Tennis & Newton's Laws

Jun 14, 2011 | By Ryan Haas

Physics is an everyday part of our lives that controls how objects move through space over time. The laws of physics even apply to a fast-paced sport like tennis. Three physics concepts that apply readily to the sport are Newton's laws of motion, which is a set of three rules that govern the principles of motion. Understanding these principles of motion can be useful for improving your efficiency on the court.

Development

Sir Isaac Newton graduated from Cambridge in 1665, but left the university grounds shortly after for two years because of the plague. It was during this two-year span that Newton began to make profound developments in mathematics and science, first formulating his laws of motion. In 1687, Newton published his "Philosophiae Naturalis Principia Mathematica," which contains his three laws of motion and is one of the most important works in modern science.

First Law

Newton's first law of motion states that any object that is moving will continue moving unless an external force is applied to stop it from moving. Within the game of tennis, this concept is easily seen every time a player hits the ball. Once the ball is moving from the strike of the racket, its forward trajectory would continue indefinitely if the forces of gravity, friction from the air resistance or striking the ground and the force of the opposing player's racket did not stop it.

Second Law

The second law of motion states that force equals mass times acceleration. Acceleration is a measurement of how fast a ball is gaining speed, rather than how fast it is going. In the world of tennis, you can apply Newton's second law to a service. During your serve, the mass of the tennis ball remains constant. Therefore, you can see in this equation that the more force you apply to the constant mass of the tennis ball on the serve, the greater the acceleration of that serve will be until it reaches its top speed.

Third Law

The final of Newton's laws of motion states that for every action there is an equal and opposite reaction. One example of this law in a tennis match is when a player winds up for a powerful forehand. The player twists his torso away from the ball as it comes toward him, and then quickly turns the racket in the opposite direction with equal force. The more force the player applies in the initial twist, the more force he can exert on the ball for the forehand shot.

Newton's Laws of Motion & Softball

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Newton's laws of motion help to describe all motion in the world. Understanding these laws often is made easier by relating them to a familiar concept, like softball. If you play softball, consider the forces acting on the ball, the bat, your glove and anything else involved in the game.

Newton's First Law

According to Newton's first law, an object at rest will stay at rest and an object in motion will stay in motion at the same speed and going the same direction until acted upon by some outside force. Newton's first law is evidenced constantly in softball, when you pick up a stationary ball and throw it, changing its motion with force, or when a ball is hit by the bat, changing the ball's direction initially dictated by the throw from the pitcher.

Newton's Second Law: Definition

Newton's second law of motion helps to describe the motion of an object when it is acted upon by an outside force. The second law states that an object's change in motion is equal to the sum of the forces acting upon it. At any time, there are several forces acting on a softball. Gravity pulls the ball toward the earth, air resistance pushes against the ball as it moves through the air, the ball's spin during a pitch creates a lifting force, and so on. All of these forces go into describing a ball's motion.

Newton's Second Law-Practical

A good example of Newton's second law is in the high arc of a slow softball pitch. When the ball leaves the pitcher's hand, the greatest force acting on it is the player, pushing and throwing the ball into the air. As soon as the ball is airborne, it comes under other constant forces that gradually overcome the initial force of the player's arm. Air resistance slows the ball down and gravity begins to pull the ball towards the earth. The transfer of these forces onto the ball results in the arcing motion of a slow pitch ball. When the ball reaches the bat, the force of the bat becomes the largest force and dictates the ball's new motion, out into the field.

Newton's Third Law

Newton's third law states that for every action there is an equal and opposite reaction. One example of Newton's third law is when you catch a ball. As the ball enters your mitt and contacts the leather, it stops. In that instant, your hand exhibits a force equal to that which the ball imparts on the glove. The force you exhibit is equal and opposite to the motion of the ball. The result is that the ball stops.