Author

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The Historical Context

From the Middle Ages on, and increasingly thereafter, individual European thinkers appropriated ideas and information from a wide variety of sources and applied them to many kinds of problems. Among the sources they drew on were Arabic translations of ancient Greek texts and original works by Muslim authors, rendered into Latin. Even among those European scholars who focused on the characteristics and operation of nature (as opposed to, say, theology or law), not all shared the same assumptions about how the world works, how we can discover how the world works, and how to approach Muslim or Greek ideas that appear to conflict with the Bible or with Christian doctrine. Science (called natural philosophy until well into the nineteenth century) was not a single unified idea. "New" and "old" ways of approaching nature coexisted at the same time.

Not only the information base but the mindset of educated Europeans underwent radical changes, centered on what is conventionally known as the scientific revolution of the seventeenth century.

Scholars disagree, however, on whether the term “revolution” is really appropriate. Some of the issues they have raised include these:

- The changes were set in motion by historical conditions and events that occurred in earlier centuries.
- Many medieval ways of thinking about the world continued to be influential as late as the eighteenth and nineteenth centuries.
- There was no agreement even among those engaged in science in the 1600’s about which practices resulted in genuine knowledge. Some advocated reliance on reasoning one’s way to theories (the deductive method, mostly associated with followers of Descartes and with continental practitioners). Others urged the primacy of collecting facts by observation and experiment (the inductive method, mostly associated with English scholars and followers of Francis Bacon.)
- The mathematization of science was an important feature of seventeenth-century scientific practice. But while some held that the purpose of science was to study the regularities observed in nature in order to establish mathematically formulated laws of nature, others aimed for knowledge of physical causes and doubted whether mathematics could capture the complexities and contingencies of nature.
- Two very different groups enlisted science in their cause: both radical freethinkers and those conservatives who held that finding universal laws in nature sanctioned the rule of law in society and guarded religious and moral principles against change,.
- The changes that occurred during the scientific revolution were far from pervasive. They continued to be resisted by a significant number of people working in the field of natural philosophy, as well as the general educated public. The new ideas left women and people below the upper middle classes virtually untouched before the eighteenthcentury.

Nevertheless, it would be hard to argue against the claim that by 1800 very basic changes had taken place in thinking about and observing the natural world, though changes came at different times in different places and were accepted in varying degrees. The following are some examples:

Astronomy. The picture of the universe changed from the medieval one, a universe enclosed within crystalline spheres to consideration of a plurality of worlds and the possibility of an infinite universe; and from belief in fundamental differences in the substance and behavior of matter on earth and in the heavens to knowledge of the universal laws of motion valid throughout the universe.

Anatomy. The authority of the Greek physician Galen was overturned as a result of Vesalius’ hands-on dissection of human corpses, as well as Harvey’s experiments in animal vivisection and measurement of the heart’s capacity to pump blood.

Mathematics. Theory and practice changed from pre-1500 routine use of Roman numerals to full use of Indian/Arabic numerals with the zero, logarithms, coordinates, calculus, probability theory, and the slide rule.

Botany and zoology. Medieval classification of living organisms into four elements and four types of soul was replaced by Linnaeus' eighteenth-century classification by family relationships. According to him, he avoided classing humans with apes only to avoid "bringing down the theologians on my head."

Biology. The strongly rooted belief in spontaneous generation of worms, insects, and even rats from decaying matter, mud, or "ocean vapors" was disproved after 1600 by experimental investigation and microscopic examination of reproductive organs.

Chemistry. Alchemists in the Middle Ages recognized four elements: earth, water, air, fire. They attributed characteristics of living beings to minerals and attempted to transform base metals into gold. In the late eighteenth century, scientists issued a new table of 33 elements, separated air into several gases, decomposed water into newly-discovered oxygen and hydrogen, and generally abandoned the idea that the inorganic could be animate.

Pursuit of natural philosophy broadened. In the Middle Ages, it was almost exclusively the province of churchmen in universities. In the early modern period science in universities continued, but mainly non-church-related people pursued science in voluntary and government-sponsored scientific societies. Those who were not scientists but interested in, and knowledgeable about, science included even people of merchant and craft backgrounds, and, by 1800, women.

