

Blaise Pascal

French mathematician, physicist, philosopher, and man-of-letters Blaise Pascal (June 19, 1623 – August 19, 1662) is considered one of the greatest minds in Western intellectual history. With Fermat, he developed the modern theory of probability. A mathematical prodigy, Pascal published a treatise on conic sections extending the work of Desargues in projective geometry at age 16. He is recognized for his important role in the development of the computer, and at age 18 he designed and constructed one of the first mechanical calculators. Pascal worked on a major treatise on conics, but it was never published and it is now lost, although Gottfried Leibniz saw a copy of the work. Pascal devoted his waning energies to perfecting Francesco Cavalieri's theory of indivisibles by applying them to the problem of the cycloid. He also solved the problems of the volume and surface area of the solid of revolution formed by rotating the cycloid about a line, which laid the foundations for Leibniz's calculus. In the mid 1650's, Pascal's poor health, depression and a religious epiphany turned his attention to theology.



Pascal was born in Clermont-Ferrand in 1623. The family moved to Paris in 1629 where there was greater opportunity for Blaise's father Etienne, a lawyer, magistrate and tax commissioner, to pursue his own scientific interests. Etienne had unorthodox educational ideas based on the pedagogy of Michel de Montaigne. He decided that his precocious and sickly son should not study mathematics before the age of 15, so that he might develop interests in other subjects. As a consequence all mathematical texts were removed from the house. It wasn't that Etienne didn't care for mathematics. On the contrary, he was mathematically inclined, having studied the curve known as the "conchoid of the circle" so thoroughly that it has come to be known as the "limaçon of Pascal" [Figure 6.6]. Perhaps because

mathematics was forbidden to him, young Blaise developed a great curiosity about the subject and undertook his own mathematical studies. By the age of 12 he had independently discovered most of the first book of Euclid's *Elements*. When Etienne learned of this he relented and allowed Blaise to have a copy of the book.

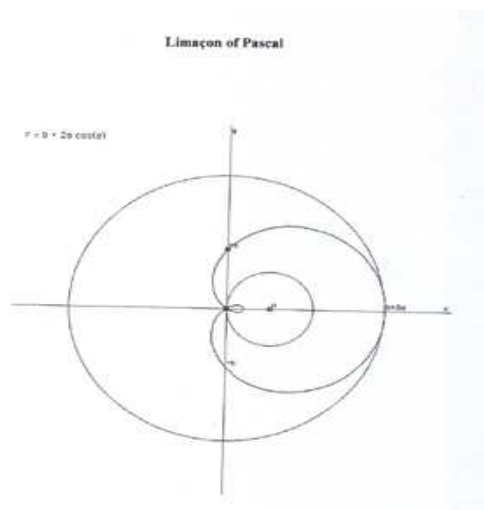


Figure 6.6

At age fourteen Blaise accompanied his father to the informal Paris meetings of the “Mersenne Academy,” named for the Minimite friar Marin Mersenne, a close friend of Descartes, Desargues and Fermat. Blaise greatly admired the work of Desargues and at the age of 16 he presented a paper to the Academy that contained a number of theorems from projective geometry. In February, 1640, Blaise published his first work, *Essai pour les coniques*, consisting of only a single page, containing his proposition of what he called the mystic hexagon, a fundamental result of projective geometry, since known as Pascal’s theorem. In essence it states that if a hexagon is inscribed in any conic section, then the points where opposite sides meet are collinear. In [Figure 6.7] the vertices of the inscribed hexagon are numbered 1 through 6 and the points I, II, and III where the opposite sides meet is the dotted line.

Pascal did not state the theorem quite in this form, for it is not true in the case of a regular hexagon inscribed in a circle unless one adds to the space the ideal points and line of projective geometry.

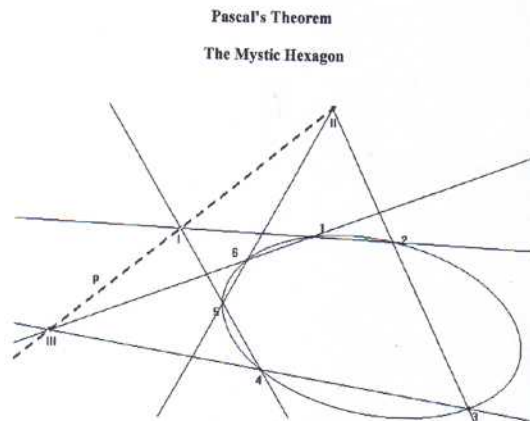


Figure 6.7

Pascal might easily have established the field of projective geometry much earlier than its 19th century revival. Instead, he turned his attention to planning a calculating machine that used a series of rotating discs, to help his father in the computation of taxes. His first attempts were failures so he gave up the project for several years. He returned to it in 1644 and finished the first model in 1645 after going through some fifty different designs. He presented one of the machines, now known as a pascaline [Figure 6.8], to the king and one to the royal chancellor. He sold a few of the machines and presented another as a gift to Queen Christina of Sweden, who, by royal decree, awarded him a monopoly. Unfortunately, it was not a commercial success as the cost to produce the pascaline was far too great.

