

## Glossary

**absolute pressure** | sum of gauge pressure and atmospheric pressure [OpenStax]

**acceleration due to gravity** | acceleration of an object as a result of gravity [OpenStax]

**acceleration vector** | instantaneous acceleration found by taking the derivative of the velocity function with respect to time in unit vector notation [OpenStax]

**accuracy** | the degree to which a measured value agrees with an accepted reference value for that measurement [OpenStax]

**Achimedes' principle** | buoyant force on an object equals the weight of the fluid it displaces [OpenStax]

**action-at-a-distance force** | type of force exerted without physical contact [OpenStax]

**amplitude (A)** | maximum displacement from the equilibrium position of an object oscillating around the equilibrium position [OpenStax]

**angular acceleration** | time rate of change of angular velocity [OpenStax]

**angular frequency** |  $\omega$ , rate of change of an angle with which an object that is moving on a circular path [OpenStax]

**angular momentum** | rotational analog of linear momentum, found by taking the product of moment of inertia and angular velocity [OpenStax]

**angular position** | angle a body has rotated through in a fixed coordinate system [OpenStax]

**angular velocity** | time rate of change of angular position [OpenStax]

**anticommutative property** | change in the order of operation introduces the minus sign [OpenStax]

**antinode** | location of maximum amplitude in standing waves [OpenStax]

**antiparallel vectors** | two vectors with directions that differ by  $180^\circ$  [OpenStax]

**aphelion** | farthest point from the Sun of an orbiting body; the corresponding term for the Moon's farthest point from Earth is the apogee [OpenStax]

**apparent weight** | reading of the weight of an object on a scale that does not account for acceleration [OpenStax]

**associative** | terms can be grouped in any fashion [OpenStax]

**average acceleration** | the rate of change in velocity; the change in velocity over time [OpenStax]

**average power** | work done in a time interval divided by the time interval [OpenStax]

**average speed** | the total distance traveled divided by elapsed time [OpenStax]

**average velocity** | the displacement divided by the time over which displacement occurs [OpenStax]

**banked curve** | curve in a road that is sloping in a manner that helps a vehicle negotiate the curve [OpenStax]

**base quantity** | physical quantity chosen by convention and practical considerations such that all other physical quantities can be expressed as algebraic combinations of them [OpenStax]

**base unit** | standard for expressing the measurement of a base quantity within a particular system of units; defined by a particular procedure used to measure the corresponding base quantity [OpenStax]

**beat frequency** | frequency of beats produced by sound waves that differ in frequency [OpenStax]

**beats** | constructive and destructive interference of two or more frequencies of sound [OpenStax]

**Bernoulli's equation** | equation resulting from applying conservation of energy to an incompressible frictionless fluid:

$$p + \frac{1}{2}\rho v^2 + \rho gh = \text{constant},$$

throughout the fluid [OpenStax]

**Bernoulli's principle** | Bernoulli's equation applied at constant depth:

$$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$$

[OpenStax]

**black hole** | mass that becomes so dense, that it collapses in on itself, creating a singularity at the center surround by an event horizon [OpenStax]

**bow wake** | v-shaped disturbance created when the wave source moves faster than the wave propagation speed [OpenStax]

**breaking stress (ultimate stress)** | value of stress at the fracture point [OpenStax]

**bulk modulus** | elastic modulus for the bulk stress [OpenStax]

**bulk strain (or volume strain)** | strain under the bulk stress, given as fractional change in volume [OpenStax]

**bulk stress (or volume stress)** | stress caused by compressive forces, in all directions [OpenStax]

**buoyant force** | net upward force on any object in any fluid due to the pressure difference at different depths [OpenStax]

**center of gravity** | point where the weight vector is attached [OpenStax]

**center of mass** | weighted average position of the mass [OpenStax]

**centripetal acceleration** | component of acceleration of an object moving in a circle that is directed radially inward toward the center of the circle [OpenStax]

**centripetal force** | any net force causing uniform circular motion [OpenStax]

**closed system** | system for which the mass is constant and the net external force on the system is zero [OpenStax]

**commutative** | operations can be performed in any order [OpenStax]

**component form of a vector** | a vector written as the vector sum of its components in terms of unit vectors [OpenStax]

