

## Biography of Galileo Galilei

Galileo Galilei was born in Pisa, Italy on February 15, 1564. He was the oldest of seven children. His father was a musician and wool trader, who wanted his son to study medicine as there was more money in medicine. At age eleven, Galileo was sent off to study in a Jesuit monastery.

### Galileo Galilei - Rerouted from Religion to Science

After four years, Galileo had announced to his father that he wanted to be a monk. This was not exactly what father had in mind, so Galileo was hastily withdrawn from the monastery. In 1581, at the age of 17, he entered the University of Pisa to study medicine, as his father wished.

### Galileo Galilei - Law of the Pendulum

At age twenty, Galileo noticed a lamp swinging overhead while he was in a cathedral. Curious to find out how long it took the lamp to swing back and forth, he used his pulse to time large and small swings. Galileo discovered something that no one else had ever realized: the period of each swing was exactly the same. The law of the pendulum, which would eventually be used to regulate clocks, made Galileo Galilei instantly famous.

Except for mathematics, Galileo Galilei was bored with university. Galileo's family was informed that their son was in danger of flunking out. A compromise was worked out, where Galileo would be tutored full-time in mathematics by the mathematician of the Tuscan court. Galileo's father was hardly overjoyed about this turn of events, since a mathematician's earning power was roughly around that of a musician, but it seemed that this might yet allow Galileo to successfully complete his college education. However, Galileo soon left the University of Pisa without a degree.

### Galileo Galilei - Mathematics

To earn a living, Galileo Galilei started tutoring students in mathematics. He did some experimenting with floating objects, developing a balance that could tell him that a piece of, say, gold was 19.3 times heavier than the same volume of water. He also started campaigning for his life's ambition: a position on the mathematics faculty at a major university. Although Galileo was clearly brilliant, he had offended many people in the field, who would choose other candidates for vacancies.

### Galileo Galilei - Dante's Inferno

Ironically, it was a lecture on literature that would turn Galileo's fortunes. The Academy of Florence had been arguing over a 100-year-old controversy: What were the location, shape, and dimensions of Dante's Inferno? Galileo Galilei wanted to seriously answer the question from the point of view of a scientist. Extrapolating from Dante's line that "[the giant Nimrod's] face was about as long/And just as wide as St. Peter's cone in Rome," Galileo deduced that Lucifer himself was 2,000 arm-length long. The audience was impressed, and within the year, Galileo had received a three-year appointment to the University of Pisa, the same university that never granted him a degree!

### The Leaning Tower of Pisa

At the time that Galileo arrived at the University, some debate had started up on one of Aristotle's "laws" of nature, that heavier objects fell faster than lighter objects. Aristotle's word had been accepted

as gospel truth, and there had been few attempts to actually test Aristotle's conclusions by actually conducting an experiment!

According to legend, Galileo decided to try. He needed to be able to drop the objects from a great height. The perfect building was right at hand--the Tower of Pisa, 54 meters tall. Galileo climbed up to the top of the building carrying a variety of balls of varying size and weight, and dumped them off of the top. They all landed at the base of the building at the same time (legend says that the demonstration was witnessed by a huge crowd of students and professors). Aristotle was wrong.

However, Galileo Galilei continued to behave rudely to his colleagues, not a good move for a junior member of the faculty. "Men are like wine flasks," he once said to a group of students. "...look at...bottles with the handsome labels. When you taste them, they are full of air or perfume or rouge. These are bottles fit only to pee into!" Not surprisingly, the University of Pisa chose not to renew Galileo's contract.

### Necessity is the Mother of Invention

Galileo Galilei moved on to the University of Padua. By 1593, he was desperate in need of additional cash. His father had died, so Galileo was the head of his family, and personally responsible for his family. Debts were pressing down on him, most notably, the dowry for one of his sisters, which was paid in installments over decades (a dowry could be thousands of crowns, and Galileo's annual salary was 180 crowns). Debtor's prison was a real threat if Galileo returned to Florence.

What Galileo needed was to come up with some sort of device that could make him a tidy profit. A rudimentary thermometer (which, for the first time, allowed temperature variations to be measured) and an ingenious device to raise water from aquifers found no market. He found greater success in 1596 with a military compass that could be used to accurately aim cannonballs. A modified civilian version that could be used for land surveying came out in 1597, and ended up earning a fair amount of money for Galileo. It helped his profit margin that 1) the instruments were sold for three times the cost of manufacture, 2) he also offered classes on how to use the instrument, and 3) the actual toolmaker was paid dirt-poor wages.

A good thing. Galileo needed the money to support his siblings, his mistress (a 21 year old with a reputation as a woman of easy habits), and his three children (two daughters and a boy). By 1602, Galileo's name was famous enough to help bring in students to the University, where Galileo was busily experimenting with magnets.

In Venice on a holiday in 1609, Galileo Galilei heard rumors that a Dutch spectacle-maker had invented a device that made distant objects seem near at hand (at first called the spyglass and later renamed the telescope). A patent had been requested, but not yet granted, and the methods were being kept secret, since it was obviously of tremendous military value for Holland.

### Galileo Galilei - Spyglass

Galileo Galilei was determined to attempt to construct his own spyglass. After a frantic 24 hours of experimentation, working only on instinct and bits of rumors, never having actually \*seen\* the Dutch spyglass, he built a 3-power telescope. After some refinement, he brought a 10-power telescope to Venice and demonstrated it to a highly impressed Senate. His salary was promptly raised, and he was honored with proclamations.

