

Glossary

aberration | failure of rays to converge at one focus because of limitations or defects in a lens or mirror

absolute pressure | the sum of gauge pressure and atmospheric pressure

absolute zero | the lowest possible temperature; the temperature at which all molecular motion ceases

AC current | current that fluctuates sinusoidally with time, expressed as $I = I_0 \sin 2\pi ft$, where I is the current at time t , I_0 is the peak current, and f is the frequency in hertz

AC voltage | voltage that fluctuates sinusoidally with time, expressed as $V = V_0 \sin 2\pi ft$, where V is the voltage at time t , V_0 is the peak voltage, and f is the frequency in hertz

acceleration | the rate of change in velocity; the change in velocity over time

acceleration due to gravity | acceleration of an object as a result of gravity

accommodation | the ability of the eye to adjust its focal length is known as accommodation

accuracy | the degree to which a measured value agrees with correct value for that measurement

acoustic impedance | property of medium that makes the propagation of sound waves more difficult

active transport | the process in which a living membrane expends energy to move substances across

activity | the rate of decay for radioactive nuclides

adaptive optics | optical technology in which computers adjust the lenses and mirrors in a device to correct for image distortions

adhesive forces | the attractive forces between molecules of different types

adiabatic process | a process in which no heat transfer takes place

air resistance | a frictional force that slows the motion of objects as they travel through the air; when solving basic physics problems, air resistance is assumed to be zero

alpha decay | type of radioactive decay in which an atomic nucleus emits an alpha particle

alpha rays | one of the types of rays emitted from the nucleus of an atom

alternating current | (AC) the flow of electric charge that periodically reverses direction

ammeter | an instrument that measures current

ampere | (amp) the SI unit for current; $1 \text{ A} = 1 \text{ C/s}$

Ampere's law | the physical law that states that the magnetic field around an electric current is proportional to the current; each segment of current produces a magnetic field like that of a long straight wire, and the total field of any shape current is the vector sum of the fields due to each segment

amplitude | the maximum displacement from the equilibrium position of an object oscillating around the equilibrium position

amplitude | the height, or magnitude, of an electromagnetic wave

amplitude modulation (AM) | a method for placing information on electromagnetic waves by modulating the amplitude of a carrier wave with an audio signal, resulting in a wave with constant frequency but varying amplitude

analog meter | a measuring instrument that gives a readout in the form of a needle movement over a marked gauge

analytical method | the method of determining the magnitude and direction of a resultant vector using the Pythagorean theorem and trigonometric identities

Anger camera | a common medical imaging device that uses a scintillator connected to a series of photomultipliers

angular acceleration | the rate of change of angular velocity with time

angular magnification | a ratio related to the focal lengths of the objective and eyepiece and given as $M = -f_o/f_e$

angular momentum | the product of moment of inertia and angular velocity

angular momentum quantum number | a quantum number associated with the angular momentum of electrons

angular velocity | ω , the rate of change of the angle with which an object moves on a circular path

antielelectron | another term for positron

antimatter | composed of antiparticles

antinode | the location of maximum amplitude in standing waves

antinode | point of maximum displacement

approximation | an estimated value based on prior experience and reasoning

arc length | Δs , the distance traveled by an object along a circular path

Archimedes' principle | the buoyant force on an object equals the weight of the fluid it displaces

astigmatism | the result of an inability of the cornea to properly focus an image onto the retina

atom | basic unit of matter, which consists of a central, positively charged nucleus surrounded by negatively charged electrons

atomic de-excitation | process by which an atom transfers from an excited electronic state back to the ground state electronic configuration; often occurs by emission of a photon

atomic excitation | a state in which an atom or ion acquires the necessary energy to promote one or more of its electrons to electronic states higher in energy than their ground state

atomic mass | the total mass of the protons, neutrons, and electrons in a single atom

atomic number | the number of protons in the nucleus of an atom

atomic number | number of protons in a nucleus

atomic spectra | the electromagnetic emission from atoms and molecules

average acceleration | the change in velocity divided by the time over which it changes

average speed | distance traveled divided by time during which motion occurs

average velocity | displacement divided by time over which displacement occurs

Avogadro's number | N_A , the number of molecules or atoms in one mole of a substance; $N_A = 6.02 \times 10^{23}$ particles/mole

axis of a polarizing filter | the direction along which the filter passes the electric field of an EM wave

B-field | another term for magnetic field

back emf | the emf generated by a running motor, because it consists of a coil turning in a magnetic field; it opposes the voltage powering the motor

banked curve | the curve in a road that is sloping in a manner that helps a vehicle negotiate the curve

barrier penetration | quantum mechanical effect whereby a particle has a nonzero probability to cross through a potential energy barrier despite not having sufficient energy to pass over the barrier; also called quantum mechanical tunneling

baryon number | a conserved physical quantity that is zero for mesons and leptons and ± 1 for baryons and antibaryons, respectively

baryons | hadrons that always decay to another baryon

basal metabolic rate | the total energy conversion rate of a person at rest

beat frequency | the frequency of the amplitude fluctuations of a wave

becquerel | SI unit for rate of decay of a radioactive material

Bernoulli's equation | the equation resulting from applying conservation of energy to an incompressible frictionless fluid: $P + 1/2\rho v^2 + \rho gh = \text{constant}$, through the fluid

Bernoulli's principle | Bernoulli's equation applied at constant depth: $P_1 + 1/2\rho v_1^2 = P_2 + 1/2\rho v_2^2$

beta decay | type of radioactive decay in which an atomic nucleus emits a beta particle

beta rays | one of the types of rays emitted from the nucleus of an atom

binding energy | also called the *work function*; the amount of energy necessary to eject an electron from a material

binding energy | the energy needed to separate nucleus into individual protons and neutrons

binding energy per nucleon | the binding energy calculated per nucleon; it reveals the details of the nuclear force—larger the BE/A , the more stable the nucleus

bioelectricity | electrical effects in and created by biological systems

Biot-Savart law | a physical law that describes the magnetic field generated by an electric current in terms of a specific equation

birefringent | crystals that split an unpolarized beam of light into two beams

blackbody | an ideal radiator, which can radiate equally well at all wavelengths

blackbody radiation | the electromagnetic radiation from a blackbody

Bohr radius | the mean radius of the orbit of an electron around the nucleus of a hydrogen atom in its ground state

Boltzmann constant | k , a physical constant that relates energy to temperature; $k = 1.38 \times 10^{-23} \text{ J/K}$

boson | particle with zero or an integer value of intrinsic spin

bottom | a quark flavor

bow wake | V-shaped disturbance created when the wave source moves faster than the wave propagation speed

break-even | when fusion power produced equals the heating power input

breeder reactors | reactors that are designed specifically to make plutonium

breeding | reaction process that produces ^{239}Pu

bremsstrahlung | German for *braking radiation*; produced when electrons are decelerated

Brewster's angle | $\theta_b = \tan^{-1}(n_2/n_1)$, where n_2 is the index of refraction of the medium from which the light is reflected and n_1 is the index of refraction of the medium in which the reflected light travels

Brewster's law | $\tan\theta_b = n_2/n_1$, where n_1 is the medium in which the incident and reflected light travel and n_2 is the index of refraction of the medium that forms the interface that reflects the light

bridge device | a device that forms a bridge between two branches of a circuit; some bridge devices are used to make null measurements in circuits

Brownian motion | the continuous random movement of particles of matter suspended in a liquid or gas

buoyant force | the net upward force on any object in any fluid

capacitance | amount of charge stored per unit volt

capacitance | the maximum amount of electric potential energy that can be stored (or separated) for a given electric potential

capacitive reactance | the opposition of a capacitor to a change in current; calculated by $X_C = 1/2\pi fC$

capacitor | a device that stores electric charge

capacitor | an electrical component used to store energy by separating electric charge on two opposing plates

capillary action | the tendency of a fluid to be raised or lowered in a narrow tube

carbon-14 dating | a radioactive dating technique based on the radioactivity of carbon-14

Carnot cycle | a cyclical process that uses only reversible processes, the adiabatic and isothermal processes

Carnot efficiency | the maximum theoretical efficiency for a heat engine

Carnot engine | a heat engine that uses a Carnot cycle

carrier particle | a fundamental particle of nature that is surrounded by a characteristic force field; photons are carrier particles of the electromagnetic force

carrier wave | an electromagnetic wave that carries a signal by modulation of its amplitude or frequency

cathode-ray tube | a vacuum tube containing a source of electrons and a screen to view images