Before about 1500, Europe was a society that thought of itself as Christendom, with virtually universally accepted values, world-view and mindset, authoritatively handed down from the past. Intellectual progress was largely thought to depend on rediscovery and absorption of the achievements of ancient Greek and Roman civilizations. By 1800, Christianity had splintered. Many more alternative values and world-views had become known. And the cutting edge of intellectual progress was associated with the application of mathematical models and experimental methods to all aspects of nature.

The promise and threat of the changes in science was associated with the increasingly accepted idea of methodical doubt about all that earlier had been taken for granted. This led to questioning, discarding, and rejecting aspects of the past to start from scratch, abandoning authorities and preconceived ideas, encouraging attitudes that by the eighteenth century expanded to include new ideas for changing society.

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Historical preconditions and influences that set the stage for the scientific revolution were many and varied:

- Broadening informational, geographical, and cultural horizons were brought about by:
    - The series of Crusades between the eleventh and fifteenth centuries.
    - Overland trade with Asia during the era of the Mongol Empires in the thirteenth and fourteenth centuries.
    - The voyages of discovery followed by colonization starting in the late fifteenth century gave not only individuals but governments a stake in gathering new information, which often cast doubt on traditional authorities.
    - A consistent trickle and occasional flood of philosophical, scientific, mathematical, and other works translated from Greek, Arabic, and Hebrew into Latin, starting in the twelfth century, and into vernacular languages from the seventeenth century; the publication in print of early Muslim as well as Greek and Hebrew scholarship.
    - Increasing demand for literacy and number skills in commerce and in government bureaucracies; acquaintance with scientific principles in crafts and industries such as metallurgy, mining, navigation, the making of scientific instruments.
    - New methods and institutions that promoted sharing of knowledge by different groups of people, such as universities, printing firms, scientific societies, salons, coffee-houses, reading groups, and public lectures.
    - The willingness of early modern scientists to draw on the experience and know-how of others, not only scientists and philosophers but also engineers, artisans, navigators, cartographers, gunners, and others.
- Increasing secularization of interests and power-bases increased focus on this world rather than on the afterlife; reduced the ability of religious authorities to stifle new scientific ideas that ran afoul of the Bible or church doctrines.
    - During the Middle Ages, education passed from cathedrals and monasteries to universities. Subjects belonging to natural philosophy became part of the formal university curriculum; theology, while still "queen of sciences," was only one professional school alongside medicine and law. Moreover, universities were self-governing corporations with a wide range of rights and privileges, including that of the faculty to decide what is to be taught.
    - Mobility of labor (partly due to scarcity caused by the Black Death), urbanization, and the use of mercenary armies, reduced the effectiveness of formal excommunication from the Church as a way to control belief and behavior.
    - Secular rulers appropriated powers previously held by Church authorities, such as appointing bishops, trying cases in secular rather than church courts; German princes and other rulers renouncing the Pope and joining the Protestant movement; Henry VIII making himself head of the Church of England.
    - During the Renaissance, a number of trends contributed to religion's loss of priority among a segment of the population: educated elites' admiration for classical authors, forms, and works; their emphasis on secular subject-matter, human-centered themes, and realistic representation of the human body; their critical approach to history that eventually spread to examination of religion-related writings.

    - The discovery and translation of many more works by Plato and his followers than had been known in the Middle Ages; the emphasis in these works on thinking about the world in mathematical ways made a big impact on the scholarly world.
    - From the sixteenth century, rulers and governments came to support science and scientists for the latter's pragmatic usefulness in many fields, such as navigation, metallurgy, and gunnery.
- Christianity's ability to give space within the faith's parameters for the pursuit of science, and the fact that its practitioners were faithful believers, helped give cultural legitimacy to the new science in the still devout seventeenth century.
    - Medieval scholastics, trying to reconcile Christianity with the philosophies of pagan Greece and Rome as well as with some Muslim writers, came to the conclusion that there was no inherently necessary conflict between science and faith.
    - The belief that God wrote two books, the Bible, and the "Book of Nature," by which his existence and intentions could be known. This idea was emphasized during the early modern period. Therefore, the study of nature had religious value, and the notion that humans should use their God-given faculties of observation and reason to read the "Book of Nature" accurately could be regarded as a religious duty.

