THE GREAT PHILOSOPHERS

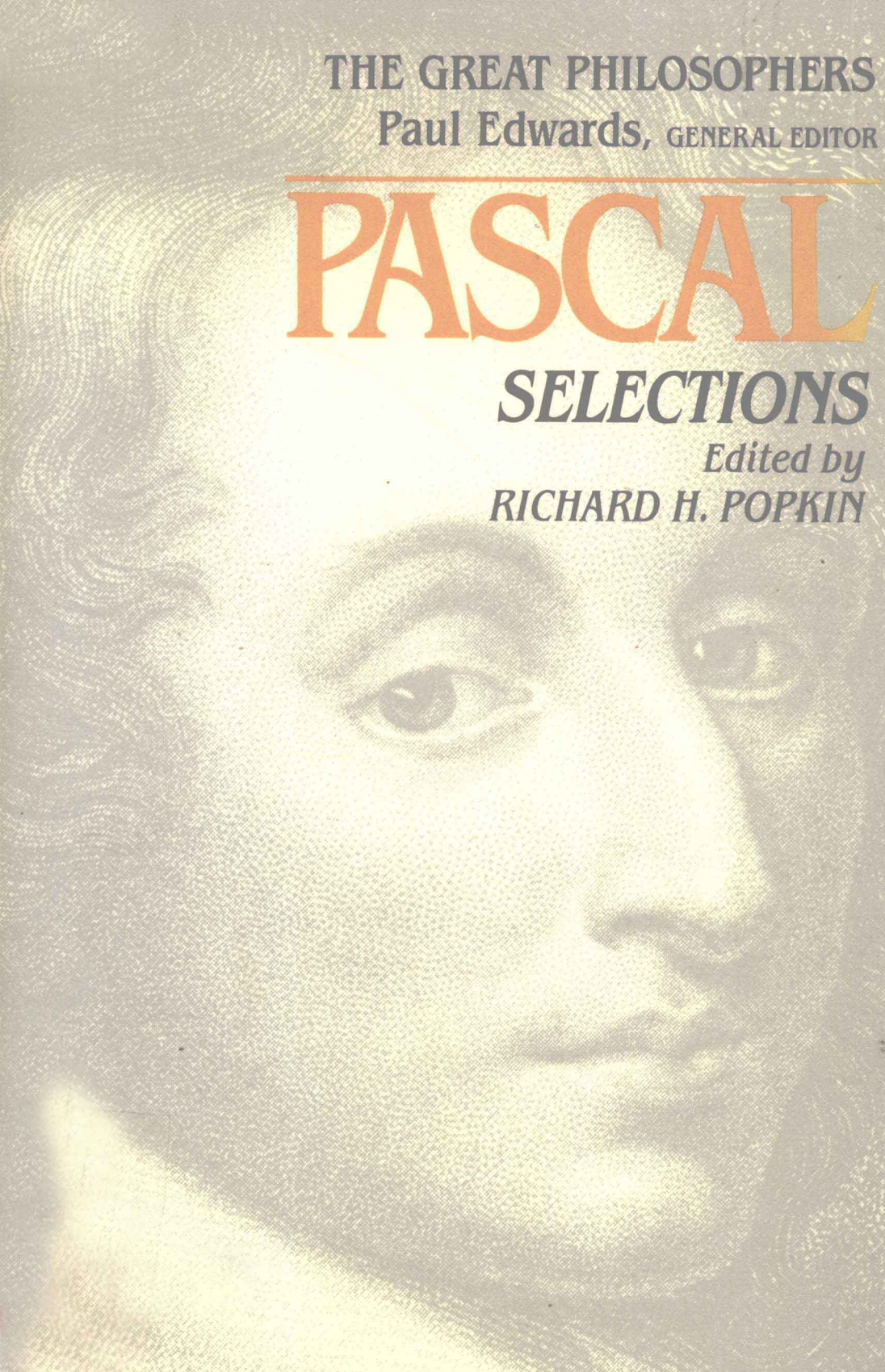
Paul Edwards, GENERAL EDITOR

PASCAL

SELECTIONS

Edited by

RICHARD H. POPKIN



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Selections

Edited,
with Introduction, Notes, and
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Contents

Introduction

Blaise Pascal (1623–1662), the brilliant mathematician, physicist, inventor, philosopher, and theologian, was born in Clermont, Auvergne, in south-central France. His father was of the minor nobility and held government office, working on state financial affairs. Pascal's mother died three years after his birth, leaving her grief-stricken husband to raise two daughters and one son.

