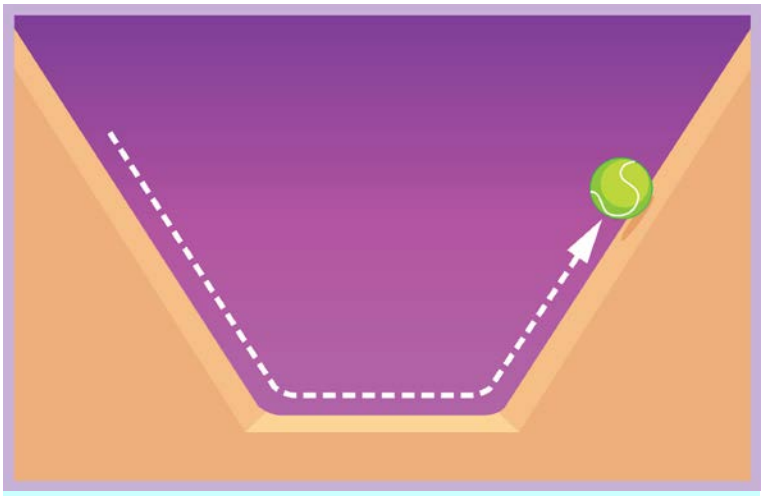
Inertia—Forever

Often, physicists refer to Isaac Newton's first law of motion as the "law of inertia." What exactly is inertia? Where did it come from?

Inertia says that an object in motion will continue in motion forever unless an external force acts on it.

Newton's first law can be stated in common terms: An object at rest will stay at rest forever if nothing pushes it or pulls it. An object in motion will stay in motion and keep the same velocity forever if nothing pushes it or pulls it. This is a difficult concept to accept. Simply put, it means that an object will continue doing whatever it is doing (resting or moving) until something else interferes with it. That "something else" is a force, whether it is gravity or some other outside force. Thus, is inertia a force? Not exactly.

Aristotle, the Greek philosopher, was the first researcher to leave a record of his study of motion. He believed that motion is either "natural" or "violent." If a book is on a table, it is "naturally" at rest and not moving. If a book is dropped, it "naturally" falls on the floor. However, if a book on a table is pushed, a "violent" motion occurs. (The push is the force , or "violent" motion, needed to move the book.) All motion, according to Aristotle, required force if it was not "natural." Does not that contradict the concept of inertia? Yes, it does. The law of inertian states that objects keep moving until they encounter some force that stops them from moving. Aristotle believed that purposeful movement required a sustained force. He was wrong!

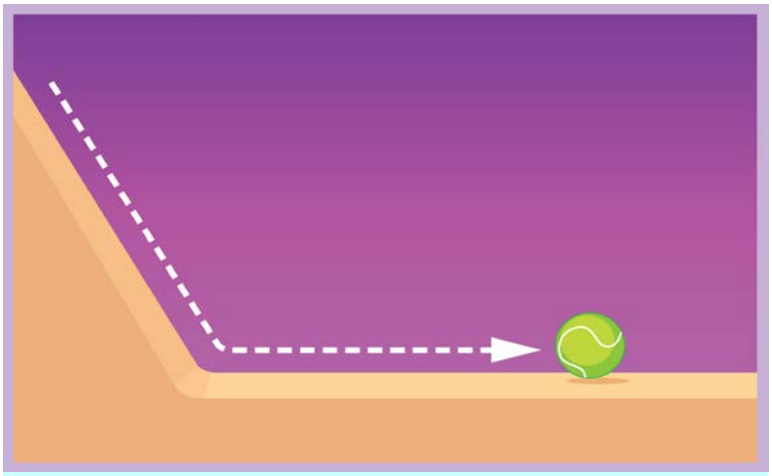


The ball will move back and forth, always reaching the same height on each end.

It took hundreds of years for scientists and philosophers to challenge Aristotle's views on motion. In the 16th century, Galileo formalized the concept of inertia as the property of matter that opposes change in velocity. He conducted a series of experiments by using bronze balls rolling down inclined planes. He noticed that if he started a ball at a certain height on the left incline, it would roll to approximately the same height on the right incline before returning. (Of course, the presence of friction slowed the ball a bit.) Galileo changed the slope of the incline on the right and hypothesized that the ball would continue rolling and reaching the same height on each side. He was right!

Galileo's next logical question was what would happen if the slope of the incline on the right was taken away completely. He thought about what he knew about the motion of a ball and

tried to imagine a frictionless plane. In the real world, every surface has some amount of friction, so all he could do was a thought experiment. Thought experiments, where a scientist imagines an outcome without doing a physical experiment, are common in science when materials or equipment are unavailable. Galileo's thought experiment lead him to conclude that if a ball rolled down an inclined plane onto a level surface where there was no friction, the ball would keep moving at a constant speed forever.



Newton's first law states that an object in motion will continue in motion forever.

The French philosopher, Rene Descartes, clarified Galileo's discoveries with his laws of motion. In Descartes' *Principles of Philosophy*, he identified three laws of nature. His first law states that an object remains in the same state and that once it is moved, it continues to move. Sounds familiar? Newton studied Descartes' writings and used the first two laws as the basis for his first law—an object at rest stays at rest and an object in motion continues in motion unless it is acted on by an external force. In his book *The Mathematical Principles of Natural Philosophy*, Newton described his three laws of motion using what he had learned by proving and disproving earlier scientific theories of Aristotle, Galileo, and Descartes. Newton's three laws launched the modern era of scientific thinking.