Nevertheless, problems arose in specific instances where new ideas conflicted with the authority of Scripture, doctrine, or those ancient philosophers accepted as important for the faithful to study. Threats to these authorities were countered by religious institutions, though not always immediately, consistently, or successfully.

The widespread current of skepticism that developed in the sixteenth and seventeenth centuries encouraged questioning of authorities, beliefs, and previously held ideas. Contributing to the development of this skepticism were the shocks to established world-views, shaking of previously secure beliefs, disappointments with existing knowledge and authorities, and radical uncertainties created by the following:

- Early events that encouraged questioning traditional wisdom and institutions included the fourteenth-century Black Death, to which traditional society's response was wholly inadequate; the Popes' loss of authority to kings and to church Councils; and the scandal of two Popes, one in Rome and one in Avignon, France, claiming legitimacy.
- The success of the Protestant Reformation led to a splintering of Christendom into multiple denominations within European Christianity, all claiming to be the one true way to salvation.
- Devastating religious wars that involved most of Europe raged during virtually the entire period between the mid-sixteenth and mid-seventeenth centuries.

- Information was brought back from voyages of discovery and colonizing ventures about peoples who had radically different ways of thinking, behaving, and organizing society.

It would be easy to claim, and with justification, that the scientific revolution was a watershed event in history. Such a claim, however, does not do justice to the complexity of the phenomena for which "scientific revolution" is at best a shorthand term. This unit is intended to illustrate some of the complexities, to help students consider some of the questions raised, and to encourage them to raise some of their own.

Lesson 2

Student Handout—Science Comes of Age: Was It a Revolution?

Document I. "Minds and Hands Both Needed" from Leonardo da Vinci's 1510's manuscript on painting

They say knowledge born of experience is mechanical, but that knowledge born and consummated in the mind is scientific. . . . But to me it seems that all sciences are vain and full of errors that are not born of experience, mother of all certainty, and that are not tested by experience, that is to say that do not . . . pass through any of the five senses.

For if we are doubtful about the certainty of things that pass through the senses, how much more should we question the many things against which these senses rebel, such as the nature of God and the soul and the like, about which there are endless disputes and controversies. . . . Where there are quarrels there true science is not; because truth can only end one way—wherever it is known, controversy is silenced for all time, and should controversy nevertheless arise again, then our conclusions must have been uncertain and confused. . . .

Experience . . . always proceeds from accurately determined first principles, step by step in true sequences . . . as can be seen in the elements of mathematics founded on numbers and measures called arithmetic and geometry, which deal with discontinuous and continuous quantities with absolute truth. Here no one argues as to whether twice three is more or less than six. . . .

Astronomy and the other sciences also entail manual operations although they have their beginning in the mind, like painting, which arises in the mind of the contemplator but cannot be accomplished without manual operation. The scientific and true principles of painting first determine what is…darkness, light, color, body, figure, position, distance, nearness, motion, and rest. These are understood by the mind alone and entail no manual operation; and they constitute the science of painting which remains in the mind . . . and from it is then born the actual creation [which needs hands].

Source: Qtd. in Elizabeth G. Holt, ed., *A Documentary History of Art*, vol. 1 (Garden City, NY: Doubleday Anchor, 1957-), 275-7.

Document J. "The Earth Moves" from Copernicus's 1543 book *On the Revolutions of Heavenly Orbs*

When I had thought for a long time about the uncertainty of the traditional mathematical doctrine concerning the paths of the heavenly bodies, it seemed to me very regrettable that no more correct theory had yet been advanced by philosophers for the movements in that universe which the best and most perfect Architect had made for us. . . .

Therefore I took the pains to read through the writings of all the philosophers that I could get together in order to find out if some one of them had not stated the opinion that the movements of the heavenly bodies might be other than the professional mathematicians had claimed. And I did find . . . in Cicero [Roman lawyer, politician and philosopher] that Nicetas [Byzantine bishop and writer on religious topics] had thought that the earth moves. I read in Plutarch [Greek biographer and historian] that some others also had been of this opinion. . . .

