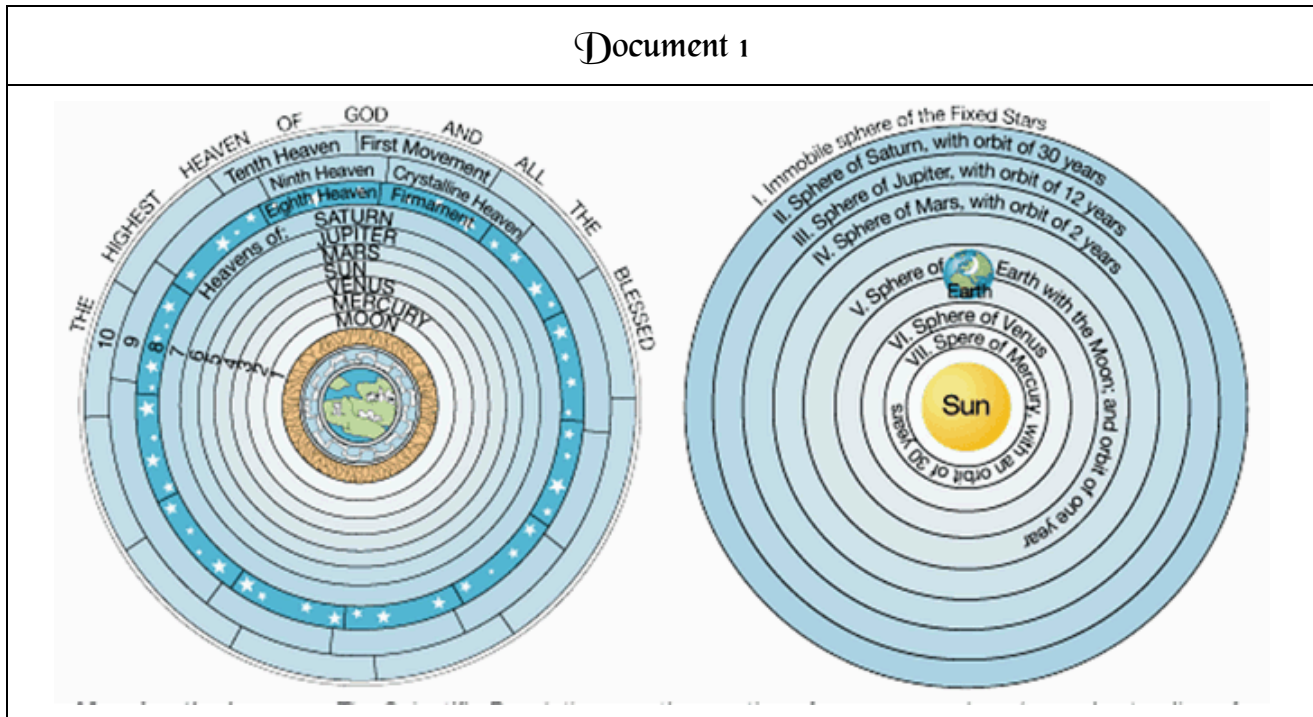


## The Scientific Revolution – Document Packet #1

### Document 1



### Document 2

It is generally agreed that the Middle Ages preserved for the use of later times the science of the ancients. Therein lies both the scientific achievement and the scientific failure of the medieval civilization. . . . What the Middle Ages took over they did not very much enrich. Indeed so small was their own contribution that historians of science are apt to regard the Middle Ages as something of a pause. . . .

Thus some advance on planes both purely intellectual and technical there was; yet taken together and placed against the vast panorama of medieval life, or indeed against the achievements of Greek and Hellenistic science in the fourth century B.C., or with the scientific activity of the seventeenth century, all these achievements are bound to appear very poor. Why then this poverty?