In 1631 the father, Etienne, moved his young family to Paris, the center of cultural life in France. But because he opposed some financial regulations of Cardinal Richilieu, the country's chief minister, he was forced to leave the city in 1638. However, he was pardoned after one of his daughters took part in a children's play given for Richilieu. On his return to Paris, Etienne Pascal became the royal tax commissioner at Rouen.

The elder Pascal was a man of wide interests with great concern for his children. He decided to educate them himself, without tutors. It was evident from the outset of this experiment that young Blaise was a prodigy, with strong mathematical interests. However, the father did not want to teach the son mathematics before he had become a master of Greek and Latin. He feared that Blaise would be too distracted by mathematics and would neglect other subjects.

And so, without any training or instruction, young Pascal, at age twelve, began to work out the principles of geometry by himself. He had reached as far as the thirty-second proposition of the first book of Euclid when his father found out what he was doing. Etienne then abandoned his original plan for the boy's education and gave him a copy of Euclid's *Elements of Geometry*. Soon after, the father and son joined a group of participants at weekly lectures on mathematics and science, which had been organized by Father Marin Mersenne, a leading mathematician in his own right and a friend of such eminent philosopher-scientists as René Descartes, Pierre Gassendi, and Thomas Hobbes.

PASCAL AS MATHEMATICIAN

Young Pascal's mathematical achievements were astounding. At the age of sixteen, he wrote his major mathematical work, *Essai pour les coniques (Essay on Conic Sections)*, which was published the following year. In her later biography of her brother, one of his sisters reported that people thought what Blaise had done was "so great an intellectual achievement that people said that they had seen nothing as mighty since the time of Archimedes" in ancient times.

In 1642, at age nineteen, Pascal invented the calculating machine. After watching the arduous way in which his father added up the fiscal accounts of the French government, Pascal figured out the mathematical principles needed to construct a machine that would do the calculations. This machine (described in two of the selections in this book) was one of the first genuine achievements of the "new science" that was developing in the seventeenth century. It was basically the same as the calculating devices used up until the development of the computer, and is, in fact, considered the grandfather of the computer, since the latter is actually a much extended use of Pascal's principles, aided by power sources unknown until three centuries later. In recognition of this, one of the better-known computer languages is called PASCAL.

As indicated by the writings included in this book from 1645 and 1652, Pascal had inordinate difficulties in putting his calculating machine theory into practice. At that time the gulf between mathematical theory and physical capability was very great, the state of metallurgical work not being up to the theory. It was extremely difficult to make the appropriate gears and to keep them in alignment as the machine was moved from place to place. Pascal was so proud of his mathematical machine that he offered a model to Queen Christina of Sweden, who was developing a great center of learning at her court in Stockholm.

Pascal continued his mathematical researches throughout the remainder of his life. He made very important contributions to the theory of probability, to number theory, and to geometry. And he helped prepare the way for the discovery of calculus by Gottfried Wilhelm von Leibniz and Isaac Newton shortly after him.

After his religious conversion in 1654 (discussed below), Pascal did little serious mathematical work. He kept up his correspondence with some of the leading mathematicians of the time, however, and he reported that as the result of a night of insomnia in 1658, he worked out an important analysis of the nature of the cycloid curve. During his religious period, he wrote his basic work on the philosophy of mathematics, *L'Esprit géométrique (The Geometrical Mind)*, about 1651–1658 (see pp. 173–194 of this volume). It was probably intended as the preface to a textbook in geometry, which was to be used at the Jansenist school at the abbey of Port-Royal.

Also, in the *Pensées*, we see that important mathematical ideas are interwoven in Pascal's philosophical and theological reflections.