**compressibility** | reciprocal of the bulk modulus [OpenStax]

**compressive strain** | strain that occurs when forces are contracting an object, causing its shortening [OpenStax]

**compressive stress** | stress caused by compressive forces, only in one direction [OpenStax]

**conservative force** | force that does work independent of path [OpenStax]

**conserved quantity** | one that cannot be created or destroyed, but may be transformed between different forms of itself [OpenStax]

**constructive interference** | when two waves arrive at the same point exactly in phase; that is, the crests of the two waves are precisely aligned, as are the troughs [OpenStax]

**conversion factor** | a ratio that expresses how many of one unit are equal to another unit [OpenStax]

**Coriolis force** | inertial force causing the apparent deflection of moving objects when viewed in a rotating frame of reference [OpenStax]

**corkscrew right-hand rule** | a rule used to determine the direction of the vector product [OpenStax]

**critically damped** | condition in which the damping of an oscillator causes it to return as quickly as possible to its equilibrium position without oscillating back and forth about this position [OpenStax]

**cross product** | the result of the vector multiplication of vectors is a vector called a cross product; also called a vector product [OpenStax]

**density** | mass per unit volume of a substance or object [OpenStax]

**derived quantity** | physical quantity defined using algebraic combinations of base quantities [OpenStax]

**derived units** | units that can be calculated using algebraic combinations of the fundamental units [OpenStax]

**destructive interference** | when two identical waves arrive at the same point exactly out of phase; that is, precisely aligned crest to trough [OpenStax]

**difference of two vectors** | vector sum of the first vector with the vector antiparallel to the second [OpenStax]

**dimension** | expression of the dependence of a physical quantity on the base quantities as a product of powers of symbols representing the base quantities; in general, the dimension of a quantity has the form  $L^a M^b T^c I^d \Theta^e N^f J^g$  for some powers a, b, c, d, e, f, and g [OpenStax]

**dimensionally consistent** | equation in which every term has the same dimensions and the arguments of any mathematical functions appearing in the equation are dimensionless [OpenStax]

**dimensionless** | quantity with a dimension of  $L^0 M^0 T^0 I^0 \Theta^0 N^0 J^0 = 1$ ; also called quantity of dimension 1 or a pure number [OpenStax]

**direction angle** | in a plane, an angle between the positive direction of the x-axis and the vector, measured counterclockwise from the axis to the vector [OpenStax]

**discrepancy** | the difference between the measured value and a given standard or expected value [OpenStax]

**displacement** | the change in position of an object [OpenStax]

**displacement** | change in position [OpenStax]

**displacement vector** | vector from the initial position to a final position on a trajectory of a particle [OpenStax]

**distance traveled** | the total length of the path traveled between two positions [OpenStax]

**distributive** | multiplication can be distributed over terms in summation [OpenStax]

**Doppler effect** | alteration in the observed frequency of a sound due to motion of either the source or the observer [OpenStax]

**Doppler shift** | actual change in frequency due to relative motion of source and observer [OpenStax]

**dot product** | the result of the scalar multiplication of two vectors is a scalar called a dot product; also called a scalar product [OpenStax]

**drag force** | force that always opposes the motion of an object in a fluid; unlike simple friction, the drag force is proportional to some function of the velocity of the object in that fluid [OpenStax]

**dynamics** | study of how forces affect the motion of objects and systems [OpenStax]

**elapsed time** | the difference between the ending time and the beginning time [OpenStax]

**elastic** | object that comes back to its original size and shape when the load is no longer present [OpenStax]

**elastic** | collision that conserves kinetic energy [OpenStax]

**elastic limit** | stress value beyond which material no longer behaves elastically and becomes permanently deformed [OpenStax]

**elastic modulus** | proportionality constant in linear relation between stress and strain, in SI pascals [OpenStax]

**elastic potential energy** | potential energy stored as a result of deformation of an elastic object, such as the stretching of a spring [OpenStax]

**energy conservation** | total energy of an isolated system is constant [OpenStax]

**English units** | system of measurement used in the United States; includes units of measure such as feet, gallons, and pounds [OpenStax]

**equal vectors** | two vectors are equal if and only if all their corresponding components are equal; alternately, two parallel vectors of equal magnitudes [OpenStax]

**equilibrium** | body is in equilibrium when its linear and angular accelerations are both zero relative to an inertial frame of reference [OpenStax]