To this question many answers can be and have been given. But what most of them boil down to is the absence in medieval life of what I should be inclined to call scientific incentives. Students of science sometimes differ about the true inspiration of scientific progress. Some seek and find it in man's intellectual curiosity, in his desire to understand the workings of nature. Others believe that scientific knowledge grew and still grows out of man's attempts to improve his tools and his methods of production; that, in short, scientific truth is a by-product of technical progress. I do not want here to take sides in this particular controversy; what I want to suggest is that the Middle Ages were doubly unfortunate in that both the inspirations, the intellectual as well as the practical, failed more or less.

The easiest to account for is the intellectual. The Middle Ages were the age of faith, and to

that extent they were unfavourable to scientific speculation. It is not that scientists as such were proscribed. For on the whole the persecution of men for their scientific ideas was very rare: rare because men with dangerous ideas, or indeed with any scientific ideas at all, were themselves very rare; and it is indeed surprising that there were any at all. This does not mean that there were no intellectual giants. All it means is that in an age which was one of faith, men of intellect and spirit found the calls of faith itself--its elucidation, its controversies, and its conquests--a task sufficient to absorb them. To put it simply, they had no time for occupations like science.

In fact they had neither the time nor the inclination. For even if there had been enough men to engage in activities as mundane as science, there would still be very little reason for them to do so. In times when medieval religious dogma stood whole and unshaken the intellectual objects and the methods of science were, to say the least, superfluous. The purpose of scientific enquiry is to build up piecemeal a unified theory of the universe, of its origin and of its working. But in the Middle Ages was that process really necessary? Did not medieval man already possess in God, in the story of Creation and in the doctrine of Omnipotent Will, a complete explanation of how the world came about and of how, by what means and to what purpose, it was being conducted? Why build up in laborious and painstaking mosaic a design, which was already there from the outset, clear and visible to all?

So much for intellectual incentive. The practical incentive was almost equally feeble. Greater understanding of nature could not come from technical improvements, chiefly because technical improvements were so few. Medieval occupations continued for centuries without appreciable change of method. After the great period of initial development, i.e., after the late eleventh century, the routine of medieval farming in the greater part of Europe became as fixed as the landscape itself. In the history of the smithies, the weaving shops, or the potteries, there were occasional periods of innovation, but taking the Middle Ages as a whole technical improvement was very rare and very slow. For this medieval economic policy was largely to blame. In the course of centuries economic activities got surrounded with a vast structure of bye-laws and regulations. . . . For bye-laws were as a rule based on the technical methods in existence when they were framed; and once framed they were to stand in the way of all subsequent change.

What is more, so deeply ingrained was the spirit of protection that in every local trade the technical methods were treated as a secret. . . . The men of the Middle Ages were unable to do more than they did because they were lacking in scientific incentive. What they achieved in advancing the practical arts of humanity or in preserving and transmitting ancient learning, they did in so far and as long as they were not typically medieval.

**SECONDARY SOURCE:** Michael Postan, "Why Was Science Backward in the Middle Ages?" in *A Short History of Science: Origins and Results of the Scientific Revolution* (London: Routledge and Kegan Paul), pp. 10-17.

### Document 3

There were an infinite number of motives which led men to engage in scientific work and to clear the scientific point of view from encumbrances; but we may group together some of the most important under general headings, always remembering that in actual life each of them was compounded with the others. There were economic motives. The Portuguese explorers wanted their new instrument for navigation; the German mine-owners asked questions about metallurgy and about machines for lifting and carrying heavy loads; Italian engineers improved their canals and locks and harbors by applying the principles of hydrostatics; English trading companies employed experts who used new methods of drawing charts. Not far removed from the economic motives were those of the physicians and

surgeons, who revolutionized anatomy and physiology, and did much more good than harm with their new medicines and new operations, though some of them now seem absurd. Like the doctors, the soldiers called science to their aid in designing and aiming artillery or in planning fortifications. But there were other motives far removed from the economic sphere. Jewelers learnt much about precious and semi-precious stones, but so did magicians. Musicians learnt the mathematics of harmony; painters and architects studied light and color, substances and proportions, not only as craftsmen but as artists. For a number of reasons religion impelled men to scientific study. The most definite and old-established was the desire to reach absolute correctness in calculating the dates for the annual fixed and movable festivals of the Church: it was a pope who presided over the astronomical researchers by which the calendar was reformed in the sixteenth century. Deeper and stronger was the desire to study the wonders of science, and the order which it unraveled in the universe, as manifestations of the Creator's will. This was closer than any of the other motives to the central impulse which actuated them all, the disinterested desire to know.