Celsius scale | temperature scale in which the freezing point of water is 0°C and the boiling point of water is 100°C

center of gravity | the point where the total weight of the body is assumed to be concentrated

center of mass | the point where the entire mass of an object can be thought to be concentrated

centrifugal force | a fictitious force that tends to throw an object off when the object is rotating in a non-inertial frame of reference

centripetal acceleration | the acceleration of an object moving in a circle, directed toward the center

centripetal force | any net force causing uniform circular motion

change in angular velocity | the difference between final and initial values of angular velocity

change in entropy | the ratio of heat transfer to temperature Q/T

change in momentum | the difference between the final and initial momentum; the mass times the change in velocity

characteristic time constant | denoted by τ , of a particular series RL circuit is calculated by $\tau = L/R$, where L is the inductance and R is the resistance

characteristic x rays | x rays whose energy depends on the material they were produced in

charm | a quark flavor, which is the counterpart of the strange quark

chart of the nuclides | a table comprising stable and unstable nuclei

chemical energy | the energy in a substance stored in the bonds between atoms and molecules that can be released in a chemical reaction

classical physics | physics that was developed from the Renaissance to the end of the 19th century

classical relativity | the study of relative velocities in situations where speeds are less than about 1% of the speed of light—that is, less than 3000 km/s

classical velocity addition | the method of adding velocities when $v \ll c$; velocities add like regular numbers in one-dimensional motion: $u = v + u'$, where v is the velocity between two observers, u is the velocity of an object relative to one observer, and u' is the velocity relative to the other observer

coefficient of linear expansion | α , the change in length, per unit length, per 1°C change in temperature; a constant used in the calculation of linear expansion; the coefficient of linear expansion depends on the material and to some degree on the temperature of the material

coefficient of performance | for a heat pump, it is the ratio of heat transfer at the output (the hot reservoir) to the work supplied; for a refrigerator or air conditioner, it is the ratio of heat transfer from the cold reservoir to the work supplied

coefficient of volume expansion | β , the change in volume, per unit volume, per 1°C change in temperature

coherent | waves are in phase or have a definite phase relationship

cohesive forces | the attractive forces between molecules of the same type

colliding beams | head-on collisions between particles moving in opposite directions

color | a quark flavor

color constancy | a part of the visual perception system that allows people to perceive color in a variety of conditions and to see some consistency in the color

commutative | refers to the interchangeability of order in a function; vector addition is commutative because the order in which vectors are added together does not affect the final sum

component (of a 2-d vector) | a piece of a vector that points in either the vertical or the horizontal direction; every 2-d vector can be expressed as a sum of two vertical and horizontal vector components

compound microscope | a microscope constructed from two convex lenses, the first serving as the ocular lens (close to the eye) and the second serving as the objective lens

Compton effect | the phenomenon whereby x rays scattered from materials have decreased energy

conduction | heat transfer through stationary matter by physical contact

conductor | a material that allows electrons to move separately from their atomic orbits

conductor | an object with properties that allow charges to move about freely within it

confocal microscopes | microscopes that use the extended focal region to obtain three-dimensional images rather than two-dimensional images

conservation laws | require that energy and charge be conserved in a system

conservation of mechanical energy | the rule that the sum of the kinetic energies and potential energies remains constant if only conservative forces act on and within a system

conservation of momentum principle | when the net external force is zero, the total momentum of the system is conserved or constant

conservation of total baryon number | a general rule based on the observation that the total number of nucleons was always conserved in nuclear reactions and decays

conservation of total electron family number | a general rule stating that the total electron family number stays the same through an interaction

conservation of total muon family number | a general rule stating that the total muon family number stays the same through an interaction

conservative force | a force that does the same work for any given initial and final configuration, regardless of the path followed

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

constructive interference for a diffraction grating | occurs when the condition $d \sin \theta = m\lambda$ (form $= 0, 1, -1, 2, -2, \dots$) is satisfied, where d is the distance between slits in the grating, λ is the wavelength of light, and m is the order of the maximum

constructive interference for a double slit | the path length difference must be an integral multiple of the wavelength

contact angle | the angle θ between the tangent to the liquid surface and the surface

contrast | the difference in intensity between objects and the background on which they are observed

convection | heat transfer by the macroscopic movement of fluid

converging lens | a convex lens in which light rays that enter it parallel to its axis converge at a single point on the opposite side

converging mirror | a concave mirror in which light rays that strike it parallel to its axis converge at one or more points along the axis

conversion factor | a ratio expressing how many of one unit are equal to another unit

Coriolis force | the fictitious force causing the apparent deflection of moving objects when viewed in a rotating frame of reference

corner reflector | an object consisting of two mutually perpendicular reflecting surfaces, so that the light that enters is reflected back exactly parallel to the direction from which it came

correspondence principle | in the classical limit (large, slow-moving objects), quantum mechanics becomes the same as classical physics

Coulomb force | another term for the electrostatic force

Coulomb interaction | the interaction between two charged particles generated by the Coulomb forces they exert on one another

Coulomb's law | the mathematical equation calculating the electrostatic force vector between two charged particles

critical angle | incident angle that produces an angle of refraction of 90°

critical damping | the 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

critical mass | minimum amount necessary for self-sustained fission of a given nuclide

critical point | the temperature above which a liquid cannot exist

critical pressure | the minimum pressure needed for a liquid to exist at the critical temperature

critical temperature | the temperature above which a liquid cannot exist

criticality | condition in which a chain reaction easily becomes self-sustaining

curie | the activity of 1g of ^{226}Ra , equal to $3.70 \times 10^{10}\text{Bq}$

Curie temperature | the temperature above which a ferromagnetic material cannot be magnetized

current | the flow of charge through an electric circuit past a given point of measurement

current sensitivity | the maximum current that a galvanometer can read

cyclical process | a process in which the path returns to its original state at the end of every cycle

cyclotron | accelerator that uses fixed-frequency alternating electric fields and fixed magnets to accelerate particles in a circular spiral path

Dalton's law of partial pressures | the physical law that states that the total pressure of a gas is the sum of partial pressures of the component gases

daughter | the nucleus obtained when parent nucleus decays and produces another nucleus following the rules and the conservation laws

de Broglie wavelength | the wavelength possessed by a particle of matter, calculated by $\lambda = h/p$

decay | the process by which an atomic nucleus of an unstable atom loses mass and energy by emitting ionizing particles

decay constant | quantity that is inversely proportional to the half-life and that is used in equation for number of nuclei as a function of time

decay equation | the equation to find out how much of a radioactive material is left after a given period of time

decay series | process whereby subsequent nuclides decay until a stable nuclide is produced

deceleration | acceleration in the direction opposite to velocity; acceleration that results in a decrease in velocity

defibrillator | a machine used to provide an electrical shock to a heart attack victim's heart in order to restore the heart's normal rhythmic pattern

deformation | displacement from equilibrium

deformation | change in shape due to the application of force

degree Celsius | unit on the Celsius temperature scale

degree Fahrenheit | unit on the Fahrenheit temperature scale

density | the mass per unit volume of a substance or object

dependent variable | the variable that is being measured; usually plotted along the y-axis

derived units | units that can be calculated using algebraic combinations of the fundamental units

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

destructive interference for a double slit | the path length difference must be a half-integral multiple of the wavelength

destructive interference for a single slit | occurs when $D \sin \theta = m\lambda$, (form = 1, -1, 2, -2, 3, ...), where D is the slit width, λ is the light's wavelength, θ is the angle relative to the original direction of the light, and m is the order of the minimum

dew point | the temperature at which relative humidity is 100%; the temperature at which water starts to condense out of the air

dialysis | the transport of any molecule other than water through a semipermeable membrane from a region of high concentration to one of low concentration

diastolic pressure | the minimum blood pressure in the artery

diastolic pressure | minimum arterial blood pressure; indicator for the fluid balance

dielectric | an insulating material

dielectric strength | the maximum electric field above which an insulating material begins to break down and conduct

diffraction | the bending of a wave around the edges of an opening or an obstacle

diffraction grating | a large number of evenly spaced parallel slits

diffusion | the movement of substances due to random thermal molecular motion

digital meter | a measuring instrument that gives a readout in a digital form

dipole | a molecule's lack of symmetrical charge distribution, causing one side to be more positive and another to be more negative

direct current | (DC) the flow of electric charge in only one direction

direction (of a vector) | the orientation of a vector in space

direction of magnetic field lines | the direction that the north end of a compass needle points

direction of polarization | the direction parallel to the electric field for EM waves

dispersion | spreading of white light into its full spectrum of wavelengths

displacement | the change in position of an object

distance | the magnitude of displacement between two positions

distance traveled | the total length of the path traveled between two positions

diverging lens | a concave lens in which light rays that enter it parallel to its axis bend away (diverge) from its axis

diverging mirror | a convex mirror in which light rays that strike it parallel to its axis bend away (diverge) from its axis

domains | regions within a material that behave like small bar magnets

Doppler effect | an alteration in the observed frequency of a sound due to motion of either the source or the observer

Doppler shift | the actual change in frequency due to relative motion of source and observer

Doppler-shifted ultrasound | a medical technique to detect motion and determine velocity through the Doppler shift of an echo

double-slit interference | an experiment in which waves or particles from a single source impinge upon two slits so that the resulting interference pattern may be observed

down | the second-lightest of all quarks

drag force |

F_D , found to be proportional to the square of the speed of the object; mathematically $F_D \propto v^2$ $F_D = 1/2 C_p A v^2$,

where C is the drag coefficient, A is the area of the object facing the fluid, and ρ is the density of the fluid

drift velocity | the average velocity at which free charges flow in response to an electric field

dynamic equilibrium | a state of equilibrium in which the net external force and torque on a system moving with constant velocity are zero

dynamics | the study of how forces affect the motion of objects and systems

eddy current | a current loop in a conductor caused by motional emf

efficiency | a measure of the effectiveness of the input of energy to do work; useful energy or work divided by the total input of energy

elapsed time | the difference between the ending time and beginning time

elastic collision | a collision that also conserves internal kinetic energy

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

electric charge | a physical property of an object that causes it to be attracted toward or repelled from another charged object; each charged object generates and is influenced by a force called an electromagnetic force

electric current | the rate at which charge flows, $I = \Delta Q / \Delta t$

electric field | a three-dimensional map of the electric force extended out into space from a point charge

electric field | a vector quantity (E); the lines of electric force per unit charge, moving radially outward from a positive charge and in toward a negative charge

electric field lines | a series of lines drawn from a point charge representing the magnitude and direction of force exerted by that charge

electric field lines | a pattern of imaginary lines that extend between an electric source and charged objects in the surrounding area, with arrows pointed away from positively charged objects and toward negatively charged objects. The more lines in the pattern, the stronger the electric field in that region

