Dynamic Chiropractic

WHIPLASH / NECK PAIN

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PHYSICS XXII: CIRCULARITY

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Projectile motion has both horizontal and vertical components in a gravitational field, but in the remoteness of intergalactic space projectile motion has only linear trajectory motion relative to the projectile mechanism. A body set in motion with its speed and direction (velocity) determined by a projecting mechanism, such as an explosion resulting in a thrust away from its center, is known as a projectile. In a gravitational field, if a body is so projected horizontally, relative to the downward pull of gravity towards its g-center, with a certain velocity, and if that same body, as say a marble, is simply dropped from the same height, the time (but not the distance) the marble takes to hit the floor will be the same. This is true no matter what the distance the projected marble is impelled to travel horizontally. There is, therefore, a rigid relationship between the projectile speed of the marble and the time of travel before impact with the interrupting floor.

If the line through space that the projectile draws is plotted on a graph, we see that it will describe an arc. And if there was no floor to stop its angular motion downward and it could continue its path of motion even through the Earth itself, we would then see that the angularity of its trajectory becomes ever more linear as it gets nearer to the earth's g-center.

The simplest kind of accelerated motion is rectilinear (or simple linear), i.e., moving in a straight line in which the acceleration (rate of change of velocity)is constant, i.e., in which the velocity changes at the same rate throughout the motion. When an object moves in a curved path, the direction of its velocity changes constantly, and this change in direction also gives rise to an acceleration. A projectile arcing downward in its flight path, then, is constantly accelerating.

The Three Laws of Angular Motion are: (1) a rotating body (around an axis) will continue to rotate with constant angular speed, with its axis of rotation in the same direction, unless an unbalanced torque acts upon it. Rotational inertia is the resistance of a body to assume angular motion or once assumed to stop. In other words, a body set to spinning has a tendency to keep spinning and a rotating wheel/axis has a tendency to keep its axis in a constant direction in space (the principle of the gyroscope). If a wheel (or disk) is rotating about a frictionless axis, it will continue to rotate at a constant angular velocity -- assuming no air resistance also -- unless an outside torque is exerted upon it.

Acceleration is inversely proportional to the "moment of inertia," thus: a L; or a I or L Ia; L = 2 Ia (360 divided by 2 =57.3 = radian), in which L = units of force x distance; 2 = a constant; Ia = units of mass-times-length-times-length, e.g., gm-cm2; a = measured in revolutions-per-second, per second; and the dyne-centimeters is the unit of torque (pound-foot in the English system).

(I hope that the above paragraph is not mere jibberish for all readers.) I will return to these confusing scribbles and attempt to clarify them. (2) When an unbalanced torque acts on a body, the body will be accelerated angularly in the direction of the applied torque, and such angular acceleration will be proportional to the torque and inversely proportional to the "moment of inertia" of the body around its axis of rotation. Doesn't this law sound almost like Newton's Second Law of (Linear) Motion? In fact, if we substituted the terms "force" for "torque," "linearly" for "angularly," and "mass of the body" for "moment of inertia of the body," this law would then read exactly the same as the Second Law already discussed at length. (3) If any agency A exerts a torque L on a given body B, body B will exert an equal and opposite torque on the agency A.

The application of a torque (the Greek letter "tau") will induce an acceleration in angular motion. The units of angular acceleration are radians per second, per second or radians/sec.2 (A radian is an arc of a circle equal in length to the radius of the circle.) The product of the magnitude of a force and its "force arm" is called "the moment of the force about the axis," or torque. Torque is expressed in pound-feet. In general, if the forces applied to a body do not all act at a single point, there is the possibility that the body will rotate. The turning effect of any force is given by multiplying the amount of the force by the distance from the pivot point to the line of force: this "turning effect" is called torque, and the distance from the pivot point is called the torque arm; in symbols: $T = Fh$ where T = torque, F = force, h = the torque arm. If F is in pounds and h is in feet, the units for T will be foot-pounds. If a body is not to rotate, then the net torque must be zero, i.e., the sum of all operating torques that tend to turn the body in one direction must be equal to the sum of all those tending to turn it in the opposite direction ("direction" here refers to the sense of rotation clockwise to the right or counterclockwise to the left).

Net force linearly is $F = ma$; net torque angularly is $L = Ia$.

Linear momentum (mv); angular momentum (I) (= Greek letter omega).

Torque is also sometimes called "moment of force," which implies that a force is always associated with torque. Torque arises from an applied force on an object. Thus, an "unbalanced torque" (one not opposed by an opposite torque of equal strength) is always capable of producing rotational (or angular) motion. However, a force alone cannot produce a torque; it must have a lever arm (momentum") in addition to the force. Torque, then, is the product of applied force and lever arm. The lever arm is always the perpendicular distance from the line of action of the force producing the torque to the axis of rotation; thus: L (torque) = F x R (lever arm distance). The larger the unbalanced torque, the more rapid will be the angular motion produced. Sometimes this relationship is expressed as L = F x d (the perpendicular distance from the line of action of the force to the axis of rotation.)

The "moment of inertia" (I) of the body is the angular equivalent of mass-in-linear-motion. The moment of inertia of a sphere-shaped body rotating around a diameter of the sphere (its axis of rotation) is expressed by this formula: I sphere = 2/5 mr.2 A "moment" is the turning effect (torque) of a force; it equals the force multiplied by the perpendicular distance between the force and the fulcrum (or turning point). Torque = fr, or torque equals the force f x r (the distance).

Note: Torque can be produced even if the entire body is free to move and not affixed at a point of rotation.