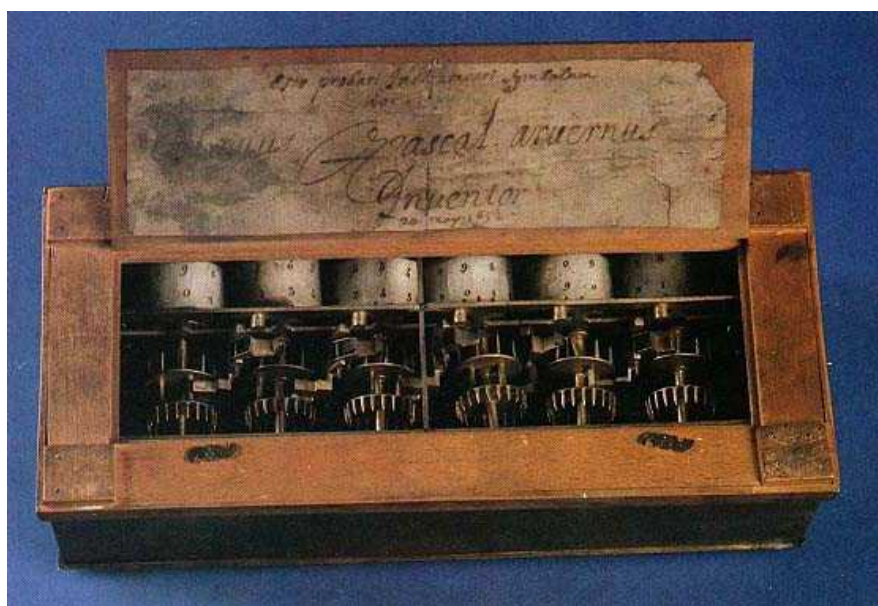


Figure 6.8

In 1648 Pascal abandoned the study of mathematics when he became interested in hydrostatics. He conducted extensive experiments on the properties of fluids, through which he demonstrated that air has weight. His celebrated experiment at the summit of Puy-de-Dôme (at a height of 1200 meters) confirmed that the level of the mercury column in a barometer is determined by an increase or decrease in the surrounding atmospheric pressure, thus clarifying the hydrostatic paradox. He also formulated the so-called Pascal's principle, which states that in a contained fluid, the pressure exerted on it is constant in all directions. Commentary on these experiments was published posthumously (1663) in his *Treatise on the Equilibrium of Liquids* and *Treatise on the Weight of the Mass of the Air*.

In 1654, Pascal's friend, the Chevalier de Meré, proposed the question: "In eight throws of a die a player is to attempt to throw a one, but after three unsuccessful trials the game is interrupted. How should he be indemnified?" Pascal wrote to Fermat about the question and their exchange of letters on

the subject became the origins of modern mathematical probability. Neither Pascal nor Fermat published their results, but in 1657 Christiaan Huygens published *On Reasoning in Games of Chance*, prompted by their correspondence. Pascal also wrote extensively on the triangular arrangement of the coefficients of the power of a binomial. Although Chinese mathematicians knew of it some 600 years earlier as did Cardano a century earlier, Pascal derived enough new properties that it is now known as “Pascal’s Triangle.” Figure 6.9 illustrates the first seven rows of the triangle that continues indefinitely.

