

# Inventors and Scientists: Sir Isaac Newton

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Portrait of Sir Isaac Newton circa 1715-1720 Bonhams

**Synopsis:** Sir Isaac Newton developed the three basic Laws of Motion and stated the Law of Universal Gravitation, which together laid the foundation for our current understanding of physics and the Universe.

## Early Life And Education

Isaac Newton was born prematurely on January 4, 1643, in Lincolnshire, England. His father had died before his birth. When he was 3, his mother remarried and left him with his grandparents on a farm, while she moved to a village a mile and a half away from him. He grew up with few playmates, and amused himself by contemplating the world around him.

His mother returned when Newton was 11 years old and sent him to King's School. Rather than playing after school with the other boys, Newton spent his free time making wooden models, kites of various designs, sundials, even a water clock. When his mother, who was hardly literate, took him out of school at 15 to turn him into a farmer, the headmaster, who recognized where Newton's talents lay, prevailed on her to let Newton return to school.

## Early Discoveries

Newton attended Cambridge University from 1661 to 1665. The university temporarily closed soon after he got his degree because people in urban areas were dying from the plague. Newton retreated to his grandparents' farm for two years, during which time he proved that "white" light was composed of all colors, and started to figure out calculus and universal gravitation — all before he was 24 years old.

It was on his grandparents' farm that Newton sat under the famous apple tree and watched one of its fruits fall to the ground. He wondered if the force that pulled the apple to the ground could extend out to the Moon and keep it in its orbit around Earth. Perhaps that force could extend into the Universe indefinitely.

After the plague subsided, Newton returned to Cambridge to earn his master's degree and become a professor of mathematics there. His lectures bored many of his students, but he continued his own thinking and experiments, undaunted. When his mother died, he inherited enough wealth to leave his teaching job and move to London, where he became the president of the Royal Society of London for Improving Natural Knowledge, the top organization of scientists in England.

## Laws Of Motion And Gravity

Newton's most important book was written in Latin; its title was translated as *Mathematical Principles of Natural Philosophy*. It was published in 1687. The book proved to be one of the most influential works in the history of science. In its pages, Newton asserted the three Laws of Motion, elaborated Johannes Kepler's Laws of Motion, and stated the Law of Universal Gravitation. The book is primarily a mathematical work, in which Newton developed and applied calculus, the mathematics of change, which allowed him to understand the motion of celestial bodies.

To reach his conclusions, he also used accurate observations of planetary motion, which he made by designing and building a new kind of telescope, one that used mirrors to reflect, rather than lenses to refract, light.

## Newton's Three Laws Of Motion

Every body continues at rest or in motion in a straight line unless compelled to change by forces impressed upon it. Galileo Galilei first formulated this, and Newton recast it.

Every change of motion is proportional to the force impressed and is made in the direction of the straight line in which that force is impressed. A planet would continue outward into space but is perfectly balanced by the Sun's inward pull, which Newton termed "centripetal" force.

To every action there is always opposed an equal reaction, or the mutual action of two bodies on each other is always equal and directed to contrary parts.

## **Law Of Universal Gravitation**

Putting these laws together, Newton was able to state the Law of Universal Gravitation: “Every particle of matter attracts every other particle with a force proportional to the product of the masses of the two particles and inversely proportional to the square of the distance between them.” Stated more simply, the gravitational attraction between two bodies decreases rapidly as the distance between them increases.

This calculation proved powerful because it presented the Universe as an endless void filled with small material bodies moving according to harmonious, rational principles. Newton understood gravity as a universal property of all bodies, its force dependent only on the amount of matter contained in each body. Everything, from apples to planets, obeys the same unchanging laws.

By combining physics, mathematics, and astronomy, Newton made a giant leap in human understanding of Earth and the cosmos. Newton’s mathematical method for dealing with changing quantities is now called calculus. He did not publish his method, but solved problems using it. Later, the German scientist Gottfried Wilhelm von Leibniz also worked out calculus, and his notation proved easier to use. Newton accused Leibniz, in a nasty dispute, of stealing his ideas, but historians now believe that each invented calculus independently.

Newton was made a knight by Queen Anne in 1705. At his death in 1727, he was buried in London’s Westminster Abbey. Shortly before he died, Newton remarked:

*I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore and diverting myself in now and then finding a smoother pebble or prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me.*

## Quiz

- 1 According to the article, each of the following influenced Newton's work EXCEPT:
- (A) his formal education
  - (B) his passion for teaching
  - (C) living on his grandparents' farm
  - (D) observation of the physical world
- 2 Based on the article, which of the following would be a fair conclusion to make about Newton?
- (A) Newton was inspired by the work of other scientists at Cambridge University.
  - (B) Newton was mainly interested in the study of advanced mathematics.
  - (C) Newton preferred working with his hands and his mind to interacting with other people.
  - (D) Newton learned most of his scientific and mathematical skills from his formal education.

- 3 Read the following sentence from the section "Laws of motion and gravity."

*In its pages, Newton asserted the three Laws of Motion, elaborated Johannes Kepler's Laws of Motion, and stated the Law of Universal Gravitation.*

Which of the following words BEST matches the meaning and tone of the word "elaborated" as used in the sentence?

- (A) refuted
- (B) debated
- (C) augmented
- (D) substantiated

- 4 Read the following quote from the section "Law of Universal Gravitation."

*I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore and diverting myself in now and then finding a smoother pebble or prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me.*

Which of the following options BEST describes the tone of the above quote?

- (A) joyous
- (B) humble
- (C) mournful
- (D) condescending