electric field strength | the magnitude of the electric field, denoted E -field

electric generator | a device for converting mechanical work into electric energy; it induces an emf by rotating a coil in a magnetic field

electric potential | potential energy per unit charge

electric power | the rate at which electrical energy is supplied by a source or dissipated by a device; it is the product of current times voltage

electrical energy | the energy carried by a flow of charge

electrocardiogram (ECG) | usually abbreviated ECG, a record of voltages created by depolarization and repolarization, especially in the heart

electromagnet | an object that is temporarily magnetic when an electrical current is passed through it

electromagnetic force | one of the four fundamental forces of nature; the electromagnetic force consists of static electricity, moving electricity and magnetism

electromagnetic induction | the process of inducing an emf (voltage) with a change in magnetic flux

electromagnetic spectrum | the full range of wavelengths or frequencies of electromagnetic radiation

electromagnetic waves | radiation in the form of waves of electric and magnetic energy

electromagnetism | the use of electrical currents to induce magnetism

electromotive force (emf) | the potential difference of a source of electricity when no current is flowing; measured in volts

electromotive force (emf) | energy produced per unit charge, drawn from a source that produces an electrical current

electron | a particle orbiting the nucleus of an atom and carrying the smallest unit of negative charge

electron capture | the process in which a proton-rich nuclide absorbs an inner atomic electron and simultaneously emits a neutrino

electron capture equation | equation representing the electron capture

electron family number | the number ± 1 that is assigned to all members of the electron family, or the number 0 that is assigned to all particles not in the electron family

electron volt | the energy given to a fundamental charge accelerated through a potential difference of one volt

electron's antineutrino | antiparticle of electron's neutrino

electron's neutrino | a subatomic elementary particle which has no net electric charge

electrostatic equilibrium | an electrostatically balanced state in which all free electrical charges have stopped moving about

electrostatic force | the amount and direction of attraction or repulsion between two charged bodies

electrostatic precipitators | filters that apply charges to particles in the air, then attract those charges to a filter, removing them from the airstream

electrostatic repulsion | the phenomenon of two objects with like charges repelling each other

electrostatics | the study of electric forces that are static or slow-moving

electroweak theory | theory showing connections between EM and weak forces

emf induced in a generator coil | $\text{emf} = NAB\omega \sin \omega t$, where A is the area of an N -turn coil rotated at a constant angular velocity ω in a uniform magnetic field B , over a period of time t

emissivity | measure of how well an object radiates

energies of hydrogen-like atoms | Bohr formula for energies of electron states in hydrogen-like atoms: $E_n = -Z^2 n^2 E_0$ ($n=1, 2, 3, \dots$)

energy | the ability to do work

energy stored in an inductor | self-explanatory; calculated by $E_{\text{ind}} = \frac{1}{2} LI^2$

energy-level diagram | a diagram used to analyze the energy level of electrons in the orbits of an atom

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

entropy | a measurement of a system's disorder and its inability to do work in a system

equipotential line | a line along which the electric potential is constant

external force | a force acting on an object or system that originates outside of the object or system

extremely low frequency (ELF) | electromagnetic radiation with wavelengths usually in the range of 0 to 300 Hz, but also about 1 kHz

eyepiece | the lens or combination of lenses in an optical instrument nearest to the eye of the observer

Fahrenheit scale | temperature scale in which the freezing point of water is 32 °F and the boiling point of water is 212 °F

far point | the object point imaged by the eye onto the retina in an unaccommodated eye

Faraday cage | a metal shield which prevents electric charge from penetrating its surface

Faraday's law of induction | the means of calculating the emf in a coil due to changing magnetic flux, given by $\text{emf} = -N \Delta \Phi / \Delta t$

farsightedness | another term for hyperopia, the condition of an eye where incoming rays of light reach the retina before they converge into a focused image

fermion | particle with a half-integer value of intrinsic spin

ferromagnetic | materials, such as iron, cobalt, nickel, and gadolinium, that exhibit strong magnetic effects

Feynman diagram | a graph of time versus position that describes the exchange of virtual particles between subatomic particles

fiber optics | transmission of light down fibers of plastic or glass, applying the principle of total internal reflection

fictitious force | a force having no physical origin

field | a map of the amount and direction of a force acting on other objects, extending out into space

fine structure | the splitting of spectral lines of the hydrogen spectrum when the spectral lines are examined at very high resolution

first law of thermodynamics | states that the change in internal energy of a system equals the net heat transfer *into* the system minus the net work done *by* the system

first postulate of special relativity | the idea that the laws of physics are the same and can be stated in their simplest form in all inertial frames of reference

fission fragments | a daughter nuclei

flavors | quark type

flow rate | abbreviated Q , it is the volume V that flows past a particular point during a time t , or $Q = V/t$

fluid dynamics | the physics of fluids in motion

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

fluorescence | any process in which an atom or molecule, excited by a photon of a given energy, de-excites by emission of a lower-energy photon

focal length | distance from the center of a lens or curved mirror to its focal point

focal point | for a converging lens or mirror, the point at which converging light rays cross; for a diverging lens or mirror, the point from which diverging light rays appear to originate

food irradiation | treatment of food with ionizing radiation

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

force constant | a constant related to the rigidity of a system: the larger the force constant, the more rigid the system; the force constant is represented by k

force field | a region in which a test particle will experience a force

fossil fuels | oil, natural gas, and coal

free charge | an electrical charge (either positive or negative) which can move about separately from its base molecule

free electron | an electron that is free to move away from its atomic orbit

free radicals | ions with unstable oxygen- or hydrogen-containing molecules

free-body diagram | a sketch showing all of the external forces acting on an object or system; the system is represented by a dot, and the forces are represented by vectors extending outward from the dot

free-fall | the state of movement that results from gravitational force only

free-fall | a situation in which the only force acting on an object is the force due to gravity

frequency | number of events per unit of time

frequency | the number of complete wave cycles (up-down-up) passing a given point within one second (cycles/second)

frequency modulation (FM) | a method of placing information on electromagnetic waves by modulating the frequency of a carrier wave with an audio signal, producing a wave of constant amplitude but varying frequency

friction | a force past each other of objects that are touching; examples include rough surfaces and air resistance

friction | the force between surfaces that opposes one sliding on the other; friction changes mechanical energy into thermal energy

friction | a force that opposes relative motion or attempts at motion between systems in contact

full-scale deflection | the maximum deflection of a galvanometer needle, also known as current sensitivity; a galvanometer with a full-scale deflection of 50 μA size 12{"50" mA} {} has a maximum deflection of its needle when 50 μA size 12{"50" \mu A} {} flows through it

fundamental | the lowest-frequency resonance

fundamental frequency | the lowest frequency of a periodic waveform

fundamental particle | particle with no substructure

fundamental units | units that can only be expressed relative to the procedure used to measure them

galvanometer | an analog measuring device, denoted by G, that measures current flow using a needle deflection caused by a magnetic field force acting upon a current-carrying wire

gamma camera | another name for an Anger camera

gamma decay | type of radioactive decay in which an atomic nucleus emits a gamma particle

gamma ray | (γ -ray); extremely high frequency electromagnetic radiation emitted by the nucleus of an atom, either from natural nuclear decay or induced nuclear processes in nuclear reactors and weapons. The lower end of the γ -ray frequency range overlaps the upper end of the X-ray range, but γ rays can have the highest frequency of any electromagnetic radiation

gamma ray | also γ -ray; highest-energy photon in the EM spectrum

gamma rays | one of the types of rays emitted from the nucleus of an atom

gauge boson | particle that carries one of the four forces

gauge pressure | the pressure relative to atmospheric pressure

gauss | G, the unit of the magnetic field strength; 1 G=10⁻⁴T size 12{"1 G"="10" rSup { size 8{ - 4 } } "T} {}

Geiger tube | a very common radiation detector that usually gives an audio output

geometric optics | part of optics dealing with the ray aspect of light

glaucoma | condition caused by the buildup of fluid pressure in the eye

gluons | exchange particles, analogous to the exchange of photons that gives rise to the electromagnetic force between two charged particles

gluons | eight proposed particles which carry the strong force

grand unified theory | theory that shows unification of the strong and electroweak forces

gravitational constant | a proportionality factor used in the equation for Newton's universal law of gravitation; it is a universal constant—that is, it is thought to be the same everywhere in the universe

gravitational potential energy | the energy an object has due to its position in a gravitational field

gray (Gy) | the SI unit for radiation dose which is defined to be 1 Gy=1 J/kg=100 radsize

greenhouse effect | warming of the Earth that is due to gases such as carbon dioxide and methane that absorb infrared radiation from the Earth's surface and radiate it in all directions, thus sending a fraction of it back toward the surface of the Earth

grounded | when a conductor is connected to the Earth, allowing charge to freely flow to and from Earth's unlimited reservoir

grounded | connected to the ground with a conductor, so that charge flows freely to and from the Earth to the grounded object

grounding | fixing a conductor at zero volts by connecting it to the earth or ground

hadrons | particles that feel the strong nuclear force

half-life | the time in which there is a 50% chance that a nucleus will decay

Hall effect | the creation of voltage across a current-carrying conductor by a magnetic field

Hall emf | the electromotive force created by a current-carrying conductor by a magnetic field, $\epsilon = Blv$ size 12{\epsilon = ital "Blv"} {}

harmonics | the term used to refer collectively to the fundamental and its overtones

head (of a vector) | the end point of a vector; the location of the tip of the vector's arrowhead; also referred to as the "tip"

head-to-tail method | a method of adding vectors in which the tail of each vector is placed at the head of the previous vector

hearing | the perception of sound

heat | the spontaneous transfer of energy due to a temperature difference

heat engine | a machine that uses heat transfer to do work

heat of sublimation | the energy required to change a substance from the solid phase to the vapor phase

heat pump | a machine that generates heat transfer from cold to hot

Heisenberg's uncertainty principle | a fundamental limit to the precision with which pairs of quantities (momentum and position, and energy and time) can be measured

henry | the unit of inductance; 1H=1 Ω ·s

hertz | an SI unit denoting the frequency of an electromagnetic wave, in cycles per second