PASCAL AS PHYSICIST

Pascal was interested in both experimental physics and in applying the power of mathematics to explaining physical events. In 1646 he learned of the experiment performed with a barometer in Italy by physicist Evangelista Torricelli. This involved setting an inverted tube filled with mercury in a bowl that was also filled with mercury. The mercury in the inverted tube did not all flow into the bowl; some of it remained in the inverted tube. Pascal repeated the experiment and confirmed the result. Then he asked, what could account for some of the mercury remaining suspended in the tube? And what could be the content of the space in the tube above the column of mercury?

Several scientists of the time believed that the atmosphere must be responsible for keeping some of the mercury in the tube. But they were unable to offer any proof. They also were all in agreement that the space in the tube above the column of mercury must contain some type of rarified and invisible matter, since nature, according to the Aristotelian tradition, abhors a vacuum. Pascal, in 1647, published his *Experiences nouvelles touchant le vide (New Experiments Concerning the Vacuum)*, parts of which are included in this book; see pp. 33–41). He described a series of experiments he had performed using tubes of different shapes and sizes, and various kinds of liquids. From the experiments he was able to set forth the basic laws about atmospheric pressure, showing how much water and how much mercury could be supported by the pressure of the air surrounding the tubes. He also showed how large a siphon had to be for it to be able to function. And he presented his reasons for believing that a genuine vacuum not only could, but did, exist on top of the column of mercury or other fluid supported in a barometric device.

Pascal's results and his conclusions were genuinely novel, and in some ways disturbing, at the time. He was challenged by one Father Estienne Noël, the rector of the Collège de Clermont in Paris. Father Noël reiterated the accepted view that nature abhors a vacuum. Since that was so, the space that Pascal claimed to be empty on top of the column of fluid in the barometer must in fact contain some special kind of matter. Pascal's reply (see pp. 49–55 in this book) presents what he saw as the conditions for judging scientific hypotheses. It is perhaps the clearest statement in the seventeenth century on scientific method. Pascal insisted that confirming an hypothesis—showing that all the known facts fit with it, or follow from it—does not show that the hypothesis is true. It only shows that the hypothesis is possible or even probable. On the other hand, one could show

that an hypothesis is false if one could derive a contradiction from it, or if a conclusion from the hypothesis was counter to known facts. If it leads, Pascal asserted, "to something contrary to a single one of the phenomena, that suffices to establish its falsity." (Pascal's view here is close to that of Sir Karl Popper in his principle of falsification.) Having set forth his criterion for disproving hypotheses, Pascal then went on to show that the hypothesis of Aristotle and Father Noël (that nature abhors a vacuum) is false because conclusions that are contrary to experimentally established facts follow from it. Pascal's theory that there is a genuine vacuum above the mercury column fit the facts, and hence is a possible or probable explanation of the phenomenon observed in the barometer.

Shortly after writing his unfinished piece on the vacuum, Pascal's brother-in-law performed the famous experiment of taking a barometer up a mountain (1648). He carried an inverted tube of mercury in a bowl of mercury up Le Puy-de-Dôme, outside of Clérmont-Ferrand. By measuring the height of the column of mercury from start to finish, it was shown that the level of the mercury in the tube decreased as one climbed higher. Pascal checked the results at different heights by carrying the materials up church towers in Paris. On the basis of these experiments, he announced that nature does not abhor a vacuum. The effects attributed to the alleged abhorrence were, in fact, due to atmospheric pressure. Thus Pascal was able to combine ingeniously designed experiments with a careful analysis of possible explanatory hypotheses in order to reach one of the significant achievements of seventeenth-century science — the development of a mechanical explanation of air pressure and gas pressure in general — and to eliminate some of nature's alleged occult qualities and alleged personality. Only the preface of Pascal's *Treatise on the Vacuum* survives, and is included in this volume (see pp. 62–66).

In his preface, as well as scattered through his other scientific and religious writings, Pascal defended the "new science," both in terms of its theory of what nature is like and in terms of the method to be used in learning about nature. Although it is often claimed that there was an opposition between science and religion, even a warfare between them, Pascal, both as a scientist and as a devout believer, saw the experimental science of the seventeenth century as the most fruitful way of finding out about nature. He maintained that in the study of nature one should not allow respect for authority to take precedence over either reasoning or experience. In understanding God and His relationship to humankind, the reverse was the case; traditional authority took precedence over new reasoning and new data.

