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Motion

Motion in physics , change with time of the position or orientation of a body .

. Motion that changes the orientation of a body is called rotation . In both cases all points in the body have the same velocity . (directed speed) and the same acceleration (time rate of change of velocity) . The most general kind of motion combines both translation and rotation . All motions are relative to some frame of reference . Saying that a body is at rest , which means that is not in motion , merely means that it is being described with respect to a frame of reference that is moving together with the body . For example , a body on the surface of the earth may appear to be at rest , but that is only because the observer is also on the surface of the earth . The Earth itself , together with both the body and the observer , is moving in its orbit around the sun and rotating on its own axis at all times . As a rule , the motion of bodies obey Newton's laws of motion . However , motion at speeds close to the speed of light must be

treated by using the theory of relatively , and the motion of very small bodies (such as electrons) must be treated by using quantum mechanics .

Kinematics : branch of physics and a subdivision of classical mechanics concerned with the geometrically possible motion of a body or system of bodies without consideration of the forces involved (i.e.. causes and effects of the motions). Kinematics aims to provide a description of the spatial position of bodies or systems of material particles , the rate at which the particles are moving (velocity) , and the rate at which their velocity is changing (accelerateion) .

When the causative forces are disregarded , motion descriptions are possible only for particles having constrained motion – i..e moving on determinate paths . In unconstrained, or free , motion the forces determine the shape of the path .

For a particle moving on a straight path , a list of positions and corresponding times would constitute a suitable scheme for describing the motion of the particle . A continuous description would require a

mathematical formula expressing position in terms of time .

When a particles moves on a curved path , a description of its position becomes more complicated and requires two or three dimensions . In such cases continuous description in the form of a single graph or mathematical formula are not feasible . The position of a particle moving on a circle , for example , can be described by a rotating radius of the circle , like the spoke of a wheel with one end fixed at the centre of the circle and the other end attached to the particle . The rotating radius is known as a position vector for the particle , and , if the angle between it and a fixed radius is known as a function of time , the magnitude of the velocity and acceleration of the particle can be calculated . Velocity and acceleration , however , have direction as well as magnitude ; velocity is always tangent to the path , while acceleration has two components , one tangent to the path and the other perpendicular to the tangent .

dynamics, branch of physical science and subdivision of mechanics that is concerned with the motion of material objects in relation to the physical factors that affect them: force, mass, momentum, and energy.

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A brief treatment of dynamics follows. For full treatment, see

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Dynamics is distinguished from kinematics, which describes motion, without regard to its causes, in terms of position, velocity, and acceleration, and kinetics, which is concerned with the effect of forces and torques on the motion of bodies having mass. The foundations of dynamics were laid at the end of the 16th century by Galileo, who, by experimenting with a smooth ball rolling down an inclined plane, derived the law of motion for falling bodies; he was also the first to recognize that force is the cause of changes in the velocity of a body, a fact formulated by Isaac Newton in

fact formulated by Isaac Newton in the 17th century in his second law of motion. This law states that the force acting on a body is equal to the rate of change of the body's momentum. *See also* Newton's laws of motion.

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momentum, product of the mass of a particle and its velocity. Momentum is a vector quantity; i.e., it has both magnitude and direction. Isaac Newton's second law of motion states that the time rate of change of momentum is equal to the force acting on the particle. *See* Newton's laws of motion.

From Newton's second law it follows that, if a constant force acts on a particle for a given time, the product of force and the time interval (the impulse) is equal to the change in the momentum. Conversely, the momentum of a particle is a measure of the time required for a constant force to bring it to rest.

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The momentum of any collection of particles is equal to the vector sum of the individual momenta. According to Newton's third law, the particles exert equal and opposite forces on one another, so any change in the momentum of one particle is exactly balanced by an equal and opposite change of the momentum of another particle. Thus, in the absence of a net external force acting on a collection of particles, their total momentum never changes; this is the meaning of the law of conservation of momentum. *See also* conservation law; angular momentum

energy, in physics, the capacity for doing work. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other various forms. There are, moreover, heat and work —i.e., energy in the process of transfer from one body to another. After it has been transferred, energy is always designated according to its nature. Hence, heat transferred may become thermal energy, while work done may manifest itself in the form of mechanical energy.

All forms of energy are associated with motion. For example, any given body has kinetic energy if it is in motion. A tensioned device such as a bow or spring, though at rest, has the potential for creating motion; it contains potential energy because of its configuration. Similarly, nuclear energy is potential energy because it results from the configuration of subatomic particles in the nucleus of an atom.

Key People: William Thomson, Baron Kelvin • Hans Bethe • Lev Davidovich

Energy can be neither created nor destroyed but only changed from one form to another. This principle is known as the conservation of energy or the first law of thermodynamics. For example, when a box slides down a hill, the potential energy that the box has from being located high up on the slope is converted to kinetic energy, energy of motion. As the box slows to a stop through friction, the kinetic energy from the box's motion is converted to thermal energy that heats the box and the slope.

Energy can be converted from one form to another in various other ways. Usable mechanical or electrical energy is, for instance, produced by many kinds of devices, including fuel-burning heat engines, generators, batteries, fuel cells, and magnetohydrodynamic systems.

In the International System of Units (SI), energy is measured in joules. One joule is equal to the work done by a one-newton force acting over a one-metre distance.

Energy is treated in a number of articles. For the development of the

Energy is treated in a number of articles. For the development of the concept of energy and the principle of energy conservation, *see* principles of physical science; mechanics; thermodynamics; and conservation of energy. For the major sources of energy and the mechanisms by which the transition of energy from one form to another occurs, *see* coal; solar energy; wind power; nuclear fission; oil shale; petroleum; electromagnetism; and energy conversion.

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power, in science and engineering, time rate of doing work or delivering energy, expressible as the amount of work done *W*, or energy transferred, divided by the time interval *t*—or *W*/*t*. A given amount of work can be done by a low-powered motor in a long time or by a high-powered motor in a short time. Units of power are those of work (or energy) per unit time, such as foot-pounds per minute, joules per second (or watts), and ergs per second. Power is expressible also as the product of the force applied to move an object and the speed of the object in the direction of the force. If the magnitude of the force *F* is measured in pounds and the speed is

as foot-pounds per minute, joules per second (or watts), and ergs per second. Power is expressible also as the product of the force applied to move an object and the speed of the object in the direction of the force. If the magnitude of the force F is measured in pounds and the speed v in feet per minute, the power equals Fv foot-pounds per minute. In the International System of Units, power is measured in newton metres per second.

Most machines have rotating shafts, and, in terms of the twisting moment, or magnitude of torque (τ), on a shaft and the angular speed ω of the shaft, the power is given by $\tau\omega$. τ is usually expressed in inch-pounds, ω in radians per second, and power in inch-pounds per second. Another unit of mechanical power is the horsepower (hp), which is equal to 33,000 foot-pounds per minute, or 6,600 inch-pounds per second.