Higgs boson | a massive particle that, if observed, would give validity to the theory that carrier particles are identical under certain circumstances

high dose | a dose greater than 1 Sv (100 rem)

hologram | means *entire picture* (from the Greek word *holo*, as in holistic), because the image produced is three dimensional

holography | the process of producing holograms

Hooke's law | proportional relationship between the force F on a material and the deformation ΔL it causes, $F=k\Delta L$

horizontally polarized | the oscillations are in a horizontal plane

hormesis | a term used to describe generally favorable biological responses to low exposures of toxins or radiation

horsepower | an older non-SI unit of power, with 1 hp=746 W

hues | identity of a color as it relates specifically to the spectrum

human metabolism | conversion of food into heat transfer, work, and stored fat

Huygens's principle | every point on a wavefront is a source of wavelets that spread out in the forward direction at the same speed as the wave itself. The new wavefront is a line tangent to all of the wavelets

hydrogen spectrum wavelengths | the wavelengths of visible light from hydrogen; can be calculated by $\lambda = R(1/n_2^2 - 1/n_1^2)$ size 12{{\lambda } = R\left(\frac{1}{{n_2}^2} - \frac{1}{{n_1}^2} \right)} {} where $R = 1.097 \times 10^7 \text{ m}^{-1}$ size 12{R = 1.097 \times {10}^7 {\text{m}}^{-1}} {}

hydrogen-like atom | any atom with only a single electron

hyperopia | the condition of an eye where incoming rays of light reach the retina before they converge into a focused image

ideal angle | the angle at which a car can turn safely on a steep curve, which is in proportion to the ideal speed

ideal banking | the 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

ideal gas law | the physical law that relates the pressure and volume of a gas to the number of gas molecules or number of moles of gas and the temperature of the gas

ideal speed | the maximum safe speed at which a vehicle can turn on a curve without the aid of friction between the tire and the road

ignition | when a fusion reaction produces enough energy to be self-sustaining after external energy input is cut off

impedance | the AC analogue to resistance in a DC circuit; it is the combined effect of resistance, inductive reactance, and capacitive reactance in the form $Z = \sqrt{R^2 + (X_L - X_C)^2}$ size 12{Z = \sqrt {R^2 + {\left({X_L - X_C} \right)}^2}} {}

impulse | the average net external force times the time it acts; equal to the change in momentum

incoherent | waves have random phase relationships

independent variable | the variable that the dependent variable is measured with respect to; usually plotted along the xsize 12{x} {}-axis

index of refraction | for a material, the ratio of the speed of light in vacuum to that in the material

inductance | a property of a device describing how efficient it is at inducing emf in another device

induction | the process by which an electrically charged object brought near a neutral object creates a charge in that object

induction | (magnetic induction) the creation of emfs and hence currents by magnetic fields

inductive reactance | the opposition of an inductor to a change in current; calculated by $X_L = 2\pi fL$

inductor | a device that exhibits significant self-inductance

inelastic collision | a collision in which internal kinetic energy is not conserved

inertia | the tendency of an object to remain at rest or remain in motion

inertial confinement | a technique that aims multiple lasers at tiny fuel pellets evaporating and crushing them to high density

inertial frame of reference | a coordinate system that is not accelerating; all forces acting in an inertial frame of reference are real forces, as opposed to fictitious forces that are observed due to an accelerating frame of reference

inertial frame of reference | a reference frame in which a body at rest remains at rest and a body in motion moves at a constant speed in a straight line unless acted on by an outside force

infrared radiation | photons with energies slightly less than red light

infrared radiation (IR) | a region of the electromagnetic spectrum with a frequency range that extends from just below the red region of the visible light spectrum up to the microwave region, or from 0.74 μm to 300 μm

infrasound | sounds below 20 Hz

ink-jet printer | small ink droplets sprayed with an electric charge are controlled by electrostatic plates to create images on paper

instantaneous acceleration | acceleration at a specific point in time

instantaneous speed | magnitude of the instantaneous velocity

instantaneous velocity | velocity at a specific instant, or the average velocity over an infinitesimal time interval

insulator | a material that holds electrons securely within their atomic orbits

intensity | power per unit area

intensity | the power per unit area carried by a wave

intensity | the power of an electric or magnetic field per unit area, for example, Watts per square meter

intensity reflection coefficient | a measure of the ratio of the intensity of the wave reflected off a boundary between two media relative to the intensity of the incident wave

interference microscopes | microscopes that enhance contrast between objects and background by superimposing a reference beam of light upon the light emerging from the sample

internal energy | the sum of the kinetic and potential energies of a system's atoms and molecules

internal kinetic energy | the sum of the kinetic energies of the objects in a system

internal resistance | the amount of resistance within the voltage source

intraocular pressure | fluid pressure in the eye

intrinsic magnetic field | the magnetic field generated due to the intrinsic spin of electrons

intrinsic spin | the internal or intrinsic angular momentum of electrons

ionizing radiation | radiation that ionizes materials that absorb it

ionizing radiation | radiation (whether nuclear in origin or not) that produces ionization whether nuclear in origin or not

ionosphere | a layer of charged particles located around 100 km above the surface of Earth, which is responsible for a range of phenomena including the electric field surrounding Earth

irreversible process | any process that depends on path direction

isobaric process | constant-pressure process in which a gas does work

isochoric process | a constant-volume process

isolated system | a system in which the net external force is zero

isothermal process | a constant-temperature process

isotopes | nuclei having the same Z and different N s

joule | SI unit of work and energy, equal to one newton-meter

Joule's law | the relationship between potential electrical power, voltage, and resistance in an electrical circuit, given by: $P = IV$

junction rule | Kirchhoff's first rule, which applies the conservation of charge to a junction; current is the flow of charge; thus, whatever charge flows into the junction must flow out; the rule can be stated $I_1 = I_2 + I_3$

Kelvin scale | temperature scale in which 0 K is the lowest possible temperature, representing absolute zero

kilocalorie | 1 kilocalorie = 1000 calories

kilogram | the SI unit for mass, abbreviated (kg)

kilowatt-hour | (kW·h) unit used primarily for electrical energy provided by electric utility companies

kinematics | the study of motion without considering its causes

kinematics | the study of motion without regard to mass or force

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

kinetic energy | the energy an object has by reason of its motion, equal to $\frac{1}{2}mv^2$ for the translational (i.e., non-rotational) motion of an object of mass m moving at speed v

kinetic friction | a force that opposes the motion of two systems that are in contact and moving relative to one another

Kirchhoff's rules | a set of two rules, based on conservation of charge and energy, governing current and changes in potential in an electric circuit

laminar | a type of fluid flow in which layers do not mix

laser | acronym for light amplification by stimulated emission of radiation

laser printer | uses a laser to create a photoconductive image on a drum, which attracts dry ink particles that are then rolled onto a sheet of paper to print a high-quality copy of the image

laser vision correction | a medical procedure used to correct astigmatism and eyesight deficiencies such as myopia and hyperopia

latent heat coefficient | a physical constant equal to the amount of heat transferred for every 1 kg of a substance during the change in phase of the substance

law | a description, using concise language or a mathematical formula, a generalized pattern in nature that is supported by scientific evidence and repeated experiments

law of conservation of angular momentum | angular momentum is conserved, i.e., the initial angular momentum is equal to the final angular momentum when no external torque is applied to the system

law of conservation of charge | states that whenever a charge is created, an equal amount of charge with the opposite sign is created simultaneously

law of conservation of energy | the general law that total energy is constant in any process; energy may change in form or be transferred from one system to another, but the total remains the same

law of inertia | see Newton's first law of motion

law of reflection | angle of reflection equals the angle of incidence

law of reflection | angle of reflection equals the angle of incidence

length contraction | L , the shortening of the measured length of an object moving relative to the observer's frame: $L = L_0 \sqrt{1 - v^2/c^2}$

Lenz's law | the minus sign in Faraday's law, signifying that the emf induced in a coil opposes the change in magnetic flux

leptons | particles that do not feel the strong nuclear force

linear accelerator | accelerator that accelerates particles in a straight line

linear hypothesis | assumption that risk is directly proportional to risk from high doses

linear momentum | the product of mass and velocity

liquid drop model | a model of nucleus (only to understand some of its features) in which nucleons in a nucleus act like atoms in a drop

liter | a unit of volume, equal to 10^{-3} m^3

longitudinal wave | a wave in which the disturbance is parallel to the direction of propagation

loop rule | Kirchhoff's second rule, which states that in a closed loop, whatever energy is supplied by emf must be transferred into other forms by devices in the loop, since there are no other ways in which energy can be transferred into or out of the circuit. Thus, the emf equals the sum of the IRs (voltage) drops in the loop and can be stated: $\text{emf} = I r_1 + I r_2 + \dots + I r_n$

