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The Age of Discovery - Gravity and Gauss

By Colleen Messina

By the seventeenth century, mathematics had come a long way from the tallies and abacuses of the ancient world. Mathematicians had finally adopted the new Arabic numbers, as well as the symbols for addition, subtraction, multiplication, and division. Logarithms made difficult problems much easier, and calculus opened up new possibilities in science. Mathematicians applied these new tools in exciting ways ranging from world exploration to astronomy. Ships crisscrossed the oceans to new places, and telescopes scanned the skies and discovered the elliptical orbits of planets. The understanding of gravity revolutionized military science. It was truly an age of discovery.

The discovery of gravity especially changed how people viewed the world. Up until the 16th century, people thought that heavy objects fell faster. A feisty Italian named Galileo Galilei had another idea. In 1585, he climbed to the top of the leaning Tower of Pisa, made sure no one was down below, and dropped two objects. One object was heavy and the other was light, but both reached the ground at the same time. Galileo proved that objects fall at the same rate and accelerate as they fall. Eventually, military engineers understood that a cannonball shoots out in a straight path, but the force of gravity makes the cannonball fall downward in a curve called a parabola. The engineers could then fortify their strongholds in the right places, and artillerymen could shoot their cannons more accurately. Galileo's experiment revolutionized military science.

Galileo also did experiments with pendulums that helped clockmakers design accurate clocks. Seamen needed accurate time-keeping devices to navigate during long journeys. The weight-driven clocks of the previous centuries were not accurate enough; now seamen needed to measure minutes and seconds, so the new clocks were invaluable. Navigators then accurately plotted the daily positions of their ships on maps that had vertical and horizontal lines of latitude and longitude. When they connected the dots on these grids, they saw an accurate record of the ship's journey.

Rene Descartes, a great French mathematician and philosopher, also liked grids. He had a big nose and a sheath of black hair that came down to his eyebrows. He always stayed in bed until late in the morning and said that that was the only way to get ready to do mathematics! Descartes tied geometry and algebra together by writing equations for a geometric shape, like a parabola, on a graph. His analytic geometry became the foundation of the higher mathematics of today, and some people call him the first modern mathematician. The Cartesian coordinate system is named after Descartes.

Another mathematician who laid the foundation for higher math was a number-crunching prodigy. In 1779, three-year-old Carl Friedrich Gauss watched his father add up the payroll for a crew of bricklayers and pointed out a mistake his father made in the calculations! When Gauss was 14, a wealthy Duke noticed his incredible abilities and was so impressed that he sponsored Gauss's entire education. This patronage was well deserved, as Gauss dominated mathematics of the nineteenth century.

Gauss first became famous when an Italian astronomer discovered an asteroid in 1801. Joseph Piazzi accidentally found a minor planet and then lost sight of it in the bright sky near the sun. This new planet, called Ceres, caused a great rush of excitement all over Europe. When it disappeared, astronomers were upset because they didn't know how to find the new planet again. Gauss used the tables of logarithms he had memorized to predict where Ceres would reappear. The tiny planet showed up on the other side of the sun just where Gauss said it would! Gauss received many honors from scientific societies because of this triumph.

Gauss paved the way for higher algebra by his understanding of "complex numbers." The term "complex number" was coined in 1860. A complex number is an ordinary number and another number multiplied by the square root of minus one. A complex number might not sound too useful, but it is important for solving practical physics problems. Gauss also did experiments in electricity and made so many discoveries that a "gauss" became the unit of measurement in magnetism. In addition, Gauss also wrote books on the motion of celestial bodies and figured out how to calculate the distance of faraway stars. He was a brilliant, busy man!

While Gauss worked on theoretical problems, other mathematicians

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were practical. They invented new counting machines to make their calculations easier. A man named John Napier devised a cheap, simple device called, "Napier's bones" for multiplication. This device had rods engraved with the numbers 1 through 9. Rotating the rods and adding the numbers horizontally made multiplication fast and easy.

Charles Babbage was an English inventor who designed a machine called the analytical engine in 1830 that far surpassed any previous counting machine. He wanted the engine to have an automatic calculator that figure things out from the results of prior calculations. Babbage's assistant, Ada Lovelace, was an innovative mathematician who wrote a program for the analytical engine. Ada was the first computer programmer! In 1979, scientists named a programming language "ADA" in her honor. Babbage tinkered with plans for this machine until he died in 1871, but unfortunately, never built it. Babbage was a genius, but he was about a hundred years ahead of his time. His ideas eventually formed the basis for the electronic computers of the twentieth century.

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Questions

_____ 1. Which scientist performed an experiment from the top of the Tower of Pisa?

A. Descartes
B. Galileo
C. Gauss
D. Newton

_____ 2. What field was affected by Galileo's experiments with gravity?

A. magnetism
B. electricity
C. military science
D. counting machines

_____ 3. Check which discoveries Galileo made from the Tower of Pisa experiment.

A. Objects accelerate as they fall.
B. The Tower leaned too much to make the experiment useful.
C. Objects fall at the same rate regardless of weight.
D. A scientist should warn people before dropping objects from great heights.

_____ 4. What kind of geometry did Descartes develop?

A. lateral
B. longitudinal
C. topographic
D. analytic

_____ 5. Why did Carl Gauss first become famous?

A. A wealthy duke financed his education.
B. He located a lost asteroid.
C. He loved complicated equations.
D. He was brilliant at an early age.

_____ 6. What is unique about a complex number?

A. It involves negative numbers.
B. It involves the square root of minus one.
C. It is used in complicated equations.
D. It is very large.

_____ 7. What was John Napier's counting machine called?

A. Napier's calculator
B. Napier's abacus
C. Napier's bones
D. Napier's multiplier

_____ 8. Who was the first computer programmer?

A. John Napier
B. Ada Lovelace
C. Albert Einstein
D. Charles Babbage

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Pretend that you are an Italian who lived near the Leaning Tower of Pisa. One day you notice a man dropping things off the top of the Tower. Write a paragraph about your impression of Galileo's experiments from the point of view of an uneducated 16th century Italian peasant.

Write a headline and newspaper article about the discovery, disappearance, and reappearance of the asteroid, Ceres, in 1801.