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Secret Notebook

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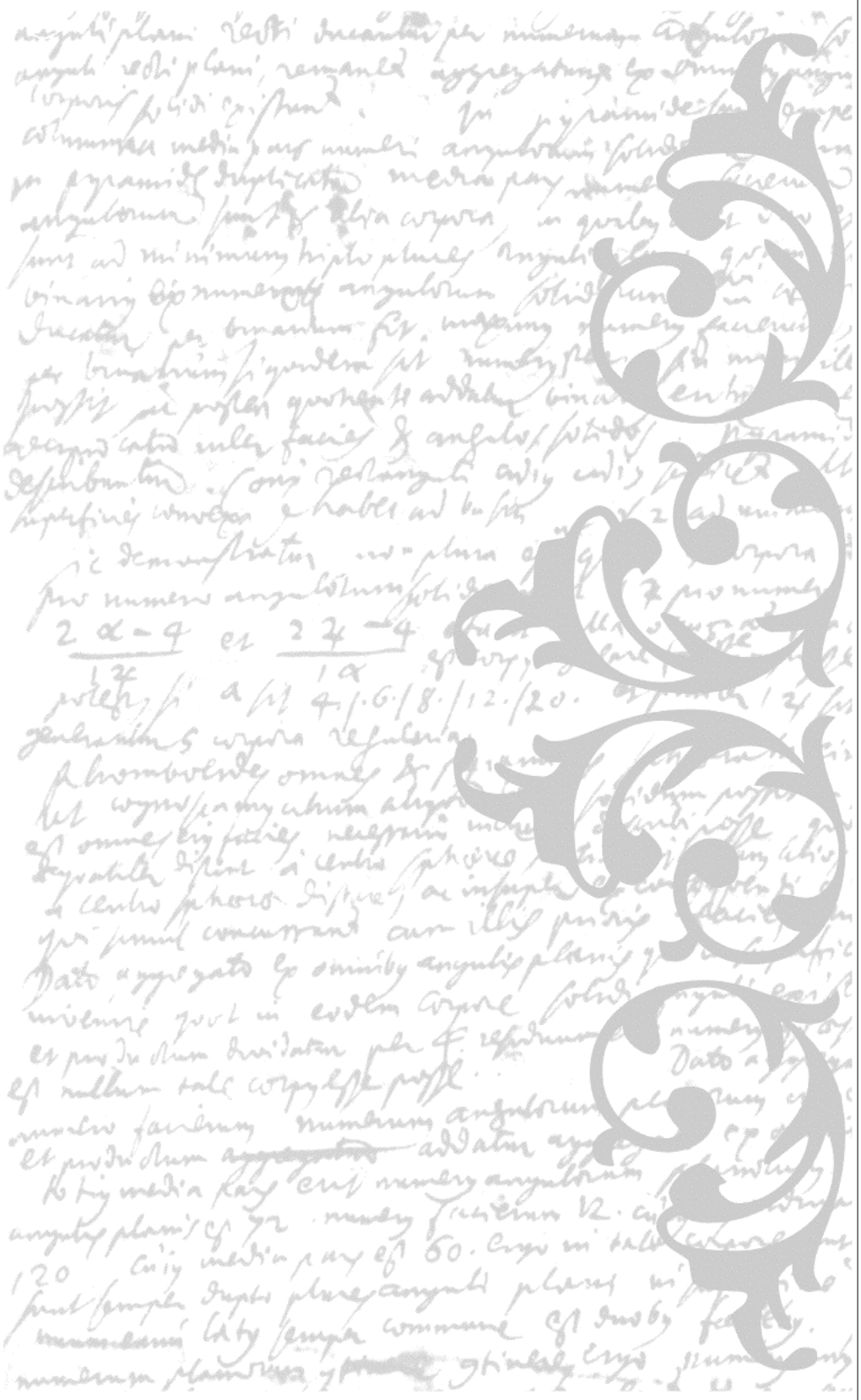

DESCARTES' *Secret Notebook*

A TRUE TALE OF MATHEMATICS, MYSTICISM, AND THE QUEST TO UNDERSTAND THE UNIVERSE

AMIR D. ACZEL

Broadway Books
New York

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For Debra

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Introduction

I HELD THE FRAGILE ANCIENT MANUSCRIPT in my hand. I opened it carefully, and read:

PREAMBLES

Fear of God is the beginning of wisdom. The actors, called to the scene, in order to hide their flaming cheeks, don a mask. Like them, when climbing on stage in the theater of the world, where, thus far, I have only been a spectator, I advance masked. At the time of my youth, witnessing ingenious discoveries, I asked myself whether I could invent all on my own, without leaning on the work of others. Henceforth, little by little, I became aware that I was proceeding according to

determined rules. Science is like a woman: if faithful, she stays by her husband, she is honored; if she gives herself to everyone, she is degraded.

The manuscript continued further. After a few more pages, I read another fragment of text:

OLYMPICA

November 11, 1620. I began to conceive the foundation of an admirable discovery.

These were the enigmatic words of René Descartes (1596–1650). They were never intended for eyes other than his own. But the manuscript I now held in my hands was not written by Descartes. It was a copy of Descartes' secret writings made by none other than Gottfried Wilhelm Leibniz (1646–1716)—one of the greatest mathematicians of all time and the man who, only a few years after copying Descartes' notebook in Paris in 1676, would give us the calculus.

The idea for a book about Descartes occurred to me while lost in a snowstorm somewhere in eastern Ontario, hard by the Quebec border, around midnight in early January of 2002. We were on our way back home to Massachusetts from a holiday visit to relatives in Toronto, hoping to spend the last night of our trip in Montreal, when our car got mired in deep snow dropped by a sudden blizzard. I turned off the highway to look for a place to wait out the storm; but after making an unfortunate sequence of turns onto various country roads, I came to the conclusion that I had gotten us completely lost. The visibility was poor,

there were no lights in sight, and we had no idea where to turn. I knew that if the fuel ran out, eventually we would start to freeze.

While driving, I glanced at my dashboard. And I remembered something this car came equipped with—something I had never had the need to use before. On my dashboard, I recognized the small lit button, and I pressed it. There followed the sound of a telephone number being dialed automatically. "Good evening, Mr. Aczel," said a pleasant voice from a thousand miles away. "How are you this evening? I see that you are heading south on Glen Donald Road, half a mile north of the intersection with County Road 27, outside of Cornwall, Ontario."

"Aha . . . ," I said, trying to keep my voice from betraying that I had absolutely no idea where we were. "We are looking for a hotel. . . . It's snowing hard."

"No problem at all," was the response. "Where are you trying to go?"

"Montreal."

"That's not hard," reassured the voice from civilization. "Make a left turn at the next intersection, the one with County Road 27. Follow that road for two miles, and then turn right at the intersection, and you will see the on-ramp for Highway 401 to Montreal. Which hotel would you prefer? There's a Marriott just as you reach the city from this direction. I can make you a reservation, and I'll be back with more directions as you continue."

The voice on this cell phone led us throughout the night: from a deserted country road in snowy Ontario all the way to a warm hotel room in Montreal, directing us at every turn along the way. The person giving us instructions from afar knew our position, accurate to within a dozen feet, during every minute of the trip. The technology that made all this possible is the Global Positioning System (GPS), which allows one to determine the location of a small radio receiver (called a GPS receiver) anywhere in the world. In this case, a device installed in my car, linked to an internal cellular phone, allowed the company that provides this

service to determine the location of my vehicle wherever it might be. The amazing GPS technology works because of an invention made almost four centuries ago by the philosopher, scientist, and mathematician René Descartes.

Descartes gave us the *Cartesian coordinate system*, named after him—a system of crisscrossed parallel lines, in two, three, or more dimensions, that allows us to *describe numerically* the position of a point in space. In this case, the position of the point (my car) was described in terms of its latitude and longitude, which were then translated into a location on a map. The GPS system works in three dimensions as well: it can give you, in addition to your latitude and longitude, your altitude—and this makes it useful in directing an airplane.

But Descartes' coordinate system is used for a lot more than GPS. Every pixel on your computer screen is described internally by a pair of numbers: its horizontal and vertical coordinates. Thus all computer technology relies on Descartes' invention. Graphs and diagrams and maps of all kinds rely on the Cartesian system, and so do digital photographs, so popular these days, and pictures and documents sent on the Internet, and engineering designs, and space flights, and oil exploration.

And the applications go even further—beyond our three-dimensional intuition of pictures and graphs and shapes. When data are available on many variables—more than the visual three dimensions of everyday life—such data can *still* be analyzed using the Cartesian coordinates. Your bank, for example, may have data on your income, your assets, the number of years at your current employment, the number of people in your family, your age, your educational level, and so forth. These *multidimensional* data can be mapped on a many-variable scale using the Cartesian coordinates (even though such a "map" cannot be visualized and is meaningful only within the context of the computer analyzing the data) and through statistical analysis lead to a decision by the bank to approve or deny your loan application. Statistical and scientific algorithms that analyze data on many variables use the Cartesian system in

the analysis. The number of applications of the Cartesian coordinate system in our daily lives is immense. Literally everything we do or see or use in our daily lives has something to do with Descartes' great invention.

Interestingly, Descartes' invention of the coordinate system that bears his name was a special outcome of a much grander design. Descartes achieved an immense advance in mathematics, launching modern mathematical theory four centuries ago, when he unified algebra with geometry by inventing analytic geometry: a way of connecting the equations and formulas of algebra with the figures and shapes of geometry. The Cartesian coordinate system was just the device he created in order to facilitate this unification.