When I had received this suggestion I began myself also to meditate upon a motion of the earth. And although this theory might seem nonsensical, yet because I knew that others before me were allowed the liberty to suppose all sorts of circles in order to explain the phenomena in the heavens, so I too would be permitted to try whether building on the theory of the earth's motion I might find more satisfactory explanations for the movements of the heavenly bodies.

After I had then assumed the motions which I assign to the earth in the following work, I found, after careful investigation extending through years, that if the movements of the other planets were referred to the motion of the earth in its orbit and reckoned according to the revolution of each star, not only could their observed phenomena be logically explained, but also the succession of the stars, and their size, and all their orbits, and the heavens themselves would present such a harmonious order that no single part could be changed without disarranging the others and the whole universe. In accordance with this theory I have drawn up the plan of my work. . . .

The first thing for us to realize is that the universe is spherical. This is so either because, of all forms, the sphere is most perfect, requiring no joins; or because it is the most capacious, and so best fitted to enclose and preserve all things; or because all things strive to be bounded thus, as we observe in drops of water and other liquids. There can be no doubt, then, about the rightness of assigning this shape to the heavenly bodies.

Source: Qtd. in H. Webster, *Historical Selections* (Boston: D. C. Heath, 1929), 885-6; and in Dennis Richard Danielson, *The Book of the Cosmsos* (Cambridge, MA: Perseus, 2000), 108. Language simplified by Anne Chapman.

Document K. "About Magnets" from William Gilbert's 1600 book *On the Great Magnet the Earth*

For the discovery of secret things and the investigation of hidden causes, sure experiments and demonstrated arguments are preferable to probable conjectures and the opinions of philosophical speculators. Aiming for the better understanding of that great loadstone [magnet] the earth, and of the extraordinary forces of this globe, we have decided to begin first with magnetic bodies and the parts of the earth that we may handle and perceive with the senses, and then to proceed with magnetic experiments… Every day, in our experiments, novel, unheard-of properties came to light. . . .

Many things in our reasonings and our hypotheses will perhaps seem hard to accept, since they differ from the general opinion. But I have no doubt that hereafter they will win authoritativeness from the demonstrations themselves. . . .

We do not at all quote the ancients and the Greeks as our supporters. Our doctrine of the loadstone contradicts most of the principles and theories of the Greeks. . . . We have had no hesitation in setting forth, in hypotheses that are provable, the things that we have through a long experience discovered.

Wood floating on water never turns by its own forces towards the poles of the world save by chance. Neither do threads of gold, silver, copper, zinc, lead, nor glass, when passed through cork and floated, ever have sure direction. When rubbed with a loadstone they show neither poles nor points of variation; for bodies that do not of their own accord turn towards the poles and are not obedient to the earth are in no way governed by the loadstone's touch. The energy of the loadstone cannot enter them, nor, if it could enter them, would that energy have any effect. This because the [magnetic] property of the earth is debased in them because it is mixed with a variety of other humors… The properties of iron, on the other hand, are awakened by the approach of a loadstone, and put forth their strength. . . .

Here we must express wonder at the false opinion of Baptista Porta, [author of *Natural Magic*, 1558, which includes discussions of magnets, experiments, cookery, alchemy, and demonology] who claims that iron rubbed with a diamond turns to the north. Now this is contrary to our magnetic rules; and therefore we made the experiment ourselves with seventy-five diamonds in the presence of many witnesses, using a number of iron bars and pieces of wire, manipulating them with the greatest care while they floated in water, supported by corks; yet never did I see the effect mentioned by Porta. . . .

Source: William Gilbert, *On the Loadstone and Magnetic Bodies, and On the Great Magnet the Earth.* Trans. P. Fleury Mottelay (New York: John Wiley and Sons, 1893), xlvii-li, 217-8. Language simplified by Anne Chapman.

Document L. Acceptance of Proven Truth from Cardinal Bellarmine's 1616 letter to a defender of Copernicus's theory

If there were a real proof that the Sun is in the center of the universe, that the Earth is in the third heaven [the third from the center of the eight or nine crystalline spheres or "heavens" into which the planets and stars were thought to be fixed] and that the Sun does not go round the Earth but the Earth round the Sun, then we should have to proceed with great circumspection [care] in explaining passages of Scripture which appear to teach the contrary, and rather admit that we did not understand them than declare an opinion to be false which is proved to be true.