**equilibrium point** | position where the assumed conservative, net force on a particle, given by the slope of its potential energy curve, is zero [OpenStax]

**equilibrium position** | position where the spring is neither stretched nor compressed [OpenStax]

**escape velocity** | initial velocity an object needs to escape the gravitational pull of another; it is more accurately defined as the velocity of an object with zero total mechanical energy [OpenStax]

**estimation** | using prior experience and sound physical reasoning to arrive at a rough idea of a quantity's value; sometimes called an "order-of-magnitude approximation," a "guesstimate," a "back-of-the-envelope calculation," or a "Fermi calculation" [OpenStax]

**event horizon** | location of the Schwarzschild radius and is the location near a black hole from within which no object, even light, can escape [OpenStax]

**exact differential** | is the total differential of a function and requires the use of partial derivatives if the function involves more than one dimension [OpenStax]

**explosion** | single object breaks up into multiple objects; kinetic energy is not conserved in explosions [OpenStax]

**external force** | force applied to an extended object that changes the momentum of the extended object as a whole [OpenStax]

**external force** | force acting on an object or system that originates outside of the object or system [OpenStax]

**first equilibrium condition** | expresses translational equilibrium; all external forces acting on the body balance out and their vector sum is zero [OpenStax]

**fixed boundary condition** | when the medium at a boundary is fixed in place so it cannot move [OpenStax]

**flow rate** | abbreviated  $Q$ , it is the volume  $V$  that flows past a particular point during a time  $t$ , or  $Q = \frac{dV}{dt}$  [OpenStax]

**fluids** | liquids and gases; a fluid is a state of matter that yields to shearing forces [OpenStax]

**force** | push or pull on an object with a specific magnitude and direction; can be represented by vectors or expressed as a multiple of a standard force [OpenStax]

**force constant (k)** | characteristic of a spring which is defined as the ratio of the force applied to the spring to the displacement caused by the force [OpenStax]

**free boundary condition** | exists when the medium at the boundary is free to move [OpenStax]

**free fall** | situation in which the only force acting on an object is gravity [OpenStax]

**free fall** | the state of movement that results from gravitational force only [OpenStax]

**free-body diagram** | sketch showing all external forces acting on an object or system; the system is represented by a single isolated point, and the forces are represented by vectors extending outward from that point [OpenStax]

**frequency (f)** | number of events per unit of time [OpenStax]

**friction** | force that opposes relative motion or attempts at motion between systems in contact [OpenStax]

**fundamental** | the lowest-frequency resonance [OpenStax]

**fundamental frequency** | lowest frequency that will produce a standing wave [OpenStax]

**gauge pressure** | pressure relative to atmospheric pressure [OpenStax]

**gravitational field** | vector field that surrounds the mass creating the field; the field is represented by field lines, in which the direction of the field is tangent to the lines, and the magnitude (or field strength) is inversely proportional to the spacing of the lines; other masses respond to this field [OpenStax]

**gravitational torque** | torque on the body caused by its weight; it occurs when the center of gravity of the body is not located on the axis of rotation [OpenStax]

**gravitationally bound** | two objects are gravitationally bound if their orbits are closed; gravitationally bound systems have a negative total mechanical energy [OpenStax]

**harmonics** | the term used to refer collectively to the fundamental and its overtones [OpenStax]

**hearing** | perception of sound [OpenStax]

**Hooke's law** | in a spring, a restoring force proportional to and in the opposite direction of the imposed displacement [OpenStax]

**hydraulic jack** | simple machine that uses cylinders of different diameters to distribute force [OpenStax]

**hydrostatic equilibrium** | state at which water is not flowing, or is static [OpenStax]

**ideal banking** | sloping of a curve in a road, where the angle of the slope allows the vehicle to negotiate the curve at a certain speed without the aid of friction between the tires and the road; the net external force on the vehicle equals the horizontal centripetal force in the absence of friction [OpenStax]

**ideal fluid** | fluid with negligible viscosity [OpenStax]

**impulse** | effect of applying a force on a system for a time interval; this time interval is usually small, but does not have to be [OpenStax]

**impulse-momentum theorem** | change of momentum of a system is equal to the impulse applied to the system [OpenStax]

**inelastic** | collision that does not conserve kinetic energy [OpenStax]

**inertia** | ability of an object to resist changes in its motion [OpenStax]

**inertial force** | force that has no physical origin [OpenStax]

**inertial reference frame** | reference frame moving at constant velocity relative to an inertial frame is also inertial; a reference frame accelerating relative to an inertial frame is not inertial [OpenStax]