Of course, Descartes' greatest fame comes not simply from his work in mathematics or in physics—in which he also made important discoveries, especially on gravity and falling objects, as well as in optics—but from his philosophy. Descartes' "*Cogito, ergo sum*" (I think, therefore I am), and the philosophy behind this statement, is a pillar of modern philosophy; and his rationalism—*Cartesianism*—is considered of great importance in the development of philosophical thinking. Descartes is often viewed as the founder of modern philosophy. In his *Meditations*, published in 1641, Descartes wrote: "It must be acknowledged that this pronouncement, *I am, I exist,* whenever I assert it or conceive it in my mind, is necessarily true." In the introduction to the book they edited, *Descartes and His Contemporaries*, M. Grene and R. Ariew describe Descartes' statement above as signaling a turning point in Western thought: "Suddenly, we have reached a new level of awareness, at which we could ask reflective questions about ourselves: Can we reach out from consciousness to an external world? Who are we as minds in relation to our bodies?" Some scholars have even asserted that Descartes' philosophy, in its introduction of the self into human consciousness, inaugurated modern psychological theory. Descartes' method of reasoning thus created self-reflection, which incorporated into philosophy the el-

ements of modern psychology. Descartes pioneered metaphysical investigations, and hypothesized about the relation between body and soul. He tried to use reason and logic to prove the existence of God (in whom he believed).

There is a direct link between Descartes' logical, rational approach to philosophy and his work in mathematics. The reason for this is that Descartes' philosophy is based on an ambitious attempt to found all of human knowledge on the same precise, strictly logical principles that the ancient Greeks had used in creating their enduring geometry.

I believe that Descartes' work in mathematics, physics, and philosophy, as well as in other areas this unique individual studied, such as biology, anatomy, and music theory, are unified by invisible links of logic. This recondite internal rationality is what Descartes was all about—for the hidden Descartes was fundamentally a supreme mathematician: a man who was so good at doing mathematics that he came to believe he could apply his mathematical skills and methods to every area of human study.

Descartes lived in one of the most tumultuous, and yet intellectually fecund, periods in history. Descartes' time, the first half of the seventeenth century, was the era of the Thirty Years War, in which Catholics and Protestants were mercilessly pitted against each other in a series of bloody battles. This period also saw the ruthless suppression by the Catholic Church of new scientific and philosophical ideas, as evidenced by the trial of Galileo by the Inquisition, the persecution by the church of other thinkers who supported the theory of Copernicus, and the burning of forbidden books. However, this was also a period of great intellectual revival—an extension of the Renaissance to science, mathematics, and philosophy. Classical ideas in these areas were being studied and extended by intellectuals throughout Europe. Descartes' work was both a product of this period and the vanguard, leading the way in the development of mathematics and philosophy right up to our time.

My favorite café in all Paris is Les Deux Magots—that icon of literary society made famous by Hemingway, Fitzgerald, Sartre, and Beauvoir—facing the ancient church of Saint-Germain-des-Prés. Six months after our Canadian trip in the snow, I found myself on a sunny day sitting at this café with my friend the historian Richard Landes. We were drinking iced coffee, and Richard was telling me about arrangements he wanted to make for me to meet the director of the Descartes center in Paris, now that I'd come to the French capital to research the life of the philosopher and mathematician.

I was renting an apartment in the Marais—the oldest, medieval part of Paris, and the only section of the city that had not been razed in the nineteenth century by Baron Georges Haussmann as part of his plan to build the wide and elegant boulevards we associate with Paris today. This part of the city, with its narrow ancient streets, looks very much as it appeared in the days of Descartes. My apartment, on the rue du Bourg-Tibourg, was in a building erected in 1629. Both the building and the apartment, on which apparently little work had been done in the past few centuries other than necessary maintenance, looked very much as they must have looked when Descartes walked these very streets when he lived just around the corner from this address for a short time in 1644: on the rue des Ecouffes, between the rue du Roi de Sicile and the rue des Blancs-Manteaux.

The apartment consisted of one large room with a kitchen corner and a bath, and it had a high ceiling supported by the original dark brown wooden beams so characteristic of seventeenth-century French construction. A narrow, dark spiral staircase with small windows cut into the thick stone walls led up to the apartment. Looking at the building from outside, one could admire the tall Parisian windows and notice

the protruding iron supports holding together the exterior walls of this ancient structure. Knowing that my building was there at the time Descartes walked these same streets lent my search an added sense of reality.

I spent my days at the libraries and archives of Paris, researching material on Descartes and his work; I traveled to the locations at which he stayed or lived throughout Europe—Descartes was a great traveler who saw most of the Continent—and I walked the perimeter of the Place des Vosges, under the ancient arches, exactly as Descartes did in 1647 discussing mathematics with Blaise Pascal. I held in my hands original letters Descartes had written to his friend Marin Mersenne; I perused countless manuscripts written over the centuries; I even bought an original book of Descartes', published in 1664. But sometime in the middle of my search, I made a surprising discovery: Descartes had kept a secret notebook.

I was now sitting at the heart of the area in which Descartes loved most to live whenever he was in Paris for longer stays—the then-as-now-fashionable district of Saint-Germain-des-Prés. Richard was talking fast about Descartes and history and Paris, but we were too often interrupted by the perpetual ring of his cell phone. I looked at the ancient church in front of us. I knew it was very old—its construction began in the sixth century. The church has a graceful tower, dating to the tenth century and still in its original state. It has a rustic kind of beauty, seen more often in churches in the French countryside, and in fact it used to be out in the fields, outside the city walls—hence the designation "des Prés." And I knew something else about this church: inside it is a crypt containing the remains of René Descartes. But the body of the great

philosopher and mathematician—so revered by the French—lacks a head. Descartes' skull, or rather a skull purported to be that of the philosopher, is displayed elsewhere in Paris. Nothing about Descartes is simple, and nothing is what it seems, as I learned in my quest to understand Descartes and to uncover his secrets.

Prologue

Leibniz's Search in Paris

On June 1, 1676, Gottfried Wilhelm Leibniz, who would become known as one of the greatest mathematicians of all time and who—along with Newton, who worked independently in England—would be credited with the discovery of the calculus, stepped off a carriage in front of a house in Paris, climbed up a set of stairs, and knocked on a heavy wooden door.

Leibniz had arrived in Paris a few years earlier from Hanover, in his native Germany. He was on a diplomatic mission on behalf of his patron, a German nobleman. But personally, Leibniz was on a search for Descartes' hidden writings. He had heard that when Descartes died, in Stockholm in 1650, he had left behind a

locked box containing writings that he never intended to publish and had kept secret throughout his life. Leibniz knew that these writings were kept somewhere in the French capital, and over three and a half years in Paris, Leibniz made every effort to locate this treasure. Finally, using a network of connections, Leibniz was able to obtain the name and address of Claude Clerselier (1614–84), a man who had been a friend of Descartes and an editor and translator of his works.

Leibniz learned that a quarter of a century earlier, Clerselier received Descartes' hidden manuscripts as a present from his brother-in-law Pierre Chanut (1601–62), who had been France's ambassador to Sweden and a confidant of Descartes during the few months he served as philosophy teacher to Queen Christina of Sweden before he died.

Some time after Descartes' death, Ambassador Chanut loaded the box containing Descartes' hidden manuscripts onto a ship in Stockholm headed for France. After long delays en route, the cargo was unloaded sometime in 1653 at the French port of Rouen. The box was then reloaded onto a boat that was to take it up the Seine River to Paris. But just as the boat entered Paris and was passing by the palace of the Louvre, it capsized and sank. The sealed box containing Descartes' manuscripts remained submerged for three days. Then, miraculously, it disentangled itself from the wreckage and was found on the bank of the river some distance downstream.

Upon hearing this news, Clerselier—who had been expecting the precious cargo for a long time and had sadly just given up hope of ever seeing the manuscripts after he heard that the boat had capsized—rushed to the river with all his servants and ordered them to retrieve the papers quickly. He instructed his servants to spread the parchment sheets of Descartes' manuscripts on tables in his house to dry. The servants were illiterate, and found it difficult to reassemble the manuscripts. But Clerselier worked hard to save Descartes' hidden writings,

and spent many years reading the manuscripts and putting them in order. There was, however, one notebook whose content he could not understand.

The elderly man opened the door slightly, but seeing someone he did not recognize, shut it again. "Please," pleaded the young man from behind the locked door, "please read this letter," and he thrust in through a reopened crack in the door a letter of introduction from the duke of Hanover, asking whoever was shown it to offer all help to its bearer.

After quickly reading the letter, Clerselier opened his door and motioned Leibniz in. Clerselier was a possessive man, and had been jealously guarding Descartes' writings. He viewed himself as the protector of his late friend's secrets. Clerselier listened intently as Leibniz explained his urgent and unusual need to see the documents. Upon hearing the story, he understood that this young man's future and reputation might well depend on the content of Descartes' hidden writings. So reluctantly, and despite his inclination to the contrary, Clerselier agreed to let Leibniz see Descartes' work, and even to copy it.

Leibniz sat down, opened a manuscript, and read:

PREAMBLES

> Fear of God is the beginning of wisdom. The actors, called to the scene, in order to hide their flaming cheeks, don a mask. . . .

But after reading Descartes' description of his hope of discovering science all on his own, and of "advancing masked" through life, Leibniz read the following as the manuscript continued:

MATHEMATICAL TREASURE OF

POLYBIUS THE COSMOPOLITAN

> Providing the reader with the true means of resolving all the difficulties of this science; it is demonstrated that, on these difficulties, the human spirit can find nothing more. This, to shake off idle chatter, and to dismiss the recklessness of some who promise to demonstrate in all the sciences new miracles.

Leibniz understood that Descartes had planned to write a book about an important mathematical discovery using a pseudonym. René Descartes would be Polybius the Cosmopolitan. Leibniz paused for a moment. Then he continued to peruse the unusual document; but what he read next startled him:

> Offered, once again, to the erudite scholars of the entire world, and especially to G. F. R. C.

In the copy he made of the manuscript, Leibniz added a parenthetical word, making it read:

> G. (Germania) F. R. C.