In his scientific and philosophical views, Pascal accepted a type of fundamental skepticism about what we could know about the world. Nature, which he thought of as always active, could not be known directly. In the *Pensées* as well as in scientific writings, he emphasized the many reasons

why we could never penetrate to knowing the secrets of nature, reasons that involved our limitations and the nature of nature. As a result, said Pascal, we can study nature only through its effects. But we cannot know all of these effects since they are endless; also they are infinitely large and infinitely small. We can, however, through experience and reasoning about experience, discover in the course of time more and more about the natural world. And we can codify this in terms of laws of nature. As we collect more and more data, we should reasonably expect that many of the previously accepted views and hypotheses about nature are no longer tenable and must be replaced by newer ones. At any given time in the world's history, our interpretation of nature is limited by how much experience we have collected. The truths about nature itself are unchanging. But our understanding of these truths is a part of the development of human history, and it varies as our historical development changes. Hence the history of science as a human enterprise is different from science, a body of fixed truths about nature. The latter is what we are seeking but only approximating at each stage in our history. In view of this, there is no particular reason for preferring ancient scientific views, or thinkers like Aristotle, to the views of modern scientists, based on more recent investigations. Hence Pascal was on the side of the scientific innovators and was one of the most important of them at the time. He defended Copernicus and Galileo for their scientific views, and followed in their footsteps in seeking mechanical and mathematical accounts of how nature behaved.

RELIGIOUS VIEWS

Although Pascal's achievements in mathematics and physics are highly significant, his religious and philosophical views have had even greater influence. His writings on these subjects grew out of his activities in the Jansenist movement, with which he became involved in 1646 after his father was injured. Two Jansenists took care of his father, and this led the whole family, including Blaise, to become interested and concerned with the group.

Jansenism was a reform movement within Catholicism. It has had an important influence both openly and clandestinely in European religious affairs, especially in France. The movement gets its name from Cornelius Jansen (1585–1638), who was the bishop of Ypres. Strongly attracted to the views of St. Augustine, especially concerning the all-important role of divine grace in human salvation, Jansen opposed what he saw as a lax moral view being espoused by the Jesuits to the effect that human beings could take steps that aided in their salvation. Jansen's views were published in his book, *De Augustinus*, in 1641 by one of the leading French Jansenists, Antoine Arnauld (1612–1694). This set off a controversy that led to the

condemnation of certain of Jansen's views, and finally to the suppression of the movement, which went underground in France, but survives today in The Netherlands and Germany.

The abbey of Port-Royal, which had been spiritually and morally reformed by Arnauld's sister, Angelique, from its dissolute condition early in the century, became the center of Jansenist activities. People moved there to concentrate on their spiritual lives. The leading Jansenist in France, Jean Vergier Du Hauranne, the abbé de Saint-Cyran (1591–1643), was its spiritual adviser. The Pascals went to the abbey to hear sermons, and Blaise became interested in the Jansenist theology.

After his father's death in 1651, Pascal's sister Jacqueline decided to become a nun at Port-Royal in spite of her brother's opposition. Possibly as a reaction to his father's death, Pascal turned away from religious activities from 1652 to 1654 and became a *libertin*, associating with free-thinkers, gamblers, and womanizers. Nonetheless he frequently visited his sister at Port-Royal and told her that he had great contempt for the ordinary world and the people in it, but that he did not feel drawn to God. Then, on the night of November 23, 1654, when crossing a Paris bridge in a carriage during a storm, he had an overwhelming religious experience. Immediately afterward he wrote down what he recalled of it, in the statement called the *Memorial* (pp. 69–70). He carried it sewn into his clothes from then on, and it was found shortly after his death. In the statement Pascal indicated that he felt himself in the presence of the god of Abraham, Isaac, and Jacob, and not the god of the philosophers. He determined to devote the rest of his life primarily to religious activities and to remain forever in the presence of the living God.

At the beginning of 1655, Pascal went on a retreat to Port-Royal-des-Champs, one of the two Port-Royal convents. There he met the Jansenist theologian, Isaac Le Maistre de Saci, and had a discussion with him, which was published as *Entretien avec M. de Saci* (see pp. 79–89). Pascal presents what he found positive and negative in the views of Montaigne and Epictetus. In the course of the discussion, one finds that many of the basic themes of Pascal's central religious work were already at least partially worked out.

