

Newton's laws of motion in football

Sue Young explains how Newton's laws of motion apply to football

Newton's first law: inertia

An object remains in its state of rest or motion in a straight line, unless compelled to change that state by external forces exerted upon it.

Inertia is the resistance to a change in velocity of an object. Mass determines inertia so the greater the mass, the greater the inertia, which means changes in velocity (speed and/or direction) will be more difficult.

Applied to football:

- In a penalty, the ball (object) will remain on the spot (state of rest) unless it is kicked by the player (an external force is exerted upon it).
- The ball (object) will travel along the ground (motion) until friction (external force) causes it to stop or another player exerts a force upon it to either stop the ball or change its direction.

Newton's second law: acceleration

The rate of momentum of an object (or the acceleration for an object of constant mass) is proportional to the force causing it and the change that takes place in the direction in which the force acts.

More simply, the magnitude of the force (size and direction) determines the magnitude of the acceleration to a given object.

Applied to football:

- When the player kicks (force) the ball during the game, the acceleration of the ball (rate of change of momentum) is proportional to the size of the force. The harder the ball is kicked, the further and faster it will travel.

Newton's third law: action and reaction

To every action force there is an equal and opposite reaction force

Applied to football:

- When a footballer jumps up (action) to perform a header a force is exerted on the ground to gain height. At the same time, the ground exerts an upward force (equal and opposite reaction) upon the footballer. The ground reaction force is the equal and opposite force given to the footballer who exerts a muscular force into the ground as they flex their knees and hips in preparation to jump.

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