He did not need to annotate the acronym "F. R. C." He knew it well . . . perhaps too well. Leibniz felt a quiver run down his spine as he realized that an invisible secret bond linked him with the late French philosopher.

Looking carefully at the manuscripts in front of him, Leibniz understood that the *Preambles* and the *Olympica,* which announced Descartes' "admirable discovery" but did not give the discovery itself, were only frag-

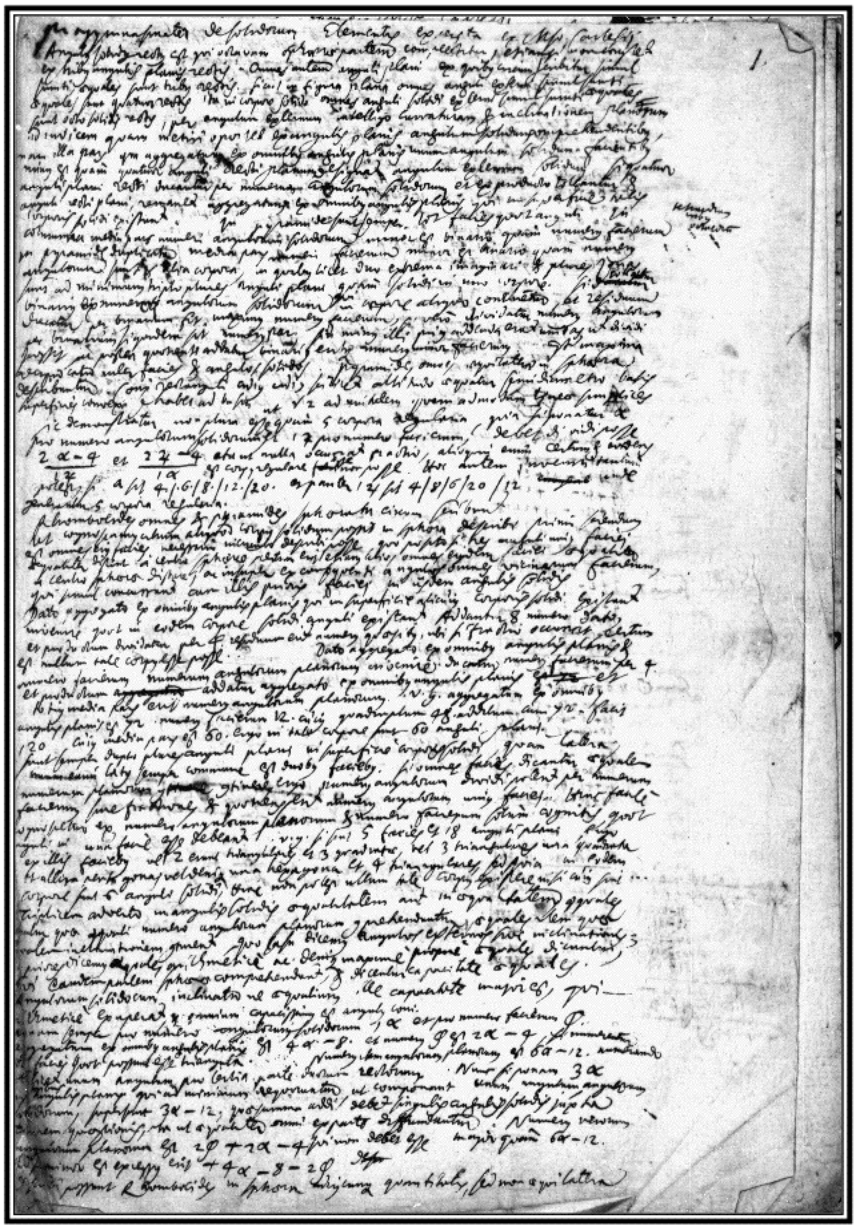
ments designed to introduce the actual work in which the truth Descartes did not disclose in these manuscripts was exposed. But what was the work, and where was it? As he was about to find out, Leibniz was now very close to Descartes' deepest secret, the discovery nearest to Descartes' heart—one that would need to be veiled with a pseudonym, mysterious language, and bizarre, mystical notation.

"Yes, there is one more item," said the elderly gentleman after Leibniz had finished five days of copying and eagerly asked him if there was anything else. "But nobody else has ever seen it before. It's a notebook—his secret notebook." Then he added, "But I don't think you would understand it anyway. I've worked on it for years, but nothing in it, symbols, drawings, formulas, makes any sense at all. It is completely coded."

Leibniz pleaded, and again explained his desperate need to learn everything he could about the hidden work of Descartes. He promised that he would keep the secret, whatever it was that was hidden in Descartes' pages. Finally, Clerselier relented, but imposed tight restrictions on the access to this notebook.

Descartes' notebook consisted of sixteen parchment pages. It contained bizarre notation. Some of the symbols resembled those associated with alchemy and astrology—not the characters usually found in writings on mathematics. And next to them were strange, obscure figures. Then there were seemingly incomprehensible sequences of numbers. What did all these mean?

Working intently and very fast—perhaps furtively, for we don't know exactly what were the conditions Clerselier had imposed when he finally allowed Leibniz to see the notebook—Leibniz had to decipher Descartes' code while at the same time doing the copying. He was able



A page from Leibniz's copy of Descartes' secret notebook

to copy only one and a half pages by the time he had to stop his work. Part of Leibniz's copy of Descartes' secret notebook is shown on page 15.

Some years after Leibniz made this copy, Descartes' original notebook disappeared forever. And for over three centuries, no one could understand the meaning of the copy Leibniz had made of Descartes' secret notebook.

What the bizarre symbols, including $\supset$, meant, and what the sequences of numbers—

4 6 8 12 20 ***and*** **4 8 6 20 12**

—signified, remained a deep mystery.

Why did Descartes keep a secret notebook? What were its contents? And why did Leibniz feel compelled to travel to Paris, seek out Clerselier, and copy pages from Descartes' notebook?

Chapter 1

The Gardens of Touraine

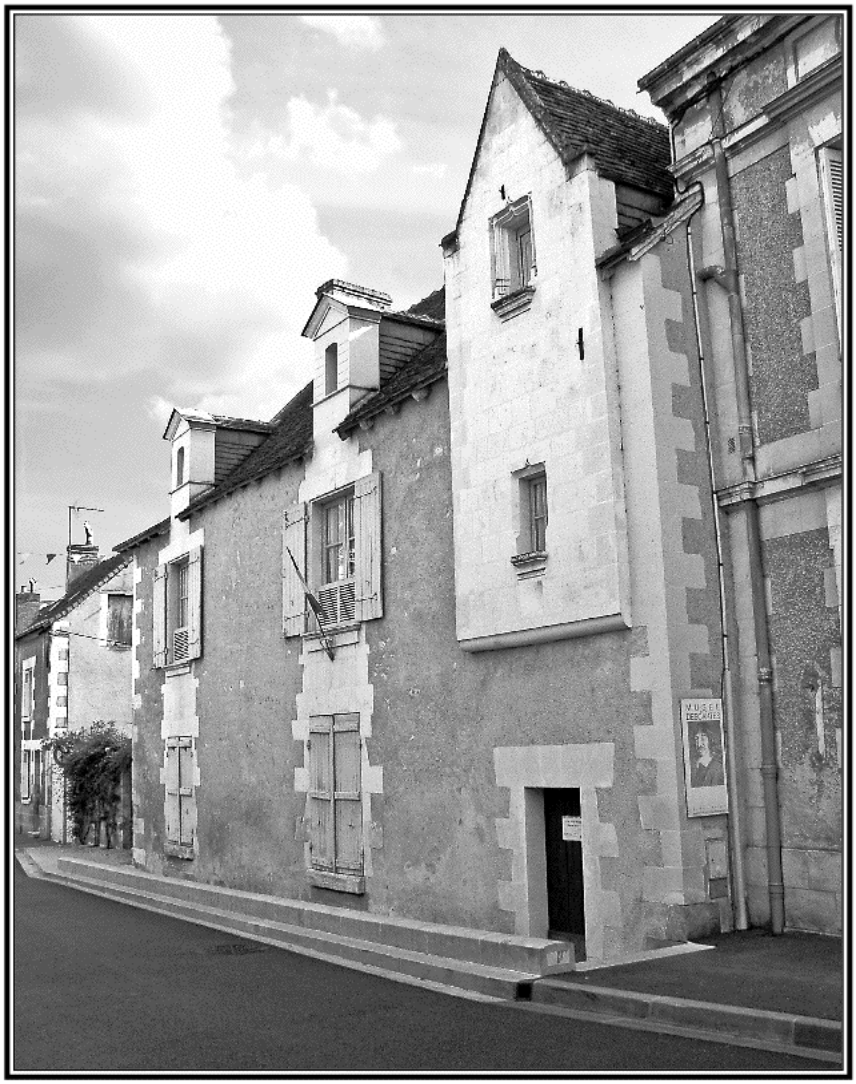
JUST BEFORE RENÉ DESCARTES WAS born, on March 31, 1596, his mother, Jeanne Brochard, took an action that may well have altered the course of Western civilization. For like Julius Caesar crossing the Rubicon in 49 B.C., Jeanne Brochard crossed the Creuse River, which lay between her family home, in the region of Poitou, and the small town of La Haye, which lies in the region of Touraine, in western central France.

The Descartes family had originated in Poitou and had lived for many years in the town of Châtellerault, about twenty-five kilometers south of La Haye. Descartes' parents, Joachim Descartes and Jeanne Brochard, who were married on January 15, 1589, owned a stately man-

The Descartes family mansion in Châtellerault

sion in the center of Châtellerault, at 126 rue Carrou-Bernard (today's rue Bourbon).