**instantaneous acceleration** | acceleration at a specific point in time [OpenStax]

**instantaneous angular acceleration** | derivative of angular velocity with respect to time [OpenStax]

**instantaneous angular velocity** | derivative of angular position with respect to time [OpenStax]

**instantaneous speed** | the absolute value of the instantaneous velocity [OpenStax]

**instantaneous velocity** | the velocity at a specific instant or time point [OpenStax]

**intensity (I)** | power per unit area [OpenStax]

**interference** | overlap of two or more waves at the same point and time [OpenStax]

**internal force** | force that the simple particles that make up an extended object exert on each other. Internal forces can be attractive or repulsive [OpenStax]

**Kepler's first law** | law stating that every planet moves along an ellipse, with the Sun located at a focus of the ellipse [OpenStax]

**Kepler's second law** | law stating that a planet sweeps out equal areas in equal times, meaning it has a constant areal velocity [OpenStax]

**Kepler's third law** | law stating that the square of the period is proportional to the cube of the semi-major axis of the orbit [OpenStax]

**kilogram** | SI unit for mass, abbreviated kg [OpenStax]

**kinematics** | the description of motion through properties such as position, time, velocity, and acceleration [OpenStax]

**kinematics of rotational motion** | describes the relationships among rotation angle, angular velocity, angular acceleration, and time [OpenStax]

**kinetic energy** | energy of motion, one-half an object's mass times the square of its speed [OpenStax]

**kinetic friction** | force that opposes the motion of two systems that are in contact and moving relative to each other [OpenStax]

**laminar flow** | type of fluid flow in which layers do not mix [OpenStax]

**law** | description, using concise language or a mathematical formula, of a generalized pattern in nature supported by scientific evidence and repeated experiments [OpenStax]

**law of conservation of angular momentum** | angular momentum is conserved, that is, the initial angular momentum is equal to the final angular momentum when no external torque is applied to the system [OpenStax]

**Law of Conservation of Momentum** | total momentum of a closed system cannot change [OpenStax]

**law of inertia** | see Newton's first law of motion [OpenStax]

**lever arm** | perpendicular distance from the line that the force vector lies on to a given axis [OpenStax]

**linear mass density** | the mass per unit length  $\lambda$  of a one dimensional object [OpenStax]

**linear mass density** |  $\lambda$ , expressed as the number of kilograms of material per meter [OpenStax]

**linear wave equation** | equation describing waves that result from a linear restoring force of the medium; any function that is a solution to the wave equation describes a wave moving in the positive x-direction or the negative x-direction with a constant wave speed  $v$  [OpenStax]

**linearity limit (proportionality limit)** | largest stress value beyond which stress is no longer proportional to strain [OpenStax]

**longitudinal wave** | wave in which the disturbance is parallel to the direction of propagation [OpenStax]

**loudness** | perception of sound intensity [OpenStax]

**magnitude** | length of a vector [OpenStax]

**mechanical energy** | sum of the kinetic and potential energies [OpenStax]

**mechanical wave** | wave that is governed by Newton's laws and requires a medium [OpenStax]

**meter** | SI unit for length, abbreviated m [OpenStax]

**method of adding percents** | the percent uncertainty in a quantity calculated by multiplication or division is the sum of the percent uncertainties in the items used to make the calculation [OpenStax]

**metric system** | system in which values can be calculated in factors of 10 [OpenStax]

**model** | representation of something often too difficult (or impossible) to display directly [OpenStax]

**moment of inertia** | rotational mass of rigid bodies that relates to how easy or hard it will be to change the angular velocity of the rotating rigid body [OpenStax]

**momentum** | measure of the quantity of motion that an object has; it takes into account both how fast the object is moving, and its mass; specifically, it is the product of mass and velocity; it is a vector quantity [OpenStax]

**natural angular frequency** | angular frequency of a system oscillating in SHM [OpenStax]

**neap tide** | low tide created when the Moon and the Sun form a right triangle with Earth [OpenStax]

**net external force** | vector sum of all external forces acting on an object or system; causes a mass to accelerate [OpenStax]