Lorentz force | the force on a charge moving in a magnetic field

loudness | the perception of sound intensity

low dose | a dose less than 100 mSv (10 rem)

macrostate | an overall property of a system

magic numbers | a number that indicates a shell structure for the nucleus in which closed shells are more stable

magnetic confinement | a technique in which charged particles are trapped in a small region because of difficulty in crossing magnetic field lines

magnetic damping | the drag produced by eddy currents

magnetic field | the representation of magnetic forces

magnetic field | a vector quantity (B); can be used to determine the magnetic force on a moving charged particle

magnetic field lines | the pictorial representation of the strength and the direction of a magnetic field

magnetic field lines | a pattern of continuous, imaginary lines that emerge from and enter into opposite magnetic poles. The density of the lines indicates the magnitude of the magnetic field

magnetic field strength | the magnitude of the magnetic field, denoted B -field

magnetic field strength (magnitude) produced by a long straight current-carrying wire | defined as $B = \mu_0 I / 2\pi r$, where I is the current, r is the shortest distance to the wire, and μ_0 is the permeability of free space

magnetic field strength at the center of a circular loop | defined as $B = \mu_0 I / 2R$ where R is the radius of the loop

magnetic field strength inside a solenoid | defined as $B = \mu_0 n I$ where n is the number of loops per unit length of the solenoid ($n = N/L$, with N being the number of loops and L the length)

magnetic flux | the amount of magnetic field going through a particular area, calculated with $\Phi = B A \cos \theta$ where B is the magnetic field strength over an area A at an angle θ with the perpendicular to the area

magnetic force | the force on a charge produced by its motion through a magnetic field; the Lorentz force

magnetic monopoles | an isolated magnetic pole; a south pole without a north pole, or vice versa (no magnetic monopole has ever been observed)

magnetic resonance imaging (MRI) | a medical imaging technique that uses magnetic fields create detailed images of internal tissues and organs

magnetized | to be turned into a magnet; to be induced to be magnetic

magnetocardiogram (MCG) | a recording of the heart's magnetic field as it beats

magnetoencephalogram (MEG) | a measurement of the brain's magnetic field

magnification | ratio of image height to object height

magnitude (of a vector) | the length or size of a vector; magnitude is a scalar quantity

magnitude of kinetic friction | $f_k = \mu_k N$, where μ_k is the coefficient of kinetic friction

magnitude of static friction | $f_s \leq \mu_s N$, where μ_s is the coefficient of static friction and N is the magnitude of the normal force

magnitude of the intrinsic (internal) spin angular momentum | given by $S = s(s+1) \hbar$

mass | the quantity of matter in a substance; measured in kilograms

mass number | number of nucleons in a nucleus

maximum field strength | the maximum amplitude an electromagnetic wave can reach, representing the maximum amount of electric force and/or magnetic flux that the wave can exert

Maxwell's equations | a set of four equations that describe electromagnetic phenomena

Maxwell's equations | a set of four equations that comprise a complete, overarching theory of electromagnetism

mechanical advantage | the ratio of output to input forces for any simple machine

mechanical energy | the sum of kinetic energy and potential energy

mechanical energy | sum of the kinetic energy and potential energy of a system; this sum is a constant

mechanical equivalent of heat | the work needed to produce the same effects as heat transfer

meson | particle whose mass is intermediate between the electron and nucleon masses

meson | hadrons that can decay to leptons and leave no hadrons

metabolic rate | the rate at which the body uses food energy to sustain life and to do different activities

metastable | a state whose lifetime is an order of magnitude longer than the most short-lived states

meter | the SI unit for length, abbreviated (m)

meter | common application of magnetic torque on a current-carrying loop that is very similar in construction to a motor; by design, the torque is proportional to I and not θ , so the needle deflection is proportional to the current

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

metric system | a system in which values can be calculated in factors of 10

Michelson-Morley experiment | an investigation performed in 1887 that proved that the speed of light in a vacuum is the same in all frames of reference from which it is viewed

microgravity | an environment in which the apparent net acceleration of a body is small compared with that produced by Earth at its surface

microshock sensitive | a condition in which a person's skin resistance is bypassed, possibly by a medical procedure, rendering the person vulnerable to electrical shock at currents about 1/1000 the normally required level

microstate | each sequence within a larger macrostate

microwaves | electromagnetic waves with wavelengths in the range from 1 mm to 1 m; they can be produced by currents in macroscopic circuits and devices

microwaves | photons with wavelengths on the order of a micron (μm)

micturition reflex | stimulates the feeling of needing to urinate, triggered by bladder pressure

mirror | smooth surface that reflects light at specific angles, forming an image of the person or object in front of it

model | representation of something that is often too difficult (or impossible) to display directly

model | simplified description that contains only those elements necessary to describe the physics of a physical situation

moderate dose | a dose from 0.1 Sv to 1 Sv (10 to 100 rem)

modern physics | the study of relativity, quantum mechanics, or both

mole | the quantity of a substance whose mass (in grams) is equal to its molecular mass

moment of inertia | mass times the square of perpendicular distance from the rotation axis; for a point mass, it is $I = mr^2$ and, because any object can be built up from a collection of point masses, this relationship is the basis for all other moments of inertia

motion | displacement of an object as a function of time

motor | loop of wire in a magnetic field; when current is passed through the loops, the magnetic field exerts torque on the loops, which rotates a shaft; electrical energy is converted to mechanical work in the process

muon family number | the number ± 1 that is assigned to all members of the muon family, or the number 0 that is assigned to all particles not in the muon family

mutual inductance | how effective a pair of devices are at inducing emfs in each other

myopia | a visual defect in which distant objects appear blurred because their images are focused in front of the retina rather than being focused on the retina

natural frequency | the frequency at which a system would oscillate if there were no driving and no damping forces

near point | the point nearest the eye at which an object is accurately focused on the retina at full accommodation

nearsightedness | another term for myopia, a visual defect in which distant objects appear blurred because their images are focused in front of the retina rather than being focused on the retina

nerve conduction | the transport of electrical signals by nerve cells

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

net rate of heat transfer by radiation | is $Q_{\text{net}} = \sigma \epsilon A (T_4 - T_1)$

net work | work done by the net force, or vector sum of all the forces, acting on an object

neutral equilibrium | a state of equilibrium that is independent of a system's displacements from its original position

neutrino | an electrically neutral, weakly interacting elementary subatomic particle

neutron | a neutral particle that is found in a nucleus

neutron-induced fission | fission that is initiated after the absorption of neutron

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

Newton's second law of motion | the net external force F_{net} on an object with mass m is proportional to and in the same direction as the acceleration of the object, a , and inversely proportional to the mass; defined mathematically as $a = F_{\text{net}} / m$

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 the first body exerts

Newton's universal law of gravitation | every particle in the universe attracts every other particle with a force along a line joining them; the force is directly proportional to the product of their masses and inversely proportional to the square of the distance between them

node | point of zero displacement

nodes | the points where the string does not move; more generally, nodes are where the wave disturbance is zero in a standing wave

non-inertial frame of reference | an accelerated frame of reference

nonconservative force | a force whose work depends on the path followed between the given initial and final configurations

normal force | the force that a surface applies to an object to support the weight of the object; acts perpendicular to the surface on which the object rests

north magnetic pole | the end or the side of a magnet that is attracted toward Earth's geographic north pole

note | basic unit of music with specific names, combined to generate tunes

nuclear energy | energy released by changes within atomic nuclei, such as the fusion of two light nuclei or the fission of a heavy nucleus

nuclear fission | reaction in which a nucleus splits

nuclear fusion | a reaction in which two nuclei are combined, or fused, to form a larger nucleus

nuclear magnetic resonance (NMR) | a phenomenon in which an externally applied magnetic field interacts with the nuclei of certain atoms

nuclear radiation | rays that originate in the nuclei of atoms, the first examples of which were discovered by Becquerel

nuclear reaction energy | the energy created in a nuclear reaction

nucleons | the particles found inside nuclei

nucleus | a region consisting of protons and neutrons at the center of an atom

nuclide | a type of atom whose nucleus has specific numbers of protons and neutrons

null measurements | methods of measuring current and voltage more accurately by balancing the circuit so that no current flows through the measurement device

numerical aperture | a number or measure that expresses the ability of a lens to resolve fine detail in an object being observed. Derived by mathematical formula $NA = n \sin \alpha$, where n is the refractive index of the medium between the lens and the specimen and α is the half-angle of the maximum cone of light that can enter or exit the lens.

objective lens | the lens nearest to the object being examined

ohm | the unit of resistance, given by $1\Omega = 1\text{ V/A}$

ohmic | a type of a material for which Ohm's law is valid

ohmmeter | an instrument that applies a voltage to a resistance, measures the current, calculates the resistance using Ohm's law, and provides a readout of this calculated resistance

Ohm's law | an empirical relation stating that the current I is proportional to the potential difference V , αV ; it is often written as $I = V/R$, where R is the resistance

Ohm's law | the relationship between current, voltage, and resistance within an electrical circuit: $V = IR$

optically active | substances that rotate the plane of polarization of light passing through them

orbital angular momentum | an angular momentum that corresponds to the quantum analog of classical angular momentum

orbital magnetic field | the magnetic field generated due to the orbital motion of electrons

order | the integer m used in the equations for constructive and destructive interference for a double slit

order of magnitude | refers to the size of a quantity as it relates to a power of 10

oscillate | moving back and forth regularly between two points

oscillate | to fluctuate back and forth in a steady beat

osmosis | the transport of water through a semipermeable membrane from a region of high concentration to one of low concentration

osmotic pressure | the back pressure which stops the osmotic process if one solution is pure water

Otto cycle | a thermodynamic cycle, consisting of a pair of adiabatic processes and a pair of isochoric processes, that converts heat into work, e.g., the four-stroke engine cycle of intake, compression, ignition, and exhaust

over damping | the 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

overtones | multiples of the fundamental frequency of a sound

overtones | all resonant frequencies higher than the fundamental

parallel | the wiring of resistors or other components in an electrical circuit such that each component receives an equal voltage from the power source; often pictured in a ladder-shaped diagram, with each component on a rung of the ladder

parallel plate capacitor | two identical conducting plates separated by a distance

parent | the original state of nucleus before decay

partial pressure | the pressure a gas would create if it occupied the total volume of space available

particle physics | the study of and the quest for those truly fundamental particles having no substructure

particle-wave duality | the property of behaving like either a particle or a wave; the term for the phenomenon that all particles have wave characteristics