But, as for myself, I shall not believe that there are such proofs until they are shown to me. Nor is it proof that, if the Sun [was] supported at the center of the universe and the Earth in the third heaven, everything works out the same as if it were the other way around. In case of doubt we ought not to abandon the interpretation of the sacred text [Bible] as given by the holy Fathers.

Source: Quoted in Peter Dear, ed., *The Scientific Enterprise in Early Modern Europe: Readings from Isis* (Chicago: University of Chicago Press, 1997), 147-8.

Document M. "Insect Experiments" from Francisco Redi's 1668 book on the *Generation of Insects*

It is not only the popular belief, but it is also stated authoritatively by both ancients and moderns that the rotting of a dead body, or any sort of decayed matter, can give being to worms just by itself. Desiring to trace the truth of the case, I made the following experiment.

I ordered three snakes to be killed . . . [and] placed them in an open box to decay. Not long afterwards I saw that they were covered with worms . . . .intent on devouring the meat. . . . When the meat was all consumed, the worms eagerly sought an exit, but I had closed every opening. Nineteen days later, some of the worms ceased all movements . . . and appeared to shrink and gradually assume a shape like an egg. . . . I placed these . . . . separately in glass vessels, well covered with paper, and at the end of eight days . . . from each came forth a fly. . . .

I continued similar experiments with the raw and cooked flesh of the ox, deer, buffalo, lion, tiger, dog, lamb, kid, rabbit; and sometimes with the flesh of ducks, geese, hens, swallows, etc. Finally I experimented with different kinds of fish. . . . In every case, flies were hatched. Almost always, I saw that the decaying flesh and the cracks in the boxes where it lay were covered not alone with worms, but with the eggs from which, as I have said, the worms were hatched. . . .

Having considered these things, I began to believe that all worms originated from the droppings of flies, and not from the decay of the meat. I was still more confirmed in this belief by having found that, before the meat grew wormy, flies had hovered over it, of the same kind that later bred in it.

Belief would be vain without the confirmation of experiment.

Therefore, I put a snake, some fish, some eels . . . and a slice of veal in four large, wide-mouthed flasks. Having well closed and sealed them, I then filled the same number of flasks in the same way, only leaving these open. It was not long before the meat and the fish, in these second vessels, became wormy and flies were seen entering and leaving at will.

Outside the closed flasks, on the paper cover, there was now and then a deposit, or a maggot that eagerly sought some crack through which to enter and feed. But in them I did not see a worm. Meanwhile, the different things inside the flasks had become putrid and stinking. . . .

I thought I had proved that the flesh of dead animals could not generate worms unless the eggs of live ones were deposited therein.

Source: Francesco Redi, *Experiments on the Generation of Insects*. Trans. M. Bigelow (Chicago: Open Court Publishing, 1909), 22-36. Text slightly rephrased for clarity by Anne Chapman.

Document N. "I Believe in Witchcraft" from Addison's 1711 essay in the periodical *The Spectator*

There are some opinions in which a man should stand neuter, without engaging his assent to one side or the other. Such a hovering faith as this, which refuses to settle upon any destination, is absolutely necessary in a mind that is careful to avoid errors and prepossessions. What the arguments press equally on both sides on matters that are indifferent to us, the safest method is to give ourselves up to neither. . . . I believe in general that there is, and has been such a thing as witchcraft; but at the same time can give no credit to any particular instance of it.

Source: Quoted in Phyllis J. Guskin, "The Context of Witchcraft," *Eighteenth Century Studies* 15 (1981): 58.

Document O. "Technology Adopts Science" from Leupold's 1725 treatise on improving machinery

His Majesty the King of Poland and His Highness the elector of Saxony have been graciously pleased to command me to supervise and to improve the organization of the engineering and machines of all the mines. . . . For [this], the following preparation is necessary:

1. A clear list must be made of all devices and machines which are in the mines or foundries . . . their parts and component pieces must be drawn accurately to scale . . . and calculated by Theory.