**net work** | work done by all the forces acting on an object [OpenStax]

**neutron star** | most compact object known—outside of a black hole itself [OpenStax]

**newton** | SI unit of force; 1 N is the force needed to accelerate an object with a mass of 1 kg at a rate of 1 m/s<sup>2</sup> [OpenStax]

**Newton's first law of motion** | body at rest remains at rest or, if in motion, remains in motion at constant velocity unless acted on by a net external force; also known as the law of inertia [OpenStax]

**Newton's law of gravitation** | every mass attracts every other mass with a force proportional to the product of their masses, inversely proportional to the square of the distance between them, and with direction along the line connecting the center of mass of each [OpenStax]

**Newton's second law for rotation** | sum of the torques on a rotating system equals its moment of inertia times its angular acceleration [OpenStax]

**Newton's second law of motion** | acceleration of a system is directly proportional to and in the same direction as the net external force acting on the system and is inversely proportional to its mass [OpenStax]

**Newton's third law of motion** | whenever one body exerts a force on a second body, the first body experiences a force that is equal in magnitude and opposite in direction to the force that it exerts [OpenStax]

**node** | point where the string does not move; more generally, nodes are where the wave disturbance is zero in a standing wave [OpenStax]

**non-conservative force** | force that does work that depends on path [OpenStax]

**non-Euclidean geometry** | geometry of curved space, describing the relationships among angles and lines on the surface of a sphere, hyperboloid, etc. [OpenStax]

**non-renewable** | energy source that is not renewable, but is depleted by human consumption [OpenStax]

**noninertial frame of reference** | accelerated frame of reference [OpenStax]

**normal force** | force supporting the weight of an object, or a load, that is perpendicular to the surface of contact between the load and its support; the surface applies this force to an object to support the weight of the object [OpenStax]

**normal mode** | possible standing wave pattern for a standing wave on a string [OpenStax]

**normal pressure** | pressure of one atmosphere, serves as a reference level for pressure [OpenStax]

**notes** | basic unit of music with specific names, combined to generate tunes [OpenStax]

**null vector** | a vector with all its components equal to zero [OpenStax]

**orbital period** | time required for a satellite to complete one orbit [OpenStax]

**orbital speed** | speed of a satellite in a circular orbit; it can be also be used for the instantaneous speed for noncircular orbits in which the speed is not constant [OpenStax]

**order of magnitude** | the size of a quantity as it relates to a power of 10 [OpenStax]

**orthogonal vectors** | two vectors with directions that differ by exactly 90°, synonymous with perpendicular vectors [OpenStax]

**oscillation** | single fluctuation of a quantity, or repeated and regular fluctuations of a quantity, between two extreme values around an equilibrium or average value [OpenStax]

**overdamped** | condition in which damping of an oscillator causes it to return to equilibrium without oscillating; oscillator moves more slowly toward equilibrium than in the critically damped system [OpenStax]

**overtone** | frequency that produces standing waves and is higher than the fundamental frequency [OpenStax]

**overtones** | all resonant frequencies higher than the fundamental [OpenStax]

**parallel axis** | axis of rotation that is parallel to an axis about which the moment of inertia of an object is known [OpenStax]

**parallel vectors** | two vectors with exactly the same direction angles [OpenStax]

**parallel-axis theorem** | if the moment of inertia is known for a given axis, it can be found for any axis parallel to it [OpenStax]

**parallelogram rule** | geometric construction of the vector sum in a plane [OpenStax]

**pascal (Pa)** | SI unit of stress, SI unit of pressure [OpenStax]

**Pascal's principle** | change in pressure applied to an enclosed fluid is transmitted undiminished to all portions of the fluid and to the walls of its container [OpenStax]

**percent uncertainty** | the ratio of the uncertainty of a measurement to the measured value, expressed as a percentage [OpenStax]

**perfectly inelastic** | collision after which all objects are motionless, the final kinetic energy is zero, and the loss of kinetic energy is a maximum [OpenStax]

**perihelion** | point of closest approach to the Sun of an orbiting body; the corresponding term for the Moon's closest approach to Earth is the perigee [OpenStax]

**period (T)** | time taken to complete one oscillation [OpenStax]

**periodic motion** | motion that repeats itself at regular time intervals [OpenStax]

**phase shift** | angle, in radians, that is used in a cosine or sine function to shift the function left or right, used to match up the function with the initial conditions of data [OpenStax]