From this time onward, Pascal was a frequent visitor at one or the other of the Port-Royal convents and was in contact with Arnauld and others about the challenges being made to Jansenism, either in terms of what was in Jansen's book or what Arnauld had written in defense of Jansenism. As Arnauld's defense was leading to an attempt in early 1656 to revoke his doctoral degree, Pascal, in cooperation with Arnauld and Pierre Nicole, began a series of defenses, the *Lettres provinciales (Provincial Letters)*. Eighteen of these were published (1656–1657), and notes for a nineteenth exist. The letters try both to defend the Jansenists from persecution and to challenge the moral theory of their chief opponents, the Jesuits.

The *Provincial Letters* were published secretly, unsigned, one at a time. They are a series of satirical polemics with Pascal as the main author, although Arnauld and Nicole apparently supplied him with most of the documentation, which helped to make the satire so forceful and comical. The work begins as a series of letters to Pascal's brother-in-law who lived in the country (the provincial). The first three were intended as a last-minute effort to head off the condemnation of Arnauld by the theology professors of the Sorbonne. In spite of the brilliance of these letters, Arnauld was condemned on January 31, 1656, and his title of "doctor" was taken away. The fourth to the tenth letters present a counterattack, challenging the moral theory of the Jesuits by showing the apparent immoral and ludicrous results of their casuistry.

The eleventh to the sixteenth letters were no longer addressed to the "provincial," but to the Jesuit fathers, attacking their views and political activities, and also defending their anonymous author against his opponents. This indicates that the *Letters* had an immediate effect. The last two were addressed to the king's confessor, and they amount to a plea in favor of the Jansenists at Port-Royal. Pascal made some notes for another letter, but apparently gave it up because it became obvious that the king and his advisers had sided against the Jansenists. The *Letters* were published as a collection in 1657 and have become a classic example of philosophical and theological argument by satire. (Voltaire considered them as great as the satires of Molière.)

The Jansenists lost their battle for survival as a legitimately accepted Catholic group during 1656–1657. Soon after, they were forced to sign a statement abjuring Jansen's views. Port-Royal was destroyed, and those who would not give in, such as Arnauld, fled from France. Others continued their views underground and reappeared in French history around the time of the French Revolution, which began in 1789. (Important revolutionary figures such as the abbé Henri Grégoire were Jansenists.) In exile they kept up what they called the Old Catholic Church, which merged in the 1870s with those who would not accept the doctrine of papal infallibility. Only after Vatican II, the ecumenical council of 1962–1965, convened by John XXIII, was a truce worked out with the Church of Rome. The Jensenists, who had been very powerful in mid-seventeenth-century France, went into a long eclipse, occasionally reappearing on the scene. The *Provincial Letters*, a classic of French literature, has made the Jansenists a continuous part of the literary world. Pascal, in defending them, left a brilliant and thought-provoking work on the basis of morality and Christian theology. (Substantial selections from the *Letters* are included in this volume.)

Besides the *Provincial Letters*, Pascal worked on a variety of subjects after becoming immersed in the Jansenist movement, mostly religious and philosophical, but also including mathematical work. In 1659 he became seri-

ously ill and wrote relatively little thereafter. Prior to his illness he composed his *Écrits sur la Grâce (Writings on Grace)*, *De l'Esprit géométrique (On the Mathematical Mind)*, *De l'art de persuader (On the Art of Persuasion)*, the work on the cycloid curve, and portions of his *Apologie de la religion chrétienne*, the unfinished work that was published after his death as the *Pensées*.

Pascal had a short period of improvement in his health in 1660 and wrote his three discourses on the condition of the great (see pp. 74–78), dealing with role of accidental fortune in human affairs. The next year, during the final Jansenist struggle with their enemies, his sister Jacqueline died, apparently from a heart attack resulting from the bitterness and hopelessness of the contest. Pascal then wrote his last work on Jansenism, urging the Jansenists not to yield and not to sign the *formulaire*, the statement denying their principles. After this, Pascal withdrew from any further controversial activities.