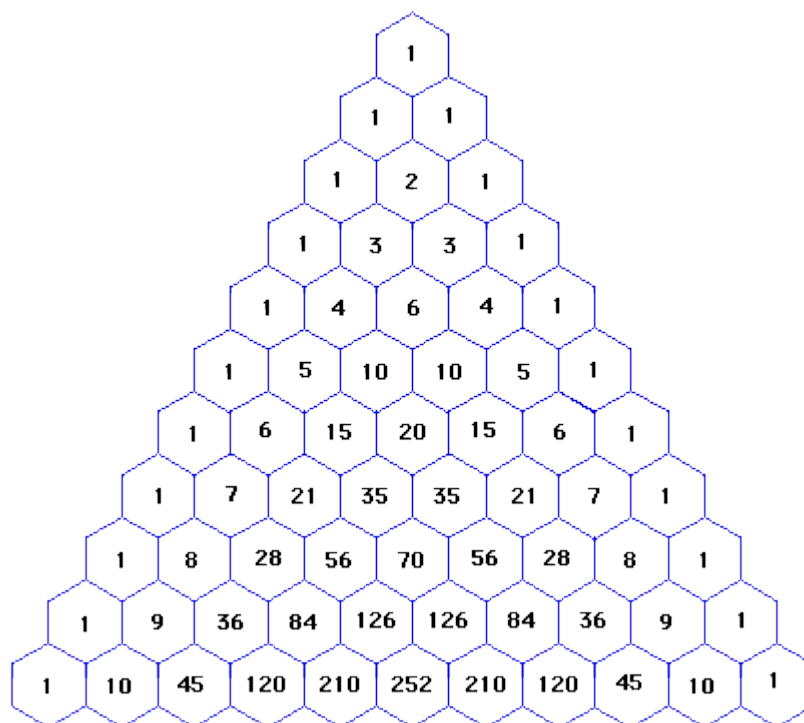


Figure 6.9

Numerous sources have reported the story of Pascal’s conversion in November 1654. Allegedly, Pascal’s life changed dramatically when he nearly lost his life in an accident. Horses pulling his carriage bolted leaving him hanging over a bridge across the river Seine. Although he was rescued without injury, it had a great psychological affect on him. This account may be apocryphal and it has at

least been embellished several times in the telling, as nowhere in Pascal's writings is there any description of the event. What is known is that after several months of intense depression, he had a profound two-hour ecstatic vision that led to his conversion to the Jansenists, a strict sect of Christianity founded by a Flemish theologian and Bishop of Ypres Cornelius Jansen. An opponent of the Jesuits, Jansen championed a return to the principles laid down in the teachings of Doctor of the Church St. Augustine of Hippo (354 – 430). The Jansenist evangelical reform movement rejected the notion of free will, replaced by that of predestination and the necessity of God's grace to be saved. After Jansen died in 1638, his followers made their base at the abbey in Port-Royal des Champs, France. Pascal entered the Jansenist monastery, although he did not take orders. The higher moral standards of the Jansenists as opposed, which was in stark contrast to the corrupt and worldly church under the dominance of Cardinal Richelieu, King Louis XIII's chief minister, appealed to all of the Pascal siblings. His sister Jacqueline had already entered the Jansenist convent after the death of their father Etienne. Like her brother, Jacqueline was a child prodigy. She composed verses when she was only eight years old and some of her poetry was published when she was twelve. In 1638 Etienne was involved in a protest against the fiscal policies of Richelieu, and as a result had to flee Paris to escape arrest. The next year Jacqueline appeared at court in a play presented by children. She took the opportunity to make an appeal to Richelieu for her father. Soon thereafter, her father was allowed to return to Paris and a few months later was appointed to a government post at Rouen.

Pascal did little further mathematics. He wrote religious works, under the *nom de plume*, Louis de Montale. The so-called *Provincial Letters* were published during the period 1656-1657. The 18 epistles were written in defense of his friend Antoine Arnauld, a Jansenist and an opponent of the Jesuits, who was on trial before the faculty of theology in Paris for his controversial religious views. These writings on behalf of the Jansenists are considered "a monument in the evolution of French prose." In 1657 and

1658, Pascal wrote notes on apologetics, intending to organize them into a book. These were published after his death as *Pensées* (“Thoughts”). It includes what is known as “Pascal’s wager,” in which he proposed “God is, or He is not, which way should we incline?” He framed the issue in terms of a game of chance. His “wager” expresses the conviction that belief in God is reasonable on the grounds that there are no rational grounds either for belief or disbelief, so belief is not less reasonable than unbelief. This being so, it is wiser to gamble on the existence of God since this involves gain if it is true, and no significant loss if it is false.

Pascal lived in the age of the rise of rationalism. Copernicus’ discovery that the earth moves around the sun made human beings insignificant factors in the immensity of the universe. Pascal was prompted to state his horror: “The eternal silence of these infinite spaces terrifies me.” Reasoning not revelation was to be the final source for truth. Pascal did not deny the powers of reason, but he did feel it had limitations, writing, “reason’s last step is the recognition that there are an infinite number of things which are beyond it.” According to Pascal human knowledge is somewhere between certainty and complete ignorance. [He foresaw that science had come to belong to man’s quest for power, not truth.] He believed that as men might feel lost in creation’s vast perspectives, they must turn again to an all-knowing and all-caring God. Descartes had said, “I think, therefore I am.” Pascal said, “I look for God, therefore I have found Him.” He briefly returned to scientific work, contributing to the *Éléments de géométrie* and publishing his findings on cycloid curves, before devoting the rest of his life to helping the poor. He died at 39 in intense pain when a malignant growth in his abdomen spread to his brain. Near the end he received the Holy Viaticum (the Eucharist given to a dying person), which he had requested several times. He cried out as he half rose from his couch: “May God never abandon me!”

Quotation of the Day: “It is not certain that everything is uncertain.” – Blaise Pascal