Joachim Descartes was the councillor of the Parliament of Brittany, and this important job kept him away in distant Rennes. Jeanne needed her mother's help in birthing the baby, and this is why she traveled north and across the river to Touraine to give birth to René Descartes



Descartes' grandmother's house (now the Descartes Museum)

in her mother's house in La Haye. Sometime later, once she had recovered, she returned to Châtellerault. Despite this accident of birth, throughout his life, René's friends would often call him René *le Poitevin*—René of Poitou.

The regions of Poitou and Touraine include pastoral farmlands that have been cultivated since antiquity. There are low hills, many of which

are forested, and rich flatlands, irrigated by rivers that cut through this fertile land. Cows and sheep graze here, and many kinds of crops are grown. La Haye is a small town of stone houses with gray roofs. At the time of Descartes, the population of the town numbered about 750 people.

Châtellerault is a larger, more genteel town than La Haye, with wide avenues and an elegant city square, and it serves as the hub of rural life in the region. Because this part of France is so fertile and rich in water and agricultural resources, the people who live here are well off. North of La Haye one can still visit the beautiful châteaus of the Loire Valley, as well as forests and game reserves, which existed at the time of Descartes. The châteaus, many of them restored to their original state, with lavish fifteenth- and sixteenth-century furnishings and surrounded by sculpted gardens, give us a feel for the life of the rich at the time of Descartes.

While the regions of Poitou and Touraine are similar in their topography, scenery, and the way the towns and villages are laid out, there was one important difference between them. While Poitou was mainly Protestant, Touraine was mostly Catholic. We know that in the fifteen years from 1576 to 1591, there were only seventy-two Protestant baptisms in La Haye. This significant religious difference between the two regions would affect the life of René Descartes. For this accident of birth—being born, and later also raised, in a strongly Catholic region while his family hailed from a Protestant one—would exert a significant impact on René's personality, thus influencing his actions throughout his life and determining the course of development of his philosophical and scientific ideas and the way he divulged them to the world.

Descartes lived in a century that knew severe tensions, including wars, between Catholics and Protestants. The fact that he was born in a Catholic region and would be raised by a devout Catholic governess, while many of his family's friends and associates in Poitou were Protestants, contributed to Descartes' natural secretiveness. It also made him, as an adult, much more concerned about the Catholic Inquisition than perhaps he should have been, and not worried enough about the

persecution he could face from Protestants. Consequently, Descartes would refrain from publishing elements of his science and philosophy for fear of the Inquisition, and yet would readily settle in Protestant countries, where academics and theologians would viciously attack his work in part because they knew he was a Catholic.

René Descartes was baptized a Catholic in Saint George's Chapel in La Haye, a twelfth-century Norman church, on April 3, 1596. His baptismal certificate reads:

> This day was baptized René, son of the noble man Joachym Descartes, councillor of the King and his Parliament of Brittany, and of damsel Jeanne Brochard. His godparents, noble Michel Ferrand, councillor of the King, lieutenant general of Châtellerault, and noble René Brochard, councillor of the King, judge magistrate at Poitiers, and dame Jeanne Proust, wife of monsieur Sain, controller of weights and measures for the King at Châtellerault.
>
> **[signed]**
>
> **Ferrand Jehanne Proust René Brochard**

Michel Ferrand, René Descartes' godfather, was his great-uncle—Joachim Descartes' uncle on his mother's side. René Brochard was the baby's grandfather, Jeanne Brochard's father. Jeanne's mother, René Descartes' grandmother, was Jeanne Sain. Her brother's wife was Jeanne (Jehanne) Proust.

The name La Haye comes from the French word *haie*, meaning hedge. Originally the town was named Haia, and in the eleventh century, as

the language evolved, the spelling was changed to Haya. In Descartes' time it was called La Haye–en–Touraine. In 1802, the town's name was changed to La Haye–Descartes, in honor of the philosopher, and in 1967, "La Haye" was altogether dropped and the town is now known as Descartes.

There was once a castle in the area, and the wealthiest and most powerful citizens of La Haye lived in it. As the feudal system disintegrated, the castle was abandoned and the people moved down to the town, where they could live more comfortably. But life in this area remained difficult. People suffered both from wars and from disease. The plague ravaged La Haye and its surroundings several times in the late sixteenth and early seventeenth centuries. In 1607, the town was placed under quarantine after a recurrence of the plague killed many people in the area.

In early times, the hedges denoted by the French name Haia (or Haya or Haie) stood for thorny hedges that were planted by the townspeople in an effort to defend themselves and their property from marauding bands of brigands and highwaymen that pillaged and looted the countryside. But as times improved after the duke of Anjou took control of the area in September 1596—six months after the birth of René Descartes—the hedges implied by the name of the town came to mean hedges of beautiful gardens. To this day, this part of France is known for its exquisite gardens and areas of great natural beauty.

Late in life, just before he left on his final journey to Stockholm, Descartes wrote to his dearest friend, Princess Elizabeth: "A man who was born in the gardens of Touraine, shouldn't he avoid going to live in the land of the bears, between rocks and ice?" Descartes may well have been thinking of the garden of his own childhood home, his grandmother's house in La Haye, when he wrote these words to Elizabeth. Descartes' childhood home is an attractive two-story country house with four large rooms, although it is not nearly as impressive as the family mansion in Châtellerault. But it is surrounded by an exuberant garden,

now restored to its original state, with flowers under the generous canopy of graceful trees. One can imagine the young boy enjoying many hours of undisturbed thinking and playing in this tranquil garden.

A year after René was born, shortly after giving birth to her fourth child, Jeanne Brochard died. The newborn survived for three more days, and then died too. Some of Descartes' biographers have written that René's personality was deeply affected by the loss of his mother, and have even speculated that the young boy blamed himself for her death because he did not quite understand—the event having taken place so close to his own birth—that she died sometime after giving birth to her *next* child.

After the death of his wife, Joachim remarried. He took a Breton woman named Anne Morin as his wife, and with her had another son and another daughter (and two other babies who died in infancy). They bought a house in Rennes, where René's older sister joined them in 1610, and where she got married in 1613 to a local man. Until then, René and his older brother and sister were raised by a governess. René Descartes was extremely attached to his governess, who was a devout Catholic. She lived to old age, and Descartes specified in his will that she was to receive a significant amount of money annually for her support.

As a child, René became known as the young philosopher of the family because he had a great curiosity about the world, always wanting to know why things were the way they were. The child grew up in the natural environment of farming and hunting and strolling in the woods. Throughout his life he would make references to the bucolic land of his birth and its natural rhythms. In letters to friends, and in published works, he would describe his childhood memories: the smell of the earth after a rainstorm; the trees at different seasons of the year; the process of

fermentation of hay, and the making of new wine; the churning of butter from fresh milk; and the feel of the dust rising up from the earth as it was being plowed. Perhaps it was this early closeness to nature that kindled his interest in physics and mathematics as means for understanding nature and unraveling her secrets.

The Descartes family was wealthy, and René would inherit even more assets directly from his grandfathers on both sides, both of whom had been successful medical doctors. His great-grandfather Jean Ferrand had been the personal physician of Queen Eleanor of Austria, the wife of Francis I of France, in the middle of the sixteenth century. He attained great wealth, which was eventually passed on to his daughter Claude, who married Pierre Descartes. Their son was Joachim Descartes, René's father. In 1566, when Joachim was only three years old, his father, Pierre, died of kidney stones. Pierre's father-in-law, Jean Ferrand, Queen Eleanor's personal physician, performed the autopsy on his son-in-law. In 1570 he wrote up the results of the operation and published them in a scientific paper, in Latin, about lithiasis—the formation of stony concretions in the body. His deep curiosity about nature—even to the point of dissecting the body of his own son-in-law—was passed on to his descendants. While, unlike his grandparents, René Descartes would not pursue medicine as a profession, late in life he would dissect many animals in search of the secret to eternal life.

René Descartes would spend much time during his adult life managing his inheritance. This wealth, including significant land holdings in Poitou, would enable him to pursue his interests without concern about a livelihood. It would afford him to indulge his whim of volunteering for military campaigns as a gentleman soldier without compensation—sim-

ply for the thrill of adventure. He would be able to afford luxurious accommodations wherever he traveled, and to employ servants and a valet. His money would even allow him to look after the education of his staff, thus sharing with them some of the privilege of his family's wealth. Descartes would grow up to be a very generous employer and friend.

Despite Adrien Baillet's statement in his very comprehensive 1691 biography of Descartes that the family belonged to the nobility, recent research indicates that, as far as René's life is concerned, this was not true. The renowned French historian Geneviève Rodis-Lewis explains in her 1995 biography, *Descartes*, that the Descartes family gained the rank of knighthood, the lowest status of nobility in France, only in 1668—eighteen years after René's death. According to French law, nobility was conferred on families after three successive generations had served the king in high office. Joachim Descartes certainly held such a position, and some have argued that he had originally sought to become councillor to the Parliament of Brittany in hopes of obtaining nobility status for his descendents. But René Descartes would choose a different direction in life, and so nobility would be conferred on the family only after another member had satisfied the three-generations requirement, years after René's death.

After he remarried, Joachim Descartes spent most of his time in Rennes with his new wife and the children she bore him. He also had interests and family business farther south and west in Nantes, also in Brittany. As they grew older, René and his brother and sister traveled frequently to visit their father. Eventually, René Descartes would see all of western France as his home territory, since time in his later childhood was spent throughout the regions of Poitou, Touraine, and Brittany.

But the frequent travel throughout the region was hard on the boy. In adulthood, Descartes described his health as a child as poor, and

recounted in letters to friends that every doctor who had ever seen him as a child had said that he was in such poor health that he would most likely die at a young age. His devoted governess took such good care of him, however, that when he was eleven years old he was healthy enough to be sent away to study at the prestigious Jesuit College of La Flèche.

