Motion

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How to Cite This Article

When you place a book on a table, why does the book stay there and not suddenly scoot off to the side? When you drop a rubber ball, why does it fall and then bounce? The answers to these questions belong to the science called *mechanics*, the branch of physics concerned with how and why objects move—that is, with the forces that cause objects to move and the principles that guide their movement. This knowledge has important applications in everything from building safe roads to launching satellites into space.

Second Law of Motion

Newton's second law of motion states: *The rate of change of motion of a body is directly proportional to the net force acting on the body, inversely proportional to the mass of the body, and takes place in the direction in which the net force acts*.

In the example of the automobile, this second law of motion applies when the driver upsets the balance of forces by stepping on the gas pedal and increasing the driving force of the wheels. As long as the driving force is greater than the resisting force, the car will accelerate. The rate of acceleration depends on two factors. One is the mass of the vehicle: it takes considerably more force to accelerate a heavy sport-utility vehicle than it does a small compact car. The other factor is the magnitude of the net force. The more power the engine delivers to the wheels, the greater the net force and the more rapid the acceleration will be.

Just like a free-falling object, the car encounters increasing air resistance as it speeds up. The imbalance between driving force and resisting force is gradually reduced, decreasing the rate of acceleration. To continue accelerating, the driver must feed more power to the engine. Again the air resistance will increase, and again the imbalance between driving and resisting forces will be gradually reduced. Eventually, it will become zero at the limit of engine power, and the car will be traveling at its maximum speed.

If the driver switches off the engine of a car moving down a straight road, the car eventually rolls to a stop. This happens because the balance of forces acting on the car tips in favor of friction and air resistance, causing negative acceleration. In a collision, a car meets sudden resistance that instantly changes its velocity. The faster a car is moving, the greater the force of impact of the collision and the more potentially damaging the effect will be.

Newton's second law, which is sometimes called the law of acceleration, also states that the acceleration of an object will always be in the same direction as the net forces applied to the object. This law makes it possible to accurately predict the motion of an object (given information about the forces acting on it) using the process of vector addition. (See also *Figures 5a–c* for an example of Newton's second law at work.)

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