2. The power of each engine must be calculated as accurately as possible and . . . what [it] is now doing and what according to principles or theory it should be doing. . .

3. At the same time, all the mechanical and physical foundations and causes of both performance and non-performance should be explained clearly by experiments and sketches, together with the calculations, both geometrical and mechanical. . . .

5. I have invented devices for measuring . . . water-power, so that by means of an accurate clock with a second-hand . . . and of certain tables and rules, anyone should be able to calculate that in one minute or in one second, so much water will flow through. . . .

8. I will produce divers machines, inventing them entirely anew, in order to investigate the power of falling water [which is] . . . one of the most important items; for the whole question of improving machinery depends on (1) the right application of force, (2) the elimination of friction. . . .

9. I will give faithful guidance and teaching by experiments and on the engines at every mining-town or district where I find mining-crafts and persons who have need of the principles governing mechanics and their engines, and who are desirous of knowledge.

Source: Quoted in Friedrich Klemm, *A History of Western Technology,* trans. D. W. Singer (New York: Charles Scribner's Sons, 1959), 238-9.

Document P. "History As Science" from David Hume's 1748 book *Concerning Human Understanding*

It is universally acknowledged that there is great uniformity among the actions of men, in all nations and ages, and that human nature remains still the same. . . . The same motives always produce the same actions. The same events follow from the same causes. . . .

Mankind are so much the same in all times and places that history informs us of nothing new or strange. . . . Its chief use is only to discover the constant and universal principles of human nature, by showing men in all varieties of circumstances and situations, and furnishing us with materials from which we may form our own observations. . . . These records of wars, intrigues, factions, and revolutions are so many collections of experiments, by which the politician or moral philosopher fixes the principles of his science, in the same manner as the physician or natural philosopher becomes acquainted with the nature of plants, minerals, and other external objects, by the experiments which he forms concerning them.

Source: Quoted in Isaac Kramnick, *The Portable Enlightenment Reader* (New York: Penguin Books, 1995), 359-60.

Document R. "Science Leads to God" from Colin Maclaurin's 1775 book on Newton's Discoveries

A strong curiosity has prompted men in all times to study nature; every useful art has some connections with this science…But natural philosophy [science] is subservient to purposes of a higher kind, and is chiefly to be valued as it lays a sure foundation for natural religion and moral philosophy; by leading us, in a satisfactory manner, to the knowledge of the Author and Governor of the universe…

Source: Quoted in Carl L. Becker, *The Heavenly City of Eighteenth-Century Philosophers* (New Haven: Yale UP, 1932), 62.

Sir Isaac Newton (1643-1727)
English Physicist and Mathematician
Mezzotint by James McArdell after Enoch Seeman. 1760. Prints & Photographs Division, Library of Congress LC-USZ62-10191

Document S. "Dare to Know!" from Kant's 1784 essay on "What is Enlightenment?"

Enlightenment is man's emergence from his self-imposed nonage [immaturity.] Nonage is the inability to use one's own understanding without another's guidance. This nonage is self-imposed if its cause lies not in lack of understanding but in indecision and lack of courage to use one's own mind without another's guidance. *Sapere aude!* [Dare to know!] "Have the courage to use your own understanding," is therefore the motto of the Enlightenment.

Laziness and cowardice are the reasons why such a large part of mankind gladly remain minors all their lives, long after nature has freed them from external guidance. They are the reasons why it is so easy for others to set themselves up as guardians. It is so comfortable to be a minor. If I have a book that thinks for me, a pastor who acts as my conscience, a physician who prescribes my diet, and so on—then I have no need to exert myself. I have no need to think, if only I can pay; others will take care of that disagreeable business for me. Those guardians who have kindly taken supervision upon themselves see to it that the overwhelming majority of mankind—among them the entire fair sex—should consider the step to maturity not only as hard, but as extremely dangerous.

First, these guardians make their domestic cattle stupid and carefully prevent the docile creatures from taking a single step without the leading-strings to which they have fastened them. Then they show them the danger that would threaten them if they should try to walk by themselves. Now, this danger is really not very great; after stumbling a few times they would, at last, learn to walk. However, examples of such failures intimidate and generally discourage all further attempts. . . .

