Dynamic Chiropractic

WHIPLASH / NECK PAIN

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PHYSICS XX: KNEE-DEEP IN FORMULAE

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Speed = distance/time (s = d/t) -- scalar, if direction of the moving object is not stated, but if it is, then s = velocity for a vector quantity; if direction is stated plus speed that makes it a vector and not just a scalar. Thus, speed equals the distance an object covers divided by time it takes the object to traverse that distance. Example: 120 miles divided by 3 hours = 40 mi/hour(s). Here 40 mi/hr is the average speed.

a = s/t (= change); then, acceleration (a) is equal to the change in speed of a moving object (s) divided by the time (t) it takes to change speed. Example: a motorist "puts the pedal to the metal" and his speed jumps from 30 to 45 mi/hr in 10 seconds: a = 45 - 30 or 15 mph increase = 1.5 mph/sec. (After all, acceleration is the rate at which speed changes.

a = v/t (the usual formula): thus, an object, starting from rest, reaches a speed of 25 mph in 5 seconds: its acceleration is a 25/5 = 5 miles per hour per second which is the average acceleration (a).

p = ms (in which p = momentum, m = mass, and s = speed of an object). Momentum is the quantity (or amount) of motion. Example: a 100 lb. boy ran down a street at a speed of 5 miles per hour (100 lbs. x 5 mph = 500 pounds mph). Note! If it had been specified that the boy was running in the direction from south to north on 8th street, the formula would have read p = mv (v = velocity, i.e., speed in a specified direction somewhere).

Ft is called the "impulse of a force." For a constant force, Ft = m1 v1 - mo vo, where mo vo is the initial or original momentum and m1 v1 is the final momentum. F = ma (force equals mass time acceleration) is the mathematical expression of Newton's Second Law of Motion. F = ma says that the force (F) required to accelerate a body is directly proportional to the mass and the acceleration it produces, thus: a F. This relationship may be expressed another way by making use of impulse (the force multiplied by the time that the force acts, or F x t) and momentum (the mass multiplied by the velocity, or m x v). Thus, we have this mathematical statement: impulse = momentum, or Ft=mv. Look upon this "manipulation" of formulae as a kind of intellectual game, okay?

Slowing down (deceleration or negative acceleration) or speeding up (acceleration or positive acceleration) of a body or changing the object's direction involve a change in either the magnitude (speed) or the direction of the body (together speed + direction = velocity); therefore, in every case the body is accelerated positively or negatively by an external-to-the-object force acting on the body to produce this acceleration. Also, in every case, the direction of the acceleration is the same as that of the "unbalanced, applied force." This remains true whether or not the body is initially at rest or is moving in any direction (straight or curved) and with any speed. For any body, the ratio of the magnitude of the force to that of acceleration is always the same, i.e., is a constant: = constant for any given body. This ratio is different for different bodies as each body has a different mass. (Review article #47 of this series.) This constant ratio of force to acceleration (a F) is considered a property of the body, called its mass, where m = or F = ma. (Remember this one)? The mass of a body therefore represents the force per unit of acceleration. Since the ratio of force to acceleration is always the same, a constant for a given body, it is only necessary to make one measurement to determine the mass: Thus, if the acceleration of a given body is found to be 5 ft/sec2 when the applied force is 20 lbs., then the mass of the body is: m = = 5ft/sec2 = 4 ft/sec2. Conclusion: Anything which requires a force to cause it to accelerate has mass!

If a large force is needed to speed up a body, slow it down, or deviate it sidewise if it is already moving, then the mass of the body must likewise be large, and we can therefore say that the body has "large inertia." If it takes a small amount of force to effect these kinds of changes, the mass is small and so is its inertia. With this in mind, we can therefore conclude that the mass of a body can be considered to represent in a quantitative way that ascribed property of matter which is qualitatively described as inertia.

The motion of body can be described in terms of velocity, or v = d/t, and acceleration, or a = v/t, in the one combined formula of v = at. Velocity is the rate of change of position of a body and is expressed as the distance traveled (in the direction of motion) for each unit of time. Thus, the velocity may be expressed as feet per second (ft/sec) or miles per hour (mph) in the direction of motion. Position of a body (or point) is located in space by reference to some origin of coordinates. "Change of position" is called "displacement(s)," but displacement is not the same concept as "distance traveled." We could, therefore, define velocity as the "time-rate of displacement."

Acceleration, on the other hand, is the rate of change of velocity of a body. When an object is accelerating, the distance it moves in a period of time can be found by multiplying its average velocity (v) by time: a = vt. When an object accelerates uniformly from rest (zero velocity), the distance it covers is proportional to the square of the time taken to reach its maximum, acceleration: Uniform motion or constant speed formula: v = s/t or s = vt.

Every thing that exists moves! In other words, if it exists, it exists in motion; it is, to use a cumbersome term, a mass-in-motion. This implies that if it is not in motion or at rest, which is a kind of suspended motion, it thus does not exist. We have to remember that both rest (or zero motion or equilibrium) and motion itself are relative terms; thus, there is no absolute motion or absolute rest in the universe. And if this last statement is "absolutely" true (being philosophically an absolute statement), it should logically follow that absolute non-motion or absolute rest equals non-existence, or stated positively, motion equals existence or is at least its essential characteristic! That is to say, in order to exist, a thing must exhibit some kind of motion.

Let's see if we can sort out a couple of these concepts:

Speed is the rate of change in the position of a body without respect to direction (the rate of motion). Speed is a scalar quantity, as the car's speed is 25 mph. It is the magnitude quantity of the vector called velocity, the other vector quantity being direction. Speed = distance/time or s = d/t. Speed is measured by the distance covered divided by the elapsed time.

Velocity is the rate of change in the position of a body, expressed with respect to a given direction: velocity = distance/time or v = d/t.

Even where the rate of motion (speed) is not constant over the entire distance traveled, s = d/t gives the average speed for the entire distance. This is also the formula for constant or uniform speed. Savg = d/t (here speed is not constant or uniform, i.e., it is a changing speed over a distance). Savg = average speed, but for a body moving at a constant speed, S, it is also its average speed, Savg.

If you persisted to this point, I congratulate you.

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