Pascal's Principle | a change in pressure applied to an enclosed fluid is transmitted undiminished to all portions of the fluid and to the walls of its container

Pauli exclusion principle | a principle that states that no two electrons can have the same set of quantum numbers; that is, no two electrons can be in the same state

peak emf | $\text{emf}_0 = NAB\omega$

percent relative humidity | the ratio of vapor density to saturation vapor density

percent uncertainty | the ratio of the uncertainty of a measurement to the measured value, expressed as a percentage

perfectly inelastic collision | a collision in which the colliding objects stick together

period | time it takes to complete one oscillation

periodic motion | motion that repeats itself at regular time intervals

permeability of free space | the measure of the ability of a material, in this case free space, to support a magnetic field; the constant $\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$

perpendicular lever arm | the shortest distance from the pivot point to the line along which F lies

phase angle | denoted by ϕ , the amount by which the voltage and current are out of phase with each other in a circuit

phase diagram | a graph of pressure vs. temperature of a particular substance, showing at which pressures and temperatures the three phases of the substance occur

phase-contrast microscope | microscope utilizing wave interference and differences in phases to enhance contrast

phon | the numerical unit of loudness

phosphorescence | the de-excitation of a metastable state

photoconductor | a substance that is an insulator until it is exposed to light, when it becomes a conductor

photoelectric effect | the phenomenon whereby some materials eject electrons when light is shined on them

photomultiplier | a device that converts light into electrical signals

photon | a quantum, or particle, of electromagnetic radiation

photon energy | the amount of energy a photon has; $E = hf$

photon momentum | the amount of momentum a photon has, calculated by $p = h\lambda = E/c$

physical quantity | a characteristic or property of an object that can be measured or calculated from other measurements

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

pion | particle exchanged between nucleons, transmitting the force between them

pit | a tiny indentation on the spiral track moulded into the top of the polycarbonate layer of CD

pitch | the perception of the frequency of a sound

Planck's constant | $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$

planetary model of the atom | the most familiar model or illustration of the structure of the atom

point charge | A charged particle, designated Q , generating an electric field

point masses | structureless particles with no rotation or spin

Poiseuille's law | the rate of laminar flow of an incompressible fluid in a tube: $Q = (P_2 - P_1)\pi r^4 / 8\eta l$

Poiseuille's law for resistance | the resistance to laminar flow of an incompressible fluid in a tube: $R = 8\eta l / \pi r^4$

polar molecule | a molecule with an asymmetrical distribution of positive and negative charge

polar molecule | a molecule with inherent separation of charge

polarization | slight shifting of positive and negative charges to opposite sides of an atom or molecule

polarization | the attribute that wave oscillations have a definite direction relative to the direction of propagation of the wave

polarization microscope | microscope that enhances contrast by utilizing a wave characteristic of light, useful for objects that are optically active

polarized | a state in which the positive and negative charges within an object have collected in separate locations

polarized | waves having the electric and magnetic field oscillations in a definite direction

population inversion | the condition in which the majority of atoms in a sample are in a metastable state

position | the location of an object at a particular time

positron | the particle that results from positive beta decay; also known as an antielectron

positron decay | type of beta decay in which a proton is converted to a neutron, releasing a positron and a neutrino

positron emission tomography (PET) | tomography technique that uses β^+ emitters and detects the two annihilation γ rays, aiding in source localization

potential difference | the difference in electric potential between two points in an electric circuit, measured in volts

potential difference (or voltage) | change in potential energy of a charge moved from one point to another, divided by the charge; units of potential difference are joules per coulomb, known as volt

potential energy | energy due to position, shape, or configuration

potential energy of a spring | the stored energy of a spring as a function of its displacement; when Hooke's law applies, it is given by the expression $1/2kx^2$ where x is the distance the spring is compressed or extended and k is the spring constant

potentiometer | a null measurement device for measuring potentials (voltages)

power | the rate at which work is done

power | inverse of focal length

power factor | the amount by which the power delivered in the circuit is less than the theoretical maximum of the circuit due to voltage and current being out of phase; calculated by $\cos\phi$

precision | the degree to which repeated measurements agree with each other

presbyopia | a condition in which the lens of the eye becomes progressively unable to focus on objects close to the viewer

pressure | the force per unit area perpendicular to the force, over which the force acts

pressure | the weight of the fluid divided by the area supporting it

probability distribution | the overall spatial distribution of probabilities to find a particle at a given location

projectile | an object that travels through the air and experiences only acceleration due to gravity

projectile motion | the motion of an object that is subject only to the acceleration of gravity

proper length | L_0 , the distance between two points measured by an observer who is at rest relative to both of the points; Earth-bound observers measure proper length when measuring the distance between two points that are stationary relative to the Earth

proper time | Δt_0 , the time measured by an observer at rest relative to the event being observed: $\Delta t = \Delta t_0 \sqrt{1 - v^2/c^2} = \gamma \Delta t_0$, where $\gamma = 1/\sqrt{1 - v^2/c^2}$

proton | a particle in the nucleus of an atom and carrying a positive charge equal in magnitude and opposite in sign to the amount of negative charge carried by an electron

proton-proton cycle | the combined reactions $^1\text{H} + ^1\text{H} \rightarrow ^2\text{H} + e^+ + \nu_e$, $^1\text{H} + ^2\text{H} \rightarrow ^3\text{He} + \gamma$, and $^3\text{He} + ^3\text{He} \rightarrow ^4\text{He} + ^1\text{H} + ^1\text{H}$

protons | the positively charged nucleons found in a nucleus

PV diagram | a graph of pressure vs. volume

quality factor | same as relative biological effectiveness

quantized | the fact that certain physical entities exist only with particular discrete values and not every conceivable value

quantum chromodynamics | quark theory including color

quantum chromodynamics | the governing theory of connecting quantum number color to gluons

quantum electrodynamics | the theory of electromagnetism on the particle scale

quantum mechanical tunneling | quantum mechanical effect whereby a particle has a nonzero probability to cross through a potential energy barrier despite not having sufficient energy to pass over the barrier; also called barrier penetration

quantum mechanics | the study of objects smaller than can be seen with a microscope

quantum mechanics | the branch of physics that deals with small objects and with the quantization of various entities, especially energy

quantum numbers | the values of quantized entities, such as energy and angular momentum

quark | fundamental constituent of matter and an elementary particle

quark | an elementary particle and a fundamental constituent of matter

R factor | the ratio of thickness to the conductivity of a material

rad | the ionizing energy deposited per kilogram of tissue

radar | a common application of microwaves. Radar can determine the distance to objects as diverse as clouds and aircraft, as well as determine the speed of a car or the intensity of a rainstorm

radians | a unit of angle measurement

radiant energy | the energy carried by electromagnetic waves

radiation | heat transfer which occurs when microwaves, infrared radiation, visible light, or other electromagnetic radiation is emitted or absorbed

radiation | energy transferred by electromagnetic waves directly as a result of a temperature difference

radiation detector | a device that is used to detect and track the radiation from a radioactive reaction

radio waves | electromagnetic waves with wavelengths in the range from 1 mm to 100 km; they are produced by currents in wires and circuits and by astronomical phenomena

radioactive | a substance or object that emits nuclear radiation

radioactive dating | an application of radioactive decay in which the age of a material is determined by the amount of radioactivity of a particular type that occurs

radioactivity | the emission of rays from the nuclei of atoms

radiolytic products | compounds produced due to chemical reactions of free radicals

radiopharmaceutical | compound used for medical imaging

radiotherapy | the use of ionizing radiation to treat ailments

radius of a nucleus | the radius of a nucleus is $r = r_0 A^{1/3}$

radius of curvature | radius of a circular path

rainbow | dispersion of sunlight into a continuous distribution of colors according to wavelength, produced by the refraction and reflection of sunlight by water droplets in the sky

range | the maximum horizontal distance that a projectile travels

range of radiation | the distance that the radiation can travel through a material

rate of conductive heat transfer | rate of heat transfer from one material to another

rate of decay | the number of radioactive events per unit time

ray | straight line that originates at some point

Rayleigh criterion | two images are just resolvable when the center of the diffraction pattern of one is directly over the first minimum of the diffraction pattern of the other