Chapter 2

Jesuit Mathematics and the Pleasures of the Capital

In 1603, King Henry IV, who had been raised a Protestant but converted to Catholicism, gave the Jesuits, as a gesture of his goodwill toward this powerful Catholic order, his château and vast grounds in the town of La Flèche, to be used by them as the site of a new college. The Jesuits enlarged the château, and the result was a series of large interconnected Renaissance buildings with spacious, square, symmetric inner courtyards. Entering the grounds, one is struck by the perfect order and symmetry of the checkerboard array of grand courtyards, and by the well-manicured gardens beyond them. This is one of the most impressive college grounds anywhere; today it is the site of a military academy, the Prytanée National Militaire.

La Flèche was well chosen for a college. It lies in Anjou, north of Touraine, in a rich area with forests and gentle rolling hills. The town is attractive, with a river running through its center and lush meadows surrounding it. The gate of the college opens right into the spacious town square. Once students left the grounds of the college, they were in the center of the town with its many places to eat, drink, and find entertainment.

The college was inaugurated by King Henry IV, and opened its gates in 1604. France's brightest students from the best families were encouraged to apply for acceptance. Among the students accepted to the first class to enter this elite new college was Marin Mersenne (1588–1648), who would become Descartes' most devoted and loyal friend.

The college was run as a semimilitary school. The students had to wear a uniform, including breeches with pom-pom fastenings, a fancy blue blouse with large-puffed sleeves, and a felt hat. Each student was given a long list of items he had to bring to school. These included candles, various kinds of pencils, quills, and notebooks, and items of personal use.

According to new research, René Descartes entered the College of La Flèche right after Easter 1607. A college such as La Flèche was an educational institution at which young boys studied before going to a university. As such, it was akin to a modern preparatory school rather than what we call a college today. Descartes' admission to the college was delayed because his health wasn't good enough when he was younger; and until then, he was educated at home by a tutor. René was eleven years old when he started his studies at La Flèche, and he stayed there until his graduation eight years later, in 1615. The tuition at the college was

free, but students' families had to pay for room and board and other expenses. At the time Descartes studied there, the college had about fourteen hundred students, who came from all over France. Fortunately, the college was a day's journey from Descartes' home in La Haye, so he could easily visit his grandmother and governess.

Since Descartes was still frail, the family made a special request to the college, asking that its administration take exceptionally good care of his health. The rector, Père Charlet, who was a relative of the Descartes family and whom René would later describe as "almost a father to me," was eager to comply, and gave René unprecedented privileges so that the boy would not feel any stress, in hopes that his health would improve. He thus allowed René to sleep late in the mornings and stay in bed until he felt well enough to join the others in the classroom. This unique arrangement started Descartes on a lifelong routine of waking up late in the mornings and staying in bed, thinking and working, until he was ready to get up and face the day. Most of his life until his last few months in Sweden, with the exception of periods in which he was in an army involved in heavy fighting, Descartes never had a forced wake-up in the morning, but rather arose whenever his body was sufficiently rested.

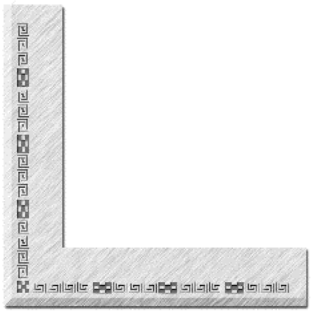
Life at the college, for everyone else, began at 5:00 A.M. From 5:00 until 5:45, the students said their morning prayers, washed and dressed, and got ready for work. Personal hygiene was very important: students were made to wash well, and if they were sick they were confined to the infirmary. The time from 5:45 to 7:15 was spent on individual work, followed by breakfast. The first classes were held from 7:30 until 10:00. René Descartes was exempt from having to sit through these early classes. At 10:00 A.M., mass was held, followed by dinner, which was the first substantial meal of the day. There followed a period set aside for recreation. Afternoon classes began at 1:30 and lasted until either 4:30 or 5:30, depending on the season. The students spent the remainder of

the day—until 9:00 P.M., when they went to bed—having their evening meal and playing games, mostly ball games that were popular in France during this period (including the famous *jeu de paume*). They were also allowed to play cards, a popular pastime, but the involvement of money in any kind of game was strictly prohibited. Just before they retired at 9:00 P.M., they attended a spiritual lecture. On special days, equestrian skills were taught, as well as swordsmanship.

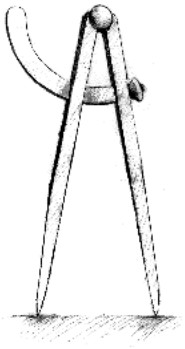
René Descartes joined his fellow students after the morning classes had ended. His special arrangement, allowing him to stay in bed late, made him learn how to study on his own. This was especially useful in mathematics, where he could derive ideas by himself, without having to sit through the material slowly with an entire class. This habit of intellectual independence enabled him to forge ahead swiftly and—a little later in life—to create new mathematical and scientific knowledge on his own without being held back by conventional beliefs.

Students were taught grammar, which meant Latin and Greek. They also studied humanities, rhetoric, and philosophy. Both humanities and rhetoric were centered on the classics. Humanities included the works of the Roman poets Virgil, Horace, and Ovid, while rhetoric was mostly a study of Cicero and the Platonic method of argumentation. The philosophy taught at La Flèche consisted of the works of Aristotle, in the medieval scholastic tradition, as well as logic, physics, and metaphysics.

The Jesuits taught their students the essentials of Greek mathematics: the works of Euclid, Pythagoras, and Archimedes. The Greeks, with their clear, abstract view of nature and its elements, simplified all construction in geometry to figures that could be drawn with only two tools—the simplest tools they could conceive and ones that they believed should suffice to construct any geometrical figure one could imagine or need. These two elementary tools were an unmarked straightedge and a compass.

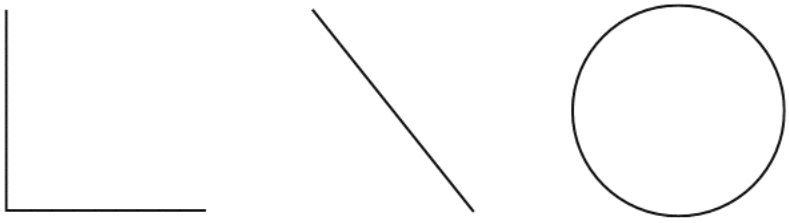


A straightedge



A compass

The straightedge made angles and straight lines, while the compass was used for making circles and marking off distances. By combining the operations of both instruments, anything that was of importance to Greek mathematicians could be drawn.



Figures drawn with straightedge and compass

Descartes was fascinated by the simplicity of thought and the power of abstraction the ancient Greeks had demonstrated with their geometry, an entire science based on the use of two instruments. The priests who taught this ancient knowledge at the college outlined the entire theory of Euclidean geometry, and explained to the students how to prove a variety of theorems in geometry. Mathematics courses at La

Flèche also included arithmetic, in which the rules of computation were studied, as well as algebra, in which methods of solution of equations were explained—as much as these equations were understood at that time.

Interestingly, the grounds and buildings of the College of La Flèche, perfectly symmetrical and square in their design, seemed constructed as if by straightedge and compass. Descartes' writings later in life—particularly his *Discourse on the Method* of 1637—make it clear that he was impressed by symmetry and straight lines in the design of buildings and towns:

> Thus old cities, which were at their beginnings nothing but small towns, and have become in time large cities, are generally not well designed as by compass *[ordinairement si mal compassées]*, at the cost of the regularity of their squares that an engineer traced following his fantasy on the plane. . . . Seeing how the buildings are arranged, here a large one, there a small one, and how they make the streets curved and unequal, one would conclude that it was chance, rather than the will of men using reason, that has thus laid them out.

What the young boy saw on the grounds of his college and learned from his study of Greek geometry using straightedge and compass became important elements in shaping his philosophy and his mathematics. With enough imagination, one can trace the origins of the Cartesian coordinate system to the perfectly symmetric design of the grounds of Descartes' College of La Flèche.

During his time at La Flèche, Descartes and the other students at the college took part in a most unusual ceremony. King Henry IV was considered the founder of the college, and the gate to the college bore (and still does today) the letter *H* on each side, in honor of the king, as did most buildings on the campus. In his will, the king had specified that

his heart, that of his queen, and those of their heirs were to be buried at the Church of Saint Thomas on the grounds of the college, his former Château of La Flèche.

Henry IV, whom history would remember as one of France's most benevolent monarchs (he's the king who promised a "chicken in every pot" in his realm for Sunday meals), had difficulties throughout his rule with tensions between Protestants and Catholics, the latter never quite trusting him completely even though he was nominally a Catholic. Things became more dangerous for the king when in 1610 he allied himself with several German Protestant princes against Catholic Spain. On May 14 of that year, the king's carriage was passing through a particularly busy street in Paris, the rue de la Ferronerie. As traffic on the street momentarily came to a halt, a Catholic fanatic named Ravaillac rushed onto the royal carriage and stabbed the king in the chest. He died almost instantly.

After the king's assassination, the ritual prescribed in the king's will began. It started with prayers for the soul of the dead king held on May 15 at the church of the College of La Flèche. The king's body was embalmed in the Louvre palace, and the heart was carefully removed. The heart was kept for three days in the Jesuit chapel in Paris, and then transferred to the care of Père Provincial Armand, who gathered a group of twenty leading Jesuits and a larger number of the king's knights to accompany the heart to its final resting place in La Flèche.

The college chose a group of twenty-four of its most distinguished students to join the procession as the party carrying the king's heart arrived in town. Among these twenty-four students was René Descartes. The procession came to order at the central square in town, and now included also archers and royal guards, who had joined it. From the town of La Flèche, the entire assemblage marched to an open field and stopped. Torches were lit, and in a solemn ceremony, the heart was transferred from Père Armand to the duke of Montbazon. The procession then continued on to college grounds and into the Church of Saint

Thomas. Inside the church, the duke raised the heart for all to see, and in a communal prayer, it was placed in an urn forever to remain in the church. This ceremony was deeply etched into René Descartes' memory.