One of the last things Pascal did in his short life was to propose another invention, that of an omnibus, a large horse-driven carriage that would carry many people from one point in Paris to another for a fixed fare. This would have been the first busline in European history. (Unfortunately it did not come to fruition, since the people who could pay the fare had their own carriages and the others just walked. The first actual functioning busline came into being in London at the beginning of the nineteenth century.) One of Pascal's reasons for proposing the introduction of the bus was that he wanted to earn some money in order to give it away to the poor. In his final years, Pascal gave away practically all of his possessions. In his will he bequeathed portions of the anticipated earnings from the bus to different hospitals.

PHILOSOPHY OF MATHEMATICS AND SCIENCE

When Pascal died, two very important unpublished works were found—the *Pensées* and *De l'Esprit géométrique*. The first (discussed later) was published in 1670, eight years after his death. The second became known from a copy in the possession of Pascal's nephew. Two short extracts were published in 1728. Condorcet, in his important edition of Pascal of 1776, published half of the text, and the rest, except for a few lines, was published three years later. The complete text was finally published in 1844. It is believed that *De l'Esprit géométrique* was probably intended as a preface to a geometry text that Pascal was asked by Arnauld to prepare for the students at the school at Port-Royal. It was not so used, and Arnauld wrote his own preface. The accompanying *De l'Art de persuader* was published in full in 1728. Themes from these two works run through the *Pensées*, but it is only in these relatively short presentations that Pascal set forth his theory about the nature of mathematical and scientific evidence.

The ideal method for discovering truths, said Pascal, would be one in which we were able to define all of the terms used and then were able to demonstrate all propositions from truths that had already been established. Unfortunately, this is not possible because the basic terms that are to be defined presuppose others basic terms, if we are to understand the meaning of the former. It is also the case that basic or fundamental propositions that we are attempting to prove presuppose other basic propositions. And so, we are not able to arrive at first, or primitive, terms and principles. In any mathematical or logicial system, we can start only with such primitive terms that require no additional definitions to make themselves clear but that are not ultimately defined. Similarly, we can start only with principles that we find so clear that nothing clearer can help us in establishing them. Thus, Pascal pointed out, human beings by their own means cannot reach the ideal, and hence are powerless to establish a science in "an absolutely perfected manner."

If we are so limited, the best procedure that humankind can find is the geometrical one. In describing what this is, Pascal set forth the definition of an axiomatic system and its limitations for establishing truths. In this, Pascal, perhaps more than Leibniz, saw what twentieth-century logicians were going to develop. Essentially, Pascal contended, what we can start with are those terms that are clear and are known to everyone. In practice they do not require definition, since everyone knows what they mean. Then, other terms can be defined by using them. Similarly, propositions known by everyone can be assumed, and other propositions can be derived from them. Developing such an axiomatic system would not allow us to claim that we know by natural reason, for instance, that Euclidean geometry is true, since we possess neither the ultimate definitions of the basic terms nor evidence that the premises are true. What we can say, according to Pascal's analysis, is that the geometrical method provides the greatest certitude that human beings are able to attain by their limited capabilities. They can put some of their information into an axiom system, with primitive terms and basic premises or axioms. They can derive propositions in a logical fashion from these. The set of such propositions are true if the axioms are true, *but* human beings cannot tell if this is the case.

The Art of Persuasion complements the study of geometrical method by offering an explanation of how people, in fact, happen to be convinced by first principles, and by the conclusions that are drawn from them. Pascal contended here, and developed the theme in the *Pensées*, that in all our reasonings we are led to a kind of total skepticism, since we cannot by reason and evidence establish the truth of our first principles. Putting them in axiom systems shows what conclusions we can draw from them, but it does not throw any light on their truth. And treating them as scientific hypotheses can, at best, show that they are plausible and have not yet been refuted. We have to turn elsewhere if we are to limit or avoid the constant

drift toward skepticism. But where? For Pascal, the answer has to be outside the rational world, by recognizing that we gain our principles, and our assurance of them, by instinct, and as he pressed in the *Pensées*, by revelation. It is through reliance on our feelings and our religious life that we find our certainty.