**SECONDARY SOURCE:** Sir George Clark, *Early Modern Europe*. Oxford University Press (Oxford, England, 1957), pp. 164-165.

#### Document 4

I think that in discussions of physical problems we ought to begin not from the authority of scriptural passages, but from sense-experiences and necessary demonstrations; for the holy Bible and the phenomena of nature proceed alike from the divine Word, the former as the dictate of the Holy Ghost and the latter as the observant executrix of God's commands. It is necessary for the Bible, in order to be accommodated to the understanding of every man, to speak many things which appear to differ from the absolute truth so far as the bare meaning of the words is concerned. But Nature, on the other hand, is inexorable and immutable; she never transgresses the laws imposed upon her, or cares a whit whether her abstruse reasons and methods of operation are understandable to men. For that reason it appears that nothing physical which sense-experience sets before our eyes, or which necessary demonstrations prove to us, ought to be called in question (much less condemned) upon the testimony of biblical passages which may have some different meaning beneath their words. For the Bible is not chained in every expression to conditions as strict as those which govern all physical effects; nor is God any less excellently revealed in Nature's actions than in the sacred statements of the Bible. . . .

From this I do not mean to infer that we need not have an extraordinary esteem for the passages of holy Scripture. On the contrary, having arrived at any certainties in physics, we ought to utilize these as the most appropriate aids in the true exposition of the Bible and in the investigation of those meanings which are necessarily contained therein, for these must be concordant with demonstrated truths. I should judge that the authority of the Bible was designed to persuade men of those articles and propositions which, surpassing all human reasoning, could not be made credible by science, or by any other means than through the very mouth of the Holy Spirit.

Yet even in those propositions which are not matters of faith, this authority ought to be preferred over that of all human writings which are supported only by bare assertions or probable arguments, and not set forth in a demonstrative way. This I hold to be necessary and proper to the same extent that divine wisdom surpasses all human judgment and conjecture.

But I do not feel obliged to believe that that same God who has endowed us with senses, reason, and intellect has intended to forgo their use and by some other means to give us knowledge which we can attain by them.

**SOURCE:** A Letter to Christina of Tuscany from Galileo Galilei, 1615.

## Document 5

We say, pronounce, sentence, and declare that you, the said Galileo, by reason of the matters adduced in trial, and by you confessed as above, have rendered yourself in the judgment of this Holy Office vehemently suspected of heresy, namely, of having believed and held the doctrine—which is false and contrary to the sacred and divine Scriptures—that the Sun is the center of the world and does not move from east to west and that the Earth moves and is not the center of the world; and that an opinion may be held and defended as probable after it has been declared and defined to be contrary to the Holy Scripture; and that consequently you have incurred all the censures and penalties imposed and promulgated in the sacred canons and other constitutions, general and particular, against such delinquents. From which we are content that you be absolved, provided that, first, with a sincere heart and unfeigned faith, you abjure, curse, and detest before us the aforesaid errors and heresies and every other error and heresy contrary to the Catholic and Apostolic Roman Church in the form to be prescribed by us for you.

**SOURCE:** The Papal Inquisition's condemnation of Galileo, 1633.

## Document 6

### **RULE I**

We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.

To this purpose the philosophers say that Nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity, and affects not the pomp of superfluous causes.

### **RULE II**

Therefore to the same natural effects we must, as far as possible, assign the same causes. As to respiration in a man and in a beast; the descent of stones in Europe and in America; the light of our culinary fire and of the sun; the reflection of light in the earth, and in the planets.

### **RULE III**

The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever:

For since the qualities of bodies are only known to us by experiments, we are to hold for universal all such as universally agree with experiments; and such as are not liable to diminution can never be quite taken away. .

**SOURCE:** *Mathematical Principles of Natural Philosophy*, Sir Isaac Newton, 1687.