After his graduation in 1615, Descartes moved to Poitiers to study law at the university. He spent an uneventful year there, since he was not interested in the law. Much of his spare time was devoted to practicing his swordsmanship skills learned at La Flèche. He received his doctor of law degree in 1616, and after spending a pleasant summer with his family in Rennes, riding horses and enjoying the outdoors, he moved to Paris. (In 1985, Descartes' thesis for his law degree was discovered at the University of Poitiers. The date of acceptance of the thesis was November 10, 1616. When they found the thesis, scholars were struck by its date. This day—November 10, and sometimes the night of November 10–11, or November 11—reappears as if by magic as the date of many key events in the life of Descartes.)

Descartes' family did not take well to his expressed wish to move to Paris after his graduation. Even though René's health was now much better than it had been in his childhood, the family was concerned about the prospect of his living alone so far away. Joachim Descartes was especially worried about his son moving to the big city, but René assured him that this was what he wanted to do and that it was an important step toward his future. At twenty, he argued, he was old enough to live on his own and find his way in the world. The father finally agreed to let him go—but only on the condition that he move to Paris with servants and a valet to assist him. Throughout his life, Descartes would never be without a valet. He chose them well—his valets were always

extremely loyal to him and would literally risk their lives for his safety and well-being.

The city of Paris has always been the center of life for the French, who have been flocking there for centuries from small towns and villages throughout the land. They come to seek a better life, economic rewards, and culture. But many come to Paris for the sheer excitement it offers. In the days of Descartes, this impulse was no different than it is today.

Descartes lived during the time of d'Artagnan and the swashbuckling adventures depicted in Alexandre Dumas' *Three Musketeers*. Looking at seventeenth-century French paintings and engravings gives us a good idea about the styles of the time of Descartes: richly colored flowing silk garments with voluptuous folds, plumed velvet hats, shoes with ornate silver buckles. Descartes loved to dress in style, and he carried his polished sword with him wherever he went, as did many young gentlemen of his time. He was intent on learning as much as he could from "the great book of the world," as he called it. He was on a search for truth about life and the human experience. And what better place to explore life than the city of Paris?

By the time he finally moved to Paris, Descartes' health was excellent. He had lost the paleness of his youth, and he no longer suffered from whatever ailments had plagued him in childhood. Feeling well for the first time in his life, and finally having finished his education, he was eager to experience life. In Paris he met up with many of his old friends from La Flèche, who had congregated in the capital, and he also made some new ones.

Descartes' early days in Paris were a carnival of drinking, gambling, and merrymaking. He learned very quickly that he had a knack for card

games and other games of chance—now, unlike at college, played for money. He was very successful at these games, winning significant amounts of money, which made him even more popular with his old and new friends alike. Descartes was constantly surrounded by people, and life for him was a continuous, endless party. These young men paraded down the streets of Paris, pursuing beautiful women.

When he was a child, René had a crush on a young girl who had a lazy-eye problem. This childhood memory made him always focus his attention on women's eyes. As a young man in Paris, he found himself especially attracted to women who had beautiful eyes.

Among René's new friends in Paris was Claude Mydorge, who had been the treasurer of the city of Amiens, and who enjoyed a reputation as a first-rate mathematician. Mydorge was a dozen years older than Descartes, a man of the world, and he had an especially engaging and vivacious personality and a good sense of humor. Descartes was attached to him, and the two men spent many hours together enjoying themselves as well as discussing mathematics. Among René's acquaintances from La Flèche was Marin Mersenne. Mersenne had by then finished a course of study at the Sorbonne and had received the habit of the Minim order on July 17, 1611, in the monastery of Nigeon, near Paris. The Order of the Minim Brothers was founded in 1435 by Saint Francis of Paola in Calabria, Italy. To the Minims, humility is the primary virtue, and the name Minim derives from *minimi*, since they view themselves as "the least" of all the religious.

Six months after Descartes arrived in Paris, Mersenne was ordained a priest and became a friar of the Minim monastery at the Place Royale (today's Place des Vosges). Descartes would often visit Mersenne, who had a very wide range of scientific and mathematical interests, and talk with him and explore new ideas. Mersenne quickly became Descartes' closest friend. According to Baillet, the stimulating interactions Descartes enjoyed with Mersenne served as a counterweight to the general lack of purpose that characterized his early days in Paris.

Descartes also loved music. Some scholars have drawn a connection between his interest in music and his great ability in mathematics. At any rate, Descartes and his many friends pursued musical interests together, attending concerts and performances throughout the capital.

After about a year of play and enjoyments of all kinds, René Descartes felt the need to become more serious. In Paris he had come in contact with new ideas. French intellectuals were studying Greek geometry, trying to embellish the works of the ancient Greeks. Euclid's *Elements* had by then been extended to include three more volumes beyond the original thirteen. Physics, too, was developing, as scientists were studying the nature of falling objects and exploring the riddle of gravity. Descartes longed to study these new ideas, and his feverish social life became an impediment to achieving this goal. To concentrate on his work, the young man now felt he had to distance himself from his many friends—but they made it hard for him to do so. Whenever Descartes stayed home to read and work, his friends would come over to his apartment and beseech him to join them on the streets and at the nightspots of the city.

In desperation, Descartes took a drastic measure—he secretly moved and did not give his friends his new address. He needed to be in an area where people would not recognize him whenever he went out for a walk, or recognize his servants or valet when they shopped or ran errands for him. So Descartes moved outside the walls of the city, to the neighborhood around the ancient Church of Saint-Germain-des-Prés. He loved this part of Paris because it was peaceful and quiet, and more rural. There were open fields here, to which young men would occasionally come to duel, an activity discouraged by the authorities. Descartes began to view himself as a spectator rather than an actor in the drama

of daily life around him. For over a year, no one saw Descartes. His friends worried, and they suspected that he might have left Paris to return to his father's house in Brittany. They complained to one another about his incivility in leaving without saying good-bye. Some of them made inquiries in Rennes, but learned that he was not in Brittany, nor in Touraine or Poitou. They kept looking for him in the capital, but found him at no ball or banquet or reception. His friends were close to giving him up as lost.

Hiding out in a new part of the city worked for Descartes for some time. But his friends were still searching for him everywhere. One day, Descartes' valet was recognized on the street by one of these acquaintances, who then secretly followed the valet out of the city walls and into the area of Saint-Germain. The man waited for the valet to disappear up a flight of stairs, and then followed up the same stairway. He looked through the keyhole into Descartes' bedroom.

The man observed Descartes lying in bed reading, then sitting up in bed to write in a notebook, then lying down again to read, and a little later sitting up again to write in the notebook. The friend realized that Descartes was immersed in work he seemed determined to keep from the rest of the world. He would not disturb him, now that he understood Descartes' need to withdraw from the excited life of the capital to pursue his private work, and he quietly left.

Scholars believe that Descartes likely wrote his enigmatic *Preambles*, which included the statement "I advance masked," in his hideaway in Saint-Germain. Descartes' *Preambles* continued:

> The sciences are now masked; the masks lifted, they appear in all their beauty. To someone who can see the entire chain of the sciences, it would seem no harder to discern them than to do so with the sequence of all the numbers. Strict limits are prescribed for all spirits, and these limits may not be trespassed.

> If some, by a flaw of spirit, are unable to follow the principles of invention, they may at least appreciate the real value of the sciences, and this should suffice to bring them true judgment on the evaluation of all things.

Descartes' ideas about the "chain of the sciences" and the sequence of the natural numbers bore a striking resemblance to mysterious writings of a mystical nature that had begun to appear in Europe in the early part of that same decade. The authors of these treatises on science and mathematics had remained anonymous.

Two years after he arrived in the French capital, René Descartes was ready to move on. He had always enjoyed a fast lifestyle, and he liked to fence and ride horses; now he longed for a life of action. Descartes had heard that up in Holland, Maurice of Nassau, the new prince of Orange and the Protestant champion in the religious wars, was gathering men from several countries—including two French regiments—and training them in his camps for war with the gathering Catholic forces of Spain and Austria.

Although he was a Catholic, Descartes was interested in joining Prince Maurice's army. He felt that he could learn much about the art of war from the prince and his generals, and religion did not weigh in his decision, perhaps because he would join as a volunteer and would not have to fight if he chose not to do so. Descartes sent his servants back to his father in Rennes and, taking only his valet with him, traveled to Breda in southern Holland to volunteer his services. He would learn the art of war, but would not be paid for his military service—other than a token single gold doubloon. Unpaid, he would retain many free-

doms, and these rights would allow him to pursue his research in mathematics and science, and to try to uncover their hidden meanings. Descartes would use the army as a vehicle for travel and adventure. In the words of Baillet, Descartes would use the army as "a passport to the world."

Chapter 3

The Dutch Puzzle

"Quid hoc significat?" the young French soldier asked the slightly older Dutchman standing next to him, addressing him in Latin, the lingua franca of the educated throughout Europe. They were both among a group that had crowded around a curious poster attached to a tree trunk in the main square of the city of Breda, on the morning of November 10, 1618. "What does this mean?"

The Dutchman was from Middleburg and had just finished his studies in medicine and mathematics, and was hoping to take up the position of assistant principal of the Latin School of Utrecht. He had come to Breda to help his uncle slaughter his pigs, and was also hoping to find a wife. He took a long look at the young French soldier facing him. René Descartes

wore the distinctive uniform of a volunteer in the army of Maurice of Nassau, the prince of Orange.

The Dutchman also noticed that the soldier was wearing a fancy plumed green hat, and that a silver sword hung from his hip—not the usual musket other soldiers carried. He looked not much older than twenty-two or twenty-three, was of medium height, slightly less perhaps, with longish thick and wavy dark brown hair, and a mustache and goatee to match. And he had piercing, earnest brown eyes.