**phon** | numerical unit of loudness [OpenStax]

**physical pendulum** | any extended object that swings like a pendulum [OpenStax]

**physical quantity** | characteristic or property of an object that can be measured or calculated from other measurements [OpenStax]

**physics** | science concerned with describing the interactions of energy, matter, space, and time; especially interested in what fundamental mechanisms underlie every phenomenon [OpenStax]

**pitch** | perception of the frequency of a sound [OpenStax]

**plastic behavior** | material deforms irreversibly, does not go back to its original shape and size when load is removed and stress vanishes [OpenStax]



**Poiseuille's law** | rate of laminar flow of an incompressible fluid in a tube:

$$Q = \frac{(p_2 - p_1)\pi r^4}{8\eta l}$$

[OpenStax]

**Poiseuille's law for resistance** | resistance to laminar flow of an incompressible fluid in a tube:

$$R = \frac{8\eta l}{\pi r^4}$$

[OpenStax]

**polar coordinate system** | an orthogonal coordinate system where location in a plane is given by polar coordinates [OpenStax]

**polar coordinates** | a radial coordinate and an angle [OpenStax]

**position** | the location of an object at a particular time [OpenStax]

**position vector** | vector from the origin of a chosen coordinate system to the position of a particle in two- or three-dimensional space [OpenStax]

**potential energy** | function of position, energy possessed by an object relative to the system considered [OpenStax]

**potential energy diagram** | graph of a particle's potential energy as a function of position [OpenStax]

**potential energy difference** | negative of the work done acting between two points in space [OpenStax]

**power** | (or instantaneous power) rate of doing work [OpenStax]

**precession** | circular motion of the pole of the axis of a spinning object around another axis due to a torque [OpenStax]

**precision** | the degree to which repeated measurements agree with each other [OpenStax]

**pressure** | force per unit area exerted perpendicular to the area over which the force acts [OpenStax]

**pressure** | force pressing in normal direction on a surface per the surface area, the bulk stress in fluids [OpenStax]

**principle of equivalence** | part of the general theory of relativity, it states that there no difference between free fall and being weightless, or a uniform gravitational field and uniform acceleration [OpenStax]

**projectile motion** | motion of an object subject only to the acceleration of gravity [OpenStax]

**pulse** | single disturbance that moves through a medium, transferring energy but not mass [OpenStax]

**radial coordinate** | distance to the origin in a polar coordinate system [OpenStax]

**range** | maximum horizontal distance a projectile travels [OpenStax]

**reference frame** | coordinate system in which the position, velocity, and acceleration of an object at rest or moving is measured [OpenStax]

**relative velocity** | velocity of an object as observed from a particular reference frame, or the velocity of one reference frame with respect to another reference frame [OpenStax]

**renewable** | energy source that is replenished by natural processes, over human time scales [OpenStax]

**resonance** | large amplitude oscillations in a system produced by a small amplitude driving force, which has a frequency equal to the natural frequency [OpenStax]

**restoring force** | force acting in opposition to the force caused by a deformation [OpenStax]

**resultant vector** | vector sum of two (or more) vectors [OpenStax]

**Reynolds number** | dimensionless parameter that can reveal whether a particular flow is laminar or turbulent [OpenStax]

**rocket equation** | derived by the Soviet physicist Konstantin Tsiolkovsky in 1897, it gives us the change of velocity that the rocket obtains from burning a mass of fuel that decreases the total rocket mass from  $m_i$  down to  $m$  [OpenStax]

**rolling motion** | combination of rotational and translational motion with or without slipping [OpenStax]

**rotational dynamics** | analysis of rotational motion using the net torque and moment of inertia to find the angular acceleration [OpenStax]

**rotational kinetic energy** | kinetic energy due to the rotation of an object; this is part of its total kinetic energy [OpenStax]

**rotational work** | work done on a rigid body due to the sum of the torques integrated over the angle through with the body rotates [OpenStax]

**scalar** | a number, synonymous with a scalar quantity in physics [OpenStax]

**scalar component** | a number that multiplies a unit vector in a vector component of a vector [OpenStax]

**scalar equation** | equation in which the left-hand and right-hand sides are numbers [OpenStax]

**scalar product** | the result of the scalar multiplication of two vectors is a scalar called a scalar product; also called a dot product [OpenStax]