RC circuit | a circuit that contains both a resistor and a capacitor

real image | image that can be projected

reflected light that is completely polarized | light reflected at the angle of reflection θ_b , known as Brewster's angle

refraction | changing of a light ray's direction when it passes through variations in matter

relative biological effectiveness (RBE) | a number that expresses the relative amount of damage that a fixed amount of ionizing radiation of a given type can inflict on biological tissues

relative humidity | the amount of water in the air relative to the maximum amount the air can hold

relative osmotic pressure | the back pressure which stops the osmotic process if neither solution is pure water

relative velocity | the velocity of an object as observed from a particular reference frame

relativistic Doppler effects | a change in wavelength of radiation that is moving relative to the observer; the wavelength of the radiation is longer (called a red shift) than that emitted by the source when the source moves away from the observer and shorter (called a blue shift) when the source moves toward the observer; the shifted wavelength is described by the equation $\lambda_{\text{obs}} = \lambda_s \sqrt{1 + u/c} / \sqrt{1 - u/c}$ where λ_{obs} is the observed wavelength, λ_s is the source wavelength, and u is the velocity of the source to the observer

relativistic kinetic energy | the kinetic energy of an object moving at relativistic speeds: $K_{\text{rel}} = (\gamma - 1)mc^2$, where $\gamma = 1/\sqrt{1 - v^2/c^2}$

relativistic momentum | p , the momentum of an object moving at relativistic velocity; $p = \gamma mu$, where m is the rest mass of the object, u is its velocity relative to an observer, and the relativistic factor $\gamma = 1/\sqrt{1 - v^2/c^2}$

relativistic velocity addition | the method of adding velocities of an object moving at a relativistic speed: $u = (u' + v) / (1 + u'v/c^2)$, where v is the relative velocity between two observers, u is the velocity of an object relative to one observer, and u' is the velocity relative to the other observer

relativity | the study of objects moving at speeds greater than about 1% of the speed of light, or of objects being affected by a strong gravitational field

relativity | the study of how different observers moving relative to each other measure the same phenomenon

relativity | the study of how different observers measure the same event

renewable forms of energy | those sources that cannot be used up, such as water, wind, solar, and biomass

resistance | the electric property that impedes current; for ohmic materials, it is the ratio of voltage to current, $R = V/I$

resistance | causing a loss of electrical power in a circuit

resistivity | an intrinsic property of a material, independent of its shape or size, directly proportional to the resistance, denoted by ρ

resistor | a component that provides resistance to the current flowing through an electrical circuit

resonance | the phenomenon of driving a system with a frequency equal to the system's natural frequency

resonant | a system that displays enhanced oscillation when subjected to a periodic disturbance of the same frequency as its natural frequency

resonant frequency | the frequency at which the impedance in a circuit is at a minimum, and also the frequency at which the circuit would oscillate if not driven by a voltage source; calculated by $f_0 = 1/2\pi LC\sqrt{}$

resonate | a system being driven at its natural frequency

rest energy | the energy stored in an object at rest: $E_0 = mc^2$

rest mass | the mass of an object as measured by a person at rest relative to the object

restoring force | force acting in opposition to the force caused by a deformation

resultant | the sum of two or more vectors

resultant vector | the vector sum of two or more vectors

retinex | a theory proposed to explain color and brightness perception and constancies; is a combination of the words retina and cortex, which are the two areas responsible for the processing of visual information

retinex theory of color vision | the ability to perceive color in an ambient-colored environment

reverse dialysis | the process that occurs when back pressure is sufficient to reverse the normal direction of dialysis through membranes

reverse osmosis | the process that occurs when back pressure is sufficient to reverse the normal direction of osmosis through membranes

reversible process | a process in which both the heat engine system and the external environment theoretically can be returned to their original states

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

right hand rule 1 (RHR-1) | the rule to determine the direction of the magnetic force on a positive moving charge: when the thumb of the right hand points in the direction of the charge's velocity v and the fingers point in the direction of the magnetic field B , then the force on the charge is perpendicular and away from the palm; the force on a negative charge is perpendicular and into the palm

right hand rule 2 (RHR-2) | a rule to determine the direction of the magnetic field induced by a current-carrying wire: Point the thumb of the right hand in the direction of current, and the fingers curl in the direction of the magnetic field loops

right-hand rule | direction of angular velocity ω and angular momentum L in which the thumb of your right hand points when you curl your fingers in the direction of the disk's rotation

RLC circuit | an electric circuit that includes a resistor, capacitor and inductor

rms current | the root mean square of the current, $I_{rms} = I_0/\sqrt{2}$, where I_0 is the peak current, in an AC system

rms voltage | the root mean square of the voltage, $V_{rms} = V_0/\sqrt{2}$, where V_0 is the peak voltage, in an AC system

rods and cones | two types of photoreceptors in the human retina; rods are responsible for vision at low light levels, while cones are active at higher light levels

roentgen equivalent man (rem) | a dose unit more closely related to effects in biological tissue

rotation angle |

the ratio of the arc length to the radius of curvature on a circular path: $\Delta\theta = \Delta s/r$

rotational inertia | resistance to change of rotation. The more rotational inertia an object has, the harder it is to rotate

rotational kinetic energy | the kinetic energy due to the rotation of an object. This is part of its total kinetic energy

Rydberg constant | a physical constant related to the atomic spectra with an established value of $1.097 \times 10^7 \text{ m}^{-1}$

saturation | the condition of 100% relative humidity

scalar | a quantity that is described by magnitude, but not direction

scalar | a quantity with magnitude but no direction

scalar | physical quantity with magnitude but no direction

scientific method | a method that typically begins with an observation and question that the scientist will research; next, the scientist typically performs some research about the topic and then devises a hypothesis; then, the scientist will test the hypothesis by performing an experiment; finally, the scientist analyzes the results of the experiment and draws a conclusion

scintillators | a radiation detection method that records light produced when radiation interacts with materials

screening | the dilution or blocking of an electrostatic force on a charged object by the presence of other charges nearby

second | the SI unit for time, abbreviated (s)

second law of motion | physical law that states that the net external force equals the change in momentum of a system divided by the time over which it changes

second law of thermodynamics | heat transfer flows from a hotter to a cooler object, never the reverse, and some heat energy in any process is lost to available work in a cyclical process

second law of thermodynamics stated in terms of entropy | the total entropy of a system either increases or remains constant; it never decreases

second postulate of special relativity | the idea that the speed of light c is a constant, independent of the source

self-inductance | how effective a device is at inducing emf in itself

semipermeable | a type of membrane that allows only certain small molecules to pass through

semipermeable | property of a membrane that allows only certain types of ions to cross it

series | a sequence of resistors or other components wired into a circuit one after the other

shear deformation | deformation perpendicular to the original length of an object

shell | a probability cloud for electrons that has a single principal quantum number

shielding | a technique to limit radiation exposure

shock hazard | when electric current passes through a person

shock hazard | the term for electrical hazards due to current passing through a human

short circuit | also known as a "short," a low-resistance path between terminals of a voltage source

shunt resistance | a small resistance R_s placed in parallel with a galvanometer G to produce an ammeter; the larger the current to be measured, the smaller R_s must be; most of the current flowing through the meter is shunted through R_s to protect the galvanometer

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

SI units of torque | newton times meters, usually written as $\text{N}\cdot\text{m}$

sievert | the SI equivalent of the rem

significant figures | express the precision of a measuring tool used to measure a value

simple circuit | a circuit with a single voltage source and a single resistor

simple harmonic motion | the oscillatory motion in a system where the net force can be described by Hooke's law

simple harmonic oscillator | a device that implements Hooke's law, such as a mass that is attached to a spring, with the other end of the spring being connected to a rigid support such as a wall

simple pendulum | an object with a small mass suspended from a light wire or string

simplified theory of color vision | a theory that states that there are three primary colors, which correspond to the three types of cones

single-photon-emission computed tomography (SPECT) | tomography performed with γ -emitting radiopharmaceuticals

slope | the difference in y -value (the rise) divided by the difference in x -value (the run) of two points on a straight line

solenoid | a thin wire wound into a coil that produces a magnetic field when an electric current is passed through it

solid-state radiation detectors | semiconductors fabricated to directly convert incident radiation into electrical current

sonic boom | a constructive interference of sound created by an object moving faster than sound

sound | a disturbance of matter that is transmitted from its source outward

sound intensity level | a unitless quantity telling you the level of the sound relative to a fixed standard

sound pressure level | the ratio of the pressure amplitude to a reference pressure

south magnetic pole | the end or the side of a magnet that is attracted toward Earth's geographic south pole

space quantization | the fact that the orbital angular momentum can have only certain directions

special relativity | the theory that, in an inertial frame of reference, the motion of an object is relative to the frame from which it is viewed or measured

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

specific heat | the amount of heat necessary to change the temperature of 1.00 kg of a substance by 1.00 °C

speed of light | in a vacuum, such as space, the speed of light is a constant 3×10^8 m/s

spin projection quantum number | quantum number that can be used to calculate the intrinsic electron angular momentum along the z-axis

spin quantum number | the quantum number that parameterizes the intrinsic angular momentum (or spin angular momentum, or simply spin) of a given particle

stable equilibrium | a system, when displaced, experiences a net force or torque in a direction opposite to the direction of the displacement

standard model | combination of quantum chromodynamics and electroweak theory

standing wave | a wave that oscillates in place, with nodes where no motion happens

static electricity | a buildup of electric charge on the surface of an object

static equilibrium | a state of equilibrium in which the net external force and torque acting on a system is zero

static equilibrium | equilibrium in which the acceleration of the system is zero and accelerated rotation does not occur

static friction | a force opposes the motion of two systems that are in contact and are not moving relative to one another

statistical analysis | using statistics to examine data, such as counting microstates and macrostates

Stefan-Boltzmann law of radiation | $Q_t = \sigma e A T^4$, where σ is the Stefan-Boltzmann constant, A is the surface area of the object, T is the absolute temperature, and e is the emissivity

step-down transformer | a transformer that decreases voltage

step-up transformer | a transformer that increases voltage

stimulated emission | emission by atom or molecule in which an excited state is stimulated to decay, most readily caused by a photon of the same energy that is necessary to excite the state