### Galileo Galilei - The Moon

If he had stopped here, and become a man of wealth and leisure, Galileo Galilei might be a mere footnote in history. Instead, a revolution started when, one fall evening, the scientist trained his telescope on an object in the sky that all people at that time believed must be a perfect, smooth, polished heavenly body--the Moon. To his astonishment, Galileo Galilei viewed a surface that was uneven, rough, and full of cavities and prominences. Many people insisted that Galileo Galilei was wrong. Some of their arguments were very clever, like the mathematician who insisted that even if Galileo was seeing a rough surface on the Moon, that only meant that the entire moon had to be covered in invisible, transparent, smooth crystal.

### Galileo Galilei - Jupiter

Months passed, and his telescopes improved. On January 7, 1610, he turned his 30 power telescope towards Jupiter, and found three small, bright stars near the planet. One was off to the west, the other two were to the east, all three in a straight line. The following evening, Galileo once again took a look at Jupiter, and found that all three of the "stars" were now west of the planet, still in a straight line!

Observations over the following weeks lead Galileo to the inescapable conclusion that these small "stars" were actually small satellites that were rotating about Jupiter. If there were satellites that didn't move around the Earth, wasn't it possible that the Earth was not the center of the universe? Couldn't the Copernican idea of the Sun at the center of the solar system be correct?

### The Starry Messenger

Galileo Galilei published his findings--as a small book titled The Starry Messenger. 550 copies were published in March of 1610, to tremendous public acclaim and excitement.

### Galileo Galilei - Saturn

And there were more discoveries via the new telescope: the appearance of bumps next to the planet Saturn (Galileo thought they were companion stars; the "stars" were actually the edges of Saturn's rings), spots on the Sun's surface (though others had actually seen the spots before), and seeing Venus change from a full disk to a sliver of light.

For Galileo Galilei, saying that the Earth went around the Sun changed everything since he was contradicting the teachings of the Church. While some of the Church's mathematicians wrote that his observations were clearly correct, many members of the Church believed that he must be wrong.

In December of 1613, one of the scientist's friends told him how a powerful member of the nobility said that she could not see how his observations could be true, since they would contradict the Bible. The lady quoted a passage in Joshua where God causes the Sun to stand still and lengthen the day. How could this mean anything other than that the Sun went around the Earth?

### Galileo Galilei - Heresy Charges

Galileo Galilei was a religious man, and he agreed that the Bible could never be wrong. However, he said, the interpreters of the Bible could make mistakes, and it was a mistake to assume that the Bible had to be taken literally.

This might have been one of Galileo's major mistakes. At that time, only Church priests were allowed to interpret the Bible, or to define God's intentions. It was absolutely unthinkable for a mere member of the public to do so.

And some of the Church clergy started responding, accusing him of heresy. Some credits went to the Inquisition, the Church court that investigated charges of heresy, and formally accused Galileo Galilei.

This was a very serious matter. In 1600, a man named Giordano Bruno was convicted of being a heretic for believing that the earth moved about the Sun, and that there were many planets throughout the universe where life--living creations of God--existed. Bruno was burnt to death.

However, Galileo was found innocent of all charges, and cautioned not to teach the Copernican system. 16 years later, all that would change.

#### The Final Trial

The following years saw Galileo move on to work on other projects. With his telescope he watched the movements of Jupiter's moons, wrote them up as a list, and then came up with a way to use these measurements as a navigation tool. There was even a contraption that would allow a ship captain to navigate with his hands on the wheel. That is, assuming the captain didn't mind wearing what looked like a horned helmet!

As another amusement, Galileo started writing about ocean tides. Instead of writing his arguments as a scientific paper, he found that it was much more interesting to have an imaginary conversation, or dialogue, between three fictional characters. One character, who would support Galileo's side of the argument, was brilliant. Another character would be open to either side of the argument. The final character, named Simplicio, was dogmatic and foolish, representing all of Galileo's enemies who ignored any evidence that Galileo was right. Soon, he wrote up a similar dialogue called "Dialogue on the Two Great Systems of the World." This book talked about the Copernican system.

"Dialogue" was an immediate hit with the public, but not, of course, with the Church. The pope suspected that he was the model for Simplicio. He ordered the book banned, and also ordered the scientist to appear before the Inquisition in Rome for the crime of teaching the Copernican theory after being ordered not to do so.

Galileo Galilei was 68 years old and sick. Threatened with torture, he publicly confessed that he had been wrong to have said that the Earth moves around the Sun. Legend then has it that after his confession, Galileo quietly whispered "And yet, it moves."

Unlike many less famous prisoners, he was allowed to live under house arrest in his house outside of Florence. He was near one of his daughters, a nun. Until his death in 1642, he continued to investigate other areas of science. Amazingly, he even published a book on force and motion although he had been blinded by an eye infection.

#### The Story Continues...

The Church eventually lifted the ban on Galileo's Dialogue in 1822--by that time, it was common knowledge that the Earth was not the center of the Universe. Still later, there were statements by the Vatican Council in the early 1960's and in 1979 that implied that Galileo was pardoned, and that he had suffered at the hands of the Church. Finally, in 1992, three years after Galileo Galilei's namesake had been launched on its way to Jupiter, the Vatican formally and publicly cleared Galileo of any wrongdoing.