**scalar quantity** | quantity that can be specified completely by a single number with an appropriate physical unit [OpenStax]

**Schwarzschild radius** | critical radius ( $R_S$ ) such that if a mass were compressed to the extent that its radius becomes less than the Schwarzschild radius, then the mass will collapse to a singularity, and anything that passes inside that radius cannot escape [OpenStax]

**second** | the SI unit for time, abbreviated s [OpenStax]

**second equilibrium condition** | expresses rotational equilibrium; all torques due to external forces acting on the body balance out and their vector sum is zero [OpenStax]

**shear modulus** | elastic modulus for shear stress [OpenStax]

**shear strain** | strain caused by shear stress [OpenStax]

**shear stress** | stress caused by shearing forces [OpenStax]

**shock wave** | wave front that is produced when a sound source moves faster than the speed of sound [OpenStax]

**SI units** | the international system of units that scientists in most countries have agreed to use; includes units such as meters, liters, and grams [OpenStax]

**significant figures** | used to express the precision of a measuring tool used to measure a value [OpenStax]

**simple harmonic motion (SHM)** | oscillatory motion in a system where the restoring force is proportional to the displacement, which acts in the direction opposite to the displacement [OpenStax]

**simple harmonic oscillator** | a device that oscillates in SHM where the restoring force is proportional to the displacement and acts in the direction opposite to the displacement [OpenStax]

**simple pendulum** | point mass, called a pendulum bob, attached to a near massless string [OpenStax]

**sonic boom** | loud noise that occurs as a shock wave as it sweeps along the ground [OpenStax]

**sound** | traveling pressure wave that may be periodic; the wave can be modeled as a pressure wave or as an oscillation of molecules [OpenStax]

**sound intensity level** | unitless quantity telling you the level of the sound relative to a fixed standard [OpenStax]

**sound pressure level** | ratio of the pressure amplitude to a reference pressure [OpenStax]

**space-time** | concept of space-time is that time is essentially another coordinate that is treated the same way as any individual spatial coordinate; in the equations that represent both special and general relativity, time appears in the same context as do the spatial coordinates [OpenStax]

**specific gravity** | ratio of the density of an object to a fluid (usually water) [OpenStax]

**spring tide** | high tide created when the Moon, the Sun, and Earth are along one line [OpenStax]

**stable equilibrium point** | point where the net force on a system is zero, but a small displacement of the mass will cause a restoring force that points toward the equilibrium point [OpenStax]

**standing wave** | wave that can bounce back and forth through a particular region, effectively becoming stationary [OpenStax]

**static equilibrium** | body is in static equilibrium when it is at rest in our selected inertial frame of reference [OpenStax]

**static friction** | force that opposes the motion of two systems that are in contact and are not moving relative to each other [OpenStax]

**strain** | dimensionless quantity that gives the amount of deformation of an object or medium under stress [OpenStax]

**stress** | quantity that contains information about the magnitude of force causing deformation, defined as force per unit area [OpenStax]

**stress-strain diagram** | graph showing the relationship between stress and strain, characteristic of a material [OpenStax]

**superposition** | phenomenon that occurs when two or more waves arrive at the same point [OpenStax]

**surface mass density** | mass per unit area  $\sigma$  of a two dimensional object [OpenStax]

**system** | object or collection of objects whose motion is currently under investigation; however, your system is defined at the start of the problem, you must keep that definition for the entire problem [OpenStax]

**tail-to-head geometric construction** | geometric construction for drawing the resultant vector of many vectors [OpenStax]

**tangential acceleration** | magnitude of which is the time rate of change of speed. Its direction is tangent to the circle. [OpenStax]

**tensile strain** | strain under tensile stress, given as fractional change in length, which occurs when forces are stretching an object, causing its elongation [OpenStax]

**tensile stress** | stress caused by tensile forces, only in one direction, which occurs when forces are stretching an object, causing its elongation [OpenStax]

**tension** | pulling force that acts along a stretched flexible connector, such as a rope or cable [OpenStax]

**terminal velocity** | constant velocity achieved by a falling object, which occurs when the weight of the object is balanced by the upward drag force [OpenStax]

**theory** | testable explanation for patterns in nature supported by scientific evidence and verified multiple times by various groups of researchers [OpenStax]

