FURTHER REVIEW

THE MASTER OF MOTION

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By Charles Apple | THE SPOKESMAN-REVIEW

Some of the most fundamental scientific principals govern how forces can change the way objects move.

The rules that affect mass, velocity, inertia, acceleration and gravity were drawn up by Isaac Newton and first presented in his "Philosophiæ Naturalis Principia Mathematica" — or "Mathematical Principles of Natural Philosophy" — which he presented to the Royal Society on April 28, 1686 — 340 years ago.

INVENTING ENTIRE NEW FIELDS OF SCIENCE

Isaac Newton was born in Lincolnshire, England, on Christmas Day, 1642 — according to the Julian calendar that was in use at the time. On today's Gregorian calendar, that would have been Jan. 4, 1643.

A tiny baby born prematurely, he wasn't expected to survive. His father had died three months before. At the time, England was affected by civil war and the plague. When he was 3 years old, his mother left him with his grandmother and married a man from a nearby village.

He fell in love with science and technology while in school and, as a young boy, invented a more accurate form of sundial. His teachers and his uncle recognized Newton's genius and guided him to Trinity College, Cambridge, in 1661.

There, he became fascinated with calculus, the mathematical models of how things change. In 1665, Cambridge University was forced to close by the plague. Newton read and worked on his mathematical models and developed techniques of differentiation and integration: the groundwork for what would become the basis of his theory of calculus.

Newton returned to Cambridge in 1667, was elected a minor fellow and, the following year, received his Master of Arts degree and was named Cambridge's Lucasian Professor of Mathematics.

In 1671, Newton began to experiment with telescopes, which were very large and used enormous lenses. Also, they showed color improperly. Newton's idea was to instead use mirrors. This led him to develop a more powerful telescope that was a tenth the size of conventional models. It also allowed him to prove that white light is made of all the colors of the rainbow — what we today call the spectrum.

THE ILLUSTRATED LONDON NEWS, 1870

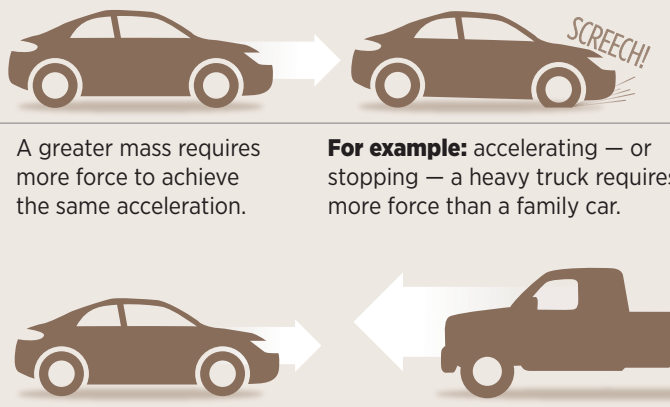
Stung by the fact that the Royal Society didn't readily accept his theories of light, Newton turned to the study of alchemy — the forerunner of today's chemistry. In 1684, German philosopher Gottfried Leibniz published a paper on describing the physical world with mathematical equations. Newton recognized the concepts, pointed out he had done the same work 20 years before and pulled out his old notes to prove it.

In 1686, another scientist challenged Newton to prove his theories about planetary orbits. This again sent Newton back to his notes to pull together equations to prove his math. The result — "The Principia Mathematica" — is regarded today as the foundation of today's science of physics.

NEWTON'S LAWS OF MOTION

What we today call Newton's three laws of motion were, in fact, three laws he developed for his "Principia Mathematica." They were:

	NEWTON'S LAWS	TRANSLATION	
1	**Newton's Law of Inertia** Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed upon it.	This means objects resist changes to their state of motion.	**For example:** a car remains at rest until a force — an engine, or gravity via a hill — is applied to it. Step hard on the brake and you're pushed forward against your seat belt.
2	**Newton's Law of Acceleration** Force is equal to the change in momentum over a change in time. For a constant mass, force equals mass times acceleration. This is often expressed as an equation: **F = ma**.	A greater mass requires more force to achieve the same acceleration.	**For example:** accelerating — or stopping — a heavy truck requires more force than a family car.
3	**Newton's Law of Action and Reaction** For every action, there is an equal and opposite reaction.	When one object exerts a force on a second object, the second object simultaneously exerts a force equal in magnitude and opposite in direction on the first.	**For example:** if a car hits another car, it might jolt the second car into motion. But it might also jolt the first car to a stop.



Newton's laws come into play in many everyday activities and in modern technologies.

- Motor vehicle safety systems such as seat belts and airbags
- Rocket and jet propulsion: Hot exhaust is pushed backwards, which causes the rocket to move forward.
- Robotics and mechanical systems
- Planets and satellites move according to Newton's laws
- Albert Einstein used Newton's laws as a starting point for his theory of relativity in dealing with extreme gravity and high speeds.

Newton presented the first "Principia" volume to the Royal Society on April 28, 1686. Edmond Halley — the mathematician and astronomer for whom the comet is named — footed the bill for publishing 750 copies of it in the summer of 1687.

A second edition was published in 1713 and a third in 1726.

"The Principia Mathematica" established Newton's reputation throughout Europe as one of the greatest mathematicians and scientific thinkers of his day.

DID AN APPLE REALLY FALL ON NEWTON'S HEAD?

In 1689, Newton was elected as a member of Parliament from Cambridge University. There, he hoped to fight against the efforts of King James II to bring back Catholic teachings to English universities.

In 1696, he was named warden of the Royal Mint. He worked to stabilize British currency by fighting counterfeiting, which had become widespread. He was elected president of the Royal Society in 1703 and, a year later, published his other major work, "Opticks," in which he detailed his theories of light, refraction and the makeup of the color spectrum. In 1705, Newton was knighted by England's Queen Anne.

It wasn't until near the end of his life that Newton, while dining with a fellow Royal Society member, first shared the story about how he came up with his rules of motion: He had been strolling outside his childhood home in 1666 when he watched an apple fall from a tree.

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"Why should it not go sideways, or upwards?" William Stukeley wrote. "But constantly to the earth's centre? Assuredly, the reason is that the darth draws it."

It's not clear whether or not the story is true. However, the legend that the apple hitting Newton in the head appears to have been added to the story later.

The one apple tree that had grown in the Newtons' garden was blown over by a storm in 1816 but regrew from its roots. A seedling from that tree now grows outside the main gate of Trinity College, Cambridge, below the room where Newton had lived.

Newton died in 1727 at age 84. By now a national hero, he was buried with honors in Westminster Abbey.

Sources: "Ultimate Visual Dictionary of Science" by Dorling Kindersley, "Encyclopedia of Knowledge" by Miles Kelly, "I Used to Know That Science" by Marianne Taylor, Isaac Newton Institute for Mathematical Studies, University of Virginia Department of Physics, NASA's Glenn Research Center, American Physical Society, PBS' "Nova," National Geographic, BBC, Astronomy.com, ScienceNotes.org, History.com