will make rich amends for the declining of a fading wreath here on earth, where reputation is often acquired as undeservedly as it is lost; whereas in heaven the sheer fact of *having* celestial honours shows that one is entitled to them. And since our Saviour reasons that his disciples ought to rejoice when their reputation is pursued by calumny and their lives by persecution ‘because their reward is great in heaven’, we may justly infer that

- the grounded expectation of such an illustrious condition, even when it is not accompanied by present applause

may bring us more contentment than

- this applause can give those who do not have that comfortable expectation.

So we have no reason to despond, or to complain of the study of theology, if it makes us decline an empty and transitory fame for a solid and eternal glory.

Conclusion

By this time, Sir, I have said as much as I think fit (and therefore, I hope, more than was necessary just for you) to show that Physeophilus had no just cause to undervalue •the study of divinity or •our friend the doctor for devoting himself to it. I hope you have not forgotten what I explicitly enough declared at the beginning of this letter, namely that because both your friend and you admit the holy Scriptures I knew that this entitled me to draw proofs from their authority. And if I need not remind you of this, perhaps I need not tell you by way of apology that I am acquainted with the laws of discoursing: if I had been arguing with atheists or sceptics I would have refrained from using some of the arguments I have employed here, as based on unconceded premises, and substituted others; but I think it very allowable for me to urge •the arguments I have used• when I deal with a person like your friend, who does not *reject the authority* of the Scriptures but only *undervalues the study* of them. And if the prolixity I have been guilty of already did not forbid me to increase it by apologies that are not absolutely necessary, I might think myself obliged to excuse the plainness of the style of this work, which may seem to require a richer dress—both because of the subject and because of you. But the matter is very serious, and you are a philosopher, and when the things we treat of are highly important I think that the most persuasive pieces of oratory are truths clearly made out. And a work of this nature is more likely to prove effectual on intelligent readers by having the reasons it presents •clearly proposed and unprejudicedly entertained than by their being •emotionally urged or elaborately adorned. And I have been all the more concerned to avoid expressions that might seem more proper to move than to convince because I foresee that I may soon have occasion to employ some of

the 'moving' sort in another letter to a friend of yours and mine, who will no doubt make you a sharer in the trouble of reading it. But in writing this for you and Physeophilus I was far more solicitous to give my arguments a good structure than ·to give them· a bright gloss. For even when we want to excite devotion, if it be in rational men, the most effective pieces of oratory are the ones which like burning-glasses inflame purely by bringing together numerous beams of light. If this letter proves so happy as to give you any satisfaction, it will thereby bring me a great one. For prizing you as I do, I cannot but wish to see you esteem those things now which I am confident we shall always have cause to esteem,

especially when the light of glory makes us better judges of the true worth of things. And it would extremely trouble me to see you disesteeming those divine things which as long as a man undervalues them the possession of heaven itself would not make him happy. And therefore if the blessing of him whose glory is aimed at in it make the success of this paper answerable to the wishes, the importance of the subject will make the service done you by it suitable to the desires, of

Sir,

Your most faithful, most affectionate, and most humble servant.