**theory of general relativity** | Einstein's theory for gravitation and accelerated reference frames; in this theory, gravitation is the result of mass and energy distorting the space-time around it; it is also often referred to as Einstein's theory of gravity [OpenStax]

**thrust** | reaction force that pushes a body forward in response to a backward force [OpenStax]

**tidal force** | difference between the gravitational force at the center of a body and that at any other location on the body; the tidal force stretches the body [OpenStax]

**timbre** | number and relative intensity of multiple sound frequencies [OpenStax]

**time of flight** | elapsed time a projectile is in the air [OpenStax]

**torque** | cross product of a force and a lever arm to a given axis [OpenStax]

**torsional pendulum** | any suspended object that oscillates by twisting its suspension [OpenStax]

**total acceleration** | vector sum of centripetal and tangential accelerations [OpenStax]

**total displacement** | the sum of individual displacements over a given time period [OpenStax]

**total linear acceleration** | vector sum of the centripetal acceleration vector and the tangential acceleration vector [OpenStax]

**trajectory** | path of a projectile through the air [OpenStax]

**transducer** | device that converts energy of a signal into measurable energy form, for example, a microphone converts sound waves into an electrical signal [OpenStax]

**transverse wave** | wave in which the disturbance is perpendicular to the direction of propagation [OpenStax]

**turbulence** | fluid flow in which layers mix together via eddies and swirls [OpenStax]

**turbulent flow** | type of fluid flow in which layers mix together via eddies and swirls [OpenStax]

**turning point** | position where the velocity of a particle, in one-dimensional motion, changes sign [OpenStax]

**two-body pursuit problem** | a kinematics problem in which the unknowns are calculated by solving the kinematic equations simultaneously for two moving objects [OpenStax]

**uncertainty** | a quantitative measure of how much measured values deviate from one another [OpenStax]

**underdamped** | condition in which damping of an oscillator causes the amplitude of oscillations of a damped harmonic oscillator to decrease over time, eventually approaching zero [OpenStax]

**unit vector** | vector of a unit magnitude that specifies direction; has no physical unit [OpenStax]

**unit vectors of the axes** | unit vectors that define orthogonal directions in a plane or in space [OpenStax]

**units** | standards used for expressing and comparing measurements [OpenStax]

**universal gravitational constant** | constant representing the strength of the gravitational force, that is believed to be the same throughout the universe [OpenStax]

**vector** | mathematical object with magnitude and direction [OpenStax]

**vector components** | orthogonal components of a vector; a vector is the vector sum of its vector components [OpenStax]

**vector equation** | equation in which the left-hand and right-hand sides are vectors [OpenStax]

**vector product** | the result of the vector multiplication of vectors is a vector called a vector product; also called a cross product [OpenStax]

**vector quantity** | physical quantity described by a mathematical vector—that is, by specifying both its magnitude and its direction; synonymous with a vector in physics [OpenStax]

**vector sum** | resultant of the combination of two (or more) vectors [OpenStax]

**velocity vector** | vector that gives the instantaneous speed and direction of a particle; tangent to the trajectory [OpenStax]

**viscosity** | measure of the internal friction in a fluid [OpenStax]

**wave** | disturbance that moves from its source and carries energy [OpenStax]

**wave function** | mathematical model of the position of particles of the medium [OpenStax]

**wave number** |  $\frac{2\pi}{\lambda}$  [OpenStax]

**wave speed** | magnitude of the wave velocity [OpenStax]

**wave velocity** | velocity at which the disturbance moves; also called the propagation velocity [OpenStax]

**wavelength** | distance between adjacent identical parts of a wave [OpenStax]

**weight** | force  $\vec{w}$  due to gravity acting on an object of mass  $m$  [OpenStax]

**work** | done when a force acts on something that undergoes a displacement from one position to another [OpenStax]

**work done by a force** | integral, from the initial position to the final position, of the dot product of the force and the infinitesimal displacement along the path over which the force acts [OpenStax]

**work-energy theorem** | net work done on a particle is equal to the change in its kinetic energy [OpenStax]

**work-energy theorem for rotation** | the total rotational work done on a rigid body is equal to the change in rotational kinetic energy of the body [OpenStax]

**Young's modulus** | elastic modulus for tensile or compressive stress [OpenStax]