Dynamic Chiropractic

HEALTH & WELLNESS / LIFESTYLE

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PHYSICS XIV: LAWS OF MOTION

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Newton's Three Laws of Motion are: (1) Every body continues at rest or in a state of uniform motion unless a force acts upon it; (2) If a force acts upon a body, the body experiences an acceleration in the direction of the force and proportional in amount to it, as well as inversely proportional to the mass of the body, and (3) Associated with every force there is an equal and oppositely directed reaction force. The field of dynamics is the study of the relationship between force and motion, a subject which will occupy us for the next several articles in this series.

The first law of motion says that no force whatever is needed to keep a body moving at a constant speed in a straight line, but a force is needed to stop such a motion or alter it in any way. This first law, then, is really a statement about the inertia of mass and deals with motion only when there are no external influences operating. Rest is thought of as merely a special case of uniform motion. Newton often referred to momentum as the quantity of motion; thus, he emphasized that matter in motion is more meaningful than "motion" in the abstract.

Momentum then is the product of the mass (matter) and the speed of the body concerned: Momentum = mass x speed, or, in formula form: p = mv where p = momentum, m = mass and v = speed in a specific direction in space. If no forces are acting on an object, its speed will be constant and therefore the momentum will also be constant. Mass is an invariant property of a body, but weight is the force with which a body is attracted to the center of the Earth. Mass is a measure of inertia, or resistance to being accelerated. Mass is an inherent property of an object and does not change, but weight is the gravitational force exerted on the object. The gravitational force (weight)) exerted by the Earth on some body = mass x gravity (m x g).

Nonaccelerating systems are, therefore, inertial systems. Inertial mass and gravitational mass are equal. A "frame of reference" in which things move with constant velocity unless acted upon by forces is called "an inertial frame." Inertia is the "reluctance" of moving objects to deviate from a straight line trajectory or of non-moving bodies to go into motion. If there were no resistances on a moving body, it would continue in motion forever. However, it is impossible to create conditions under which there are no forces acting on a moving body.

$$F = G \frac{m^1 m^2}{d^2}$$

where G is a constant and is equal to 6.67 x 10^{-11} newtons-meters^2/kilograms). This is a technical statement of Newton's Law of Universal Gravitation, which is more commonly stated thus: "All bodies in the universe exert on one another an attraction directly proportional to the product of their masses and inversely proportional to the square of the distance between them."

If you pause to think about it, you should perceive that there is a fundamental contradiction between the First Law of Motion and the Law of Universal Gravitation. Both cannot be correct as they express notions which are mutually exclusive to the validity of each other. In the first place, a force is necessary to get a body moving in a straight line at a constant speed, even though no force would be needed to maintain that constant speed in a straight line once obtained if that motion were occurring in a force-free environment. However, as the Universal Law of Gravitation states, there is no force-free part of the real universe. Therefore, constant speed in an absolutely straight line trajectory can not be obtained except in a force-free "environment."

The only force-free universe imaginable, then, would be an infinite universe with only one object in it. Since these conditions do not describe the real universe, a universe in which every moving object in it is subjected to the variable gravitational pulls of every other object in it, then Newton's First Law of Motion which says that "no force is needed to keep a body moving at a constant speed in a straight line" simply is not true and cannot be realized in the universe we know. A law of motion which describes conditions which can never be attained is no "law" at all. Galileo said, "If there is no force acting on a body already in motion, it will continue to move forever." But as we have just seen, such conditions can never be obtained in the real universe. The logical deduction from all of this is that no single body can move forever.

Another statement of Newton's First Law of Motion is: "Everybody perseveres in its state of rest or of uniform motion in a straight line, unless it is compelled to change that state by impressed forces." (Rothman, M.A., The Laws of Physics, Greenwich, Conn.: Fawcett Publications, Inc., 1963, p.70). Moreover, there is no such thing as a body at absolute rest in our universe but only at relative rest; relative, as it were, to a specific frame of reference. Relative rest can be easily seen if we think of a marble on a table being "perfectly still" inside a jet liner traveling on an angular trajectory one mile above the earth's surface at 500 mph.

A force, simply stated, is either a push or a pull phenomenon which tends to change the motion of a body. A force is always directional; therefore, we may summarize by stating it this way: A force is a physical quantity or agent or effort required to change the state of motion, hence the direction, of a body; the change may consist of "imparting motion" with, of course, specific direction to a body at rest, or accelerating positively or negatively a body already in motion in the same or different direction. A change in the direction of motion of a moving body without a resulting change in speed is one definition of torque (or strain). A force is a vector quantity having both direction as well as magnitude (speed of).

FORMULA:

$$m = \frac{F}{a}$$

,i.e., the ratio of force F to acceleration a for a given body is constant for that body, and defines its mass m.

FORMULA: $F = ma$, i.e., force can be expressed as the product of mass and acceleration.

When the vector sum of a body is zero (i.e., the body is at a state of rest) all forces acting on the body are equal and opposite, and so "at rest" actually means in a state of dynamic equilibrium between opposing forces.

Newton's Second Law of Motion: If a force acts upon a body the body experiences an acceleration in the direction of the force and proportional in amount to it, as well as inversely proportional to the mass of the body. This is the "change of motion law." Another statement of this law is: "Every change of motion is proportional to the force that makes the change, and in the direction of that straight line in which the disturbing force is impressed."

Law #2 is actually a corollary of Law #1, and together they emphasize that it is not a matter of supplying a force to keep a constant linear (or straight-line) motion going, but that a force is required to prevent it once it is started. The mathematical statement of the Second Law of Motion is this: $F = kma$ or $F = ma$ when k equals unity.

Newton's Third Law of Motion: Associated with every force is an equal and oppositely directed reaction force. This law expresses the observable fact that a force never exists alone. It is impossible to exert a force without a reaction force, i.e., a one-man tug-of-war is impossible. Please remember this third law -- the law of symmetrical forces -- when we come to our discussion of the gravitational force. Another statement of the third law is: "Reaction is always equal and opposite to action; i.e., the actions of two bodies upon each other are always equal and directly opposite." (Ibid.) One cannot exert a force without provoking opposition. Thus, if you have nothing to push against, as if you were free-floating in a vacuum, you could exert no force of push at all.

Personally, I believe that this third law should be called the Universal Law of Action-Reaction because it has such wide application in dealing with the behavior of human beings, if you stop and think about it.

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