Enlightenment requires nothing but freedom—and the most innocent of all that may be called "freedom": freedom to make public use of one's reason in all matters. Now I hear the cry from all sides: "Do not argue!" The officer says: "Do not argue! Drill!" The tax collector: "Do not argue! Pay!" The pastor: "Do not argue! Believe!" Only one ruler in the world says: "Argue as much as you please, and about what you please, but obey!"

We find restrictions on freedom everywhere. But which restriction is harmful to enlightenment? I reply: the public use of one's reason must be free at all times, and this alone can bring enlightenment to mankind.

Source: Qtd. in Peter Gay, ed. *The Enlightenment: A Comprehensive Anthology* (New York: Simon and Schuster, 1973), 384-6.

Document T. "Science and Progress" from Condorcet's 1793 *The Progress of the Human Mind*

The progress of philosophy and the sciences has favored and extended the progress of letters, and this in turn has served to make the study of sciences easier. . . .

Scholarship . . . . already knew how to weigh up authorities and compare them; it now learned how to bring every authority before the bar of reason. . . . Nevertheless, we still see the forces of enlightenment in possession of no more than a very small portion of the globe, and the truly enlightened vastly outnumbered by the great mass of men who are still given over to ignorance and prejudice. . . .

The progress of the sciences ensures the progress of the art of education which in turn advances that of the sciences. This reciprocal influence . . . deserves to be seen as one of the most powerful and active causes working for the perfection of mankind. . . . As each [science] advances, the methods of expressing a large number of proofs in economical fashion and so making it easier to understand them, advance with it. . . .

In the political sciences there are some truths that, with free people . . . can be of use only if they are widely known and acknowledged. So the influence of these sciences upon the freedom and prosperity of nations must in some degree be measured by the number of truths that, as a result of elementary instruction, are common knowledge; the swelling progress of elementary instruction, connected with the necessary progress of these sciences, promises us an improvement in the destiny of the human race. . . .

Source: Quoted in Alfred J. Andrea and James H. Overfield, eds. *The Human Record: Sources of Global History*, Vol. 2 (Boston: Houghton Mifflin, 1990), 182-5.

Student Handout 1.2—Origins of Fur

During the 1500s, Europeans began exploring the east coast of mainland North America. They traded items such as knives, hatchets, and beads to Native Americans for fur and meat. Indian trappers such as the Iroquois brought beaver furs from the interior to the St. Lawrence River and traded there for manufactured goods from Europe. Out of these early exchanges a formal fur trade was born in North America. It began in the area that is today modern Quebec. Because the best pelts were from areas that had severe winters, most trade was in Canada. Some trade, however, also developed along the Mississippi River and to the west in the Rocky Mountains.

Lesson 1

Student Handout 1.3—Origins of Indigo

True indigo comes from a plant species called *Indigofera*, which is a subtropical shrub that grows to be 4-6 feet tall. The leaves of the indigo plant are what make the beautiful blue dye that indigo is famous for around the world. The word indigo comes from ancient Greek, meaning "the Indian dye" or *indiko*. This is a clue about where the ancient Mediterranean world got indigo from.

Many different species of *Indigofera* have been found all over the world from Australia to Madagascar. Many societies have used the plant's blue dye for religious, cultural, social, political, and aesthetic purposes. Various species of the plant have been found in Guatemala and Peru, where they were used for a variety of purposes long before Europeans came to the Americas. Indigo also grows wild all over the African coast and has been used as a symbol of wealth and fertility in West African societies for centuries. Modern day countries like Mali, Cameroon, Nigeria, Niger, and Burkina Faso all have a rich history of dye techniques using indigo. Asian societies including India, Indonesia, Japan, and China have a long tradition of using indigo to print, dye, and do artistic work with textiles.

Lesson 1

Student Handout 1.4—Origins of Tea

Tea is made of the dried leaves, buds, and flowers of the tea plant. It originated in Asia in what is now the border region between India and China. The first Chinese written reference to tea goes back to the first century BCE. By the fourth century BCE, tea was deliberately grown as a medicinal, religious, and popular drink. It first became the national beverage of China during the Tang Dynasty (618-907 BCE).