The soldier was looking at him expectantly. "It is a mathematical puzzle," the Dutchman answered.

"I can see that," responded Descartes, "but what exactly does it say? I do not understand Flemish."

The man took out a piece of paper and a pencil and began to copy the geometrical designs on the poster, labeling each in Latin, rather than Flemish, and then translating into Latin the paragraph written below the diagram. He handed the paper to the young soldier and said, "They want you to prove this statement," pointing to the last sentence. Descartes looked intently at the paper in his hand, and the man added: "And I suppose you will give me the solution, once you have solved this problem?"

Descartes turned quickly from the paper and gazed intently at the man.

"Yes, of course I will give you the solution," he said with determination. "Would you please give me your address?"

The Dutchman offered him his hand and said, "Isaac Beeckman is my name."

"René Descartes," said the soldier. "Or René *le Poitevin*, as they call me, since my family comes from the French region of Poitou; although I was actually born in Touraine."

They shook hands, and Beeckman told Descartes that he was from Middleburg but was staying in Breda to help his uncle with his pigs. He

gave him his uncle's address and they bade each other good-bye. From his journal, which was discovered in a Dutch library in 1905, and from other sources, we know that Beeckman did not believe that the young soldier would be able to solve the puzzle.

The next morning, as Isaac Beeckman was about to have breakfast at his uncle's house, there was a persistent loud knock on the door. The servant opened the door and let in the young soldier. He was accompanied by his valet. Descartes showed Beeckman his solution to the Dutch puzzle. Beeckman, who was a competent mathematician, was amazed by the soldier's solution to a very difficult mathematical problem. He had not expected a random person to solve a problem that many trained mathematicians and professors could not. Descartes' brilliant solution cemented a friendship between the two men. It was also a watershed event in the life of the young Descartes, since this was the moment he first realized that he was a very gifted mathematician.

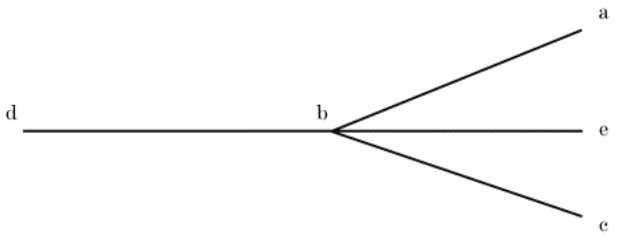
The puzzle Descartes solved and demonstrated to his new friend was not an isolated problem suddenly appearing on a poster in southern Holland. The seventeenth century saw a revival of the classical geometry of ancient Greece as educated people throughout Europe sought intellectual challenges and the hidden meanings of mathematics. Ancient Greek texts were being republished in Latin, foremost among them Euclid's classic volumes of the *Elements*, written in Alexandria about 300 B.C. Euclid's work was, in fact, the most important textbook published on the new printing presses invented less than a century and a half before Descartes' time. Other ancient texts, such as Diophantus's *Arithmetica*, written around A.D. 250, were also being printed in seventeenth-century Europe. It was on the margin of a copy of this book

that Pierre de Fermat (1601–65) wrote his famous Last Theorem, which would haunt mathematicians and amateurs alike until its final, dramatic proof late in the twentieth century.

These newly republished mathematical texts enabled a revival of the study of geometry in the schools and universities of Europe, and with these new publications arose a whole class of intellectuals who avidly pursued new solutions to ancient problems, challenging one another to solve problems they proposed and publicized on posters placed in public places. The problem Descartes solved on November 10, 1618, was one such example of a challenge issued by a mathematician through a public posting. Similar challenges issued a century earlier by mathematicians living in northern Italy had led to great developments in the area of algebra, resulting in the solution of complicated equations that the ancient Greeks and the medieval Arab mathematicians who followed them had not been able to achieve.

We don't know exactly what the problem was that Descartes solved and showed Beeckman in November 1618. We do know that it involved angles in a geometrical drawing, and that it was a very difficult problem. But one unusual, and perhaps incidental, aspect of Descartes' geometrical thought apparently impressed Beeckman very much. Descartes may have raised this particular issue on meeting Beeckman, even before he presented him with his solution to the problem from the poster the next day. In his journal, Beeckman described it on the day after he met Descartes:

> *Angulum nullum esse male probavit Des Cartes:*
>
> Yesterday, which was November 10, 1618, at Breda, a Frenchman from Poitou tried to prove the following: "In truth, there is no such thing as an angle." This was his argument: "An angle is the meeting point of two lines at one point, so that the line *ab* and the line *cb* meet at point *b*. But if you intersect an-

> gle *abc* by the line *de*, you divide point *b* into two parts, so that half of it is added to line *ab*, the other half to line *bc*. But this
>
> 
>
>
> contradicts the definition of a point, since it has no size. Hence, there is no such thing as an angle.

This, of course, is unlikely to have been the complicated mathematical puzzle Descartes solved, but rather Descartes being clever with Beeckman, showing off his mastery of Greek geometry with its axiomatic definitions—to the point of making an absurd argument. The *point* in the angle does not, in fact, get cut into two halves—precisely because it has no size. Descartes was philosophizing, and Beeckman was impressed with his mastery of the intricacies of Greek geometry.

At the time Descartes showed Beeckman his solution to the Greek geometrical problem, the two areas, geometry and algebra, were considered two different parts of a wider, and somewhat nebulous, field called *mathematics*. Geometry was about straight lines and triangles and circles—idealized visual images of the elements of the physical world. Algebra, however, was the study of *equations*—symbols and numbers on two sides of an equal sign, which had to be solved to result in some meaningful quantity. No one had imagined that these two fields could be unified

into a larger discipline. But within two decades, René Descartes would do just that.

Descartes told Beeckman that he was hoping to go to war. Beeckman worried about this prospect, and hoped that his new friend would stay in the area and that the two of them could meet often and work together on problems of mathematics and science. After he left Isaac Beeckman on November 11, 1618, and returned to his army camp, Descartes realized that he was not yet going to be sent to war. He stayed on in Prince Maurice's army for several months while the troops remained stationed outside Breda. Since he was, after all, a volunteer, Descartes did more or less what he wanted to do. He spent time learning Flemish, so that he would never again have to ask strangers for translations. Descartes had excellent facility with language—he had perfect mastery of French and Latin—and before long, he could understand Flemish well and even speak it with some fluency. This new language ability also gave him fluency in other, related, Germanic dialects. Descartes was proud of his new achievement, and on January 24, 1619, he wrote to Beeckman from his army camp: "I devote my time here to painting, military architecture, and the study of Flemish. You will soon see the progress I have made in this language, when I come to see you in Middleburg, God permit it, at the beginning of Lent." Descartes could not have known it at the time, but his new mastery of Flemish and related Germanic dialects would literally save his life.

Descartes' solution of the Dutch puzzle excited him about mathematics. For it demonstrated to him that he had a unique gift. He began to believe that mathematics held the secret to understanding the universe. He stayed most mornings in bed at camp reading and writing about mathematics and exploring its applications. He worked out an-

cient Greek problems in geometry, but he soon concluded that the power of geometry transcended pure mathematics: geometry held the secret to all creation.

Three years before they met in Breda, Isaac Beeckman had penned an article—which was discovered in his journal—about the mathematics of music. In this article, Beeckman tried to use Greek geometry to explain the harmonics of a vibrating string. While Beeckman's analysis was not very deep, Descartes did not show any lack of respect for his new friend's work. The two men worked together, trying to create a theory of music based on mathematics. They also worked on mechanics and on pure geometry. Beeckman would suggest problems, and Descartes would solve them using his brilliant mathematical abilities. By now Beeckman was back home in Middleburg, and Descartes would visit him whenever he could. When they were not together, the two friends exchanged ideas through letters.

On March 26, 1619, Descartes wrote his friend from his camp in Breda. He unfolded his plan to invent a method of solving a very wide variety of problems. He wrote: "I desire to give the public not an *Ars brevis* of Lull, but a science based on new foundations." Descartes alluded here to the work of Ramon Lull (c. 1235–1315), a medieval mystic who was born on the Spanish island of Majorca and wrote 260 books, among them the *Ars brevis* ("Brief Art") Descartes mentioned. Lull's works were a mixture of Cabbala and mysticism whose elements were ways of combining letters and numbers in an attempt to extract new knowledge about the universe.

A month later, on April 29, 1619, Descartes again wrote to Beeckman about the work of the Majorcan mystic: "Three days ago I met at an inn in Dordrecht a learned man and discussed with him the

Ars parva [Ars brevis] of Lull. He said that he could use the *Art* so successfully that he could discuss any topic whatsoever for an hour; and if one then asked him to speak about the same topic for another hour, he could do so without repeating what he had already said, and so on for another twenty hours."

Descartes was interested in the supposed power of Lull's mystical methods of obtaining knowledge. He asked Beeckman about it, and the latter, who had read some of the works of Lull, explained to him that Lull had invented a wheel on which the nine letters *B*, *C*, *D*, *E*, *F*, *G*, *H*, *J*, and *K* were arranged. These nine letters stood for attributes of creation (which were akin to the ten attributes of God, the *Sefirot*, in the Jewish Kabbalah). By producing permutations of these letters using circles revolving within other circles in a geometrical device, new concepts could be derived. Descartes' letters to Beeckman in 1619 give us the first indication of the young man's curiosity about mystical methods and ideas.

Lull's medieval magic would be reflected in the teachings of a secret society emerging in the early seventeenth century, and Descartes would find himself in the midst of these explorations of science and mysticism.

When Descartes returned to his camp in Breda, he began to suspect that he might never have a chance to see the military action he longed for. The prince of Orange had signed a truce with his enemies, and as part of this arrangement, had made a commitment not to engage in battle for a period of twelve years.