THE PENSÉES

The most famous and most complete statement of Pascal's philosophy and theology appears in the *Pensées*, his unfinished work. In 1659 Pascal gave a lecture at Port-Royal in which he described the major work he was writing, an apology for the Christian religion. Descriptions of the lecture indicate that Pascal had a fairly well-organized conception of how he would present it. When he died three years later, bundles of notes of various sizes were found pinned together in groups. A copy was made of all of the materials, in the exact form in which they existed at the time. The Port-Royalists, especially Arnauld, felt that only those portions of notes that seemed to them to be complete should be published. They also felt that the notes should be put in what the editors thought to be a coherent order.

Although the work was an immediate success and quickly became one of the classics of philosophy and religion and a masterpiece of French literature, the various editors involved for the next century and a half thought that the *Pensées* was an unfinished collection of notes left in a disordered state because the author died before he could put the material together. Therefore each editor felt free to put them together as he saw fit. And as a result, the work kept being re-edited in differing orders. A leading French historian of philosophy, Victor Cousin, in 1842 pointed out that no complete edition of Pascal's greatest work existed and that each edition had been embellished or re-ordered as the editor desired, without regard for Pascal's intention. Cousin urged that a definitive edition be prepared, based on the manuscripts in the Bibliothèque Nationale, which included the actual notes in Pascal's hand pasted on large sheets of paper. New editions were prepared, including the one by Léon Brunschvicg, which became the standard text until World War II. In the 1930s this text was challenged by Zacharie Tourneur on the grounds that it still was not Pascal's intended order because the pasting had been done after he was dead.

During the Nazi occupation of Paris, a paper manufacturer, Louis Lafuma, hid out in the manuscript room of the Bibliothèque Nationale from 1940 to 1944. He studied the manuscripts of Pascal there and realized that a nephew of Pascal had copied the notes as they existed at the time of his uncle's death, and that Arnauld and others had made the pasteups. Examining the paper, the glue, the sand, Lafuma established an order of composition. He compared it with the projected description of the work in

Pascal's lecture. After the war Lafuma edited a radically new text in terms of the order of the fragments, and in terms of which ones had been finished and put in categories by Pascal and which ones remained unclassified at his death. Because of the detailed evidence Lafuma had amassed during his enforced study (Hitler's unwitting contribution to Pascal scholarship), his radically revised text was soon accepted by Pascal scholars and became the official text used in the French school system.

Further revision to the *Pensées* has continued, chiefly by Jean Mesnard, in revising the date of Pascal's lecture and in interpreting it relative to the fragments. As Mesnard observed, "The manuscripts of the *Pensées* have not yet given up all their secrets." The dating of the fragments is not finished, and there is still the problem of putting together a completely scholarly edition, as well as a clear and readable one. "The most learned edition," Mesnard said, "can and should be at the same time the most perfectly elegant." He has offered his version, and no doubt other scholars will offer different versions.

The *Pensées* is thus one of the very few classics that keeps being re-edited, and revised. The basic content, however, remains the same. Pascal wrote out 'thoughts,' which vary from a few words, a sentence, a paragraph, to essays. Some seem much more complete and polished than others. He had organized some of the material, and other parts appear almost ready to be incorporated into this organization. The order of presentation makes some difference in terms of continuous argument, or stress on one theme or another. However, the thrust remains the same, and Pascal's analysis of the human situation comes through, as well as his presentation of the religious solution and his "defense" of it.

The *Pensées* in Lafuma's order (which is followed in the selections in this book) begins with a series of sections that set forth the human condition by exhibiting the ways people deal with and react to the ordinary world. This is followed by sections focusing on two basic philosophical concerns — how to find true knowledge and how to find genuine happiness. Pascal developed his case by using paradoxical statements, by using most forceful imagery, and by probing various claims, all gradually forcing the reader to recognize the human situation — an inability to find a satisfactory solution by human means, and the need to turn to a religious solution, even though no rational justification can be given for this. Then Pascal turned to the pedantic task of making his own religion, Christianity, plausible and preferable to paganism, Mohammedanism, and Judaism.

The *Pensées* begins by trying to make people uneasy about their lives by showing that the values, the goals that they seek are not worthwhile and will not make them happy. Part of Pascal's case is built on the assumption that people have some idea of what it would be like to be *really* happy. With this murky, shadowy ideal, all ordinary human attempts to attain happiness appear inadequate. No matter what we do, we end up in a miserable state.