Stokes' law | $F_s = 6\pi\eta r$, where r is the radius of the object, η is the viscosity of the fluid, and v is the object's velocity

strain | ratio of change in length to original length

strange | the third lightest of all quarks

strangeness | a physical quantity assigned to various particles based on decay systematics

stress | ratio of force to area

sublimation | the phase change from solid to gas

sublimation | the transition from the solid phase to the vapor phase

subshell | the probability cloud for electrons that has a single angular momentum quantum number l

supercriticality | an exponential increase in fissions

superposition | the phenomenon that occurs when two or more waves arrive at the same point

superstring theory | a theory of everything based on vibrating strings some 10^{-35} m in length

surface tension | the cohesive forces between molecules which cause the surface of a liquid to contract to the smallest possible surface area

synchrotron | a version of a cyclotron in which the frequency of the alternating voltage and the magnetic field strength are increased as the beam particles are accelerated

synchrotron radiation | radiation caused by a magnetic field accelerating a charged particle perpendicular to its velocity

system | defined by the boundaries of an object or collection of objects being observed; all forces originating from outside of the system are considered external forces

systolic pressure | the maximum blood pressure in the artery

systolic pressure | maximum arterial blood pressure; indicator for the blood flow

tagged | process of attaching a radioactive substance to a chemical compound

tail | the start point of a vector; opposite to the head or tip of the arrow

tangential acceleration | the acceleration in a direction tangent to the circle at the point of interest in circular motion

tau family number | the number ± 1 that is assigned to all members of the tau family, or the number 0 that is assigned to all particles not in the tau family

temperature | the quantity measured by a thermometer

temperature coefficient of resistivity | an empirical quantity, denoted by α , which describes the change in resistance or resistivity of a material with temperature

tensile strength | the breaking stress that will cause permanent deformation or fracture of a material

tension | the pulling force that acts along a medium, especially a stretched flexible connector, such as a rope or cable; when a rope supports the weight of an object, the force on the object due to the rope is called a tension force

terminal speed | the speed at which the viscous drag of an object falling in a viscous fluid is equal to the other forces acting on the object (such as gravity), so that the acceleration of the object is zero

terminal voltage | the voltage measured across the terminals of a source of potential difference

tesla | T, the SI unit of the magnetic field strength; $1 \text{ T} = 1 \text{ NA} \cdot \text{m}$

test charge | A particle (designated q_{test}) with either a positive or negative charge set down within an electric field generated by a point charge

theory | an explanation for patterns in nature that is supported by scientific evidence and verified multiple times by various groups of researchers

theory of quark confinement | explains how quarks can exist and yet never be isolated or directly observed

therapeutic ratio | the ratio of abnormal cells killed to normal cells killed

thermal agitation | the thermal motion of atoms and molecules in any object at a temperature above absolute zero, which causes them to emit and absorb radiation

thermal conductivity | the property of a material's ability to conduct heat

thermal energy | the energy within an object due to the random motion of its atoms and molecules that accounts for the object's temperature

thermal energy | the average translational kinetic energy of a molecule

thermal equilibrium | the condition in which heat no longer flows between two objects that are in contact; the two objects have the same temperature

thermal expansion | the change in size or volume of an object with change in temperature

thermal hazard | a hazard in which electric current causes undesired thermal effects

thermal hazard | the term for electrical hazards due to overheating

thermal stress | stress caused by thermal expansion or contraction

thin film interference | interference between light reflected from different surfaces of a thin film

three-wire system | the wiring system used at present for safety reasons, with live, neutral, and ground wires

thrust | a reaction force that pushes a body forward in response to a backward force; rockets, airplanes, and cars are pushed forward by a thrust reaction force

timbre | number and relative intensity of multiple sound frequencies

time | change, or the interval over which change occurs

time dilation | the phenomenon of time passing slower to an observer who is moving relative to another observer

tone | number and relative intensity of multiple sound frequencies

top | a quark flavor

torque | turning or twisting effectiveness of a force

torque | the turning effectiveness of a force

total energy | defined as $E = \gamma mc^2$, where $\gamma = 1/\sqrt{1-v^2/c^2}$

trajectory | the path of a projectile through the air

transformer | a device that transforms voltages from one value to another using induction

transformer equation | the equation showing that the ratio of the secondary to primary voltages in a transformer equals the ratio of the number of loops in their coils; $V_s V_p = N_s N_p$

transverse wave | a wave in which the disturbance is perpendicular to the direction of propagation

transverse wave | a wave, such as an electromagnetic wave, which oscillates perpendicular to the axis along the line of travel

triple point | the pressure and temperature at which a substance exists in equilibrium as a solid, liquid, and gas

tunneling | a quantum mechanical process of potential energy barrier penetration

turbulence | fluid flow in which layers mix together via eddies and swirls

TV | video and audio signals broadcast on electromagnetic waves

twin paradox | this asks why a twin traveling at a relativistic speed away and then back towards the Earth ages less than the Earth-bound twin. The premise to the paradox is faulty because the traveling twin is accelerating, and special relativity does not apply to accelerating frames of reference

ultra-high frequency (UHF) | TV channels in an even higher frequency range than VHF, of 470 to 1000 MHz

ultracentrifuge | a centrifuge optimized for spinning a rotor at very high speeds

ultrasound | sounds above 20,000 Hz

ultraviolet (UV) microscopes | microscopes constructed with special lenses that transmit UV rays and utilize photographic or electronic techniques to record images

ultraviolet radiation | UV; ionizing photons slightly more energetic than violet light

ultraviolet radiation (UV) | electromagnetic radiation in the range extending upward in frequency from violet light and overlapping with the lowest X-ray frequencies, with wavelengths from 400 nm down to about 10 nm

uncertainty | a quantitative measure of how much your measured values deviate from a standard or expected value

uncertainty in energy | lack of precision or lack of knowledge of precise results in measurements of energy

uncertainty in momentum | lack of precision or lack of knowledge of precise results in measurements of momentum

uncertainty in position | lack of precision or lack of knowledge of precise results in measurements of position

uncertainty in time | lack of precision or lack of knowledge of precise results in measurements of time

under damping | the condition in which damping of an oscillator causes it to return to equilibrium with the amplitude gradually decreasing to zero; system returns to equilibrium faster but overshoots and crosses the equilibrium position one or more times

uniform circular motion | the motion of an object in a circular path at constant speed

units | a standard used for expressing and comparing measurements

unpolarized | waves that are randomly polarized

unstable equilibrium | a system, when displaced, experiences a net force or torque in the same direction as the displacement from equilibrium

up | the lightest of all quarks

useful work | work done on an external system

Van de Graaff | early accelerator: simple, large-scale version of the electron gun

Van de Graaff generator | a machine that produces a large amount of excess charge, used for experiments with high voltage

vapor | a gas at a temperature below the boiling temperature

vapor pressure | the pressure at which a gas coexists with its solid or liquid phase

vector | a quantity that is described by both magnitude and direction

vector | a quantity that has both magnitude and direction; an arrow used to represent quantities with both magnitude and direction

vector | a quantity with both magnitude and direction

vector | physical quantity with both magnitude and direction

vector addition | the rules that apply to adding vectors together

vector addition | mathematical combination of two or more vectors, including their magnitudes, directions, and positions

velocity | speed in a given direction

vertically polarized | the oscillations are in a vertical plane

very high frequency (VHF) | TV channels utilizing frequencies in the two ranges of 54 to 88 MHz and 174 to 222 MHz

virtual image | image that cannot be projected

virtual particles | particles which cannot be directly observed but their effects can be directly observed

viscosity | the friction in a fluid, defined in terms of the friction between layers

viscous drag | a resistance force exerted on a moving object, with a nontrivial dependence on velocity

visible light | the narrow segment of the electromagnetic spectrum to which the normal human eye responds

visible light | the range of photon energies the human eye can detect

voltage | the electrical potential energy per unit charge; electric pressure created by a power source, such as a battery

voltage drop | the loss of electrical power as a current travels through a resistor, wire or other component

voltmeter | an instrument that measures voltage

watt | (W) SI unit of power, with $1 \text{ W} = 1 \text{ J/s}$

wave | a disturbance that moves from its source and carries energy

wave velocity | the speed at which the disturbance moves. Also called the propagation velocity or propagation speed

wavelength | the distance between adjacent identical parts of a wave

wavelength | the distance from one peak to the next in a wave

wavelength in a medium | $\lambda_n = \lambda/n$, where λ is the wavelength in vacuum, and n is the index of refraction of the medium

weight | the force due to gravity acting on an object of mass m ; defined mathematically as: $w = mg$, where g is the magnitude and direction of the acceleration due to gravity

Wheatstone bridge | a null measurement device for calculating resistance by balancing potential drops in a circuit

work | the transfer of energy by a force that causes an object to be displaced; the product of the component of the force in the direction of the displacement and the magnitude of the displacement

work-energy theorem | the result, based on Newton's laws, that the net work done on an object is equal to its change in kinetic energy

work-energy theorem | if one or more external forces act upon a rigid object, causing its kinetic energy to change from KE_1 to KE_2 then the work W done by the net force is equal to the change in kinetic energy

x ray | EM photon between γ -ray and UV in energy

x rays | a form of electromagnetic radiation

X-ray | invisible, penetrating form of very high frequency electromagnetic radiation, overlapping both the ultraviolet range and the γ -ray range

x-ray diffraction | a technique that provides the detailed information about crystallographic structure of natural and manufactured materials

xerography | a dry copying process based on electrostatics

y-intercept | the y -size $12\{y\}$ value when x size $12\{x\}$ $\{ \} = 0$, or when the graph crosses the y size $12\{y\}$ $\{ \}$ -axis

z-component of spin angular momentum | component of intrinsic electron spin along the z -axis

z-component of the angular momentum | component of orbital angular momentum of electron along the z -axis

Zeeman effect | the effect of external magnetic fields on spectral lines

zeroth law of thermodynamics | law that states that if two objects are in thermal equilibrium, and a third object is in thermal equilibrium with one of those objects, it is also in thermal equilibrium with the other object

zircon | natural gemstone with a large index of refraction