Descartes felt betrayed by this truce since he felt that the promise he had been given when he volunteered to serve the prince—that he would see military action—would likely never be met. Descartes had known since the previous year, 1618, that important political events

were taking place in Bohemia and in Germany, and that these events could lead to war. By that time, the winds of religious war had been blowing in Europe for an entire century.

When Martin Luther (1483–1546) posted his ninety-five theses on the church door in Wittenberg in 1517, launching the Lutheran branch of Christianity and hence Protestantism, religious confrontations erupted all over Europe. Luther's act is generally taken as the starting point of the Reformation, a movement for reform of the doctrines and practices of the Roman Catholic Church. The controversy between Catholics and Protestants had a strong political aspect as well, since religion and nationality tended to correlate across the Continent. By 1530, the rulers of the German states of Saxony, Hesse, Brandenburg, and Brunswick had been won over to the reformed belief, as were the kings of Sweden and Denmark. Consequently, these rulers broke away from Catholicism and made the churches in their realms conform to Protestant principles.

Calvinism, a form of Protestantism based on the teachings of John Calvin (1509–64), which includes the idea of predestination, was founded in 1536 and took hold in parts of France, western Germany, Holland, Switzerland, and Scotland. Since the rest of Europe remained Catholic and loyal to the pope, the continent was deeply divided. In France, the Wars of Religion took place in the mid-to-late sixteenth century between Catholics and the Huguenots—French Protestants. These wars were complicated by the interventions of Spain, Savoy, and Rome on the side of the Catholics, and of England, Holland, and several German principalities on the side of the Huguenots. By the time Descartes was growing up, however, there was relative peace. But this peace was not to last for long.

In 1613, a young German prince, Frederick of the Palatinate—a re-

gion in southern Germany that included part of the Rhine and the city of Heidelberg—arrived in London to marry Elizabeth Stuart, the daughter of King James I of England and Anne of Denmark, and granddaughter of Mary, Queen of Scots. Many in Europe saw in this royal wedding the forging of an important alliance between England and Protestant forces on the continent. But in fact, King James I had every intention of remaining neutral in the religious conflict that was brewing on the continent, and was hoping to balance the apparent favoring of Germany that might have been implied by his daughter's wedding by forging a similar union with Catholic Spain.

Frederick took his bride to Heidelberg, sailing down the Rhine, and they established their home in Heidelberg castle, where they lived happily and in peace for five years. But then things began to change. A strong movement on the continent saw in Frederick a potential leader who could unite the Protestant forces in Europe against the Catholic forces of the Austrian Habsburg empire, whose capital was Prague.

The Habsburg emperor Rudolf II, a benevolent and tolerant ruler who had moved the center of the Habsburg empire from Vienna to Prague, died in 1612, precipitating a power struggle for his succession. Prague under Rudolf had been a flourishing city in which new ideas were developed and learning was promoted. Rudolf had a strong interest in magic and mysticism, and under his rule, Prague became a center for alchemical, astrological, and magico-scientific studies of all kinds. Jews practiced Kabbalah in this city, and were treated equally and without discrimination. Many others studied the occult and the magical. Rudolf's palace had "wonder rooms" in which mechanical magical arts were practiced, including inanimate objects that were made to seem to talk, numerological analyses, astrological predictions, and alchemical wonders. In the 1580s, the famous English mystic and mathematician John Dee (1527–1608) spent several years in Prague spreading his magical knowledge. Dee's ideas would form the foundation of knowledge

pursued by a mystical secret society. This new society would also develop a strong political agenda for reform in Europe, and its members would see their great hope for political salvation in the person of Prince Frederick of the Palatinate.

Descartes, a devout Catholic, was serving in the Protestant army of Maurice of Nassau, who happened to be Frederick's uncle. Descartes followed closely the events in Bohemia that resulted from the power vacuum following the death of Rudolf II. He knew that on May 23, 1618, the defenestrations had taken place in Prague, in which the rebellious Bohemians threw their Habsburg governors out of the windows of their castle. The state of Bohemia then raised two armies, one headed by the count of Thurn and the other by the count of Mansfeld. Duke Maximilian of Bavaria, a Catholic, reacted by raising an army to help the Austrians of the Holy Roman Empire against the rebelling Protestant Bohemians. He allowed eight thousand men and two thousand horses to pass through Bavaria on their way from the Catholic Spanish Low Countries (allied with the Habsburgs) to prepare to attack Prague. Descartes, eagerly following these developments, could not hold back his anticipation of battle.

Since it was clear that Prince Maurice—because of the treaty he had signed—could not take his troops there, Descartes made the decision to quit his commission and travel to Germany on his own, with the intention of joining someone else's army. He was hungry for travel and adventure, and he hoped to see action.

But Descartes did not want to leave Breda without saying good-bye to his friend Isaac Beeckman. On April 20, 1619, Descartes wrote to Beeckman: "I ask of you at least to respond to me by an intermediary, since he is at my service, and to tell me how you are doing, what occupies your time, and are you still concerned with getting married?" Beeckman responded within a day. He was working on mathematics—on the ideas Descartes had discussed with him at their last meeting.

And, no, he hadn't found a wife yet. It was unusual for the two of them not to see each other. When Descartes was in Breda—from the time they first met, in November 1618, until January 1619—the two friends met almost every day. But Descartes was now with the troops and Beeckman was in Middleburg, so a letter had to suffice.

Descartes wrote to Beeckman again on April 23, 1619, saying that he wanted to see him. He told him that his soul was already traveling. Borrowing Virgil's words in the *Aeneid* (III.7), Descartes wrote: "I don't know yet where Destiny will guide me, nor where I shall stop along the way." He continued:

> Since the threat of war no longer leads with certainty to Germany, and I fear that I would find there many armed men but no combat, I will stroll, while waiting, through Denmark, Poland, and Hungary, until I find in Germany a road clear of brigands and highwaymen to take me surely to war. If I stop somewhere along the way, as I hope to do, I promise you to put in order my work on *Mechanics* or *Geometry*, and to honor you as the promoter of this work.

After saying good-bye to Beeckman, on April 24, 1619, Descartes traveled north. He left Amsterdam on April 29 and headed for Copenhagen, where he stayed for some time, and also visited the rest of Denmark. From there he continued east to Danzig. Some weeks later, Descartes headed south, traveling through much of Poland, and entered Hungary. Then he turned west and reached Frankfurt on July 20, 1619. He arrived there to witness an important event: the election of the new Holy Roman Emperor. The king of Bohemia, Ferdinand II, was elected emperor on August 28 and crowned two days later. Descartes was present at this magnificent ceremony. The new Holy Roman Emperor was given the globe and scepter of Charlemagne, and was passed Charlemagne's sword, which he raised high for all to see.

Bohemia no longer had a king, and the rebellious Protestant Bohemians—in clear defiance of their Austrian overlords—decided to *elect* a king, rather than submit to Habsburg rule. By that time, all of Protestant Europe had been looking up to Frederick, Elector Palatine of the Rhine (so called because he was one of the German princes with the privilege of electing the Holy Roman Emperor), as their potential leader. The Bohemians easily elected Frederick of the Palatinate to become Frederick V, king of Bohemia, and offered him the crown.

The prince of Orange, Frederick's maternal uncle, supported his assuming the role for which he had been elected; but James I of England, Frederick's father-in-law, who was very worried about this development, told Frederick that he thought that he was too young and inexperienced to assume what he considered the precarious role of king of a nation about to face a massive military attack. However, James's daughter, Frederick's wife, was eager to become a queen, and she pressed her husband to take the throne. Frederick should by all rights have listened to the advice of his father-in-law, for in order to remain king he would badly need England's support, and James I was clearly uninterested in helping him. As it turned out, Frederick listened to his wife and uncle and allowed himself to be crowned. Three days after the coronation of her husband, Princess Elizabeth of England was anointed Queen Elizabeth of Bohemia.

Predictably, the Austrians were outraged by the coronation of the new king and queen of Bohemia, viewing it as a rebellion by a province. Duke Maximilian of Bavaria then resolved to go to war in order to help the Austrians overthrow the new king. "During all these movements, Descartes enjoyed the tranquillity that came from his complete indifference to all these foreign affairs," Baillet tells us. Descartes stayed on in the region to work on mathematics, but soon decided to pass through

Bohemia and observe the imperial and Bohemian armies fighting each other. He saw cities and towns pass from one hand to another, and then back, as one army or the other enjoyed success in battle.

Descartes then made his decision: he would join the army of Maximilian, the duke of Bavaria. He would again be a volunteer and would not carry a musket, only his sword. Descartes would enjoy all the privileges he had enjoyed in Prince Maurice's army, including retaining his valet and having as much free time as was possible. With these terms signed, Descartes headed south, and in October 1619 reached the small town of Neuburg an der Donau, perched on the banks of the Danube in southern Germany about halfway between Munich and Nuremberg. This was where Duke Maximilian's forces were encamped for the winter. The clouds gathering over Europe that fall of 1619 would signal the beginning of the Thirty Years War. It would end only in 1648, with the signing of the Peace of Westphalia.

Chapter 4

Three Dreams in an Oven by the Danube

Now settled with the troops on the banks of the Danube, Descartes prepared to spend the winter working on science and geometry. In his *Discourse on the Method*, published in 1637—some years before the Peace of Westphalia put an end to the Thirty Years War—Descartes wrote:

> I was at that time in Germany, where the occasion of the wars that have not yet ended called me. As I left the coronation of the emperor to return to the army, the onset of winter forced me to remain in quarters that offered no opportunities for conversation or entertainment, and, by good fortune, also no worries or passions to trouble me. I remained, each entire day, alone in a closed

> oven *[poêle]*, where I had all the time, at my leisure, to entertain myself with my own thoughts.

The "oven" Descartes mentions was a room heated by a large central woodstove. The stove was used both for cooking and for heating in winter. Descartes' thoughts in the oven took place in November 1619. And we know that, in particular, something happened to Descartes on the night of November 10–11, 1619, while he slept in his oven—some